



# Infiltration Assessment – Block 21, 200 Codd’s Road, Ottawa

June 12, 2026

Prepared for:  
Wateridge Lifestyles Ltd. & Canada Lands Corp.

Cambium Reference: 24896-001

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## 1.0 Introduction

Cambium Inc. (Cambium) was retained by Wateridge Lifestyles Ltd. & Canada Lands Corp. (Client) to complete an infiltration assessment in support of the design of the proposed retirement development to be located at Block 21 of the Wateridge Village. The site is located northeast of the intersection of Codd's Road and Tawadina Road in Ottawa, Ontario (Site) as shown on the Site Location Map, Figure 1 attached. The terms of reference for the infiltration assessment were included in Cambium's Proposal No. 24896-P Rev.1, dated February 23, 2026.

The purpose of the field work and testing was to obtain information on the general subsurface soil and groundwater conditions at the site by means of a series of boreholes, monitoring wells, and in-situ infiltration testing across the site to inform the construction and design of proposed low impact development (LID) features for the Site. The locations of the proposed LID features and design specifications are provided in Appendix A.

Cambium is completing a geotechnical investigation and hydrogeological investigation/dewatering assessment for the site concurrently with the infiltration assessment. These reports are provided separately under separate covers.

As such, this report should be read in conjunction with the "*Statement of Qualifications & Limitations*" in Section 8.0 which forms an integral part of this document. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report. The data, interpretations and recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, or if the project is not initiated within eighteen months of the date of the report, Cambium should be given an opportunity to confirm that the recommendations in this report are still valid.

### 1.1 Reviewed Documents

The following documents relevant to the development were provided for review in preparation of this geotechnical report:



1. Paterson Group. (2025, October 31). *Geotechnical investigation report (Report No. PG6331-1, Revision 10)*. Paterson Group
2. Paterson Group. (2024, December 11). In-Situ Infiltration Testing: Proposed residential development, Wateridge Village Phases 6, 7 & 8, Ottawa, Ontario (Report No. PG6331-LET. 02).
3. Monument-Urso Surveying Ltd. (2025). *Topographic plan of part of Wateridge development, Block 21, City of Ottawa* (Drawing No. 25-0473\_Wateridge Village BLK 21 (Chadha)\_TPOS\_D3). Monument-Urso Surveying Ltd.
4. T. Bonhomme Architect. (2026, January 7). *Architectural - Wateridge Lifestyles: Phase 1 retirement home building* [Architectural drawings]. Wateridge Lifestyles Ltd.



## 2.0 Site Description

### 2.1 Site Description

The Site is located at Block 21 of the Wateridge Village, just northeast of the intersection of Codd's Road and Tawadina Road, in Ottawa, Ontario. The Site is currently vacant but is understood was once part of a previous development that was demolished and left vacant for several years. The property is bounded to the south by Tawadina Road and to the west and north by Codd's Road. There is currently no development to the east, but it is understood that the municipal road Bareille-Snow Street will eventually be constructed along the east property boundary.

Publicly available geological maps show that the Site is underlain by fine-textured glacio-marine deposits of silt and clay, minor sand and gravel and shallow bedrock. The underlying bedrock geology is mapped as limestone and/or dolostone of the Gull River Formation.

### 2.2 Project Description

It is Cambium's understanding that the proposed development will consist of 3 new multi-unit residential buildings. The development will be constructed in 3 phases and will include the following:

- Phase 1: Retirement Home Building – 6 storeys with 1 basement level,
- Phase 2: Senior's Apartment Building – 9 storeys with 1 basement level and link connecting Phase 1 and Phase 2 buildings,
- Phase 3: Senior's Apartment Building – 9 storeys with 1 basement level,
- The basement level of Phase 1 will be approximately the same size as the above grade structure, and the basement levels for the other two phases will have larger footprints than the above grade portions of the buildings (towers),
- The Phase 1 parking garage level finished floor elevation (FFE) is currently set at 87.75 metres above sea level (mASL), and the Phase 2 and Phase 3 parking garage level FFE is currently set at 86.56 mASL,



- Phase 1 will be constructed in 2026 with the other phases to be completed in later years;  
and,
- The buildings will be municipally serviced.

The development will incorporate multiple LID features at the site to promote on-site water infiltration and reduce runoff. LID features include permeable pavement, bioretention areas, and infiltration chambers, as shown on the site plan included in . It is understood that up to 7 LID features are proposed for the site. The base of the proposed LID features must be a meter or greater above the seasonally high water levels and surface of bedrock.



### 3.0 Methodology

#### 3.1 Borehole Investigation

The geotechnical field investigation was conducted on December 8 and 9, 2025, during which time four (4) boreholes, designated as BH101-25 to BH104-25, were advanced across the Site. To support the infiltration assessment, three additional overburden boreholes were advanced, and outfitted with monitoring wells within the footprint of proposed LID features on March 20, 2026. These additional wells were designated as MW101-26 to MW103-26, and were terminated at practical refusal atop interpreted bedrock. Additionally, a total of 6 rock probes, numbered RP201-26 through RP206-26 were advanced on March 20, 2026 to further assess depth to bedrock across the site. Table 1 provides a summary of the boreholes. All boreholes encountered practical refusal within investigation depths and rock coring was completed at all borehole locations BH101-25 to BH104-25. The approximate borehole locations relative to existing conditions are shown on the Borehole Location Plan, Figure 2. Elevations were measured based on the topographic survey [1] and provided based on geodetic metres above seal level (mASL).

**Table 1 Borehole Summary**

Borehole ID	Surface Elevation (mASL)	Depth (mbgs) / Elevation (mASL)
BH101-25	88.8	6.1 / 82.7
BH102-25	88.7	6.1 / 82.6
BH103-25	88.6	6.1 / 82.5
BH104-25	89.9	6.1 / 83.4
MW101-26	91.94	2.48/89.46
MW102-26	91.30	2.48/88.82
MW103-26	89.83	3.20/86.63
Rock Probes		
RP201-26	89.4	1.9 / 87.5
RP202-26	88.6	1.5 / 87.1
RP203-26	88.7	2.2 / 86.5
RP204-26	91.2	2.0 / 89.2
RP205-26	91.7	2.3 / 89.4
RP206-26	89.7	2.1 / 87.6



The record of the Borehole Logs is provided in .

Drilling and sampling were completed using a track-mounted drill rig operating under the supervision of a Cambium technician. The boreholes were advanced to the sampling depths by means of continuous flight solid stem augers. Samples from the boreholes were collected with 50 mm O.D. split spoon samplers. Standard Penetration Test (SPT) N values were recorded for the sampled intervals as the number of blows required to drive a split spoon sampler 305 mm into the soil, using a 63.5 kg drop hammer falling 750 mm, as per ASTM D1586 procedures. The SPT N values were used in this report to estimate the relative density/consistency of the non-cohesive/cohesive soils.

The encountered soil units and rock cores were logged in the field using visual and tactile methods, and the obtained soil samples were placed in labelled plastic bags and the rock cores were placed in core boxes for transport, future reference, laboratory testing and storage.

Groundwater conditions were noted in the open boreholes during and upon completion of drilling and three total monitoring wells were installed, one in each borehole to allow for subsequent groundwater measurements. All boreholes were backfilled and sealed in accordance with Ontario Regulation (O.Reg.) 903, as amended.

Site soil, rock, and groundwater conditions are described, and infiltration construction recommendations are discussed in the following sections of this report.

### **3.2 Site Survey**

The elevation and coordinates of each borehole were measured with RTK Topo surveying unit by a Cambium technician on site. The UTM coordinates and geodetic elevations (mASL) are included on the borehole logs provided in . Measured elevations are relative to the site benchmark (elevation of 91.69 mASL) identified as the top spindle of the fire hydrant located near the intersection of Codd's Road and Tawadina Road as noted in the topographic survey (Monument-Urso Ltd., 2025).



### 3.3 Laboratory Testing

Laboratory soil testing included Particle Size Distribution Analyses (LS-702, 705), Atterberg Limit Analysis (LS-703) and Natural Moisture Content Analyses (LS-701) have been assigned for samples taken from this site.

The results of the laboratory testing are provided in .

### 3.4 Subsurface Investigations by Others

The subsurface information is provided in a signed and sealed engineering report and the information contained is relied upon as factual.

A geotechnical investigation was completed by others for Wateridge Village, which included boreholes advanced within the subject site of this investigation (Paterson Group, 2025). All borehole logs were reviewed by Cambium for all holes completed on or near the property. The locations of these boreholes are shown on the attached Figure 2.

The boreholes were advanced to practical refusal, which due to the consistency of confirmed bedrock, is presumed to be on or near the top of bedrock. A summary of the boreholes advanced by Others is provided in the table below:

**Table 2 Summary of Boreholes by Others**

Borehole ID	Approximate Surface Elevation (mASL)	Refusal Depth (mbgs) / Elevation (mASL)	Approximate Location
BH1-22	87.9	1.8 / 86.1	Codd's Road, west of development
BH2-22	89.2	1.3 / 87.9	Codd's Road, northwest of development
BH3-22	88.4	1.1 / 87.3	Phase 2
BH4-22	89.2	2.1 / 87.1	Codd's Road, north of development
BH8-22	88.8	2.3 / 86.6	Phase 3
BH27-22	89.7	0.4 / 89.3	Phase 2
BH59-22	88.0	2.0 / 86.0	Intersection of Codd's Road and Tawadina Road
BH61-22	89.8	2.5 / 87.2	Phase 1



<b>Borehole ID</b>	<b>Approximate Surface Elevation (mASL)</b>	<b>Refusal Depth (mbgs) / Elevation (mASL)</b>	<b>Approximate Location</b>
BH1-23	89.0	2.2 / 86.8	Phase 2
BH2-23	89.2	3.1 / 86.2	Phase 1
BH14-27	90.5	1.8 / 88.7	Phase 1

Based on review of the previously completed borehole information, the subsurface conditions at the site generally consist of cohesionless fill material overlying shallow bedrock. Some native deposits were encountered underlying the fill material at select locations. The native deposits generally consist of cohesionless deposits of silty sand or glacial till. Anticipated bedrock depths range from 0.4 to 3.1 mbgs (Elevation 86.0 to 89.3 mASL).

A copy of the relevant borehole logs are provided in and the approximate locations of the boreholes, based on the borehole location plan provided in the geotechnical report, are provided on our attached Figure 2.



## 4.0 Subsurface Conditions

The detailed soil profiles encountered during the field investigation are indicated on the attached borehole logs in . It should be noted that the conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the borehole locations. The soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change. In addition, the descriptions provided on the borehole logs are inferred from a variety of factors, including visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (such as drilling speed and shaking/grinding of the augers).

The conditions of the site generally consist of fill material and/or gravelly silty sand overlying limestone bedrock.

### 4.1 Fill Material

Fill material was encountered from the surface in all borehole locations with a thickness ranging from 0.66 to 2.3 m. The fill material varies in composition between each borehole but is generally cohesionless. The material consists of dark brown sand and silt with trace gravel to some gravel. Rootlets were noted in boreholes BH101-25 and BH102-25, plastic debris was noted in borehole BH101-25, and brick and asphalt debris was noted in borehole BH104-25. Cobbles and boulders were also observed within the fill material at all borehole locations.

SPT N values obtained in the fill material this material ranged from 5 to over 50 blows per 305 mm of penetration, indicative of a loose to very dense relative density.

Particle size distribution analysis was completed on one selected sample of the fill material, and the results are summarized in Table 3.

**Table 3 Particle Size Distribution Results – Fill Material**

Sample	Depth (mbgs)	Soil	% Gravel	% Sand	% Silt and Clay
BH101-25 SS2B	1.0 to 1.4	Sand and silt, trace gravel	5	60	35



## 4.2 Native Material

Native deposits were encountered underlying the fill material at 3 of the borehole locations (BH102-25 through BH104-25). The native material is cohesionless and consisted of brown or grey brown silty sand to sand and silt with trace to some gravel, trace clay. Cobbles and boulders were noted in the native material in boreholes BH102-25 and BH103-25.

The native material was encountered at depths ranging from approximately 0.8 to 2.3 mbgs and extended to depths ranging from 1.3 to 2.8 mbgs. The native material has a thickness measured 1.8 m in BH102-25 and 0.5 m in boreholes BH103-25 and BH104-25.

SPT N values measured within the native soils range from 10 to over 50 blows per 305 mm of penetration, increasing with depth, indicative of a compact to very dense relative density.

Particle size distribution analysis was completed on one selected sample of the native material, and the results are summarized in Table 4.

**Table 4 Particle Size Distribution Results – Native Material**

Sample	Depth (mbgs)	Soil	% Gravel	% Sand	% Silt	% Clay
BH102-25 SS4	2.3 to 2.7	Sand and silt, some gravel, trace clay	7	54	35	4

## 4.3 Bedrock

All boreholes were terminated on within the underlying bedrock at the site. The validity of the bedrock was confirmed by rock coring and terminated at target depths of about 6.1 mbgs.

The bedrock is limestone of the Gull River Formation, the rock in this area is generally grey, thinly to medium bedded, slightly decomposed, moderately fractured, and of very poor to good quality.

The boreholes advanced by Others within or near the subject property all encountered practical refusal. Based on the consistency of the refusal depths, it is likely that that refusal was encountered on the underlying bedrock. Refusal depths in the area range from 0.4 to 3.1 mbgs. The subsurface soils do contain cobbles and boulders and therefore refusal may have also been encountered on a boulder within the overburden.



Table 5 presents the depths and elevations of (presumed) bedrock in all boreholes. The relevant boreholes completed by Others are also summarized in the table.

**Table 5 Depths and Elevations of the Bedrock**

Borehole	Surface Elevation (mASL)	Bedrock or Refusal Depth/Elevation (mbgs / mASL)
BH101-25	88.8	2.0 / 86.8
BH102-25	88.7	2.6 / 86.1
BH103-25	88.6	2.8 / 85.8
BH104-25	89.9	1.3 / 88.6
MW101-26	91.9	2.5 / 89.4
MW102-26	91.3	2.5 / 88.8
MW103-26	89.8	3.2 / 86.6
Boreholes Advanced by Others		
BH1-22	87.9	1.8 / 86.1
BH2-22	89.2	1.3 / 87.9
BH3-22	88.4	1.1 / 87.3
BH4-22	89.2	2.1 / 87.1
BH8-22	88.8	2.3 / 86.6
BH27-22	89.7	0.4 / 89.3
BH59-22	88.0	2.0 / 86.0
BH61-22	89.8	2.5 / 87.2
BH1-23	89.0	2.2 / 86.8
BH2-23	89.2	3.1 / 86.2
BH14-27	90.5	1.8 / 88.7

It should be noted that site grades have changed since the time of completion of the geotechnical investigation report by Others. Surface elevations and depth to refusal noted will likely differ, however refusal elevations encountered at each location should be the similar. As previously discussed, refusal may have also occurred on boulders within the overburden and do not necessarily indicate bedrock. This is likely the case for BH27-22.



## 4.4 Groundwater

### 4.4.1 Bedrock Wells

No groundwater was encountered in the boreholes immediately following drilling. Stabilized groundwater readings were measured in following drilling. The following table provides a summary of the groundwater readings within the wells installed in boreholes BH101-25 through BH104-25 and MW101-26 through MW103-26.

**Table 6 Depths and Elevations of Groundwater – Bedrock Wells**

Borehole	Surface Elevation (mASL)	Depth/Elevation of Groundwater (mbgs/mASL)	
		December 16, 2025	
BH101-25	88.8	4.3 / 84.5	
BH102-25	88.7	2.2 / 86.5	
BH103-25	88.6	3.2 / 85.4	
BH104-25	89.9	4.6 / 85.3	

Groundwater levels at the Site appear to vary between the borehole locations and will fluctuate on a seasonal basis and in response to significant precipitation or snowmelt events.

### 4.4.2 Overburden Wells

No groundwater was encountered in the boreholes immediately following drilling. Stabilized groundwater readings were measured in following drilling, on multiple events, as displayed in

**Table 7 Depths and Elevations of Groundwater – Overburden Wells**

Borehole	Surface Elevation (mASL)	Depth/Elevation of Groundwater (mbgs/mASL)	
		April 2, 2026	May 14, 2026
MW101-26	91.9	Dry at 2.5 / 89.4	Dry at 2.5 / 89.4
MW102-26	91.3	Dry at 2.5 / 88.8	Dry at 2.5 / 88.8
MW103-26	89.8	0.97 / 88.83	0.87 / 88.93



## 5.0 Infiltration Testing

In-situ infiltration tests were performed on May 14, 2026 using the Guelph Permeameter (GP) at multiple testing locations GP101-26 through GP104-26 within the footprints of proposed LID features as displayed on Figure 2. It is understood that up to 7 LID features are proposed for the site. The base of the proposed LID features must be a meter or greater above the seasonally high-water levels and surface of bedrock (Appendix A).

The testing included two constant-head levels per soil horizon, when possible.

The two targeted soil horizons were the non-native Sand and Silt fill, extending from ground surface with a thickness of approximately 0.66 to 2.3 m, and the Native Silty Sand, encountered at depths ranging from approximately 0.8 to 2.3 mbgs and extending to depths ranging from 0.66 to 2.8 mbgs. The tests were completed to assess infiltration rates within each soil horizon encountered within the subsurface and the proposed footprints of the LID features. A test was also completed within 1.5 meters of the surface of bedrock and/or the expected seasonally high-water level, and therefore, within 1.5 meters of the bottom of the proposed LID features. Testing within the non-native sand and silt fill was not feasible at GP103-26 or GP1-4-26 due to the presence of extremely dense fill from ground surface to the underlying native silty sand, which prevented the advancement of hand-augered boreholes suitable for testing.

The field results of the in-situ infiltration testing were processed using SOILMOISTURE<sup>®</sup> excel based calculation models which yield the saturated hydraulic conductivity of the soil ( $K_{fs}$ ). The average of the two constant-head tests was used to determine the saturated hydraulic conductivity ( $K_{fs}$ ) of the soil within the testing interval. The infiltration field results and calculations models are located in and Table 8 outlines the specific testing intervals, soil lithology, and resulting infiltration rates.



**Table 8 Infiltration Testing Summary**

Test ID	Ground Surface Elevation (m)	Testing Interval Depth (m bgs)	Testing Interval Elevation (m)	Average $K_{fs}$ (m/s)	Average Infiltration Rate (mm/hr)	Average Percolation Time (min/cm)
GP101-26	91.94	0.80 (Sand & Silt)	91.14	$1.81 \times 10^{-6}$	54	11
		1.2 (Silty Sand)	90.74	$8.12 \times 10^{-8}$	24	25
GP102-26	91.30	0.85 (Sand and Silt)	90.45	$1.07 \times 10^{-5}$	87	7
		1.05 (Silty Sand)	90.25	$4.40 \times 10^{-6}$	68	9
GP103-26	89.83	0.74 (Sand and Silt)	89.09	$3.94 \times 10^{-6}$	66	9
GP104-26	89.72	0.90 (Sand and Silt)	88.82	$6.15 \times 10^{-6}$	75	8

**5.1 Design Infiltration Rates**

A safety factor should be applied to the infiltration rate used for design, as recommended in the TRCA LID manual soil testing protocol (Toronto Region Conservation Authority, 2012). The safety factor compensates for the potential reductions in soil permeability due to compaction or smearing during construction, and the gradual accumulation of fine sediments over the lifespan of the designed feature.

To apply the safety factor, the infiltration rate of the proposed bottom elevation of the feature must be divided by a safety correction factor from Table C2 of the TRAC LID manual (Toronto Region Conservation Authority, 2012). To select a safety factor, the ratio of the geometric mean measured infiltration rate of the proposed bottom elevation of the feature to the rate in the least permeable soil horizon within 1.5 meters below the bottom of the design feature must be calculated.



Based on the testing completed, it is assumed that the bottom of the infiltration features on the Site will be completed approximately 1 meter above the bedrock or static groundwater level. Table 9 below the estimated design infiltration rate for each testing location, and associated LID feature displayed on the Site Plan in .

At each testing location, the least permeable soil horizon was identified within 1.5 m of the proposed bottom elevation of the LID feature. As a result, the geometric mean infiltration rate at the bottom elevation is equal to that of the least permeable underlying horizon, and an infiltration ratio of 1.0, and corresponding safety factor of 2.5 was applied at each test location.

**Table 9 Design Infiltration Rates**

Test ID	Infiltration Ratio <sup>1</sup>	Safety Factor	Design Infiltration Rates (mm/hr) <sup>2</sup>
GP101-26	1 (8.12 x 10 <sup>-8</sup> / 8.12 x 10 <sup>-8</sup> )	2.5	9.6
GP102-26	1 (4.40 x 10 <sup>-6</sup> / 4.40 x 10 <sup>-6</sup> )	2.5	27.2
GP103-26	1 (3.94 x 10 <sup>-6</sup> / 3.94 x 10 <sup>-6</sup> )	2.5	26.4
GP104-26	1 (6.15 x 10 <sup>-6</sup> / 6.15 x 10 <sup>-6</sup> )	2.5	30.0

1. Ratio is determined by dividing the geometric mean measured infiltration rate at the proposed bottom elevation of the BMP by the geometric mean measured infiltration rate of the least permeable soil horizon within 1.5 metres below the proposed bottom elevation of the feature.
2. The design infiltration rate is calculated by dividing the geometric mean measured infiltration rate at the proposed bottom elevation of the feature by the safety correction factor.



## 6.0 Closing

Please note that this work program and report are governed by the attached Qualifications and Limitations. If you have questions or comments regarding this document, please do not hesitate to contact the undersigned.

Respectfully submitted,

**Cambium Inc.**

Signed by:

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DS



Brent Redmond, M.A.Sc., P.Geo.  
Project Manager / Hydrogeologist

2026-06-12

BR/CM



## 7.0 References

- Monument-Urso Ltd. (2025). *Topographic Plan of Part of Wateridge Development, Block 21, City of Ottawa (Drawing No. 25-0473\_Wateridge Village BLK 21 (Chadha)\_TPOS\_D3.*
- Paterson Group. (2024). *In-Situ Infiltration Testing: Proposed Residential Development, Wateridge Village Phases 6, 7 & 8, Ottawa, Ontario (Report No. PG6331-LET. 02).*
- Paterson Group. (2025). *Geotechnical Investigation Report (Report No. PG6331-1, Revision 10).*
- T. Bonhomme Architect. (2026). *Architectural - Wateridge Lifestyles: Phase 1 Retirement Home Building[Architectural Drawings].*
- Toronto Region Conservation Authority. (2012). *Appendix C - Site Evaluation and Soil Testing Protocol for Stormwater Infiltration.*



## 8.0 Statement of Qualifications & Limitations

### Limited Warranty

Cambium relies on its client to provide instructions on the scope of work to be performed. Cambium undertakes all work in accordance with applicable accepted industry practices and standards, and with the degree of care and skill ordinarily exercised by professionals performing similar services for similar projects in the same region. Unless required under applicable laws, other than as expressly stated herein, no other warranties or conditions, either expressed or implied, are made regarding the services, work or reports provided.

### Reliance on Materials and Information

The findings, results, information and data prepared by Cambium are based on the materials, documents and information provided by the client to Cambium and on the facts, conditions and circumstances encountered by Cambium during the performance of the work. In formulating its findings, results, information and data, Cambium assumes that the information, documents and materials provided by the client to Cambium are factual, accurate and represent a true depiction of the circumstances that exist at the Project. Cambium relies on its client to inform Cambium if there are changes to any such information, documents and materials. Cambium does not review, analyze or attempt to verify the accuracy or completeness of the information, documents or materials provided by the client, other than in accordance with applicable accepted industry practice. Cambium will not be responsible for matters arising from incomplete, incorrect or misleading information or from facts or circumstances that are not fully disclosed to Cambium, are unknown by Cambium, or are otherwise concealed from Cambium during the provision of its services.

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When preparing reports, Cambium considers applicable legislation, regulations, governmental guidelines and policies. Cambium is not qualified to advise with respect to legal matters. The presentation of information regarding applicable legislation, regulations, governmental guidelines and policies is for information purposes only and is not intended to and should not be interpreted as constituting a legal opinion concerning the work completed or conditions outlined in a report. All legal matters should be reviewed and considered by an appropriately qualified legal practitioner.

### Site Assessments

A site assessment is created using data and information collected during the investigation of a site and based on conditions encountered at the time and particular locations at which fieldwork is conducted. The information, sample results and data collected represent the conditions only at the specific times at which and at those specific locations from which the information, samples and data were obtained and the information, sample results and data may vary at other locations and times. To the extent that Cambium's work considers any locations or times other than those from which information, sample results and data was specifically received, the work shall be based on a reasonable extrapolation from such information, sample results and data, but the actual conditions encountered may vary from those extrapolations.

Only conditions at the site and locations chosen for study by the client are evaluated; no adjacent or other properties are evaluated unless specifically requested and paid for by the client. Any physical or other aspects of the site chosen for study by the client, or any other matter not specifically addressed in findings, results, information and data prepared by Cambium, are beyond the scopes of the work performed by Cambium and such matters have not been investigated or addressed.

### Intellectual Property Rights

Upon full payment of all fees properly owing to Cambium, the client shall have a perpetual, non-exclusive, non-transferable license (without sub-licensing rights) to use the work and reports prepared by Cambium solely for their intended purpose. For greater certainty, Cambium retains all right, title, and interest in and to the work and reports, and they may not be modified, used for other purposes, or relied upon for additional work without Cambium's prior written consent.

### Reliance

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### Personal Liability

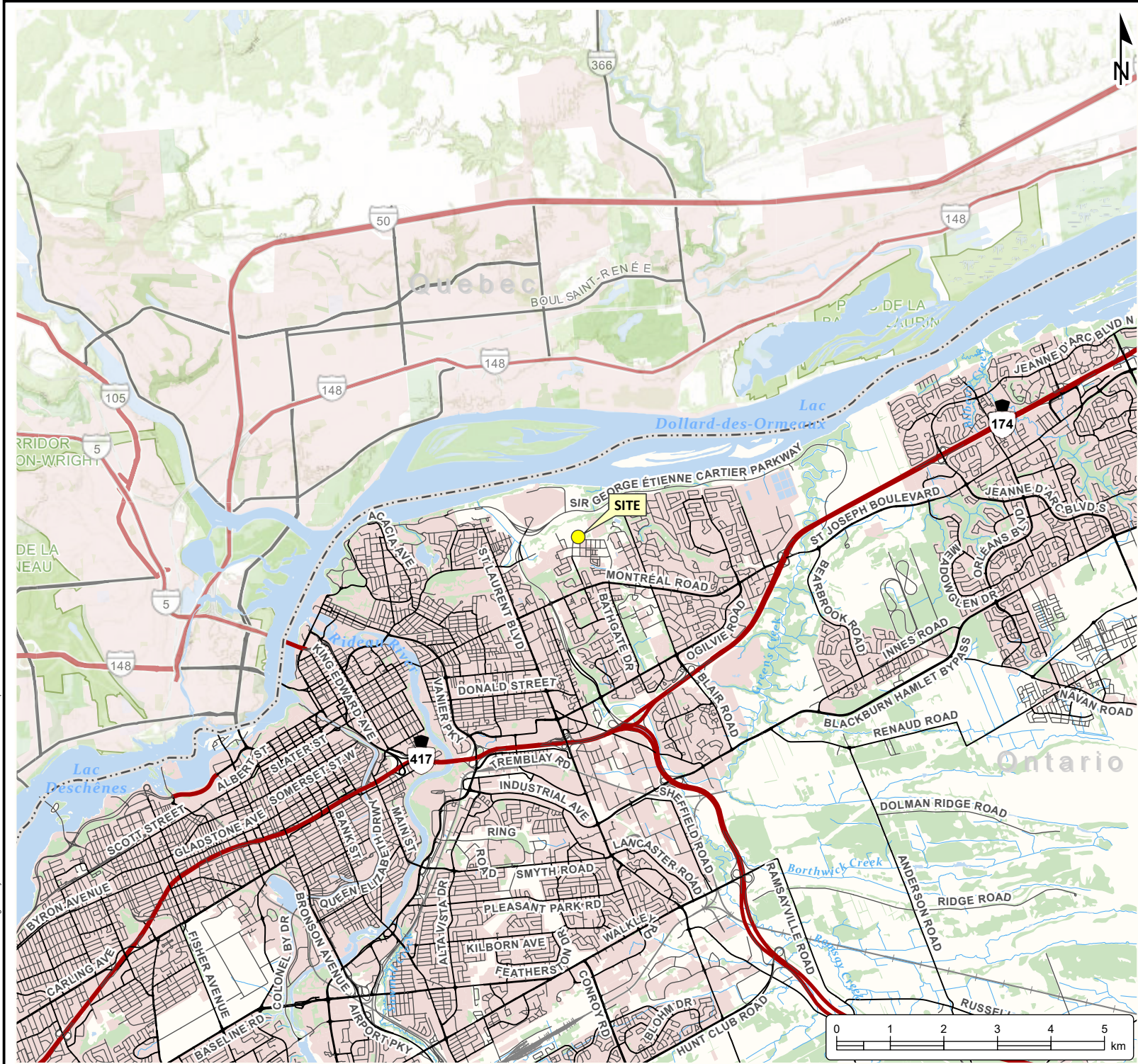
The client expressly agrees that Cambium employees shall have no personal liability to the client with respect to a claim, whether in contract, tort and/or other cause of action in law. Furthermore, the client agrees that it will bring no proceedings nor take any action in any court of law against Cambium employees in their personal capacity.



---

## Appended Figures

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**GEOTECHNICAL INVESTIGATION**  
**WATERIDGE LIFESTYLES LTD.**  
 Block 21 - Wateridge Village  
 Ottawa, Ontario

**LEGEND**

- Highway
- Major Road
- Minor Road
- Railway
- Watercourse
- Provincial Border
- Water Area
- Wooded Area
- Built Up Area

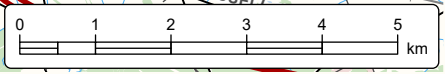
**Notes:**  
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 - Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.  
 - Cambium Inc. makes every effort to ensure this map is free from errors but cannot be held responsible for any damages due to error or omissions. This map should not be used for navigation or legal purposes. It is intended for general reference use only.

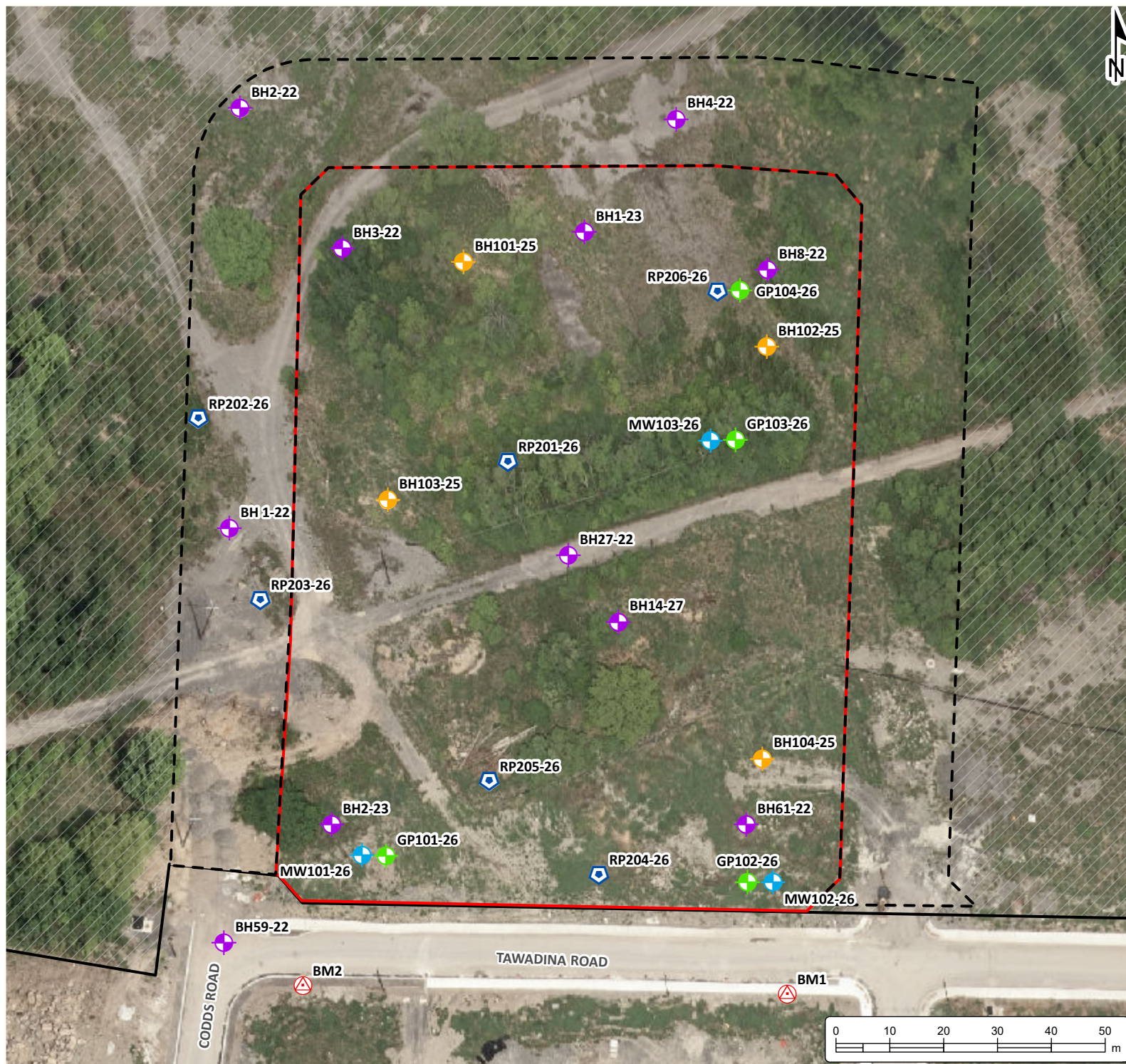


194 Sophia Street  
 Peterborough, Ontario, K9H 1E5  
 Tel: (705) 742.7900 Fax: (705) 742.7907  
 www.cambium-inc.com

**SITE LOCATION PLAN**

Project No.:	24896.001	Date:	December 2025
Scale:	1:100,000	Projection:	NAD 1983 UTM Zone 18N
Created by:	CC	Checked by:	BV
			<b>Figure: 1</b>





**GEOTECHNICAL INVESTIGATION**  
 WATERIDGE LIFESTYLES LTD.  
 Block 21 - Wateridge Village  
 Ottawa, Ontario

**LEGEND**

- Benchmark
- Borehole
- Paterson Borehole
- Monitoring Well
- Rock Point
- Guelph Permeameter Testing Location
- Proposed Road
- Site (approximate)
- Subject Property (approximate)

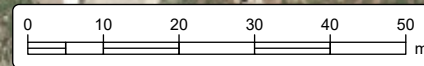
**Notes:**  
 - BM1 and BM2 are top nut of fire hydrant.  
 - Aerial imagery from the Digital Raster Acquisition Project Eastern Ontario (DRAPE) 2024. Source: Ontario Ministry of Natural Resources and Forestry. © Copyright: 2024 King's Printer of Ontario. All Rights Reserved.  
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**TEST HOLE LOCATION PLAN**

Project No.:	24896.001	Date:	May 2026
Scale:	1:1,000	Projection:	NAD 1983 UTM Zone 18N
Created by:	NLB	Checked by:	BV
			Figure: <b>2</b>

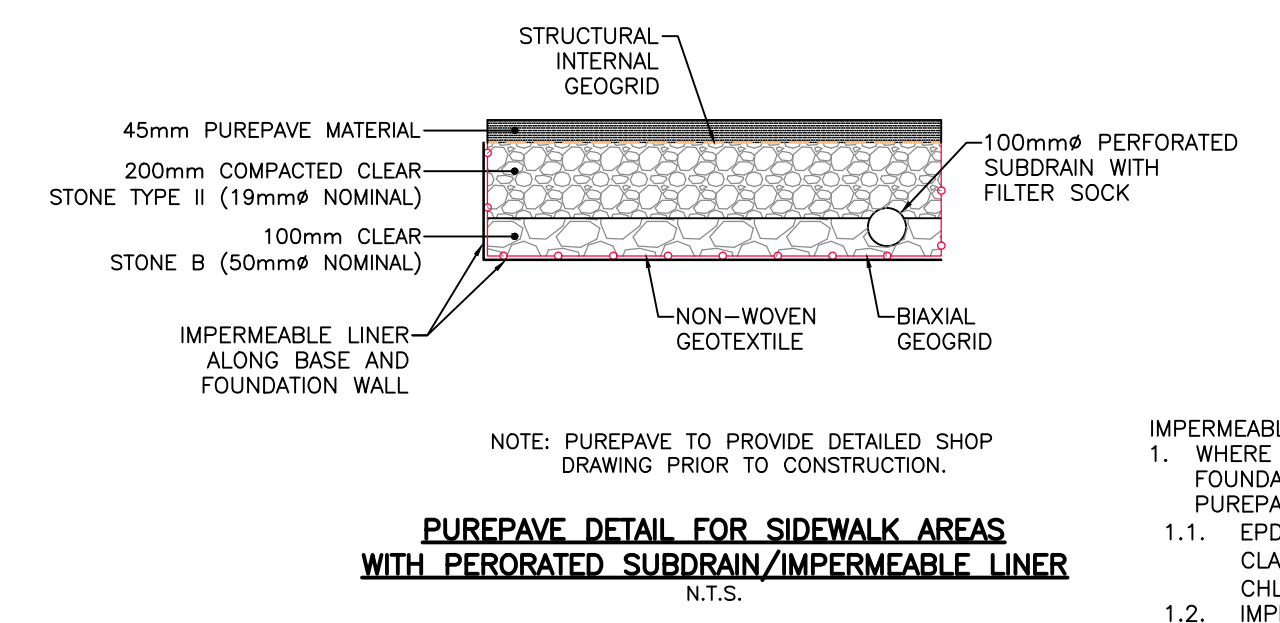
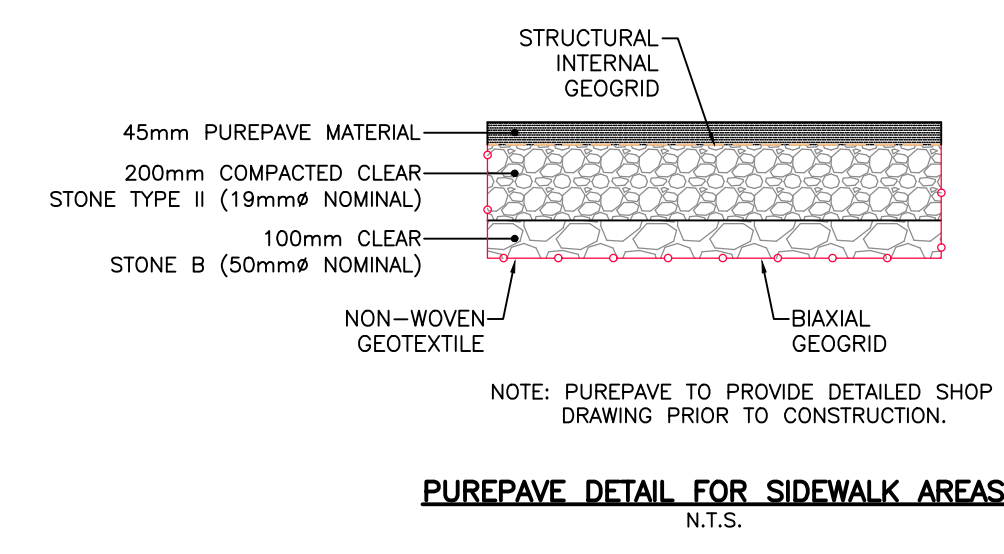
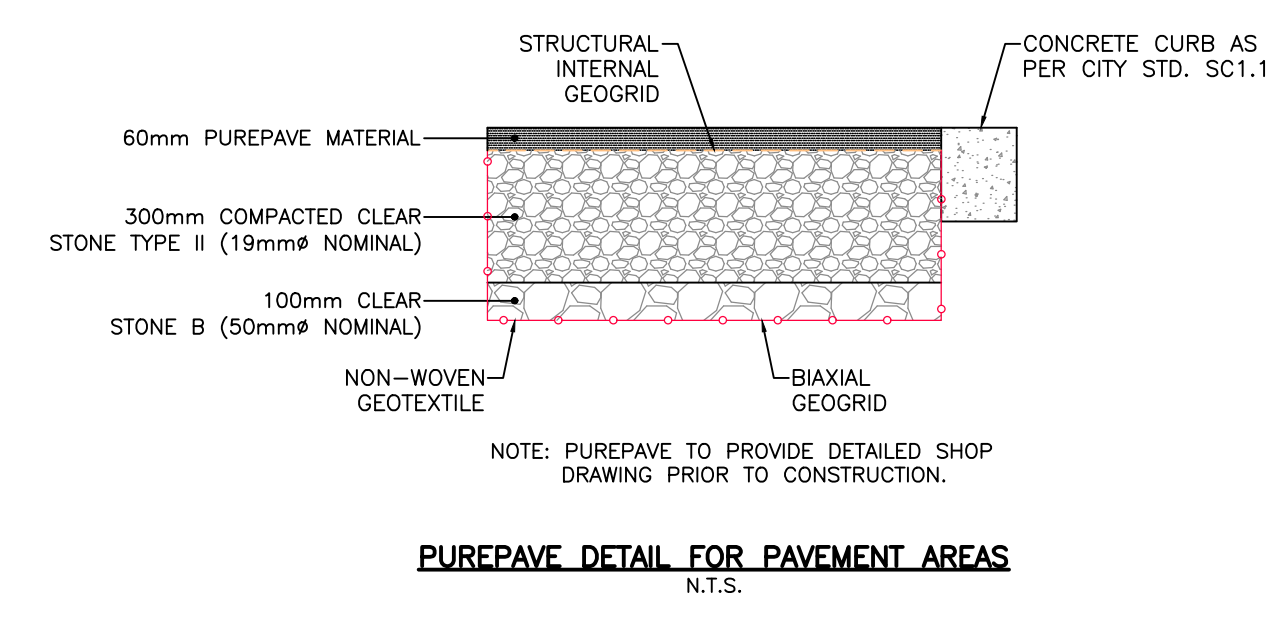
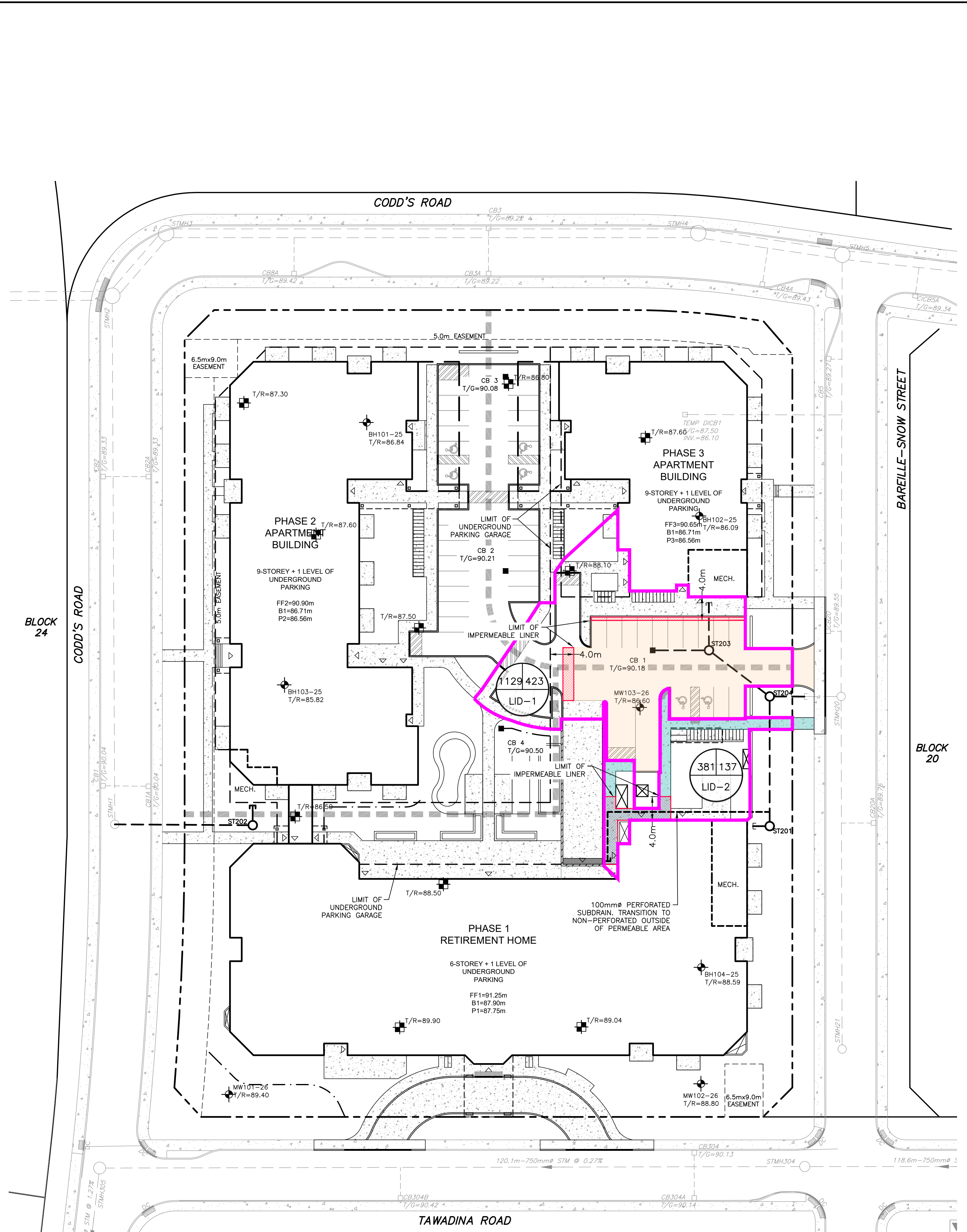
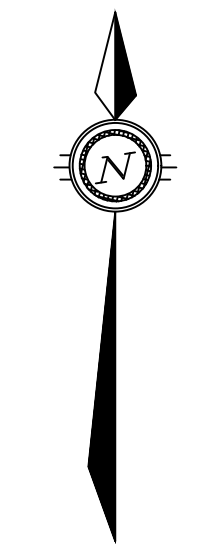
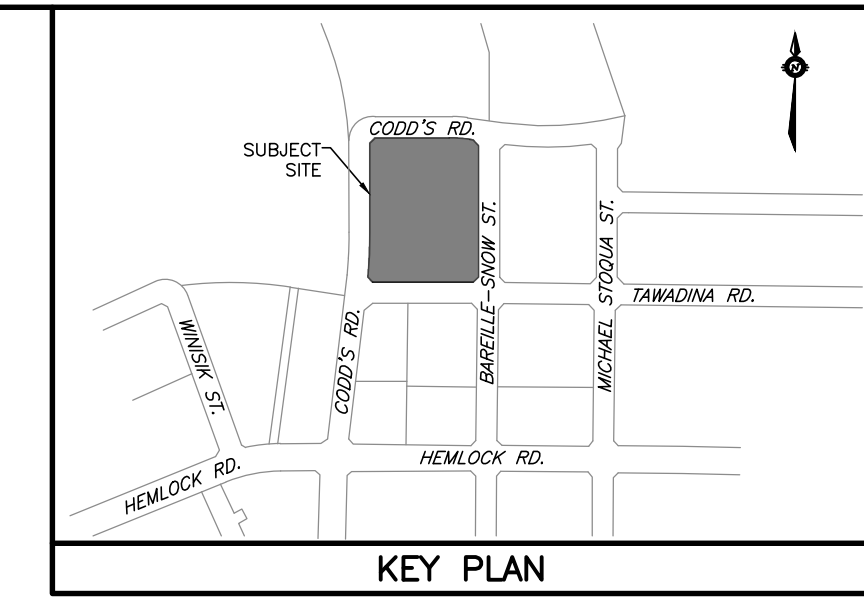




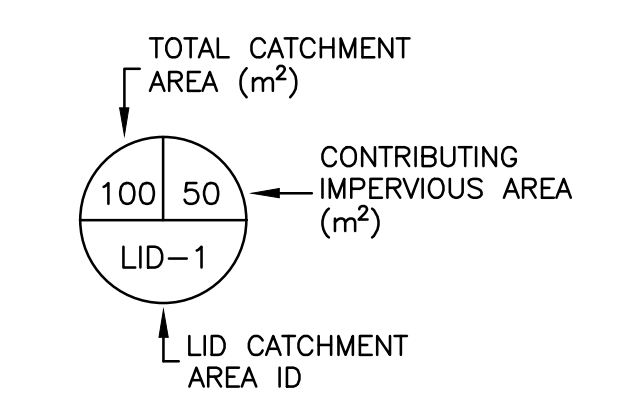
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**Appendix A**  
**LID Site Plan**

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- LEGEND**
- PROPERTY BOUNDARY
  - - - PHASING LIMIT
  - - - EASEMENT
  - EXISTING CATCH BASIN
  - EXISTING STORM SEWER & MANHOLE
  - CATCH BASIN
  - STORM SEWER & MANHOLE
  - - - SWALE
  - ⊕ BOREHOLE/MONITORING WELL (REFER TO GEOTECHNICAL)
  - ⊕ TEST PIT
  - LID CATCHMENT AREA BOUNDARY
  - PERMEABLE PAVEMENT
  - PERMEABLE SIDEWALK
  - IMPERMEABLE LINER



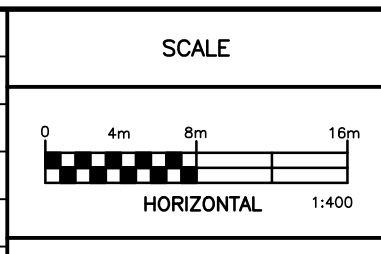
- IMPERMEABLE LINER:**
- WHERE PERMEABLE SURFACES ARE PROPOSED WITHIN 4.0m OF A BUILDING FOUNDATION AN IMPERMEABLE LINER SHALL BE INSTALLED BENEATH THE PUREPAVE SYSTEM CONFORMING TO:
    - EPDM (ETHYLENE PROPYLENE DIENE MONOMER), GCL (GEOSYNTHETIC CLAY LINER), RPE (REINFORCED POLYETHYLENE), PVC (POLY VINYL CHLORIDE), OR OTHER MATERIAL APPROVED BY PUREPAVE.
    - IMPERMEABLE LINERS SEAMS SHALL BE SEALED PER MANUFACTURER SPECIFICATIONS.
    - IMPERMEABLE LINER SUGGESTED TO BE MADE OF PVC GEOMEMBRANE OF MINIMUM 1.5 MIL THICKNESS, MEETING OR EXCEEDING THE REQUIREMENTS OF ASTM D7176 STANDARD SPECIFICATION FOR PVC GEOMEMBRANES USED IN BURIED APPLICATIONS.

**NOTES**

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMANS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

PROPERTY BOUNDARIES ARE DERIVED FROM TOPOGRAPHIC PLAN OF PART OF WATER RIDGE DEVELOPMENT BEING SHOWN AS BLOCK 21 ON DRAFT M-PLAN LOCATED NORTH OF TAWADINA ROAD AND EAST OF CODD'S ROAD, GEOGRAPHIC TOWNSHIP OF GLOUCESTER, CITY OF OTTAWA, MONUMENT-URSO SURVEYING LTD. ELEVATIONS ARE GEODETIC AND REFERRED TO THE CANADIAN GEODETIC VERTICAL DATUM (CGVD28:78).

NO.	REVISION DESCRIPTION	DATE	BY
5	REVISED PER COMMENTS	10/06/26	BLM
4	ISSUED FOR BUILDING PERMIT	05/05/26	BLM
3	REISSUED FOR TENDER	23/03/26	BLM
2	REVISED PER CLC COMMENTS	27/02/26	BLM
1	ISSUED FOR REVIEW	16/01/26	BLM



**Robinson Land Development**

2936 Baseline Road  
Suite 200  
Ottawa, ON K2H 1B3  
(613) 592-6060 rcii.com

DESIGN	BLM
CHECKED	SM
DRAWN	BLM
CHECKED	SM
APPROVED	BLM

**WATERIDGE LIFESTYLES LTD.**

**WATERIDGE VILLAGE**  
100 BAREILLE-SNOW STREET  
CITY OF OTTAWA, ON

**LID DRAINAGE AREA PLAN & DETAILS**

PROJECT No.	25117
SURVEY MONUMENT-URSO SURVEYING LTD.	
DATED	JUNE 2026
DWG. No.	25117-LID1



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**Appendix B**  
**Cambium Borehole Logs**

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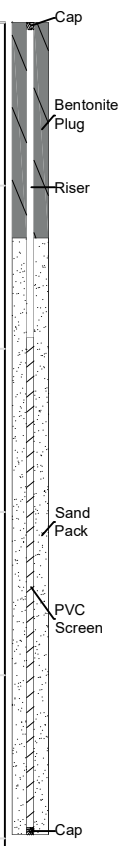
Wateridge Lifestyles  
Ltd. and Canada Lands  
Corporation

**Client:** Wateridge Lifestyles Corporation  
**Contractor:** Forage Downing Drilling  
**Project No.:** 24896-001  
**Location:** Block 21, 200 Codd's Road, Ottawa ON

**Project Name:** Wateridge Lifestyles Block 21  
**Method:** Track Mounted Hollow Stem Auger  
**Elevation:** 91.941 mASL  
**UTM:** 18T **N:** 5033652.00 **E:** 450468.00

**Log of Borehole:** MW101-26  
**Page:** 1 of 1  
**Date Completed:** March 20, 2026

SUBSURFACE PROFILE				SAMPLE							Well Installation	Log Notes			
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%)					Shear Strength Cu, kPa		
								LL	PL	PI	nat. V. rem. V.	20	40	60	80
							% Moisture		SPT (N)						
							25	50	75	20	40	60	80		
91.9	0	(SW) SAND and SILT: trace gravel; dark brown, with organics.		1	SS	58	19								
91.4	0.5														
			95.80 0.76												
90.9	1	(SM) SILTY SAND: some clay, trace gravel; light brown to grey.		2	SS	66	11								
90.4	1.5														
89.9	2														
89.4	2.5	Borehole terminated @ 2.5 mbgs due to target depth achieved.	94.07 2.49	4	SS	42	>50								
	3														
	3.5														
	4														



Water level on April 2, 2026 - Dry

GRAINSIZE DISTRIBUTION [SAMPLE] GRAVEL SAND SILT CLAY



Wateridge Lifestyles  
Ltd. and Canada Lands  
Corporation

**Client:** Wateridge Lifestyles Corporation  
**Contractor:** Forage Downing Drilling  
**Project No.:** 24896-001  
**Location:** Block 21, 200 Codd's Road, Ottawa ON

**Project Name:** Wateridge Lifestyles Block 21  
**Method:** Track Mounted Hollow Stem Auger  
**Elevation:** 95.77 mASL  
**UTM:** 18T **N:** 5033647.00 **E:** 450544.00

**Log of Borehole:** MW102-26  
**Page:** 1 of 1  
**Date Completed:** March 20, 2026

SUBSURFACE PROFILE				SAMPLE							Well Installation	Log Notes					
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%)					Shear Strength Cu, kPa				
								LL	PL	PI	nat. V. rem. V.		nat. V. rem. V.				
			Elevation Depth					% Moisture			SPT (N)						
								25	50	75	20	40	60	80			
95.8	0	[Diagonal Hatching]	(SW) SAND and SILT: cobbles and rubble; dark brown.	1	SS	66	37								Cap Bentonite Plug Riser		
95.3	0.5																
94.8	1	[Dotted Hatching]	(SM) SILTY SAND: some clay, cobbles and boulders; light brown.	2	SS	25	>50				0				Sand Pack PVC Screen Cap	Water level on April 2, 2026 - Dry	
94.3	1.5																
93.8	2																
93.3	2.5					4	SS	14	>50				0				
			Borehole terminated @ 2.5 mbgs due to target depth achieved.														
92.8	3																
92.3	3.5																
91.8	4																

GRAINSIZE DISTRIBUTION [SAMPLE] GRAVEL | SAND | SILT | CLAY

Logged By: BR

Input By: MC

Peterborough, Barrie, Whitby, Kingston, Ottawa



**Client:** Wateridge Lifestyles Ltd. and Canada Lands Corporation  
**Contractor:** Forage Downing Drilling  
**Project No.:** 24896-001  
**Location:** Block 21, 200 Codd's Road, Ottawa ON

**Project Name:** Wateridge Lifestyles Block 21  
**Method:** Track Mounted Hollow Stem Auger  
**Elevation:** 94.42 mASL  
**UTM:** 18T N: 5033729.00 E: 450533.00

**Log of Borehole:** MW103-26  
**Page:** 1 of 1  
**Date Completed:** March 20, 2026

SUBSURFACE PROFILE				SAMPLE								Well Installation	Log Notes					
Elevation (m)	Depth	Lithology	Description	Elevation / Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%)					Shear Strength Cu, kPa				
									LL	PL	PI	nat V <sub>r</sub>	rem V <sub>r</sub>	σ <sub>v</sub>	% Moisture	SPT (N)		
									25	50	75	20	40	60	80			
94.4	0	(SW) SAND and SILT: trace clay and gravel, asphalt and base material; dark brown.			1	SS	79	32									Cap	Water level on April 2, 2026 - 0.97 mbgs
93.9	0.5			93.76 / 0.66													Bentonite Plug	
93.4	1	(SM) SILTY SAND: some clay, gravel and cobbles; light brown.			2	SS	49	24									Riser	
92.9	1.5				3	SS	42	>50										
92.4	2																	
91.9	2.5				4	ST	42	>50									Sand Pack	
91.4	3																PVC Screen	
90.9	3.5				5	SS	46	>50									Cap	
90.4	4	Borehole terminated @ 3.2 mbgs due to target depth achieved.		91.22 / 3.20														

GRAINSIZE DISTRIBUTION [SAMPLE] GRAVEL SAND SILT CLAY

Logged By: BR

Input By: MC

Peterborough, Barrie, Whitby, Kingston, Ottawa



**Client:** Wateridge Lifestyles Ltd. and Canada Lands Corporation  
**Contractor:** Forage Downing Drilling  
**Project No.:** 24896-001  
**Location:** Block 21, 200 Codd's Road, Ottawa ON

**Project Name:** Wateridge Lifestyles Block 21  
**Method:** Track Mounted Hollow Stem Auger  
**Elevation:** 91.295 mASL  
**UTM:** 18T N: 5033647.00 E: 450544.00

**Log of Borehole:** MW102-26  
**Page:** 1 of 1  
**Date Completed:** March 20, 2026

SUBSURFACE PROFILE				SAMPLE								Well Installation	Log Notes				
Elevation (m)	Depth	Lithology	Description	Elevation / Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%)					Shear Strength Cu, kPa			
									LL	PL	PI	20	40	60	80		
91.3	0	[Diagonal Hatching]	(SW) SAND and SILT: cobbles and rubble; dark brown.		1	SS	66	37								Cap Bentonite Plug Riser	
90.8	0.5																
90.3	1	[Dotted Pattern]	(SM) SILTY SAND: some clay, cobbles and boulders; light brown.		2	SS	25	>50								Sand Pack PVC Screen	Water level on April 2, 2026 - Dry
89.8	1.5																
89.3	2				3	SS	63	>50									
88.8	2.5				4	SS	14	>50								Cap	
	3		Borehole terminated @ 2.5 mbgs due to target depth achieved.														
	3.5																
	4																

GRAINSIZE DISTRIBUTION [SAMPLE] GRAVEL | SAND | SILT | CLAY



**Client:** Wateridge Lifestyles Ltd. and Canada Lands Corporation  
**Contractor:** Forage Downing Drilling  
**Project No.:** 24896-001  
**Location:** Block 21, 200 Codd's Road, Ottawa ON

**Project Name:** Wateridge Lifestyles Block 21  
**Method:** Track Mounted Hollow Stem Auger  
**Elevation:** 89.828 mASL  
**UTM:** 18T N: 5033729.00 E: 450533.00

**Log of Borehole:** MW103-26  
**Page:** 1 of 1  
**Date Completed:** March 20, 2026

SUBSURFACE PROFILE				SAMPLE								Well Installation	Log Notes			
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%)			Shear Strength Cu, kPa					
								LL	PL	PI	nat. V.	rem. V.	nat. V.	rem. V.		
								% Moisture			SPT (N)					
								25	50	75	20	40	60	80		
89.8	0	(SW) SAND and SILT: trace clay and gravel, asphalt and base material; dark brown.		1	SS	79	32									
89.3	0.5															
88.8	1	(SM) SILTY SAND: some clay, gravel and cobbles; light brown.		2	SS	49	24									
88.3	1.5															
87.8	2															
87.3	2.5															
86.8	3															
86.3	3.5															
			Borehole terminated @ 3.2 mbgs due to target depth achieved.													

GRAINSIZE DISTRIBUTION [SAMPLE] GRAVEL SAND SILT CLAY

Logged By: BR

Input By: MC

Peterborough, Barrie, Whitby, Kingston, Ottawa



---

**Appendix C**  
**Grain Size Analysis**

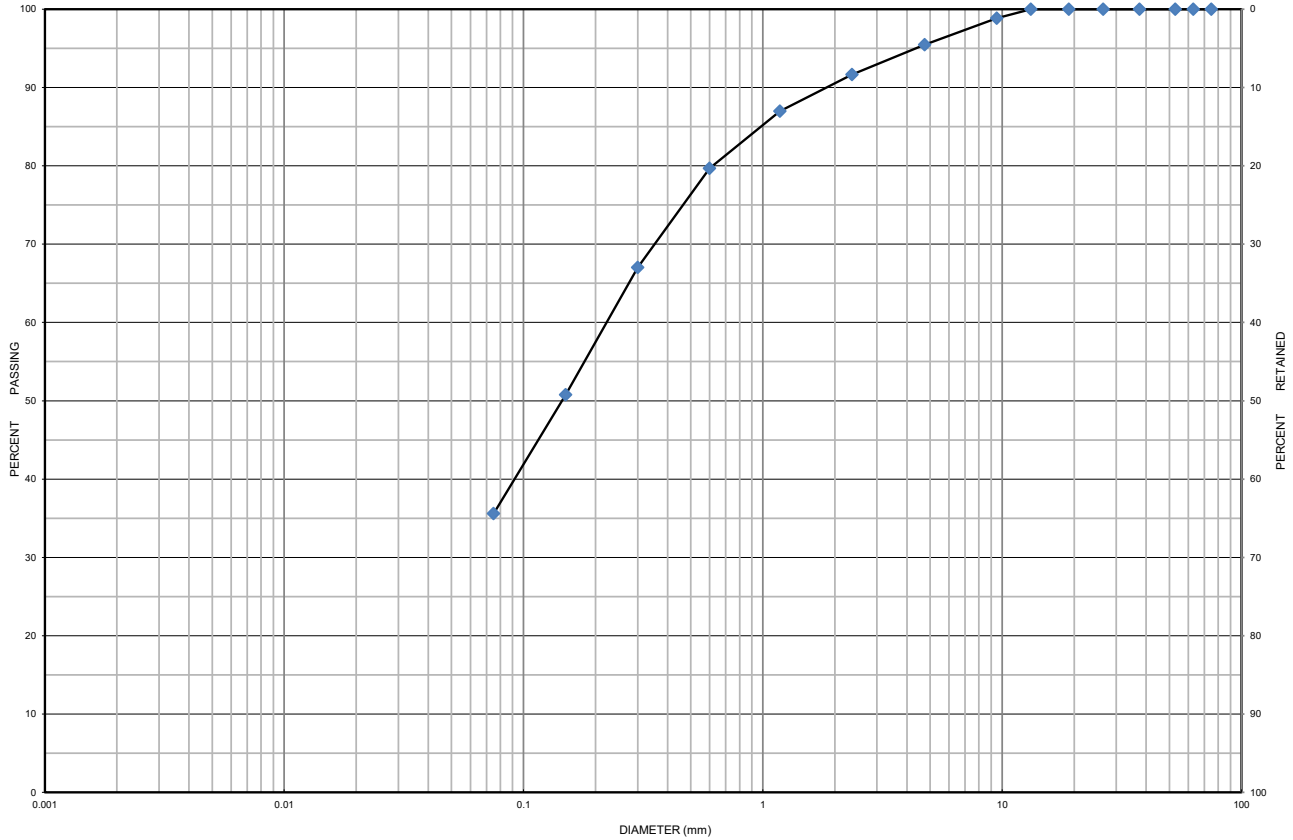
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# Grain Size Distribution Chart

**Project Number:** 24896-001      **Client:** Wateridge Lifestyles Ltd.  
**Project Name:** Wateridge Lifestyles Block 21  
**Sample Date:** December 8 -10, 2025      **Sampled By:** Rory Ryan - Cambium Inc.  
**Location:** BH 101-25 SS 2B      **Depth:** 1 m to 1.4 m      **Lab Sample No:** S-25-1942

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



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

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-25	SS 2B	1 m to 1.4 m	5	60	35		9.8
Description		Classification	D <sub>60</sub>	D <sub>30</sub>	D <sub>10</sub>	C <sub>u</sub>	C <sub>c</sub>
Sand and Silt trace Gravel		SM	0.225	-	-	-	-

Additional information available upon request

Issued By: *John Baird*  
 (Senior Project Manager)

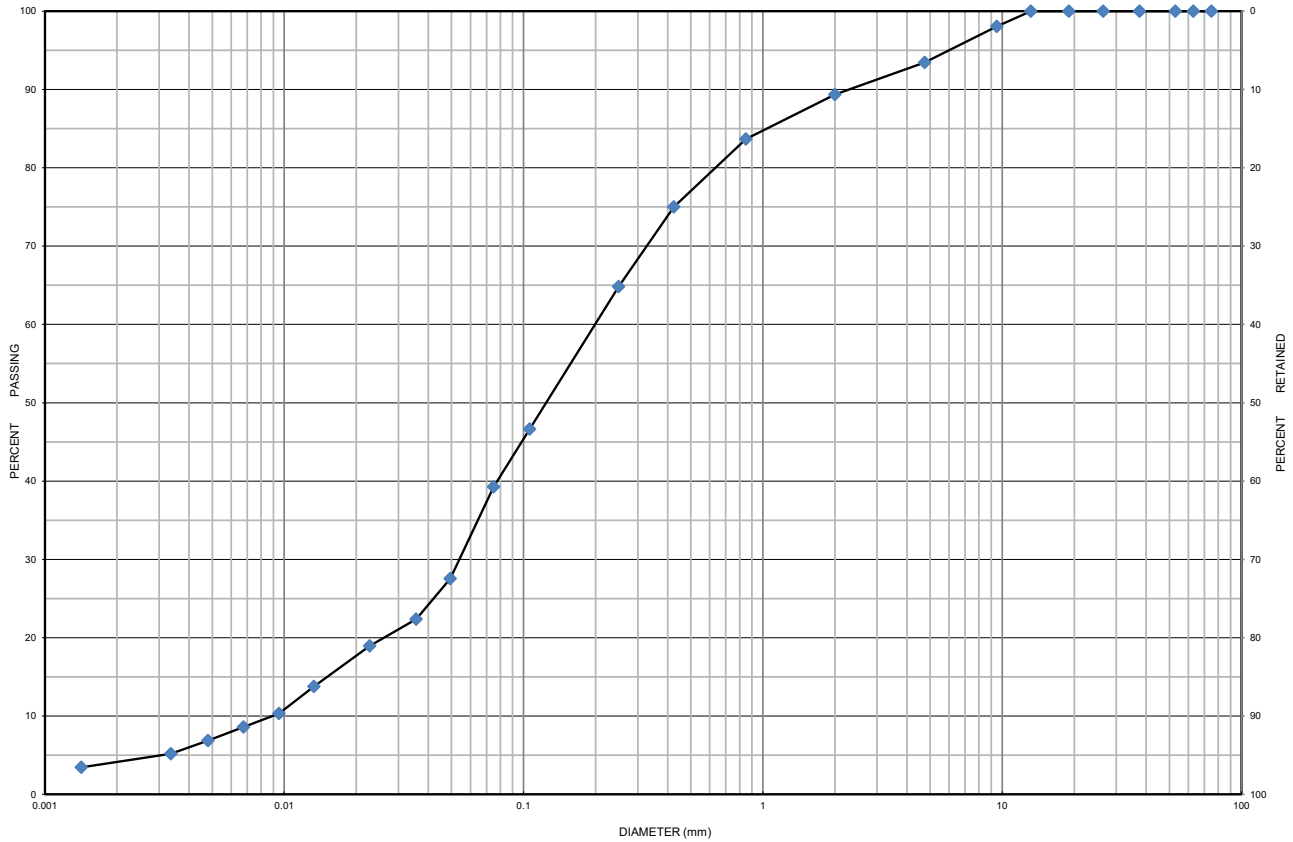
Date Issued: January 11, 2026



# Grain Size Distribution Chart

**Project Number:** 24896-001      **Client:** Wateridge Lifestyles Ltd.  
**Project Name:** Wateridge Lifestyles Block 21  
**Sample Date:** December 8 - 10, 2025      **Sampled By:** Rory Ryan - Cambium Inc.  
**Location:** BH 102-25 SS 4      **Depth:** 2.3 m to 2.7 m      **Lab Sample No:** S-25-1943

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



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

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-25	SS 4	2.3 m to 2.7 m	7	54	35	4	10.3
Description		Classification	D <sub>60</sub>	D <sub>30</sub>	D <sub>10</sub>	C <sub>u</sub>	C <sub>c</sub>
Sand and Silt some Gravel trace Clay		SM	0.200	0.054	0.009	22.22	1.62

Additional information available upon request

**Issued By:** *John Baird*  
 (Senior Project Manager)

**Date Issued:** January 13, 2026



---

**Appendix D**  
**External Borehole Logs**

---

# patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Wateridge Village Phases 6, 7 & 8  
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

DATE October 26, 2022

FILE NO.  
**PG6331**

HOLE NO.  
**BH 1-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %					
GROUND SURFACE								20	40	60	80		
<b>FILL:</b> Crushed stone, some sand		AU	1			0	87.85						
<b>FILL:</b> Brown silty sand with crushed stone		SS	2	50	20	1	86.85						
<b>GLACIAL TILL:</b> Compact to dense, brown silty sand to sandy silt with gravel, cobbles and boulders		SS	3	89	50+								
End of Borehole													
Practical refusal to augering at 1.78m depth.													
(GWL @ 1.54m - Nov. 18, 2022)													

20 40 60 80 100  
**Shear Strength (kPa)**  
▲ Undisturbed    △ Remoulded

# patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Wateridge Village Phases 6, 7 & 8  
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

DATE October 26, 2022

FILE NO.  
**PG6331**

HOLE NO.  
**BH 2-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction	
		TYPE	NUMBER	RECOVERY	N VALUE or RQD			20	40	60	80		
<b>GROUND SURFACE</b>													
Asphaltic concrete	0.03					0	89.20						
<b>FILL:</b> Light brown silty sand with gravel and crushed stone		AU	1										
		AU	2			1	88.20						
End of Borehole	1.32												
Practical refusal to augering at 1.32m depth. (BH dry - November 18, 2022)													

20 40 60 80 100  
**Shear Strength (kPa)**  
▲ Undisturbed    △ Remoulded

# patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Wateridge Village Phases 6, 7 & 8  
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

DATE October 26, 2022

FILE NO.  
**PG6331**

HOLE NO.  
**BH 3-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80		
<b>GROUND SURFACE</b>													
Asphaltic concrete 0.03						0	88.44						
<b>FILL:</b> Brown silty sand, some gravel and crushed stone		AU	1										
- trace clay by 0.7m depth 1.12		SS	2	63	50+	1	87.44						
End of Borehole													
Practical refusal to augering at 1.12m depth. (GWL @ 0.56m - Nov. 18, 2022)													

○ Water Content %

20 40 60 80 100  
**Shear Strength (kPa)**

▲ Undisturbed    △ Remoulded

# patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Wateridge Village Phases 6, 7 & 8  
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

DATE October 26, 2022

FILE NO.  
**PG6331**

HOLE NO.  
**BH 4-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %					
GROUND SURFACE								20	40	60	80		
Asphaltic concrete	0.03	AU	1			0	89.20						
FILL: Brown silty sand with gravel and crushed stone		SS	2	63	5	1	88.20						
		SS	3	57	50+	2	87.20						
End of Borehole	2.06												
Practical refusal to augering at 2.06m depth. (BH dry - November 18, 2022)													

20 40 60 80 100  
Shear Strength (kPa)  
▲ Undisturbed    △ Remoulded

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9 Auriga Drive, Ottawa, Ontario K2E 7T9

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Wateridge Village Phases 6, 7 & 8  
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

DATE October 27, 2022

FILE NO.  
**PG6331**

HOLE NO.  
**BH 8-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %				
GROUND SURFACE								20	40	60	80	
FILL: Brown silty sand with gravel, crushed stone and organics FILL: Brown silty sand with gravel and crushed stone Compact, light brown <b>SILTY SAND</b> , some gravel		AU	1			0	88.82					
Compact, light brown <b>SILTY SAND</b> , some gravel		SS	2	67	10	1	87.82					
Compact, light brown <b>SILTY SAND to SANDY SILT</b> , some gravel		SS	3	77	50+	2	86.82					
End of Borehole  Practical refusal to augering at 2.26m depth.  (BH dry - November 18, 2022)						2.26						

20 40 60 80 100  
**Shear Strength (kPa)**  
 ▲ Undisturbed    △ Remoulded



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9 Auriga Drive, Ottawa, Ontario K2E 7T9

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Wateridge Village Phases 6, 7 & 8  
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

DATE November 8, 2022

FILE NO.  
**PG6331**

HOLE NO.  
**BH59-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %				
GROUND SURFACE								20	40	60	80	
<b>FILL:</b> Brown silty sand with crushed stone, gravel and rock fragments		AU	1			0	88.03					
		SS	2	50	17	1	87.03					
		SS	3	60	17	2	86.03					
End of Borehole  Practical refusal to augering at 2.03m depth.												

20 40 60 80 100  
**Shear Strength (kPa)**  
 ▲ Undisturbed    △ Remoulded

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9 Auriga Drive, Ottawa, Ontario K2E 7T9

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Wateridge Village Phases 6, 7 & 8  
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

DATE November 8, 2022

FILE NO.  
**PG6331**

HOLE NO.  
**BH61-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction		
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %						
GROUND SURFACE						0	89.78	20	40	60	80			
<b>FILL:</b> Brown silty sand with crushed stone, gravel, cobbles and boulders  - trace organics by 1.5m depth		AU	1			0	89.78							
		SS	2	67	15	1	88.78							
		SS	3	42	36	2	87.78							
		SS	4	43	50+	2.54								
End of Borehole  Practical refusal to augering at 2.54m depth.  (BH dry - November 18, 2022)														

20 40 60 80 100  
**Shear Strength (kPa)**  
 ▲ Undisturbed    △ Remoulded



# patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
 Prop. Development - Wateridge Village Phases 6, 7 & 8  
 Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

DATE April 12, 2023

FILE NO.  
**PG6331**

HOLE NO.  
**BH 2-23**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80		
<b>GROUND SURFACE</b>						0	84.89						
<b>FILL:</b> Brown silty sand with gravel and crushed stone, trace organics		AU	1										
		SS	2	58	18	1	83.89						
<b>FILL:</b> Brown silty sand with gravel and crushed stone, cobbles, trace clay		SS	3	58	41	2	82.89						
- some rock fragments by 2.0m depth		SS	4	75	31	3	81.89						
End of Borehole						3	81.89						
Practical refusal to augering at 3.05m depth. (GWL @ 1.82m - April 20, 2023)													

20 40 60 80 100  
**Shear Strength (kPa)**  
 ▲ Undisturbed    △ Remoulded

# LOG OF BOREHOLE BH14-27

DST REF. No.: **OE-OT-015358**  
 CLIENT: **Canada Lands Company**  
 PROJECT: **Former CFB Rockcliffe**  
 LOCATION: **Ottawa, Ontario**  
 SURFACE ELEV.: **90.47 metres**

Drilling Data  
 METHOD: **Hollow Stem Auger**  
 DIAMETER: **80 mm ID**  
 DATE: **March 3, 2014**  
 COORDINATES: **5033695.61 m N, 450515.28 m E**

DEPTH (m)	ELEV. (m)	Water Data	% MOISTURE			Symbol	MATERIAL DESCRIPTION	SAMPLE #	SAMPLE TYPE	N' VALUE	VANE (kPa) ✕				REMARKS & GRAINSIZE DISTRIBUTION (%) GR SA SI CL
			W <sub>p</sub>	W	W <sub>i</sub>						20	40	60	80	
90						TOPSOIL - with grass and roots	AS1								
1.0						SAND - Gravelly, some silt, occasional cobbles and boulders, loose									21 66 (12)
89															
2.0						End of Borehole at 1.8 m Auger Refusal									
88															
3.0															
87															
4.0															
86															
5.0															
85															
6.0															
84															
7.0															
83															
8.0															
82															
9.0															
81															
10.0															
80															
11.0															
79															
12.0															
78															
13.0															
77															
14.0															
76															
15.0															
75															
16.0															
74															
17.0															
73															
18.0															
72															
19.0															
71															

BOREHOLE (STANDARD) - OTTAWA GS-OT-0153588 ROCKCLIFFE PHASE I.G.P.J. DST\_MIN.GDT 4/11/14



DST Consulting Engineers Inc.  
 203 - 2150 THURSTON DRIVE  
 OTTAWA, ONTARIO, K1G 5T9  
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 Email: ottawa@dstgroup.com  
 Web: www.dstgroup.com

**SAMPLE TYPE LEGEND**

- Auger Sample
- Rock Core
- Bentonite
- Split Spoon Sample
- Hiller Peat Sampler
- Sand
- Bulk Sample
- 70mm Thin Wall Tube

**ENCLOSURE 2**



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## **Appendix E**

# **Infiltration Testing Results**

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GP Testing Data

In-situ Infiltration Testing  
 Block 21, 200 Codd's Road, Ottawa, ON  
 Waterdige Lifestyles Inc.  
 Cambium Ref. No.: 24896.001

Location		GP101				Location		GP101			
GPS Coordinates		18T 450468E 5033652N				GPS Coordinates		18T 450468E 5033652N			
Soil		Sand and Silt, trace gravel				Soil		Silty Sand, some clay, trace gravel			
Depth		0.8 m bgs		0.8 m bgs		Depth		1.2 m bgs		1.2 m bgs	
Inner/Dual		Combined		Combined		Inner/Dual		Inner		Inner	
		Head	5 cm	Head	10 cm			Head	7.5	Head	12.5
Time (min)	Level	$\Delta h/\Delta t$ cm/min	Level	$\Delta h/\Delta t$ cm/min	Time (min)	Level	$\Delta h/\Delta t$ cm/min	Level	$\Delta h/\Delta t$ cm/min		
0.0	7.4		16.5		0.0	29.3		34.5			
1.0	7.2	-0.2	16.5	0.0	1.0	29.5	0.2	35.0	0.5		
2.0	7.4	0.2	17.5	1.0	2.0	29.8	0.3	35.4	0.4		
3.0	7.5	0.1	18.0	0.5	3.0	30.0	0.2	35.7	0.3		
4.0	7.6	0.1	18.5	0.5	4.0	30.2	0.2	36.0	0.3		
5.0	7.7	0.1	18.8	0.3	5.0	30.4	0.2	36.3	0.3		
6.0	7.8	0.1	19.2	0.4	6.0	30.6	0.2	36.5	0.2		
7.0	7.9	0.1	19.5	0.3	7.0	30.8	0.2	36.8	0.3		
8.0	8.0	0.1	19.8	0.3	8.0	31.0	0.2	37.0	0.2		
9.0	8.1	0.1	20.2	0.4	9.0	31.2	0.2	37.2	0.2		
10.0	8.2	0.1	20.6	0.4	10.0	31.4	0.2	37.4	0.2		
11.0	8.3	0.1	21.0	0.4	11.0	31.6	0.2	37.6	0.2		
12.0	8.4	0.1	21.4	0.4	12.0	31.8	0.2	37.8	0.2		
13.0	8.5	0.1	21.8	0.4	13.0	32.0	0.2	38.0	0.2		
14.0	8.6	0.1	22.2	0.4	14.0	32.2	0.2	38.2	0.2		
Geomean Steady State (cm/min)	0.1000		0.3669		Geomean Steady State (cm/min)	0.2000		0.2000			
Slope (cm/min)	0.0970		0.3960		Slope (cm/min)	0.2050		0.2450			
Single Head K	1.07E-06		2.54E-06		Single Head K	9.86E-08		6.38E-08			
Average Single Head K (m/sec)	1.81E-06				Average Single Head K (m/sec)	8.12E-08					
Two Head K (m/sec)	NA				Two Head K (m/sec)	NA					
Infiltration Rate (mm/hr)	54				Infiltration Rate (mm/hr)	24					
Percolation Time (min/cm)	11				Percolation Time (min/cm)	25					





Location		GP103				Location		GP104			
GPS Coordinates		18T 450533E 5033729N				GPS Coordinates		18T 450533E 5033729N			
Soil		Sand and Silt, trace cobbles				Soil		Sand and Silt, trace clay			
Depth		0.74 m bgs				Depth		0.90 m bgs			
Inner/Dual		Combined				Inner/Dual		Combined			
		Head	7 cm	Head	10 cm			Head	7 cm	Head	10 cm
Time (min)	Level	Δh/Δt cm/min	Level	Δh/Δt cm/min	Time (min)	Level	Δh/Δt cm/min	Level	Δh/Δt cm/min		
0.0	18.5		23.8		0.0	10.0		21.0			
0.5	18.7	0.4	24.0	0.4	1.0	10.5	0.5	22.0	1.0		
1.0	19.0	0.6	24.2	0.4	2.0	10.9	0.4	23.0	1.0		
1.5	19.3	0.6	24.5	0.6	3.0	11.3	0.4	24.0	1.0		
2.0	19.6	0.6	24.7	0.4	4.0	11.7	0.4	25.0	1.0		
2.5	19.9	0.6	25.0	0.6	5.0	12.1	0.4	26.1	1.1		
3.0	20.2	0.6	25.2	0.4	6.0	12.5	0.4	27.0	0.9		
3.5	20.4	0.4	25.5	0.6	7.0	14.2	1.7	28.0	1.0		
4.0	20.8	0.8	25.7	0.4	8.0	15.0	0.8	29.0	1.0		
4.5	21.0	0.4	25.9	0.4	9.0	15.7	0.7	30.0	1.0		
5.0	21.3	0.6	26.2	0.6	10.0	16.4	0.7				
5.5	21.6	0.6	26.5	0.6	11.0	17.0	0.6				
6.0	21.9	0.6	26.7	0.4	12.0	17.7	0.7				
6.5	22.2	0.6	27.0	0.6	13.0	18.4	0.7				
7.0	22.5	0.6	27.2	0.4	14.0	19.1	0.7				
7.5	22.8	0.6			15.0	19.8	0.7				
Slope (cm/min)	0.5770		0.4940		Slope (cm/min)	0.6880		1.0100			
Single Head K	4.83E-06		3.05E-06		Single Head K	5.93E-06		6.36E-06			
Average Single Head K (m/sec)	3.94E-06				Average Single Head K (m/sec)	6.15E-06					
Two Head K (m/sec)	NA				Two Head K (m/sec)	NA					
Infiltration Rate (mm/hr)	66				Infiltration Rate (mm/hr)	75					
Percolation Time (min/cm)	9				Percolation Time (min/cm)	8					

# SOILMOISTURE Guelph Permeameter Calculations

Input  
Result

## Single Head Method (1)

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**  
Enter water Head Height ("H" in cm): **5**  
Enter the Borehole Radius ("a" in cm): **3**

Enter the soil texture-structure category (enter one of the below numbers): **3**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R" in cm/min): **0.4000**

Res Type: 35.22  
H: 5  
a: 3  
H/a: 1.667  
a\*: 0.12  
C0.01: 0.809  
C0.04: 0.842  
C0.12: 0.803  
C0.36: 0.803  
C: 0.803  
R: 0.100  
Q: 0.059  
pi: 3.142

$\alpha^* = 0.12 \text{ cm}^{-1}$   
 $C = 0.80315$   
 $Q = 0.0587$   
 $K_{fs} = 1.07E-04 \text{ cm/sec}$   
 $6.41E-03 \text{ cm/min}$   
 $1.07E-06 \text{ m/sec}$   
 $2.52E-03 \text{ inch/min}$   
 $4.20E-05 \text{ inch/sec}$   
 $\Phi_m = 8.90E-04 \text{ cm}^2/\text{min}$

## Single Head Method (2)

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**  
Enter water Head Height ("H" in cm): **10**  
Enter the Borehole Radius ("a" in cm): **3**

Enter the soil texture-structure category (enter one of the below numbers): **3**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

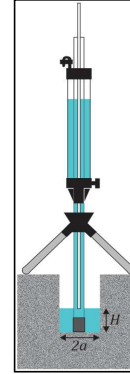
Steady State Rate of Water Level Change ("R" in cm/min): **0.4000**

Res Type: 35.22  
H: 10  
a: 3  
H/a: 3.33333  
a\*: 0.12  
C0.01: 1.21841  
C0.04: 1.29023  
C0.12: 1.28754  
C0.36: 1.28754  
C: 1.28754  
R: 0.400  
Q: 0.2348  
pi: 3.1415

$\alpha^* = 0.12 \text{ cm}^{-1}$   
 $C = 1.28754$   
 $Q = 0.2348$   
 $K_{fs} = 2.54E-04 \text{ cm/sec}$   
 $1.53E-02 \text{ cm/min}$   
 $2.54E-06 \text{ m/sec}$   
 $6.01E-03 \text{ inch/min}$   
 $4.00E-04 \text{ inch/sec}$   
 $\Phi_m = 2.12E-03 \text{ cm}^2/\text{min}$

## Average

$K_{fs} = 1.81E-04 \text{ cm/sec}$   
 $1.08E-02 \text{ cm/min}$   
 $1.81E-06 \text{ m/s}$   
 $4.27E-03 \text{ inch/min}$   
 $7.11E-05 \text{ inch/sec}$   
 $\Phi_m = 1.50E-03 \text{ cm}^2/\text{min}$



## Double Head Method

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**  
Enter the first water Head Height ("H1" in cm): **10**  
Enter the second water Head Height ("H2" in cm): **10**  
Enter the Borehole Radius ("a" in cm): **3**

Enter the soil texture-structure category (enter one of the below numbers): **3**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R1" in cm/min): **0**  
Steady State Rate of Water Level Change ("R2" in cm/min): **0**

Res Type: 0  
H1/a: #DIV/0!  
H2/a: #DIV/0!  
C1-0.01: #DIV/0!  
C2-0.01: #DIV/0!  
C1-0.04: #DIV/0!  
C2-0.04: #DIV/0!  
C1-0.12: #DIV/0!  
C2-0.12: #DIV/0!  
C1-0.36: #DIV/0!  
C2-0.36: #DIV/0!  
G-Denominator: 0

$\alpha^* = 0 \text{ cm}^{-1}$   
 $C = #DIV/0!$   
 $Q_1 = 0$   
 $Q_2 = 0$   
 $C_1 = 0$   
 $C_2 = 0$   
 $G_1 = #DIV/0!$   
 $G_2 = #DIV/0!$   
 $G_3 = #DIV/0!$   
 $G_4 = #DIV/0!$   
 $K_{fs} = #DIV/0! \text{ cm/sec}$   
 $#DIV/0! \text{ cm/min}$   
 $#DIV/0! \text{ m/sec}$   
 $#DIV/0! \text{ inch/min}$   
 $#DIV/0! \text{ inch/sec}$   
 $\Phi_m = #DIV/0! \text{ cm}^2/\text{min}$   
 $\Theta_1 = #DIV/0! \text{ cm}^3/\text{cm}^3$   
 $\Theta_2 = #DIV/0! \text{ cm}^3/\text{cm}^3$   
Sorptivity = **#DIV/0!** (cm min<sup>-0.5</sup>)  
Single Head Average Sorptivity = **0.0000** (cm min<sup>-0.5</sup>)

Calculation formulas related to shape factor (C). Where H<sub>1</sub> is the first water head height (cm), H<sub>2</sub> is the second water head height (cm), a is borehole radius (cm) and a\* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C<sub>1</sub> needs to be calculated while for two-head method, C<sub>1</sub> and C<sub>2</sub> are calculated (Zang et al., 1998).

Soil Texture-Structure Category	$\alpha^*$ (cm <sup>-1</sup> )	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left( \frac{H_2/a}{2.081 + 0.121(H_2/a)} \right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured, may also include some fine sands.	0.04	$C_1 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$ $C_2 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$
Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K<sub>fs</sub> is Soil saturated hydraulic conductivity (cm/s), Φ<sub>m</sub> is Soil matric flux potential (cm<sup>2</sup>/s), a\* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H<sub>1</sub> is the first head of water established in borehole (cm), H<sub>2</sub> is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \left( \frac{H_1}{a} \right)}$
One Head, Inner Reservoir	$Q_2 = \bar{R}_1 \times 2.16$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1) a^* + 2\pi H_1}$
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
	$Q_2 = \bar{R}_2 \times 35.22$	$G_2 = \frac{H_1 C_2}{\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	$K_{fs} = G_2 Q_2 - G_1 Q_1$
	$Q_2 = \bar{R}_2 \times 2.16$	$G_3 = \frac{(2H_1^2 + a^2 C_1) C_1}{2\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
		$G_4 = \frac{(2H_2^2 + a^2 C_2) C_2}{2\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
		$\Phi_m = G_3 Q_1 - G_4 Q_2$

# SOILMOISTURE Guelph Permeameter Calculations

Input  
Result

## Single Head Method (1)

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **2.16**  
Enter water Head Height ("H" in cm): **7.5**  
Enter the Borehole Radius ("a" in cm): **3**

Enter the soil texture-structure category (enter one of the below numbers): **3**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R" in cm/min): **0.2000**

Res Type: 2.16  
H: 7.5  
a: 3  
H/a: 2.5  
a\*: 0.12  
CO.01: 1.033  
CO.04: 1.085  
CO.12: 1.063  
CO.36: 1.063  
C: 1.063  
R: 0.200  
Q: 0.007  
pi: 3.142

$\alpha^* = 0.12 \text{ cm}^{-2}$   
 $C = 1.06262$   
 $Q = 0.0072$   
 $K_{fs} = 9.86E-06 \text{ cm/sec}$   
 $3.91E-04 \text{ cm/min}$   
 $9.86E-08 \text{ m/sec}$   
 $2.33E-04 \text{ inch/min}$   
 $3.88E-06 \text{ inch/sec}$   
 $\Phi_m = 8.21E-05 \text{ cm}^2/\text{min}$

## Single Head Method (2)

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **2.16**  
Enter water Head Height ("H" in cm): **12.5**  
Enter the Borehole Radius ("a" in cm): **3**

Enter the soil texture-structure category (enter one of the below numbers): **3**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

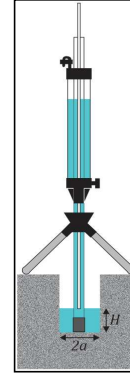
Steady State Rate of Water Level Change ("R" in cm/min): **0.2000**

Res Type: 2.16  
H: 12.5  
a: 3  
H/a: 4.16667  
a\*: 0.12  
CO.01: 1.37818  
CO.04: 1.46966  
CO.12: 1.48715  
CO.36: 1.48715  
C: 1.48715  
R: 0.200  
Q: 0.0072  
pi: 3.1415

$\alpha^* = 0.12 \text{ cm}^{-2}$   
 $C = 1.48715$   
 $Q = 0.0072$   
 $K_{fs} = 6.38E-06 \text{ cm/sec}$   
 $3.83E-04 \text{ cm/min}$   
 $6.38E-08 \text{ m/sec}$   
 $1.51E-04 \text{ inch/min}$   
 $2.51E-06 \text{ inch/sec}$   
 $\Phi_m = 5.32E-05 \text{ cm}^2/\text{min}$

## Average

$K_{fs} = 8.12E-06 \text{ cm/sec}$   
 $4.87E-04 \text{ cm/min}$   
 $8.12E-08 \text{ m/s}$   
 $1.92E-04 \text{ inch/min}$   
 $3.20E-06 \text{ inch/sec}$   
 $\Phi_m = 6.77E-05 \text{ cm}^2/\text{min}$



## Double Head Method

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **0**

Enter the first water Head Height ("H1" in cm): **0**  
Enter the second water Head Height ("H2" in cm): **0**

Enter the Borehole Radius ("a" in cm): **0**

Enter the soil texture-structure category (enter one of the below numbers): **0**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R1" in cm/min): **0**  
Steady State Rate of Water Level Change ("R2" in cm/min): **0**

Res Type: 0  
H1/a: #DIV/0!  
H2/a: #DIV/0!  
C1-0.01: #DIV/0!  
C2-0.01: #DIV/0!  
C1-0.04: #DIV/0!  
C2-0.04: #DIV/0!  
C1-0.12: #DIV/0!  
C2-0.12: #DIV/0!  
C1-0.36: #DIV/0!  
C2-0.36: #DIV/0!  
G-Denominator: 0

$\alpha^* = 0 \text{ cm}^{-2}$   
 $C = \#DIV/0!$   
 $Q_1 = 0$   
 $Q_2 = 0$   
 $C_1 = 0$   
 $C_2 = 0$   
 $G_1 = \#DIV/0!$   
 $G_2 = \#DIV/0!$   
 $G_3 = \#DIV/0!$   
 $G_4 = \#DIV/0!$   
 $K_{fs} = \#DIV/0! \text{ cm/sec}$   
 $\#DIV/0! \text{ cm/min}$   
 $\#DIV/0! \text{ m/sec}$   
 $\#DIV/0! \text{ inch/min}$   
 $\#DIV/0! \text{ inch/sec}$   
 $\Phi_m = \#DIV/0! \text{ cm}^2/\text{min}$   
 $\Theta_1 = \text{cm}^3/\text{cm}^3$   
 $\Theta_2 = \text{cm}^3/\text{cm}^3$   
Sorptivity =  $\#DIV/0! \text{ (cm min}^{-0.5}\text{)}$   
Single Head Average Sorptivity = **0.0000**  $\text{(cm min}^{-0.5}\text{)}$

Calculation formulas related to shape factor (C). Where H<sub>1</sub> is the first water head height (cm), H<sub>2</sub> is the second water head height (cm), a is borehole radius (cm) and a\* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C<sub>1</sub> needs to be calculated while for two-head method, C<sub>1</sub> and C<sub>2</sub> are calculated (Zang et al., 1998).

Soil Texture-Structure Category	$\alpha^* \text{ (cm}^{-2}\text{)}$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left( \frac{H_2/a}{2.081 + 0.121(H_2/a)} \right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured, may also include some fine sands.	0.04	$C_1 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$ $C_2 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$
Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K<sub>fs</sub> is Soil saturated hydraulic conductivity (cm/s), Φ<sub>m</sub> is Soil matric flux potential (cm<sup>2</sup>/s), a\* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H<sub>1</sub> is the first head of water established in borehole (cm), H<sub>2</sub> is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \left( \frac{H_1}{a} \right)}$
One Head, Inner Reservoir	$Q_2 = \bar{R}_1 \times 2.16$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1) a^2 + 2\pi H_1}$
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
	$Q_2 = \bar{R}_2 \times 35.22$	$G_2 = \frac{H_1 C_2}{\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	$K_{fs} = G_2 Q_2 - G_1 Q_1$
	$Q_2 = \bar{R}_2 \times 2.16$	$G_3 = \frac{(2H_1^2 + a^2 C_1) C_1}{2\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
		$G_4 = \frac{(2H_2^2 + a^2 C_2) C_2}{2\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
		$\Phi_m = G_3 Q_1 - G_4 Q_2$



# Guelph Permeameter Calculations

  Input  
  Result

## Single Head Method (1)

Reservoir Cross-sectional area in cm<sup>2</sup>  
 (enter "35.22" for Combined and "2.16" for Inner reservoir): 35.22  
 Enter water Head Height ("H" in cm): 5  
 Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 3

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R" in cm/min): 1.0000

Res Type: 35.22  
 H: 5  
 a: 3  
 H/a: 1.667  
 a\*: 0.112  
 C0.01: 0.809  
 C0.04: 0.842  
 C0.12: 0.803  
 C0.36: 0.803  
 C: 0.803  
 R: 1.000  
 Q: 0.587  
 pi: 3.142

$\alpha^* = 0.12 \text{ cm}^{-1}$   
 $C = 0.80315$   
 $Q = 0.587$   
 $K_{fs} = 1.07E-03 \text{ cm/sec}$   
 $6.41E-02 \text{ cm/min}$   
 $1.07E-05 \text{ m/sec}$   
 $2.52E-02 \text{ inch/min}$   
 $4.20E-04 \text{ inch/sec}$   
 $\Phi_m = 8.90E-03 \text{ cm}^2/\text{min}$

## Single Head Method (2)

Reservoir Cross-sectional area in cm<sup>2</sup>  
 (enter "35.22" for Combined and "2.16" for Inner reservoir):    
 Enter water Head Height ("H" in cm):    
 Enter the Borehole Radius ("a" in cm):  

Enter the soil texture-structure category (enter one of the below numbers):  

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

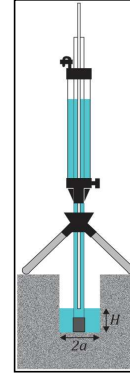
Steady State Rate of Water Level Change ("R" in cm/min):  

Res Type: 0  
 H: 0  
 a: 0  
 H/a: #DIV/0!  
 a\*: 0  
 C0.01: #DIV/0!  
 C0.04: #DIV/0!  
 C0.12: #DIV/0!  
 C0.36: #DIV/0!  
 C: 0  
 R: 0.000  
 Q: 0  
 pi: 3.1415

$\alpha^* = 0 \text{ cm}^{-1}$   
 $C = 0$   
 $Q = 0$   
 $K_{fs} = #DIV/0! \text{ cm/sec}$   
 $#DIV/0! \text{ cm/min}$   
 $#DIV/0! \text{ m/sec}$   
 $#DIV/0! \text{ inch/min}$   
 $#DIV/0! \text{ inch/sec}$   
 $\Phi_m = #DIV/0! \text{ cm}^2/\text{min}$

## Average

$K_{fs} = #DIV/0! \text{ cm/sec}$   
 $#DIV/0! \text{ cm/min}$   
 $#DIV/0! \text{ m/s}$   
 $#DIV/0! \text{ inch/min}$   
 $#DIV/0! \text{ inch/sec}$   
 $\Phi_m = #DIV/0! \text{ cm}^2/\text{min}$



## Double Head Method

Reservoir Cross-sectional area in cm<sup>2</sup>  
 (enter "35.22" for Combined and "2.16" for Inner reservoir):    
 Enter the first water Head Height ("H1" in cm):    
 Enter the second water Head Height ("H2" in cm):    
 Enter the Borehole Radius ("a" in cm):  

Enter the soil texture-structure category (enter one of the below numbers):  

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R1" in cm/min):    
 Steady State Rate of Water Level Change ("R2" in cm/min):  

Res Type: 0  
 H1/a: #DIV/0!  
 H2/a: #DIV/0!  
 C1-0.01: #DIV/0!  
 C2-0.01: #DIV/0!  
 C1-0.04: #DIV/0!  
 C2-0.04: #DIV/0!  
 C1-0.12: #DIV/0!  
 C2-0.12: #DIV/0!  
 C1-0.36: #DIV/0!  
 C2-0.36: #DIV/0!  
 G-Denominator: 0

$\alpha^* = 0 \text{ cm}^{-1}$   
 $C = #DIV/0!$   
 $Q_1 = 0$   
 $Q_2 = 0$   
 $C_1 = 0$   
 $C_2 = 0$   
 $G_1 = #DIV/0!$   
 $G_2 = #DIV/0!$   
 $G_3 = #DIV/0!$   
 $G_4 = #DIV/0!$   
 $K_{fs} = #DIV/0! \text{ cm/sec}$   
 $#DIV/0! \text{ cm/min}$   
 $#DIV/0! \text{ m/sec}$   
 $#DIV/0! \text{ inch/min}$   
 $#DIV/0! \text{ inch/sec}$   
 $\Phi_m = #DIV/0! \text{ cm}^2/\text{min}$   
 $\Theta_{fs} = #DIV/0! \text{ cm}^3/\text{cm}^3$   
 $\Theta_s = #DIV/0! \text{ cm}^3/\text{cm}^3$   
 Sorptivity =  $#DIV/0! \text{ (cm min}^{-0.5}\text{)}$   
 Single Head Average Sorptivity =  $#DIV/0! \text{ (cm min}^{-0.5}\text{)}$

Calculation formulas related to shape factor (C). Where H<sub>1</sub> is the first water head height (cm), H<sub>2</sub> is the second water head height (cm), a is borehole radius (cm) and a\* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C<sub>1</sub> needs to be calculated while for two-head method, C<sub>1</sub> and C<sub>2</sub> are calculated (Zang et al., 1998).

Soil Texture-Structure Category	$\alpha^* \text{ (cm}^{-1}\text{)}$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left( \frac{H_2/a}{2.081 + 0.121(H_2/a)} \right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured, may also include some fine sands.	0.04	$C_1 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$ $C_2 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$
Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K<sub>fs</sub> is Soil saturated hydraulic conductivity (cm/s), Φ<sub>m</sub> is Soil matric flux potential (cm<sup>2</sup>/s), a\* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H<sub>1</sub> is the first head of water established in borehole (cm), H<sub>2</sub> is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \left( \frac{H_1}{a} \right)}$
One Head, Inner Reservoir	$Q_2 = \bar{R}_1 \times 2.16$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1) a^* + 2\pi H_1}$
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$ $K_{fs} = G_2 Q_2 - G_1 Q_1$ $G_3 = \frac{(2H_1^2 + a^2 C_1) C_1}{2\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$ $G_4 = \frac{(2H_2^2 + a^2 C_2) C_2}{2\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$ $\Phi_m = G_3 Q_1 - G_4 Q_2$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	

# SOILMOISTURE Guelph Permeameter Calculations

Input  
Result

## Single Head Method (1)

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**  
Enter water Head Height ("H" in cm): **7.5**  
Enter the Borehole Radius ("a" in cm): **3**

Enter the soil texture-structure category (enter one of the below numbers): **3**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R" in cm/min): **0.5000**

Res Type: 35.22  
H: 7.5  
a: 3  
H/a: 2.5  
a\* 0.12  
C0.01: 1.033  
C0.04: 1.085  
C0.12: 1.063  
C0.36: 1.063  
C: 1.063  
R: 0.500  
Q: 0.294  
pi: 3.142

$\alpha^* = 0.12 \text{ cm}^{-1}$   
 $C = 1.06262$   
 $Q = 0.2935$   
 $K_{fs} = 4.02E-04 \text{ cm/sec}$   
 $2.41E-02 \text{ cm/min}$   
 $4.02E-06 \text{ m/sec}$   
 $9.49E-03 \text{ inch/min}$   
 $1.58E-04 \text{ inch/sec}$   
 $\Phi_m = 3.35E-03 \text{ cm}^2/\text{min}$

## Single Head Method (2)

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**  
Enter water Head Height ("H" in cm): **9.5**  
Enter the Borehole Radius ("a" in cm): **3**

Enter the soil texture-structure category (enter one of the below numbers): **3**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

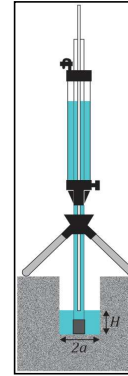
Steady State Rate of Water Level Change ("R" in cm/min): **0.7200**

Res Type: 35.22  
H: 9.5  
a: 3  
H/a: 3.16667  
a\* 0.12  
C0.01: 1.18359  
C0.04: 1.2547  
C0.12: 1.2448  
C0.36: 1.2448  
C: 1.2448  
R: 0.720  
Q: 0.42264  
pi: 3.1415

$\alpha^* = 0.12 \text{ cm}^{-1}$   
 $C = 1.2448$   
 $Q = 0.42264$   
 $K_{fs} = 4.78E-04 \text{ cm/sec}$   
 $2.87E-02 \text{ cm/min}$   
 $4.78E-06 \text{ m/sec}$   
 $1.13E-02 \text{ inch/min}$   
 $1.88E-04 \text{ inch/sec}$   
 $\Phi_m = 3.99E-03 \text{ cm}^2/\text{min}$

## Average

$K_{fs} = 4.40E-04 \text{ cm/sec}$   
 $2.64E-02 \text{ cm/min}$   
 $4.40E-06 \text{ m/s}$   
 $1.04E-02 \text{ inch/min}$   
 $1.73E-04 \text{ inch/sec}$   
 $\Phi_m = 3.67E-03 \text{ cm}^2/\text{min}$



## Double Head Method

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **0**

Enter the first water Head Height ("H1" in cm): **0**  
Enter the second water Head Height ("H2" in cm): **0**

Enter the Borehole Radius ("a" in cm): **0**

Enter the soil texture-structure category (enter one of the below numbers): **0**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R1" in cm/min): **0**  
Steady State Rate of Water Level Change ("R2" in cm/min): **0**

Res Type: 0  
H1/a: #DIV/0!  
H2/a: #DIV/0!  
C1-0.01: #DIV/0!  
C2-0.01: #DIV/0!  
C1-0.04: #DIV/0!  
C2-0.04: #DIV/0!  
C1-0.12: #DIV/0!  
C2-0.12: #DIV/0!  
C1-0.36: #DIV/0!  
C2-0.36: #DIV/0!  
G-Denominator: 0

$\alpha^* = 0 \text{ cm}^{-1}$   
 $C = #DIV/0!$   
 $Q_1 = 0$   
 $Q_2 = 0$   
 $C_1 = 0$   
 $C_2 = 0$   
 $G_1 = #DIV/0!$   
 $G_2 = #DIV/0!$   
 $G_3 = #DIV/0!$   
 $G_4 = #DIV/0!$   
 $K_{fs} = #DIV/0! \text{ cm/sec}$   
 $#DIV/0! \text{ cm/min}$   
 $#DIV/0! \text{ m/sec}$   
 $#DIV/0! \text{ inch/min}$   
 $#DIV/0! \text{ inch/sec}$   
 $\Phi_m = #DIV/0! \text{ cm}^2/\text{min}$   
 $\Theta_1 = #DIV/0! \text{ cm}^3/\text{cm}^3$   
 $\Theta_2 = #DIV/0! \text{ cm}^3/\text{cm}^3$   
Sorptivity = **#DIV/0!** (cm min<sup>-0.5</sup>)  
Single Head Average Sorptivity = **0.0000** (cm min<sup>-0.5</sup>)

Calculation formulas related to shape factor (C). Where H<sub>1</sub> is the first water head height (cm), H<sub>2</sub> is the second water head height (cm), a is borehole radius (cm) and a\* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C<sub>1</sub> needs to be calculated while for two-head method, C<sub>1</sub> and C<sub>2</sub> are calculated (Zang et al., 1998).

Soil Texture-Structure Category	$\alpha^*$ (cm <sup>-1</sup> )	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left( \frac{H_2/a}{2.081 + 0.121(H_2/a)} \right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured, may also include some fine sands.	0.04	$C_1 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$ $C_2 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$
Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K<sub>fs</sub> is Soil saturated hydraulic conductivity (cm/s), Φ<sub>m</sub> is Soil matric flux potential (cm<sup>2</sup>/s), a\* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H<sub>1</sub> is the first head of water established in borehole (cm), H<sub>2</sub> is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \left( \frac{H_1}{a} \right)}$
One Head, Inner Reservoir	$Q_2 = \bar{R}_1 \times 2.16$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1) a^* + 2\pi H_1}$
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
	$Q_2 = \bar{R}_2 \times 35.22$	$G_2 = \frac{H_1 C_2}{\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	$K_{fs} = G_2 Q_2 - G_1 Q_1$
	$Q_2 = \bar{R}_2 \times 2.16$	$G_3 = \frac{(2H_1^2 + a^2 C_1) C_1}{2\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
		$G_4 = \frac{(2H_2^2 + a^2 C_2) C_2}{2\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
		$\Phi_m = G_3 Q_1 - G_4 Q_2$



# Guelph Permeameter Calculations

  Input  
  Result

## Single Head Method (1)

Reservoir Cross-sectional area in cm<sup>2</sup>  
 (enter "35.22" for Combined and "2.16" for Inner reservoir): 35.22  
 Enter water Head Height ("H" in cm): 7  
 Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 3

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R" in cm/min): 0.5700

Res Type: 35.22  
 H: 7  
 a: 3  
 H/a: 2.333  
 a\*: 0.12  
 C0.01: 0.991  
 C0.04: 1.04  
 C0.12: 1.014  
 C0.36: 1.014  
 C: 1.014  
 R: 0.570  
 Q: 0.335  
 pi: 3.142

$\alpha^* = 0.12 \text{ cm}^{-1}$   
**C = 1.0139**  
**Q = 0.33459**  
**K<sub>fs</sub> = 4.83E-04 cm/sec**  
**2.90E-02 cm/min**  
**4.83E-06 m/sec**  
**1.14E-02 inch/min**  
**1.90E-04 inch/sec**  
**Φ<sub>m</sub> = 4.02E-03 cm<sup>2</sup>/min**

## Single Head Method (2)

Reservoir Cross-sectional area in cm<sup>2</sup>  
 (enter "35.22" for Combined and "2.16" for Inner reservoir): 35.22  
 Enter water Head Height ("H" in cm): 10  
 Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 3

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

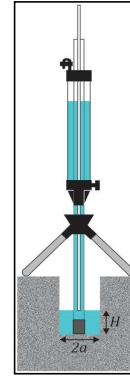
Steady State Rate of Water Level Change ("R" in cm/min): 0.4800

Res Type: 35.22  
 H: 10  
 a: 3  
 H/a: 3.33333  
 a\*: 0.12  
 C0.01: 1.21841  
 C0.04: 1.29023  
 C0.12: 1.28754  
 C0.36: 1.28754  
 C: 1.28754  
 R: 0.480  
 Q: 0.28176  
 pi: 3.1415

$\alpha^* = 0.12 \text{ cm}^{-1}$   
**C = 1.28754**  
**Q = 0.28176**  
**K<sub>fs</sub> = 3.05E-04 cm/sec**  
**1.83E-02 cm/min**  
**3.05E-06 m/sec**  
**7.21E-03 inch/min**  
**1.20E-04 inch/sec**  
**Φ<sub>m</sub> = 2.54E-03 cm<sup>2</sup>/min**

## Average

**K<sub>fs</sub> = 3.94E-04 cm/sec**  
**2.36E-02 cm/min**  
**3.94E-06 m/s**  
**9.31E-03 inch/min**  
**1.55E-04 inch/sec**  
**Φ<sub>m</sub> = 3.28E-03 cm<sup>2</sup>/min**



## Double Head Method

Reservoir Cross-sectional area in cm<sup>2</sup>  
 (enter "35.22" for Combined and "2.16" for Inner reservoir):  

Enter the first water Head Height ("H1" in cm):    
 Enter the second water Head Height ("H2" in cm):  

Enter the Borehole Radius ("a" in cm):  

Enter the soil texture-structure category (enter one of the below numbers):  

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R1" in cm/min):    
 Steady State Rate of Water Level Change ("R2" in cm/min):  

Res Type: 0  
 H1/a: #DIV/0!  
 H2/a: #DIV/0!  
 C1-0.01: #DIV/0!  
 C2-0.01: #DIV/0!  
 C1-0.04: #DIV/0!  
 C2-0.04: #DIV/0!  
 C1-0.12: #DIV/0!  
 C2-0.12: #DIV/0!  
 C1-0.36: #DIV/0!  
 C2-0.36: #DIV/0!  
 G-Denominator: 0

$\alpha^* = 0 \text{ cm}^{-1}$   
**Q<sub>1</sub> = 0**  
**Q<sub>2</sub> = 0**  
**C<sub>1</sub> = 0**  
**C<sub>2</sub> = 0**  
**G<sub>1</sub> = #DIV/0!**  
**G<sub>2</sub> = #DIV/0!**  
**G<sub>3</sub> = #DIV/0!**  
**G<sub>4</sub> = #DIV/0!**  
**K<sub>fs</sub> = #DIV/0! cm/sec**  
**#DIV/0! cm/min**  
**#DIV/0! m/sec**  
**#DIV/0! inch/min**  
**#DIV/0! inch/sec**  
**Φ<sub>m</sub> = #DIV/0! cm<sup>2</sup>/min**  
**Θ<sub>1</sub> = #DIV/0! cm<sup>3</sup>/cm<sup>3</sup>**  
**Θ<sub>2</sub> = #DIV/0! cm<sup>3</sup>/cm<sup>3</sup>**  
 Sorptivity = **#DIV/0! (cm min<sup>-0.5</sup>)**  
 Single Head Average Sorptivity = **0.0000 (cm min<sup>-0.5</sup>)**

Calculation formulas related to shape factor (C). Where H<sub>1</sub> is the first water head height (cm), H<sub>2</sub> is the second water head height (cm), a is borehole radius (cm) and a\* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C<sub>1</sub> needs to be calculated while for two-head method, C<sub>1</sub> and C<sub>2</sub> are calculated (Zang et al., 1998).

Soil Texture-Structure Category	α* (cm <sup>-1</sup> )	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left( \frac{H_2/a}{2.081 + 0.121(H_2/a)} \right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured, may also include some fine sands.	0.04	$C_1 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$ $C_2 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$
Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K<sub>fs</sub> is Soil saturated hydraulic conductivity (cm/s), Φ<sub>m</sub> is Soil matric flux potential (cm<sup>2</sup>/s), a\* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H<sub>1</sub> is the first head of water established in borehole (cm), H<sub>2</sub> is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \left( \frac{H_1}{a} \right)}$
One Head, Inner Reservoir	$Q_2 = \bar{R}_2 \times 2.16$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1) a^* + 2\pi H_1}$
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi (2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
	$Q_2 = \bar{R}_2 \times 35.22$	$G_2 = \frac{H_1 C_2}{\pi (2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	$K_{fs} = G_2 Q_2 - G_1 Q_1$
	$Q_2 = \bar{R}_2 \times 2.16$	$G_3 = \frac{(2H_1^2 + a^2 C_1) C_1}{2\pi (2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
		$G_4 = \frac{(2H_2^2 + a^2 C_2) C_2}{2\pi (2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$
		$\Phi_m = G_3 Q_1 - G_4 Q_2$

# SOILMOISTURE Guelph Permeameter Calculations

Input  
Result

## Single Head Method (1)

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**  
Enter water Head Height ("H" in cm): **7**  
Enter the Borehole Radius ("a" in cm): **3**

Enter the soil texture-structure category (enter one of the below numbers): **3**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R" in cm/min): **0.7000**

Res Type: 35.22  
H: 7  
a: 3  
H/a: 2.333  
a\* 0.12  
C0.01: 0.991  
C0.04: 1.04  
C0.12: 1.014  
C0.36: 1.014  
C: 1.014  
R: 0.700  
Q: 0.411  
pi: 3.142

$\alpha^* = 0.12 \text{ cm}^{-1}$   
 $C = 1.0139$   
 $Q = 0.4109$   
 $K_{fs} = 5.93E-04 \text{ cm/sec}$   
 $3.56E-02 \text{ cm/min}$   
 $5.93E-06 \text{ m/sec}$   
 $1.40E-02 \text{ inch/min}$   
 $2.33E-04 \text{ inch/sec}$   
 $\Phi_m = 4.94E-03 \text{ cm}^2/\text{min}$

## Single Head Method (2)

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**  
Enter water Head Height ("H" in cm): **10**  
Enter the Borehole Radius ("a" in cm): **3**

Enter the soil texture-structure category (enter one of the below numbers): **3**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

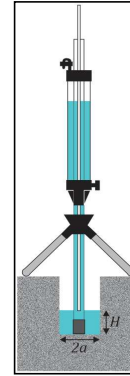
Steady State Rate of Water Level Change ("R" in cm/min): **1.0000**

Res Type: 35.22  
H: 10  
a: 3  
H/a: 3.33333  
a\* 0.12  
C0.01: 1.21841  
C0.04: 1.29023  
C0.12: 1.28754  
C0.36: 1.28754  
C: 1.28754  
R: 1.000  
Q: 0.587  
pi: 3.1415

$\alpha^* = 0.12 \text{ cm}^{-1}$   
 $C = 1.28754$   
 $Q = 0.587$   
 $K_{fs} = 6.36E-04 \text{ cm/sec}$   
 $3.82E-02 \text{ cm/min}$   
 $6.36E-06 \text{ m/sec}$   
 $1.50E-02 \text{ inch/min}$   
 $2.50E-04 \text{ inch/sec}$   
 $\Phi_m = 5.30E-03 \text{ cm}^2/\text{min}$

## Average

$K_{fs} = 6.14E-04 \text{ cm/sec}$   
 $3.69E-02 \text{ cm/min}$   
 $6.14E-06 \text{ m/s}$   
 $1.45E-02 \text{ inch/min}$   
 $2.42E-04 \text{ inch/sec}$   
 $\Phi_m = 5.12E-03 \text{ cm}^2/\text{min}$



## Double Head Method

Reservoir Cross-sectional area in cm<sup>2</sup>  
(enter "35.22" for Combined and "2.16" for Inner reservoir): **0**

Enter the first water Head Height ("H1" in cm): **0**  
Enter the second water Head Height ("H2" in cm): **0**

Enter the Borehole Radius ("a" in cm): **0**

Enter the soil texture-structure category (enter one of the below numbers): **0**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R1" in cm/min): **0**  
Steady State Rate of Water Level Change ("R2" in cm/min): **0**

Res Type: 0  
H1/a: #DIV/0!  
H2/a: #DIV/0!  
C1-0.01: #DIV/0!  
C2-0.01: #DIV/0!  
C1-0.04: #DIV/0!  
C2-0.04: #DIV/0!  
C1-0.12: #DIV/0!  
C2-0.12: #DIV/0!  
C1-0.36: #DIV/0!  
C2-0.36: #DIV/0!  
G-Denominator: 0

$\alpha^* = 0 \text{ cm}^{-1}$   
 $C = #DIV/0!$   
 $Q_1 = 0$   
 $Q_2 = 0$   
 $C_1 = 0$   
 $C_2 = 0$   
 $G_1 = #DIV/0!$   
 $G_2 = #DIV/0!$   
 $G_3 = #DIV/0!$   
 $G_4 = #DIV/0!$   
 $K_{fs} = #DIV/0! \text{ cm/sec}$   
 $#DIV/0! \text{ cm/min}$   
 $#DIV/0! \text{ m/sec}$   
 $#DIV/0! \text{ inch/min}$   
 $#DIV/0! \text{ inch/sec}$   
 $\Phi_m = #DIV/0! \text{ cm}^2/\text{min}$   
 $\Theta_1 = #DIV/0! \text{ cm}^3/\text{cm}^3$   
 $\Theta_2 = #DIV/0! \text{ cm}^3/\text{cm}^3$   
Sorptivity = **#DIV/0!** (cm min<sup>-0.5</sup>)  
Single Head Average Sorptivity = **0.0000** (cm min<sup>-0.5</sup>)

Calculation formulas related to shape factor (C). Where H<sub>1</sub> is the first water head height (cm), H<sub>2</sub> is the second water head height (cm), a is borehole radius (cm) and a\* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C<sub>1</sub> needs to be calculated while for two-head method, C<sub>1</sub> and C<sub>2</sub> are calculated (Zang et al., 1998).

Soil Texture-Structure Category	$\alpha^* (\text{cm}^{-1})$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left( \frac{H_2/a}{2.081 + 0.121(H_2/a)} \right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured, may also include some fine sands.	0.04	$C_1 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$ $C_2 = \left( \frac{H_2/a}{1.992 + 0.091(H_2/a)} \right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$
Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$ $C_2 = \left( \frac{H_2/a}{2.074 + 0.093(H_2/a)} \right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K<sub>fs</sub> is Soil saturated hydraulic conductivity (cm/s), Φ<sub>m</sub> is Soil matric flux potential (cm<sup>2</sup>/s), a\* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H<sub>1</sub> is the first head of water established in borehole (cm), H<sub>2</sub> is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \left( \frac{H_1}{a} \right)}$
One Head, Inner Reservoir	$Q_2 = \bar{R}_1 \times 2.16$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1) a^* + 2\pi H_1}$
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$ $K_{fs} = G_2 Q_2 - G_1 Q_1$ $G_3 = \frac{(2H_1^2 + a^2 C_1) C_1}{2\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$ $G_4 = \frac{(2H_2^2 + a^2 C_2) C_2}{2\pi(2H_1 H_2 (H_2 - H_1) + a^2 (H_1 C_2 - H_2 C_1))}$ $\Phi_m = G_3 Q_1 - G_4 Q_2$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	