RYZUK GEOTECHNICAL
Engineering & Materials Testing

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June 3, 2022
File No: 8298-15

WestUrban Developments Ltd.
#111-2036 Island Hwy S.
Campbell River, BC
V9W 0E8

Attn: Cameron Salisbury, MEDes, RPP, MCIP (csalisbury@westurban.ca)

Re: Proposed Mixed-Use Development
1650 Galerno Rd. – Campbell River, BC

As requested, we have completed a geotechnical investigation of the referenced site as such relates to the proposed development. Our associated observations, comments, and recommendations are contained herein. Our work has been carried out in accordance with, and is subject to, the previously accepted proposal and associated Terms of Engagement.

PROPOSED DEVELOPMENT

The site is located on the east side of S Alder Street and is bounded by residential properties to the north and east, S Alder Street to the west and Simms Creek to the south. Currently, the site is undeveloped, and sits north of the Stream Protection and Enhancement Area (SPEA) associated with Simms Creek. The property is heavily vegetated with scrub/brush along with coniferous trees spread over the entire lot area.

We note that at the time of our assessment only preliminary development plans have been provided for our review and are subject to change. From these plans, we understand that a new strata road will be constructed stemming from the intersection of Galerno Road and Passage View Drive and extending northwest near-parallel to the SPEA and connecting to S Alder St. We further understand the majority of the development will consist of townhomes to the north and south of the proposed strata road as well as an apartment structure with up to a single level of underground parking within the northwestern limit of the proposed development area.

General site preparations for the proposed development are anticipated to comprise construction of civil infrastructure (site servicing, roadways, etc.) and preparation of building lots. Grading plans have not been reviewed at this time, however, we expect such will consist of removal of all

unsuitable soil material within civil/building footprints with local fill placement up to desired road/lot elevations as required.

SURFACE AND SUBSURFACE CONDITIONS

Topographically, the proposed development site slopes down to the south at an inclination of between 5 degrees to 18 degrees within the proposed building areas and becomes progressively steeper within the SPEA towards Simms Creek roughly 8 – 15 m below the slope crest. Machine access to the northern edge of the SPEA was unsuccessful due to brush/vegetation density and wet ground conditions. Based on the provided documentation, the existing environmental setback boundary may be modified which would allow for construction closer to the SPEA slope. Therefore, more detailed building site specific slope reviews would be required once actual building locations south of the proposed strata road are known and access to the area is available.

Our geotechnical investigation consisted of advancing two test holes in the vicinity of the noted apartment complex to depths of 7.9 m and 3.6 m. Additionally, six test pits were advanced to supplement the test holes along the northern side of the proposed strata road. The attached Test Hole and Test Pit Location Plan, drawing number 8298-1, shows a general layout of the proposed area for development and testing locations.

Subsurface soil conditions generally consisted of a very thin lay of surficial organic topsoil overlying native sand in variable thicknesses, which was underlain by a brown clay layer. The clay layer extended to depth (approximately 3.6 m below ground surface) in TH22-02 but transitioned to silty sand with some cobbles below approximately 4 m in TH22-01, before meeting auger advancement refusal at 7.9 m below ground surface.

Supplementary test pits were excavated to the limit of the excavator at variable depths. The stratigraphy generally consisted of a layer of sandy topsoil/organics followed by a clay layer in test pits TP22-01, and TP22-03 to -06. We note that TP22-02 consisted of dense glacial till beneath the topsoil/organics layer and that glacial till was also observed under the clay layer in TP22-03. Detailed Test Hole Logs and the Summary of Test Pit Information are attached.

Long term groundwater observations were not undertaken as part of our work at this site, however, seepage was observed in most test pits at the base of the excavation or where there was a stratigraphy change from permeable to less permeable soils (i.e., sand over clay or glacial till). Our experience in the general area suggests that the groundwater table is on the order of 4 to 5 m or more in depth. The relatively impermeable nature of the clay soils present at depth precludes free water conditions, although groundwater influx into excavations backfilled with more permeable material may occur over time. Perched water table conditions could be experienced during and

after periods of heavy or prolonged precipitation, resulting in surface ponding and/or groundwater flow from more permeable soils overlying the hard brown clay or glacial till.

GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

Based on the above, we consider the proposed development to be geotechnically feasible, however, some careful consideration for temporary/permanent groundwater management will be necessary. Finalized building layout and grading plans should be provided once available for review of potential slope stability.

We anticipate that excavations to remove organic soils could readily be completed with hydraulic excavator equipment with suitable bearing soils to be reached at depths between 0.6 to 1.4 m below existing site grade. The native clay and sandy soils encountered are considered capable of supporting standard concrete spread footing foundations as well as paved or unpaved road structure.

Seismic Considerations

Campbell River is situated in a region of relatively high seismicity. Earthquake risk exists stemming from our proximity to the Cascadia subduction zone and numerous more local faults in southwestern BC and northwestern Washington State. Based on the observed and anticipated geological conditions at the site, the shear wave velocity in the upper 30 m (V_s^{30}) is expected to be between 360 and 760 m/s. This corresponds to a Site Classification for Seismic Site Response of 'C', in accordance with the current BC Building Code.

Excavation Considerations

For townhome construction and installation of civil infrastructure, excavation for footing construction will remain generally shallow on the order of up to 1.4 m below grade. For the proposed apartment structure, we expect the excavation will advance to a depth of up to 3.5 m for the construction of the underground parkade.

Excavation and shoring requirements (if any) are highly dependent on the final building design and parkade layout. The proximity of below grade foundation walls to property lines, utilities, sensitive areas, and water table elevation may preclude the use of open cuts in which case shoring would be required.

The stability of excavation cutslopes can vary depending on the actual soil conditions encountered, the presence of static or perched groundwater seepage, weather conditions, and the amount of time that they remain open. For planning purposes, we expect that temporary

excavation cutslopes within the observed subsurface materials will be stable at the following configurations:

- Topsoil/Fill materials – 1H:1V (Horizontal: Vertical)
- Native compact to dense sand, clay, and glacial till (above water table) – between 0.75H:1V and 1H:1V

Open cutslopes within sand that is subject to seepage may prove challenging to remain stable. When exposed, the sand and water tend to act as a heavy fluid, often collapsing when cut too steep. Open cuts in this material are not recommended without dewatering beforehand. Overburden soils exposed in open cutslopes should be covered by poly sheeting to protect from weather. All excavations deeper than 1.2 m and steeper than 1H:1V must be assessed by a geotechnical professional in accordance with WorkSafeBC guidelines.

In the event that open cutslopes cannot be accommodated, shoring will be required. Such typically consists of conventional reinforced shotcrete and rock anchors. Shoring requirements will be determined by the location of foundation walls with respect to property boundaries, underground utilities, and protected areas. The installation of such will require subsurface encroachment agreements with neighboring properties for the underground installation of anchors across property lines. Further information can be provided once building plans have been finalized.

Foundations

We expect typical pad and strip footings are the preferred foundation choice. At a minimum, all existing topsoil and loose/disturbed native soils will need to be removed from the proposed building locations. If, after removal of undesirable soils, it is desired to raise the grade back to design grade, backfill should be approved well graded granular material and should be placed in maximum 300 mm lifts and compacted to 95% Standard Proctor Maximum Dry Density (SPMDD). For frost protection, the base of all footings should extend to a depth of at least 450 mm below adjacent finished grades.

The native soils present at the site are capable of providing long term stable support to structures, however all existing topsoil and fill materials must be removed prior to placing footings or before recovering design footing grade by placement of an engineered fill. Provided that the footings bear directly on undisturbed native soils, or engineered fill placed directly atop such, foundation elements can be designed with regard to limit state design (LSD). Serviceability and Ultimate Limit State of 145 kPa and 220 kPa respectively, may be used for sizing of strip footings, and 175 kPa (SLS) and 265 kPa (ULS) may be used for sizing pad footings, which

considers a geotechnical resistance factor of 0.5 as per the current Canadian Foundation Engineering Manual.

Any excavated non-select material should not be reused in areas of structural support for foundations, slab, retaining walls, and hard surfaced pavements, or as retaining wall backfill given the high percentage of fines present in the soil resulting in poor drainage and compaction difficulty.

Care should be taken to not overly disturb the native soil or engineered fill during forming and placement of reinforcement. Any loose or softened/disturbed soil will need to be removed/recompacted prior to pouring concrete. All foundation subgrade areas will need to be inspected by the project geotechnical personnel to confirm the bearing resistance prior to pouring concrete.

We recommend minimum footing widths of 400 and 600 mm for strip and pad footings, respectively. Fill material should be placed upon approved subgrade in maximum 300 mm lifts and compacted to a minimum of 95% of Standard Proctor Maximum Dry Density (SPMDD). In perimeter areas, it is inadvisable to have the fill splay extend beyond property lines.

Foundation Wall Backfill

Foundation walls should be backfilled with clean, well graded granular material, with less than 5% passing the #200 sieve. Backfill should be placed and compacted in maximum 300 mm lifts to at least 95% of the SPMDD value. Additionally, adequate drainage should be provided for the backfill to prevent the buildup of hydrostatic pressure against foundation walls.

Foundation walls can be designed based on the attached Lateral Earth Pressure Diagrams and the following lateral earth pressure coefficients:

Lateral Earth Pressure Coefficient			
Wall Type	**Static K**		**ΔK_e**
Yielding (unrestrained)	Active (K_a)	0.25	0.18
Non-yielding (restrained)	At-Rest (K_o)	0.43	0.34

A yielding wall is able to move a minimum of 0.2% of the height of the wall to allow active pressures to development. Where such movement cannot occur, the non-yielding, at-rest earth pressure coefficient should be used. It is assumed that all walls will yield during the design seismic event. Seismic earth pressures for yielding and non-yielding walls are based on 50% and

100% of the site class C. The above earth pressure coefficients are based on a friction angle of 35 degrees.

In the case where the design assumptions above and noted on the attached diagrams are not satisfied, a site-specific assessment of the lateral earth pressures would be required. Equipment larger than a bobcat should not be allowed within 1.5 m of the foundation walls during backfilling.

Drainage Considerations

Conventional perimeter foundation drainage systems are considered appropriate for this development. The perimeter drains should consist of a perforated drainpipe surrounded by drain rock fully encompassed in a medium weight, non-woven geotextile to prevent the migration of fine-grained soil particles into the drainage system. The drain arrangement should be tied into free draining backfill material around the building. Final site grade should direct surface water away from buildings and foundation areas. Additional drainage around the development will likely be necessary to control groundwater run off/on to site and in areas near steeply sloping terrain (SPEA). Stormwater management and general site grading will be designed by the civil consultant and the final grading plans should be made available for review once prepared.

We consider inground disposal would be challenging at this site given the relatively impermeable nature of the soils encountered. Accordingly, drainage from roof leaders, slab drains, and foundation drains may be disposed of by connecting into nearby underground stormwater services.

Pavement Considerations

In areas of light traffic, 75 mm of asphalt over 250 mm of 20 mm minus crushed rock containing low fines should be sufficient. It may be possible to go to a 50 mm of asphalt over 250 mm of crushed rock, as is typical for low volume roads, but such a structure will deteriorate quicker and may crack slightly more than the 75 mm.

For heavier traffic areas, we suggest 75 mm of asphalt over a minimum of 150 mm of 20 mm minus crushed rock above a further 150 mm of 75 mm minus crushed rock. Alternatively, 300 mm of 20 mm minus could be used provided it is low in fines for good water drainage.

Optimum water content of the replacement fill soils described above is critical to achieve good compaction. We suggest performing spot check in-situ density tests to ensure soils are compacting to 100 % of SPMDD below paved areas.

We trust the preceding is suitable for your purposes at present. Please don't hesitate to contact our office if we can be of further assistance.

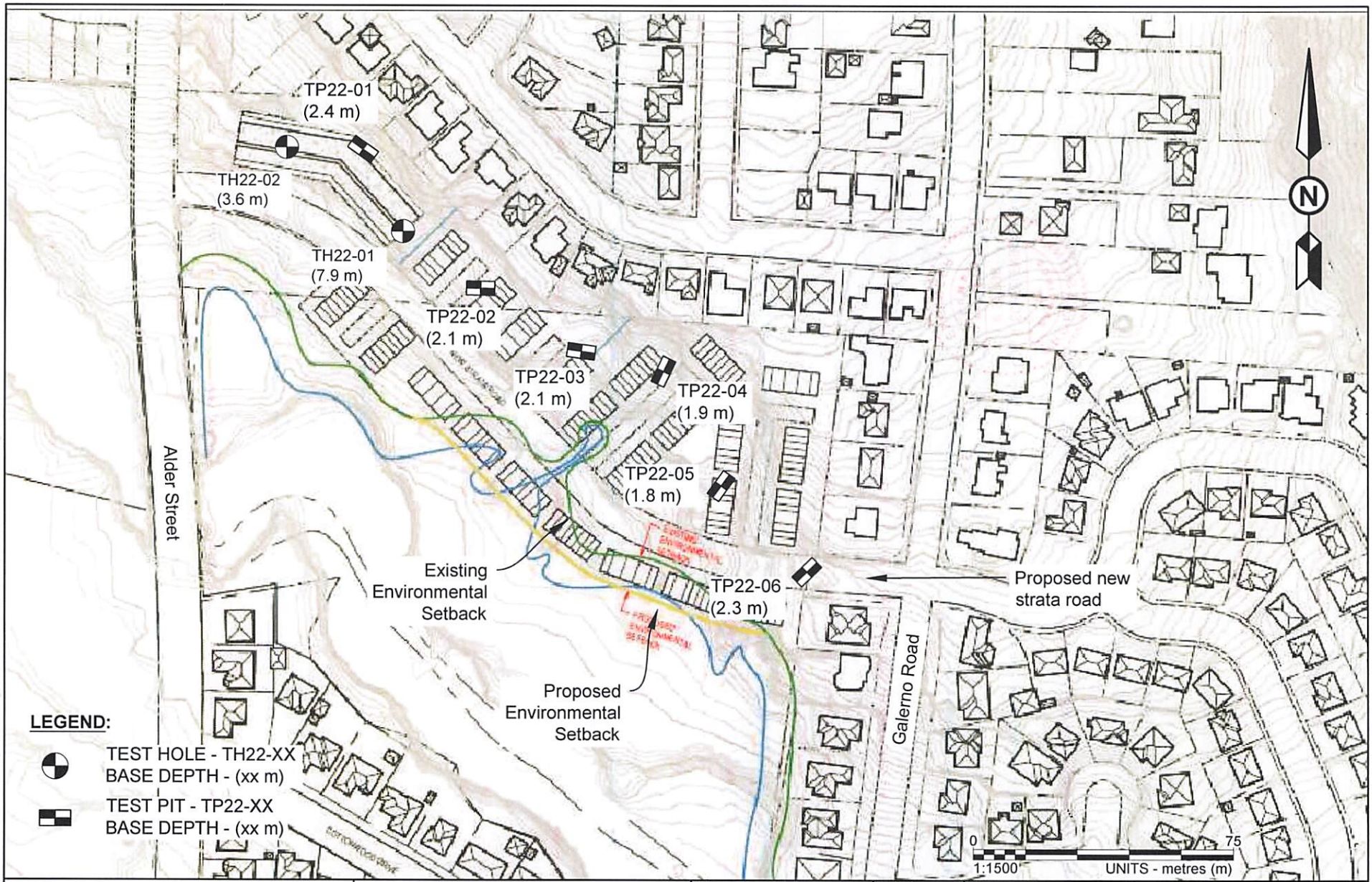
Yours very truly,
Ryzuk Geotechnical
PTPN: 1002996

Sean Gugay, EIT
Junior Engineer

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
C. P. A. SCHELLENBERG
52798
2022/06/03

Cameron Schellenberg, P. Eng.
Intermediate Engineer

Attachments – Test Hole and Test Pit Location Plan
– Test Hole Logs
– Summary of Test Pit Information
– Lateral Earth Pressure Diagram



NOTES

1. This drawing is for the intended use of the client for the specified project, and should not be used elsewhere without the express permission of the client and/or Ryzuk Geotechnical.
2. This drawing is scaled for 8.5x11 sheet and does not require further scaling to fit. Scales will differ if printed on different sheet size.
3. Background imagery recieved from WestUrban Developments Ltd.
4. Test Pit and Test Hole locations accurate up to +/- 5m.

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SEAL

DRAWN BY: SG	CLIENT: WestUrban Developments Ltd.
PROJECT MANAGER: CPAS	PROJECT TITLE: Proposed Multi-Use Development
REVIEW: LGC	PROJECT ADDRESS: 1650 Galerno Rd. - Campbell River, BC
SCALE: 1:1500	DRAWING NAME: Test Hole and Test Pit Location Plan
DATE: 2022/06/01	PROJECT No.: 8298-15
	SHEET No.: 01 of 01
	REVISION: 00

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TEST HOLE LOG

TH22-01

PROJECT: Proposed Mixed-Use Development
CLIENT: WestUrban Developments Ltd.
LOCATION: SEE TEST HOLE LOCATION PLAN
COORDINATES (m): UTM N 5538714 E 340292
COMPLETION DATE: 2022-5-18

PROJECT NO.: 8298-15
METHOD: TRACK MOUNTED AUGER
ELEVATION (m): 25.3
CONTRACTOR: DRILLWELL
LOGGED/REVIEWED BY: SG/CPAS

DEPTH (m)	MUSC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	Recovery (%)	Dynamic Cone (Blows/300mm) 20 40 60 80	COMMENTS	ELEVATION (m)
0	FILL	TOPSOIL						25
		SAND - gravelly, some organics, some cobbles, compact, brown, damp						
1		Red organic staining at 0.9 m						24
	SW	Transitions to silty, trace gravel at 1.5 m						
2								23
				01				
3		CLAY - silty, trace sand, very stiff to hard, brown, damp						
	CL	Transitions to silty-sand at 3.3 m		02				22
4		SAND - silty and gravelly, trace cobbles, compact, grey/brown, moist		03				
	SM							21
		SAND - gravelly, some cobbles, trace silt, compact to dense, grey, moist to wet		04				
5							DCPT hammer no longer advancing through strata and double bouncing, stopped test at 5.2 m in depth	20
6	SW							
								19
7				05				
								18
8		END OF TEST HOLE AT 7.9 m: - auger refusal on dense stratum						17
9								
								16
10								

SAMPLE TYPE ☒ SPLIT SPOON ■ GRAB ▥ SHELBY TUBE ▤ BULK ▮ CORE ⊘ NO RECOVERY

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TEST HOLE LOG

TH22-02

PROJECT: Proposed Mixed-Use Development
CLIENT: WestUrban Developments Ltd.
LOCATION: SEE TEST HOLE LOCATION PLAN
COORDINATES (m): UTM N 5538714 E 340292
COMPLETION DATE: 2022-5-18

PROJECT NO.: 8298-15
METHOD: TRACK MOUNTED AUGER
ELEVATION (m): 25.3
CONTRACTOR: DRILLWELL
LOGGED/REVIEWED BY: SG/CPAS

DEPTH (m)	MUSC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	Recovery (%)	COMMENTS	ELEVATION (m)
0	FILL		TOPSOIL					25
	SW		SAND - gravelly, some cobbles and organics, compact, brown, dry					
1			CLAY - silty, some sand, trace cobbles, trace organics, very stiff to hard, brown, damp	■	01			24
2	CL		Transitions to sandy, silty at 2.1 m	■	02			23
3								22
4			END OF TEST HOLE AT 3.6 m: - auger refusal on dense stratum					21
5								20
6								19
7								18
8								17
9								16
10								

SAMPLE TYPE ☒ SPLIT SPOON ■ GRAB ▥ SHELBY TUBE ▤ BULK ◧ CORE ☒ NO RECOVERY

RYZUK GEOTECHNICAL
ENGINEERING & MATERIALS TESTING

Practical. Innovative. Experienced.

Project: Proposed Multi-Use Development
1650 Galerno Rd. – Campbell River, BC
Client: WestUrban Developments Ltd.

Investigation Date: May 18, 2022
Location: See Location Plan drawing 8298-15

Inspector: SG
Ryzuk Job Number: 8298-15

Summary of Test Pit Information

Test Pit 22-01

Stratigraphy

0	to	1.4 m	TOPSOIL/ORGANICS – sandy
1.4	to	2.4 m	CLAY – trace sand, very stiff to hard, brown, organic staining, mottled
	at	2.4 m	End of Test Pit in native soil

Notes: Light to moderate seepage observed at the base

Test Pit 22-02

Stratigraphy

0	to	1.1 m	TOPSOIL/ORGANICS – sandy
1.1	to	2.1 m	Glacial Till – silty and cobbly, some sand, dense, brown, damp
	at	2.1 m	End of Test Pit in native soil

Notes: Moderate seepage observed between layer change and at base

Test Pit 22-03

Stratigraphy

0	to	0.6 m	TOPSOIL/ORGANICS – sandy
0.6	to	1.6 m	CLAY – trace sand, stiff to very stiff, brown, damp to moist
1.6	to	2.1 m	Glacial Till – silty and cobbly, some sand, dense, brown, damp to moist
	at	2.1 m	End of Test Pit in native soil

Notes: Heavy seepage observed at base and between clay/till layer

continued....

Test Pit 22-04

Stratigraphy

0	to	0.9 m	TOPSOIL/ORGANICS – sandy
0.9	to	1.9 m	CLAY – trace sand, brown, damp to moist, mottled, orange organic staining
	at	1.9 m	End of Test Pit in native soil

Notes: Light seepage at base

Test Pit 22-05

Stratigraphy

0	to	1.1 m	TOPSOIL/ORGANICS – sandy
1.1	to	1.8 m	CLAY – some cobbles, trace sand, brown, damp
	at	1.8 m	End of Test Pit in native soil

Notes: No seepage observed, excavator could not advance beyond 1.8 m in depth due to density of strata

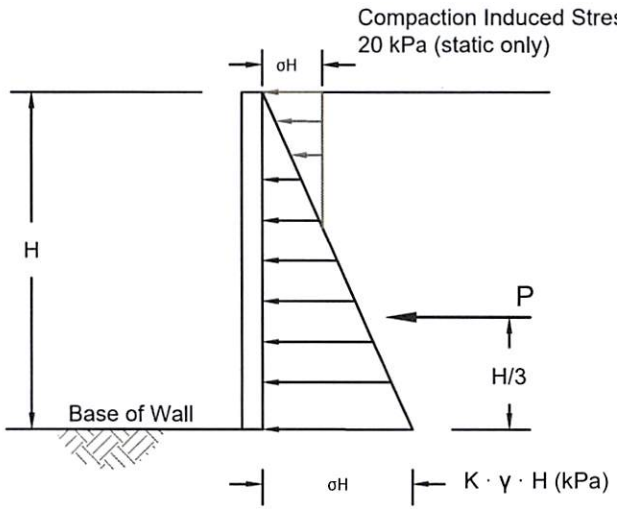
Test Pit 22-06

Stratigraphy

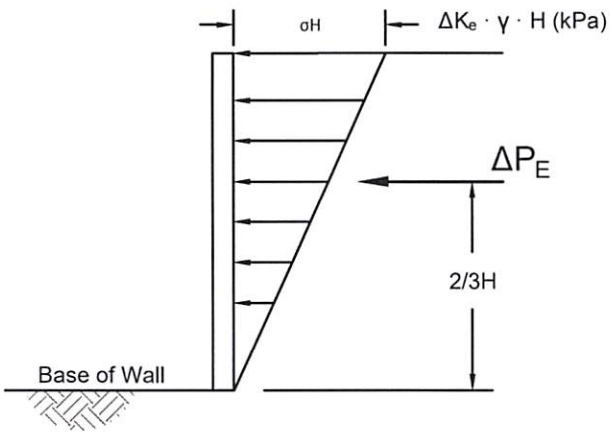
0	to	0.9 m	TOPSOIL/ORGANICS – sandy
0.9	to	2.3 m	CLAY – cobbly, trace sand, stiff, brown, damp
	at	2.3 m	End of Test Pit in native soil

Notes: No seepage observed

Lateral Earth Pressures STATIC CONDITIONS

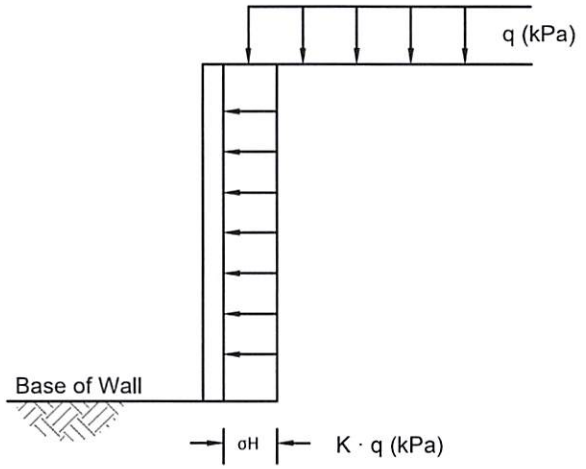


Lateral Earth Pressures SEISMIC INCREMENT (Added to Static Earth Pressures)



Dynamic Load to be added to Static Lateral Pressures

Uniform Surcharges, q (Floor Loads or Traffic Loads)



σH* = Lateral Pressure from Uniform Surchage

*Only applicable where surchage load is less than 30% of total lateral load on wall

Where:
γ = Dry Backfill unit weight 20.4 kN/m^3
H = Wall height (m)
σH = lateral earth pressure (kPa)
P = Resultant load (kN)
K = dimensionless coefficient, K_a or K_o (see Report)

Analysis Assumptions:

- Wall friction is half the soil
- Drainage is provided, such that hydrostatic pressures do not develop against wall
- Dynamic loading based on 50% of the Peak Ground Acceleration (PGA) for yielding wall and 100% PGA for a non-yielding wall
- Yielding wall assumes that wall movement of 0.2%H (rotation or translation) is possible
- The grade is flat and level adjacent to the wall
- No surcharge loads from adjacent structures or stockpiles within a horizontal distance equal to the wall height
- No equipment larger than a skid steer permitted within 1.5 m of the wall during backfill
- Compaction induced stresses will be relieved during a seismic event and are not included in Seismic load

NOTES

1. Above Diagrams are not to scale
2. All loads are unfactored.

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LATERAL EARTH PRESSURE DIAGRAMS

UPDATED MAY 2021