Integrated Rainwater Management Plan

Nexst Properties
57 Lakewood Drive, Vancouver

September 29, 2020 – Issued for CoV Rezoning Application

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1. Purpose

The purpose of this report is to outline the rainwater management strategy proposed for the 57 Lakewood Drive development and how it complies with City of Vancouver's Citywide Integrated Rainwater Management Plan (IRMP) criteria and Rainwater Management Bulletin (2018).

2. Project Description

The site, located at 57 Lakewood Drive in the municipality of the City of Vancouver, is bound by Dundas Street to the north, Lakewood Drive to the east, a laneway to the south and a private property to the west.

The existing site is composed of a multi-storey warehouse building and an outdoor paved parking lot / laydown area. This site is covered mostly by impermeable surfaces, including building rooftop and asphalt parking, with a small portion of absorbent landscaping. For an existing site plan and orthophoto, refer to *Appendix A – Pre-Development Site Plan*.

The proposed redevelopment consists of one multi-storey mixed-use rental residential building with at-grade commercial retail space and two integrated below grade parking levels. Outdoor and rooftop amenity spaces have been incorporated into the design, of which provides absorbent landscaping areas within the site.

3. Performance Objectives

The current edition of the City of Vancouver's Rainwater Management Bulletin (2018) outlines three key pieces of rainwater management criteria, those being:

- **Volume Reduction:** Capture the first 24mm that falls onto the site from all areas (including rooftops, paved areas, and landscape surfaces) in any 24-hour period and infiltrate, evaporate, or reuse it.
- **Release Rate:** Peak flow rate discharged under post-development condition must be less than the peak flow rate under pre-development condition.
- **Water Quality:** The first 24mm of rainfall from all surfaces must be treated to remove 80% of Total Suspended Solids (TSS), with this increasing to 48mm for all high pollutant surfaces (i.e. roads, driveways, parking areas, etc.).

In addition, it is our understanding that the Rainwater Management Bulletin (2018) requires the applicant to prioritize methods of IRMP infrastructure using a tiered approach, as follows:

- **1st Tier**: Provide volume reducing green infrastructure practices. For example, rainwater can be kept on site for rainwater harvesting for re-use, green roofs, and soil infiltration.
- **2nd Tier**: Provide treatment and retention in non-infiltrating landscapes. For example, rainwater can be directed to absorbent landscape on slab, closed bottom planter boxes, and lined bioretention systems.
- **3rd Tier:** Provide detention and water quality treatment as per release rate control requirements.

4. Rainwater Management Plan

The exposed surfaces of the proposed development will be predominately impervious (i.e. asphalt, roof, concrete). Soft landscaping areas have been introduced throughout the site, in the form of absorbent landscaping and closed bottom on-slab planter boxes. For a post-development site plan that summarizes the different surface finish types, refer to *Appendix B – Proposed Development Site Plan*. An area breakdown for the exposed impervious and pervious surfaces is shown in the table below:

Treatment	Area (m^2)
Hard Surfaces (Impervious)	
Asphalt	133.8
Roof	1,546.1
Concrete	268.2
Subtotal – Hard Surfaces	**1,948.1**
Soft Landscaping (Pervious)	
Absorbent Landscape	294.7
Subtotal – Soft Landscapes	**294.7**
Total Exposed Site Area	**2,242.8**

The proposed development contains 86.9% impervious surfaces (asphalt, roof, concrete) and 13.1% pervious surfaces (absorbent landscape areas).

4.1 Volume Reduction

The City of Vancouver's Rainwater Management Bulletin stipulates that the first 24mm of rain that falls across the entire site must be captured and infiltrated, evaporated, or reused per the tiered hierarchy as outlined in Section 3 above. This required retention volume is calculated as:

Site area = 2,242.8 m^2

Required Rainfall Capture Volume = 2,242.8m^2 × 24mm = 53.8m^3

To capture this volume over the project footprint, an infiltration trench (tier 1), soil infiltration through landscaping (tier 1), landscaping on slab and planter boxes (tier 2) will be utilized.

An infiltration trench (tier 1) will be located on the northern side of the site and sized to capture approx. 46.8m^3 of rainfall runoff from all impervious surfaces across the site. The runoff captured by this infiltration trench will be introduced / infiltrated into existing soils. The remaining 7.1m^3 will be retained within landscaping growing medium (tier 1) and on slab landscaping and planter boxes (tier 2).

4.1.1 Infiltration Trench

An infiltration trench will be utilized on the northern side of the site (north of the below ground parkade structure) to capture runoff from hardscape surfaces (roofs, balconies, asphalt, concrete). Runoff will be pre-treated by a proprietary treatment device (see Section 4.3) prior to discharging into the infiltration trench. After the runoff occupies the infiltration trench, it will slowly infiltrate into the surrounding soil.

The infiltration trench is designed to capture 24mm of rainwater from all impervious areas. A total of 1,948.1 m^2 of impervious surface will be directed to the infiltration trench, therefore, the trench must retain a minimum of 46.8m^3 runoff volume.

Total Impervious Area = 2,242.8 m^2 – 249.7 m^2 = 1,948.1 m^2

Required Rainfall Capture Volume = 1,948.1m^2 × 24mm = 46.8m^3

For a typical example of an infiltration trench design, refer to *Appendix C – Infiltration Trench*. The infiltration trench will have a drain rock depth of 2.0m, be 3.0m wide and 20.0m in length. The trench will be sized to retain 48.0m^3. Note that this infiltration trench sizing is preliminary and will be further refined through detailed design.

Volume of Infiltration Trench = length × width × depth × drain rock porosity

= 20.0m × 3.0m × 2.0m × 0.4 = 48.0m^3

According to the Metro Vancouver Stormwater Source Control Design Guidelines (2012), infiltration trenches shall be designed such that the ratio of site impervious area to the trench base area (I/P ratio) does not exceed the given maximum I/P ratio as specified in the criteria. The maximum allowable I/P ratio per the Metro Vancouver design guidelines is 50:1 for roof areas and 20:1 for parking areas. Knowing the impermeable surface distribution being directed to the infiltration trench, a weighted maximum allowable I/P ratio can be determined as follows:

Area of Impermeable surface (Roof) = 1,546.1 m^2 (79.4% of Impermeable Surfaces)

Area of Impermeable surface (Concrete) = 268.2 m^2 (13.7% of Impermeable Surfaces)

Area of Impermeable surface (Asphalt / Parking) = 133.8 m^2 (6.9% of Impermeable Surfaces)

Weighted Maximum I/P Ratio = 50 (Roof) × (0.794 + 0.137) + 20 (Parking) × 0.069= 47.9

The actual I/P ratio for the proposed infiltration trench is calculated as:

Base Area of Proposed Infiltration Trench = 3.0m × 20.0m = 60.0m^2

Total Area of Impermeable surface = 1,948.1m^2

Calculated I/P Ratio of Proposed Infiltration Trench = 1948.1 m^2 / 60.0m^2 = 32.5

The calculated I/P ratio of the proposed infiltration trench is 32.5. This does not exceed the maximum weighted I/P ratio of 47.9, meaning the infiltration trench meets the requirements outlined in the Metro Vancouver design guidelines.

4.1.2 Landscaping and Planter Boxes

Absorbent landscaping areas and planter boxes are located on ground level, terraces, and rooftop, covering approximately 13.1% of the site, or 294.7m^2.

Assuming landscaping has a minimum 0.3m depth of topsoil, a reasonable field moisture capacity of 30% for the soil layer and a wilting point of 10%, the available water holding capacity in the topsoil is 17.7m^3. This exceeds the minimum 7.1m^3 requirement of rainfall capture volume (294.7m^2 × 24mm). See calculation below:

Landscape area = 294.7m^2

Required Rainfall Capture Volume = 294.7m^2 × 24mm = 7.1m^3

Proposed Capture Volume = 294.7m^2 × 0.3m (depth of topsoil) × [30% (field moisture capacity of the soil layer) – 10% (wilting point)] = 17.7m^3

For the purpose of this analysis, it is assumed that all impervious hard surfaces (including building roofs, asphalt, and concrete surfaces) will not drain into landscaped areas. It is instead expected that runoff will be directed into internal piping systems and in turn, to a proprietary treatment system prior to being discharged into the infiltration trench.

4.2 Release Rate

The rainwater management system for the building and overall site will be designed such that the discharge rate of the post-development condition is not greater than the peak pre-development flow rate.

4.2.1 Pre-development Conditions

The existing site is composed of a multi-storey warehouse building and an outdoor parking lot / loading bay with absorbent landscaping areas. It is estimated that 78.7% of the site is covered by impervious hard surfaces (paved asphalt and roof), while 21.3% is pervious. The pre-development site area measures approximately 2,242.8m^2.

The City's 2014 IDF curve was used to evaluate the peak 10-year, 5-minute runoff from the site. This pre-development peak flow is estimated at **0.04 m^3/s**. The post-development flow rate will not exceed this pre-development flow. Refer to *Appendix D* for reference calculations.

4.2.2 Post-development Conditions

The redevelopment site area is consistent with the pre-development condition (2,242.8m^2). The post-development site is composed of 86.9% impermeable surface and 13.1% of pervious surfaces.

4.2.3 Release Rate Control

Per the City's Rainwater Management Bulletin, the post-development release rate during a 2100 IDF, 10-year event must be moderated such that it does not exceed the peak

pre-development flow rate (0.04 m^3/s). Note that this 0.04m^3/s flow is the maximum allowable offsite discharge during a 2100 IDF, 10-year storm event.

Typically, a flow control manhole (complete with an upstream detention tank) would be installed onsite to moderate the offsite flow to pre-development conditions. However, given that the onsite infiltration trench storage capacity is 48.0m^3, neither a flow control manhole nor a detention tank is required. The onsite storm sewer will be configured such that all site runoff will first be directed to the infiltration trench prior to any runoff being discharged offsite. In other words, the first 48.0m^3 of rainfall that enters the onsite storm sewer system will be retained onsite; any rainfall volume beyond 48.0m^3 will be directed to the municipal system.

Appendix E – Detention Requirements: Modified Rational Method, shows a family of hydrographs for different duration 2100 IDF, 10-year events. The required storage volumes shown in these calculations assume that there is no flow being discharged offsite – i.e. all onsite runoff is first directed to the infiltration trench, so offsite release rate = 0 m^3/s up until 48.0m^3 rainfall volume. Based on the calculations, after a 10-minute storm duration event, the post-development peak flow rate drops below the allowable pre-development flow rate of 0.04 m^3/s. The total rainfall volume at this 10-minute duration is 23.4m^3 (29.3m^3 when applying a 1.25 safety factor). Therefore, **a flow control manhole or detention tank is not required**, as the infiltration trench has adequate capacity (48.0m^3) to retain all rainfall that falls when the peak post-development flow is greater than the allowable pre-development flow.

4.3 Water Quality

The City's water quality treatment requirement is that the first 24mm of rainfall from all surfaces and 48mm from surfaces with high pollutant loads must be treated to remove 80% of total suspended solids (TSS). All rainfall runoff across the site (excluding landscaped areas) will be directed to a proprietary treatment device before being discharged to the infiltration trench. Flow will only be discharged to the existing municipal storm sewer when the infiltration trench meets the maximum capacity.

Per the City's quality treatment requirements, the treatment device selected for the project must be certified by Environmental Technology Verification (ETV) Canada (superseded by the new ISO 14034 ETV as of April 1, 2017) or the Washington State Department of Ecology's Technology Assessment Protocol (TAPE) to remove 80% of TSS (Total Suspended Solids). The make, model and sizing criteria for the treatment unit unit will be provided at DP submission stage.

5. Operations and Maintenance Considerations

A site-specific Operations and Maintenance (O&M) Manual for all integrated rainwater management infrastructure will be provided at DP submission stage.

6. Closing

An integrated rainfall management plan has been prepared to support the proposed development (rezoning application) of 57 Lakewood Drive site in the City of Vancouver, in accordance with the Citywide Integrated Rainwater Management Plan (IRMP) criteria and the Rainwater Management Bulletin (2018). From the use of an infiltration trench (tier 1), soil infiltration through landscaping (tier 1), landscaping on slab and planter boxes (tier 2), green infrastructure practices were prioritized and placed where deemed suitable for the project.

7. References

City of Vancouver (2018). Rainwater Management Bulletin. Retrieved September 2018 at: https://vancouver.ca/docs/bulletins/Rainwater-Management-Bulletin.pdf

City of Vancouver. (2016). Best Management Practice Toolkit (Volume II of the Citywide IRMP). Retrieved August 2018 at: https://vancouver.ca/files/cov/integrated-stormwater-management-best-practice-toolkit-volume-2.pdf

City of Vancouver. (2017). Green Buildings Policy for Rezoning – Process Requirements. Retrieved August 2018

Kerr Wood Leidal. (2017). Rain Gardens: Design, Implementation and Maintenance Considerations. Retrieved August 2018. at: https://www.kwl.ca/sites/default/files/RainGardens-paper-OCR.pdf

Metro Vancouver. (2012). Stormwater Source Control Guidelines – Final Report. Retrieved August 2018 at: http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/StormwaterSourceControlDesignGuidelines2012StormwaterSourceControlDesignGuidelines201

Appendix A

Pre-Development Site Plan – InterCAD

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LEGEND

	DEVELOPMENT AREA 2242.9 sq.m = 2.24 ha
	ABSORBENT LANDSCAPE 477.19 sq.m = 21.3%
	CONCRETE 38.3 sq.m = 1.7%
	ASPHALT / PARKING 735.3 sq.m = 32.8%
(REMAINDER)	ROOF 992.1 sq.m = 44.2%

SURFACE CLASSIFICATIONS

PERCENT PERMEABLE = 21.3%

PERCENT IMPERMEABLE = 78.7%

RUN-OFF COEFFICIENTS

(CoV DESIGN CRITERIA MANUAL, SECTION 5.2.2.1)

ABSORBANT LANDSCAPE = 0.08

CONCRETE = 0.80

ASPHALT = 0.83

ROOF = 0.85

COMBINED COEFFICIENT

= 0.68

0 5 10 15

1:250

IRMP - PRE-DEVELOPMENT SITE PLAN

57 Lakewood Drive
Nexst Properties

InterCAD Services Ltd. CONSULTING ENGINEERS

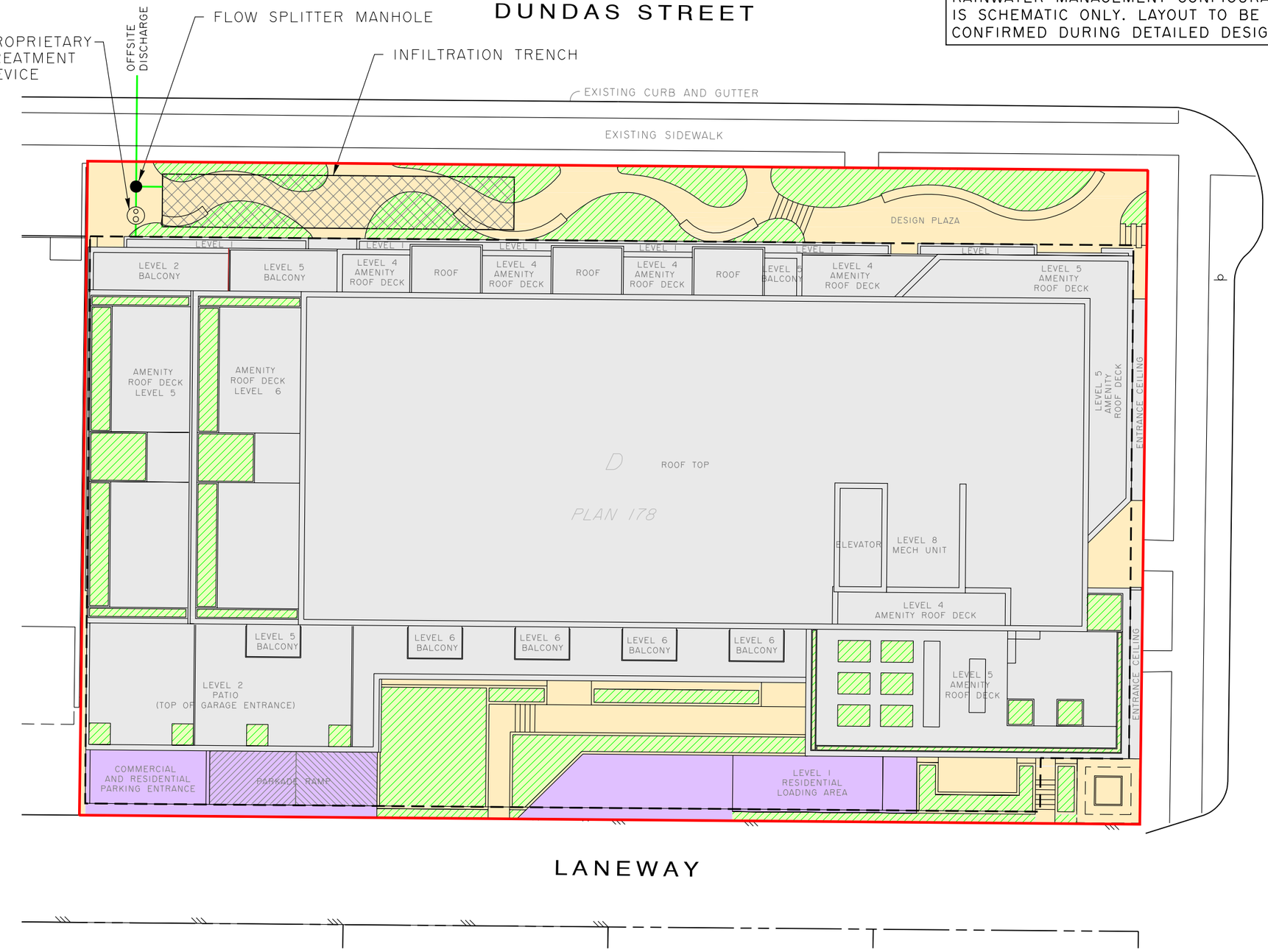
Appendix B

Proposed Development Site Plan – InterCAD

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InterCAD Services Ltd. CONSULTING ENGINEERS

RAINWATER MANAGEMENT CONFIGURATION IS SCHEMATIC ONLY. LAYOUT TO BE CONFIRMED DURING DETAILED DESIGN.



LEGEND

- DEVELOPMENT AREA
  2242.8 sq.m = 0.22 ha
- ABSORBANT LANDSCAPE
  294.7 sq.m = 13.1%
- ROOF
  1546.1 sq.m = 68.9%
- ASPHALT / PARKING
  133.8 sq.m = 6.0%
- CONCRETE
  268.2 sq.m = 12.0%
- UNDERGROUND PARKADE EXTENT

SURFACE CLASSIFICATIONS

PERCENT PERMEABLE = 13.1%

PERCENT IMPERMEABLE = 86.9%

RUN-OFF COEFFICIENTS

(CoV DESIGN CRITERIA MANUAL, SECTION 5.2.2.1)

ABSORBANT LANDSCAPE = 0.08

CONCRETE = 0.80

ASPHALT = 0.83

ROOF = 0.85

COMBINED COEFFICIENT

= 0.08 x 0.131 + 0.85 x 0.689 + 0.83 x 0.06 + 0.80 x 0.12

= 0.74

0 5 10 15

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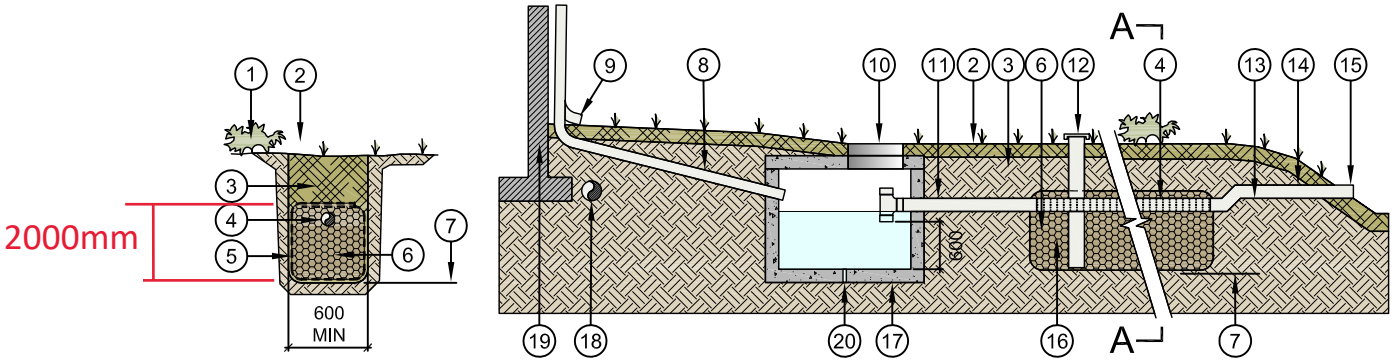
IRMP - POST-DEVELOPMENT SITE PLAN

57 Lakewood Drive
Nexst Properties

Appendix C

Infiltration Trench – Metro Vancouver

1. GRASS OR OTHER PLANTING
2. FINISH GRADE
3. GROWING MEDIUM BACKFILL
4. 100mm DIA PVC DR28 PERFORATED PIPE
5. LIGHT NON-WOVEN GEOTEXTILE C/W MIN. 400mm LAPS
6. 50mm DRAIN ROCK OR ROCK OF EQUAL POROSITY
7. MAXIMUM GROUNDWATER ELEVATION
8. NON-POLLUTED DRAINAGE FROM BUILDING OR TERRACE
9. ALTERNATE SURFACE ROUTE - WITH SPLASH PAD AND VEGETATED SWALE TO CB
10. CB LID / ACCESS HATCH FOR CLEANOUT, INSPECTION AND INFLOW / OVERFLOW FROM SUMP
11. 100mm DIA PVC SOLID PIPE C/W INLET TEE
12. OBSERVATION WELL (OPTIONAL)
13. INVERT TO TOP OF INFILTRATION PIPE (APPROX.)
14. 100mm DIA PVC SOLID PIPE
15. DISCHARGE TO STORM DRAINAGE SYSTEM. ENSURE DRAINAGE DOES NOT IMPACT NEIGHBOURING USES. DIRECT DISCHARGE TO ROAD RIGHT-OF-WAY IF NECESSARY
16. INFILTRATION TRENCH WITH LEVEL BOTTOM
17. CATCH BASIN
18. BUILDING FOOTING DRAIN (NOT CONNECTED TO INFILTRATION FACILITY)
19. BUILDING
20. 50mm DIA MIN. DRAIN HOLE



SECTION A-A

SECTION FROM WATER SOURCE TO INFILTRATION TRENCH

7 D

INFILTRATION TRENCH

Not To Scale

Section

*Exact configuration and dimensions to be determined during detail design

Appendix D

Pre-Development Peak Flow Calculations - InterCAD

InterCAD

IRMP CALCULATIONS

Client :	**Nexst Properties**	File:	**AE69**
Project:	**57 Lakewood Drive**	Date:	**Sep 1, 2020**
Subject	**Pre-Development Flow Conditions**	By:	**CL**

The pre-development design flow is calculated using the Rational Method and the City of Vancouver 2014 IDF Curve (see City of Vancouver Engineering Design Manual, Section 5.2.2.2) with a 10-year return period (for business, comercial and industrial areas, see City of Vancouver, Design Criteria Manual, Section 5.2.1). The Rational Method is defined as:

$Q = CIA / 360$

- Q = Design Flow (m^3/s)
- C = Runoff Coefficient (pre-development combined run-off coefficient)
- I = Rainfall Intensity (mm/hr)
- A = Site Area (ha)

Rainfall Intensity (I) = $A \times T^B$

- A = IDF Equation Coefficient (see City of Vancouver Engineering Design Manual, Section 5.2.2.2)
- B = IDF Equation Coefficient (see City of Vancouver Engineering Design Manual, Section 5.2.2.2)
- T = Time of Concentration (hour) (see City of Vancouver Engineering Design Manual, Section 5.2.1)

Determine Rainfall Intensity (I). For a 10-year return period using the City of Vancouver 2014 IDF curve:

A =	**23.56**	
B =	**-0.548**	
T =	**5**	min

Rainfall Intensity (I) = $A \times T^B$ = **92** mm/hr

Determine the **pre-development, 10-year design flow (Q)** using the Rational formula:

C =	**0.68**	
I =	**92**	mm/hr
A =	**0.22**	ha

Design Flow (Q) = $CIA / 360$ = **0.04** **m^3/s**

Appendix E

Detention Requirements: Modified Rational Method - InterCAD

InterCAD

IRMP CALCULATIONS

Client :	**Nexst Properties**	File:	**AE69**
Project:	**57 Lakewood Drive**	Date:	**Sep 8, 2020**
Subject	**Retention Volume Requirements (No Flow Control Manhole)**	By:	**CL**

The rainwater management system is to be designed such that the post-development flow (2100 IDF Curve, 10-year flow) is no greater than the pre-development flow (2014 IDF Curve, 10-year flow). The storage volume requirement for stormwater retention is determined using the Modified Rational Method. Required storage volume is equal to:

$$V = T_R \times (Q_{P2} - Q_{REL}) + 0.5 \times T_C \times Q_{REL}^{\ 2} \times (1/Q_{P2} - 1/Q_{P1})$$

V = Required Storage Volume (m^3)

T_R = Storm Duration (sec)

T_C = Time of Concentration (sec)

Q_{P1} = Peak Flow for Storm Duration, where $T_C = T_R$ (m^3/sec)

Q_{P2} = Peak Flow for Storm Duration, T_R (m^3/sec)

Q_{REL} = Maximum Release Rate (pre-development flow; 2014 IDF Curve, 10-year, 5-min event) (m^3/sec)

= $0.04 m^3$/sec

$Q = CIA / 360$

Q = Design Flow (m^3/s)

C = Runoff Coefficient (post-development combined run-off coefficient)

I = Rainfall Intensity (mm/hr)

A = Development Area (ha)

In order to calculate the required volume of retention when there is no flow control manhole, Q_{REL} is assumed to be 0, meaning the entire drainage volume is going towards the retention trench.

Rainfall Intensity (I) $= A \times T_R^{\ B}$

A_1 = IDF Equation Coefficient (see City of Vancouver Engineering Design Manual, Section 5.2.2.2)

B = IDF Equation Coefficient (see City of Vancouver Engineering Design Manual, Section 5.2.2.2)

T_R = Storm Duration (hour)

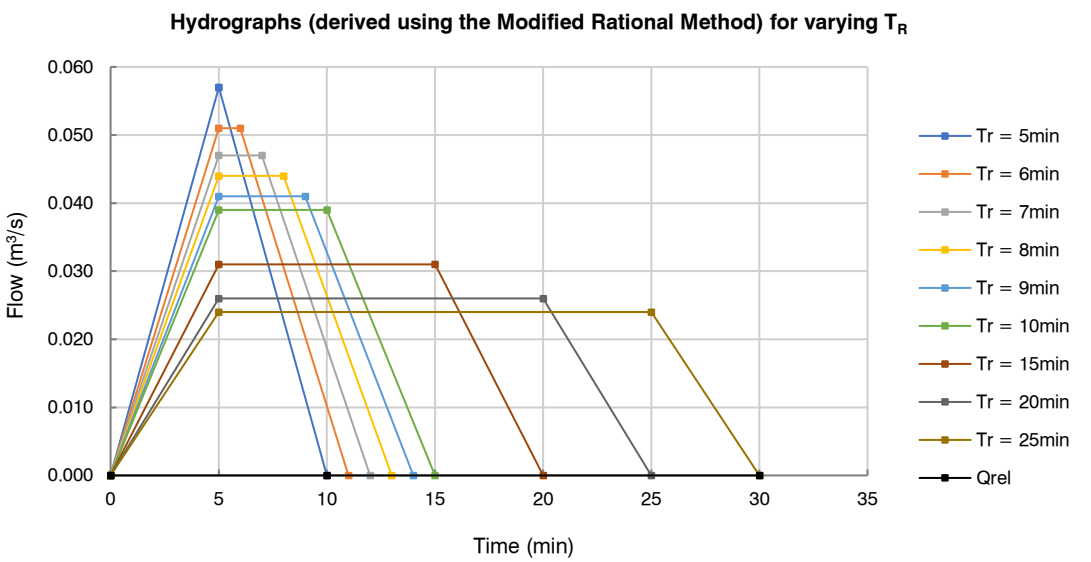
T_C =	**5**	min	
C =	**0.74**		
A =	**0.22**	ha	
A_1 =	**31.32**		
B =	**-0.55**		
Q_{P1} =	**0.057**	m^3/s	
$Q_{A.REL}$ =	**0.00**	m^3/s	(set to zero; assuming all the water drains to infiltration trench)

Client :	**Nexst Properties**	File:	**AE69**
Project:	**57 Lakewood Drive**	Date:	**Sep 8, 2020**
Subject	**Retention Volume Requirements (No Flow Control Manhole)**	By:	**CL**

Determining Rainfall Intensity (I), Peak Flow for T_R Storm Duration (Q_{P2}) and Required Storage Volume (V). Note, where V is indicated as '--', detention is not required as Peak Flow for Storm Duration (Q_{P2}) < Maximum Allowable Release Rate (Q_{REL}):

T_R (min)	I (mm/hr)	Q_{P2} (m^3/s)	V (m^3)	
5	123	0.057	**17.1**	
6	111	0.051	**18.4**	
7	102	0.047	**19.7**	
8	95	0.044	**21.1**	
9	89	0.041	**22.1**	
10	84	0.039	**23.4**	(where peak flow rate drops below the allowable pre-development flow)
15	67	0.031	**27.9**	
20	57	0.026	**31.2**	
25	51	0.024	**36.0**	

Visually representing Required Storage Volume (V) calculations for varying T_R using a family of hydrographs:



Required Storage Volume (V) is indicated by the volume value from the above iteration table, where the Q_{P2} is at Q_{REL}. This is also represented in the hydrographs above, with the required storage volume equaling the maximum area differential of any one of the family of hydrographs above the plotted allowable outflow (Q_{REL}). Applying a Factor of Safety (S_F) to the Required Storage Volume (V):

V =	**23.4**	m^3
S_F =	**1.25**	

Total Required Storage Volume = **29.3** m^3

Appendix F

Geotechnical Report – GeoPacific

GEOPACIFIC
VANCOUVER KAMLOOPS CALGARY

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F 604.429.9189
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1779 W 75th Ave.
Vancouver, B.C. Canada V6P 6P2

Champion Development Group Inc.
75 West 3rd Avenue
Vancouver, B.C.
V5Y 3T8

June 6, 2017
File: 14947

Attention: Gregory Chan

Re: Geotechnical Investigation Report: Proposed Mixed Use Development
57 Lakewood Drive, Vancouver, B.C.

1.0 INTRODUCTION

We understand that a mixed-use development is proposed for the above referenced site. The proposed development will comprise of up to 7 stories of above grade structure constructed over two levels of below grade parking with an anticipated excavation depth of up to 9 m. We understand that the construction will be of reinforced concrete and that the proposed structure will be constructed close to property lines on all sides.

This report has been prepared exclusively for Champion Development Group Inc. for their use, the use of others on their design and construction team and in the development and permitting process. This report presents the results of an investigation of the soil conditions at the proposed development site and also makes recommendations for the design and construction of the proposed structure and foundation.

2.0 SITE DESCRIPTION

The site is located at the southwest corner of the intersection of Dundas Street and Lakewood Drive. The site is rectangular in shape, measuring approximately 60 m in the east-west direction and 38 m in the north-south direction. The site slopes gradually down from the southeast with an approximate 4 m grade differential between the southeast corner and the northwest corner.

The site is bounded to the west by a commercial property, to the north by Dundas Street, to the east by Lakewood Drive and to the south by a laneway.

The site is currently occupied on the eastern half by a warehouse structure with storage and parking to the west.

The location of the site is shown on our Drawing No. 14947-1, following the text of this report.

3.0 FIELD INVESTIGATION

GeoPacific Consultants Ltd. Conducted a geotechnical investigation at the site on May 12, 2017. A total of four augured test holes were advanced using the subcontracted services of Southlands Drilling Ltd. of Delta, BC. The test holes were advanced to depths of up to 12.0 m below the existing site grades and were logged by a technician from our office. Two Dynamic Cone Penetration Tests (DCPTs) were advanced within

BEDROCK (Sandstone)

Sandstone was observed in two of our test holes at depths between 6.4 and 7.3 m below existing grade. The sandstone was observed to be weathered at the interface with the glacial till becoming harder within the first metre of drilling. The cuttings were grey, medium to fine grained sand. A sample of the sandstone near the interface with the overlying till layer was observed to have a moisture content of 9.5%.

Heavily cemented and extremely hard zones of sandstone, commonly referred to as "floaters" may be encountered within the sandstone. Floaters may require splitting or blasting to facilitate their removal.

4.2 Groundwater Conditions

Groundwater was not observed within the test holes. The static groundwater table is expected to be quite deep in this area. However, we expect that perched groundwater may be encountered at the surface of the glacial till, particularly during the wetter winter and spring months.

5.0 DISCUSSION

5.1 General

The preliminary design information suggests that the building will be founded approximately 9 m below existing site grades. At that depth, we would expect foundations would consist of conventional strip and pad footings bearing on bedrock or very dense glacial till.

The subsurface soils are not expected to be prone to liquefaction or other forms of ground softening under the design earthquake defined under the 2014 Vancouver Building Bylaw.

We confirm from a geotechnical point of view that the proposed development is feasible provided the following recommendations are implemented in the design and construction of the development.

6.0 RECOMMENDATIONS

6.1 Site Preparation for Building

Prior to construction of foundations and floor slabs, all vegetation, topsoil, fill, organic material, debris, refuse and loose or otherwise disturbed soils must be removed from the construction areas to expose a subgrade of *dense to very dense unweathered Glacial Till or Sandstone Bedrock.* Stripping depths will likely be governed by slab and footing elevations, rather than soil conditions.

It is very important that the stripped subgrade should be blinded and protected by lean mix concrete to preserve their bearing qualities and that it remain dry and free of ponded water prior to pouring concrete for footings. Any soften, disturbed subgrade should be removed under a review of GeoPacific, and replaced with lean mix concrete beneath the foundations.

Any grade reinstatement beneath building foundations must be done with lean mix concrete. Any lean mix concrete placed should have an unconfined compressive strength of at least 5 MPa at 28 days.

hydraulically connected to the perimeter drainage system to facilitate the removal of any water which accumulates under the slab. Elevator pits and sumps may be tanked rather than lowering the perimeter drainage system in these areas.

The geotechnical engineer shall be contacted for the review of the slab subgrade and underslab materials and compaction.

6.4 Foundation Drainage

A perimeter drainage system will be required for the below grade structure to prevent the development of water pressure on the foundation walls and the basement floor slabs. Groundwater flows are expected to be relatively light. Flow rates should be confirmed at the time of construction by the mechanical designer. Preliminary design can be based on 30 litres / min for the entire site.

6.5 Temporary Excavation, Shoring and Underpinning

Shoring will be required around the perimeter of the site in order to construct the proposed below grade portion of the structure. It is our opinion that the natural soils are sufficiently strong that vertical cuts may be supported with the use of an anchored shotcrete shoring system.

This is the most appropriate method for this site and it is typically the most economical method of shored excavation. Furthermore, we expect the use of conventional anchors is feasible for the majority of the site. However, hollow core (self-drilling) anchors should be anticipated in sandy zones within the till. Underpinning will be required beneath the neighbouring building to the west.

Our observations during our site investigation as well as our experience in this area indicate that cobbles and boulders may be present within the native soils. Cobbles and small boulders can typically be removed with conventional excavation equipment. However, large boulders may require splitting / blasting to facilitate their removal from the site.

Some ground movements should be expected during installation of the shoring system. Based on the soil conditions identified in the test holes and our experience with similar sites, we expect movements of up to about 10 mm at face of excavation, decreasing to 3 mm at 3 m back of the excavation face.

Light to moderate perched groundwater water flows should be expected although we expect that inflows could be handled with conventional sumps and sump pumps.

Shoring and underpinning installation requires review at the time of tie back anchor installations and trimming of panels, prior to shotcrete applications and during tensioning of the tie back anchors.

Temporary cut slopes in excess of 1.2 m in height require inspection by a professional engineer in accordance with WorkSafe B.C. guidelines.

The geotechnical engineer shall be contacted for the review of shoring installation and temporary excavations.

6.6 Earth Pressures on Foundation Walls

Earth pressures against the foundation walls are dependent on factors such as, available lateral restraint

8.0 CLOSURE

This report has been prepared exclusively for our Client for the purpose of providing geotechnical recommendations for the design and construction of the proposed residential development, temporary excavations and related earthworks. The report remains the property of GeoPacific Consultants Ltd. and unauthorised use of, or duplication of, this report is prohibited.

We are pleased to assist you with this project and we trust that this information is helpful and sufficient for your purposes at this time. Should you require any further details or if you would like clarification of any of the above, please do not hesitate to call or contact us.

For:

GeoPacific Consultants Ltd.

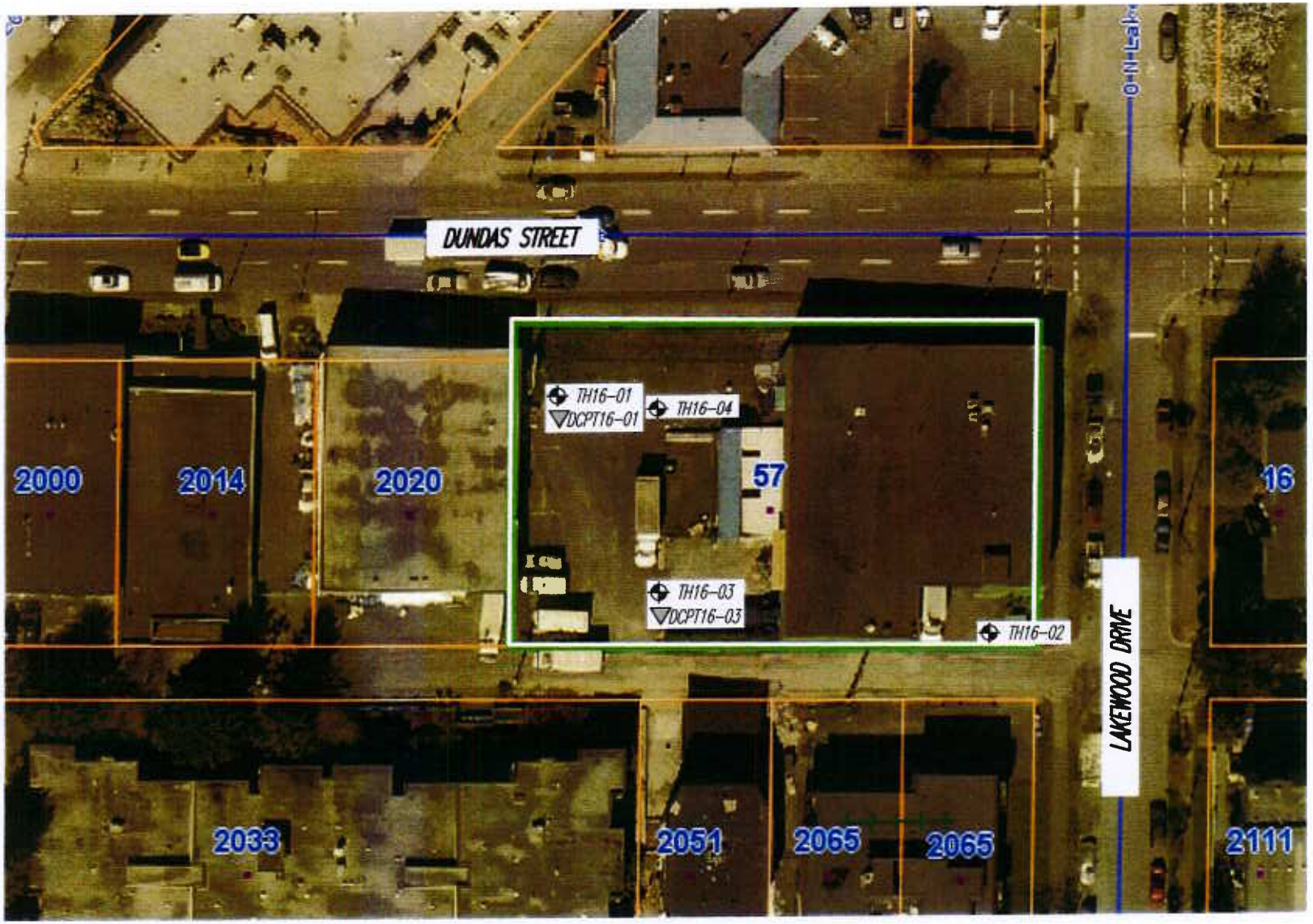
Reviewed by:



JUN 0 6 2017

Kyle Doyle, B. Eng, EIT
Geotechnical Engineer in Training

Matt Kokan, M.A.Sc., P.Eng.
Principal



LEGEND:

- TH17-# – TEST HOLE (TH) LOCATION
- DCPT17-# – DYNAMIC CONE PENETRATION TEST (DCPT) LOCATION
- SITE BOUNDARY

SITE PLAN

SCALE = 1:700

RECEIVED:

GEOPACIFIC
VANCOUVER KAMLOOPS CALGARY
1779 W. 75th Avenue
Vancouver, B.C. V6P 6P2
P 604.439.0922
F 604.439.9189

DATE		
JUNE 04, 2017		
DESIGN BY: K.G.D	APPROVED BY: M.J.K.	DRAWN BY: M.J.K
SCALE: SEE ABOVE		

MIXED USE DEVELOPMENT

57 LAKEWOOD DRIVE, VANCOUVER, BC

TEST HOLE LOCATIONS

FILE NO.: 14947

REC. NO.: 14947-01

REVISIONS:

Appendix A – TEST HOLE DATA

Test Hole Log: TH17-01

File: 14947
Project: Mixed Use Development
Client: Champion Developments
Site Location: 57 Lakewood Drive, Vancouver, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface					
		FILL 4 inches of asphalt overlying dark brown, loose mixed fill.	0.0		2, 2, 3, 13, 19, >50, >50		
		SILT and SAND Mottled brown/grey, dense, silt and sand.	1.1				
		SAND Light brown, very dense, silty sand with trace gravel, wet.	2.1				
		TILL Grey, very dense, silty sand to sand with silt and gravel.		13.6%			
				12.0%			
		SANDSTONE Grey, dry sandstone.	6.4				
				9.5%			
		End of Borehole	9.1				

Logged: KGD
Method: Solid Stem Auger
Date: May 12, 2017

Datum: Existing Ground
Figure Number: A.01

Test Hole Log: TH17-02

File: 14947
Project: Mixed Use Development
Client: Champion Developments
Site Location: 57 Lakewood Drive, Vancouver, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft)	Depth (m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0	0		Ground Surface					
			FILL 4 inches of asphalt overlying compact, red brown sand with silt.	0.0				
	1		***SAND*** Light brown, compact to dense silty sand.	1.5				
	2		***SAND*** Light brown, dense, silty sand with trace gravel.		8.7%			
	3		***TILL*** Grey, very dense, silty sand to sand with silt and gravel. Between 25 - 40 feet driller reports very difficult to drill.	3.0	8.9%			
	4							
	5							
	6							
	7							
	8							
	9							
	10				12.2%			
	11							
	12				10.7%			
40			End of Borehole	12.2				

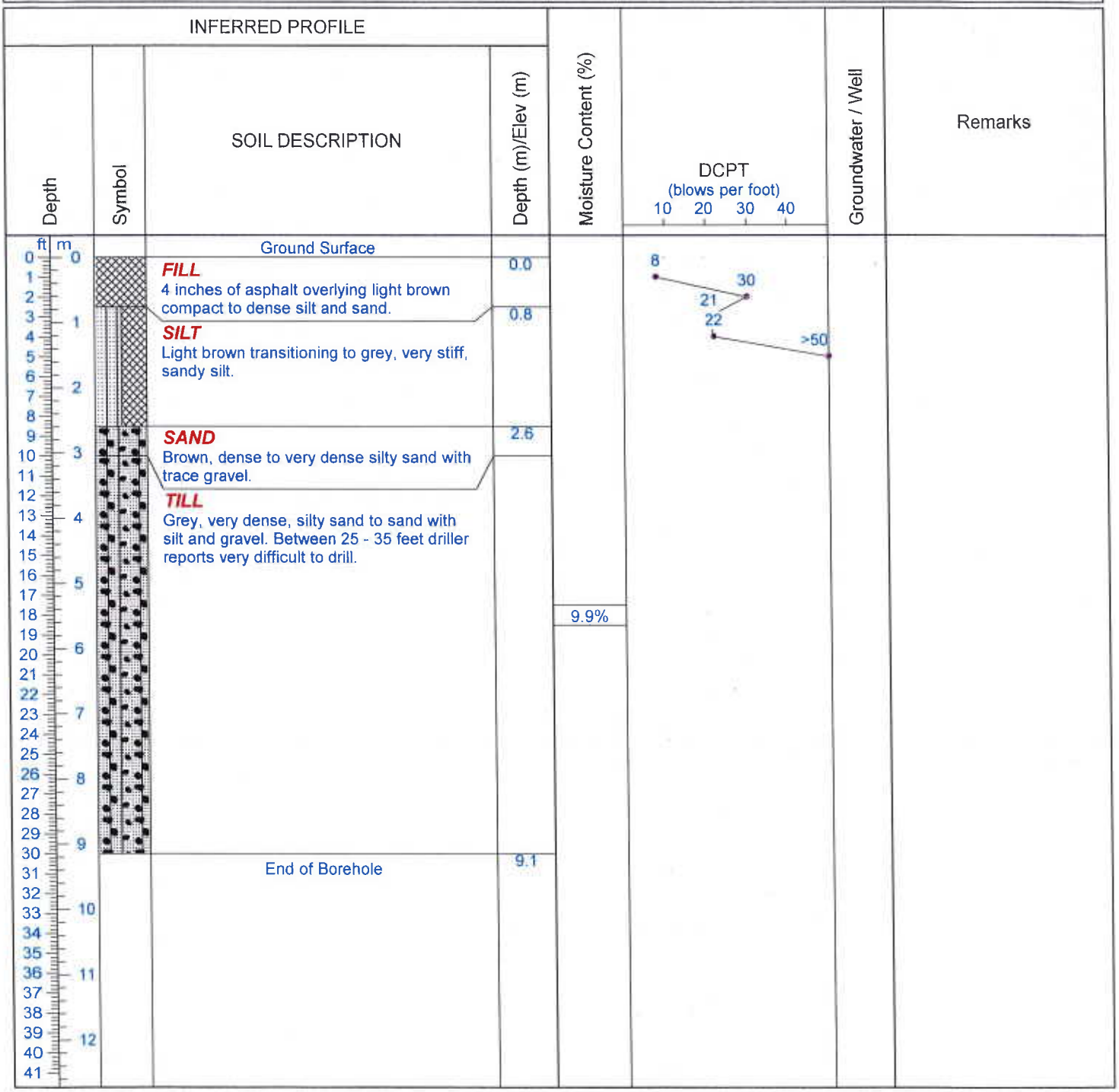
Logged: KGD
Method: Solid Stem Auger
Date: May 12, 2017

Datum: Existing Ground
Figure Number: A.02
Page: 1 of 1

Test Hole Log: TH17-03

File: 14947
Project: Mixed Use Development
Client: Champion Developments
Site Location: 57 Lakewood Drive, Vancouver, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189



Logged: KGD
Method: Solid Stem Auger
Date: May 12, 2017

Datum: Existing Ground
Figure Number: A.03
Page: 1 of 1

Test Hole Log: TH17-04

File: 14947
Project: Mixed Use Development
Client: Champion Developments
Site Location: 57 Lakewood Drive, Vancouver, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	0.0
		FILL 4 inches of asphalt overlying light brown compact to dense silt and sand.	0.6
1		***SILT*** Light brown, very stiff, sandy silt.	1.5
2		***TILL*** Grey, very dense, silty sand to sand with silt and gravel. Between 25 - 35 feet driller reports very difficult to drill.	
3			
4			
5			
6			
7			
8		***SANDSTONE*** Grey, medium grained sandstone.	7.3
		End of Borehole	
9			
10			
11			
12			

Moisture Content (%): 15.7%

DCPT (blows per foot): 10 20 30 40

Groundwater / Well

Remarks

Logged: KGD
Method: Solid Stem Auger
Date: May 12, 2017

Datum: Existing Ground
Figure Number: A.04
Page: 1 of 1

Appendix G

Landscape Plans – Durante Kreuk

Curvy bench with yellow metal back.

Continuity of yellow stripe from building face

Decorative tree

Steps down to Plaza

Public Bike Share per Engineering. To be confirmed.

Yellow stripe pop-up bike rack





Yellow Stripe pop-up bike rack

Plaza Seating

Bench

Residential Entry

privacy hedge

Patio

Patio

Amenity Patio

POTENTIAL FUTURE CRU DEMISING WALLS

LINE OF BUILDING ABOVE

P.M.T.

North

1	Sep---20	Rezoning	
no.:	date:	item:	

Revisions:

durantekreuk

Durante Kreuk Ltd.
102 - 1637 West 5th Avenue
Vancouver BC V6J 1N5

t: 604 684 4611
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Project:

LAKEWOOD + DUNDAS MIXED-USE COMMERCIAL AND RENTAL RESIDENTIAL DEVELOPMENT

57 LAKEWOOD DRIVE,
VANCOUVER, BC

Drawn by:	WH
Checked by:	DC
Date:	Aug 26, 2020
Scale:	1/8" = 1'-0"

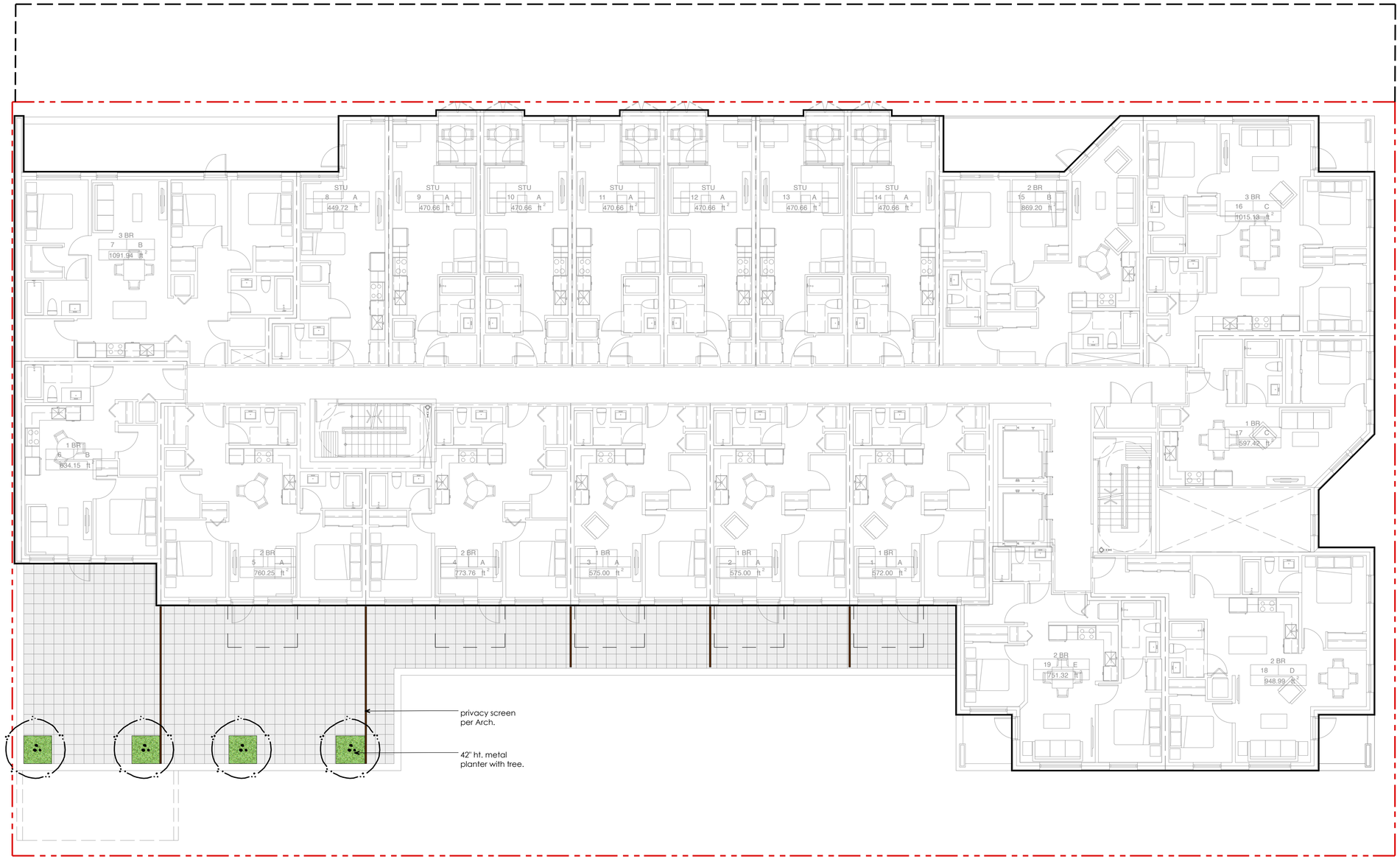
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Level 1
Overall Landscape Plan

Project No.:
20036

Sheet No.:

L01



North

no.:	date:	item:
1	Sep---20	Rezoning

Revisions:

Durante Kreuk Ltd.
102 - 1637 West 5th Avenue
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Project:

LAKEWOOD + DUNDAS MIXED-USE COMMERCIAL AND RENTAL RESIDENTIAL DEVELOPMENT

57 LAKEWOOD DRIVE,
VANCOUVER, BC

Drawn by:	WH
Checked by:	DC
Date:	Aug 26, 2020
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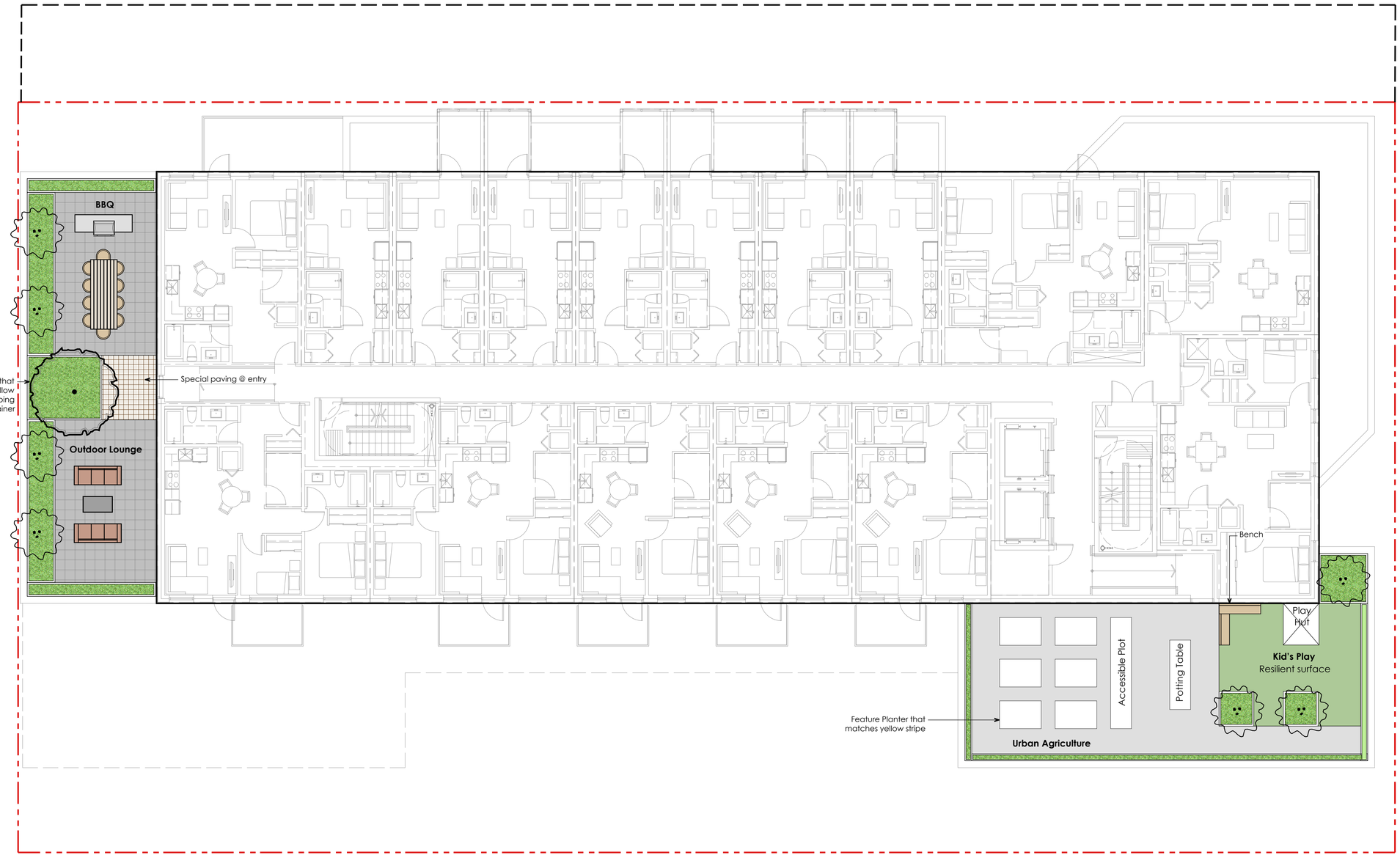
Drawing Title:

Level 2
Overall Landscape Plan

Project No.:
20036

Sheet No.:

L02



North

1	Sep---20	Rezoning
no.:	date:	item:

Revisions:

Durante Kreuk Ltd.
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Project:

LAKEWOOD + DUNDAS MIXED-USE COMMERCIAL AND RENTAL RESIDENTIAL DEVELOPMENT

57 LAKEWOOD DRIVE,
VANCOUVER, BC

Drawn by:	WH
Checked by:	DC
Date:	Aug 26, 2020
Scale:	1/8" = 1'-0"

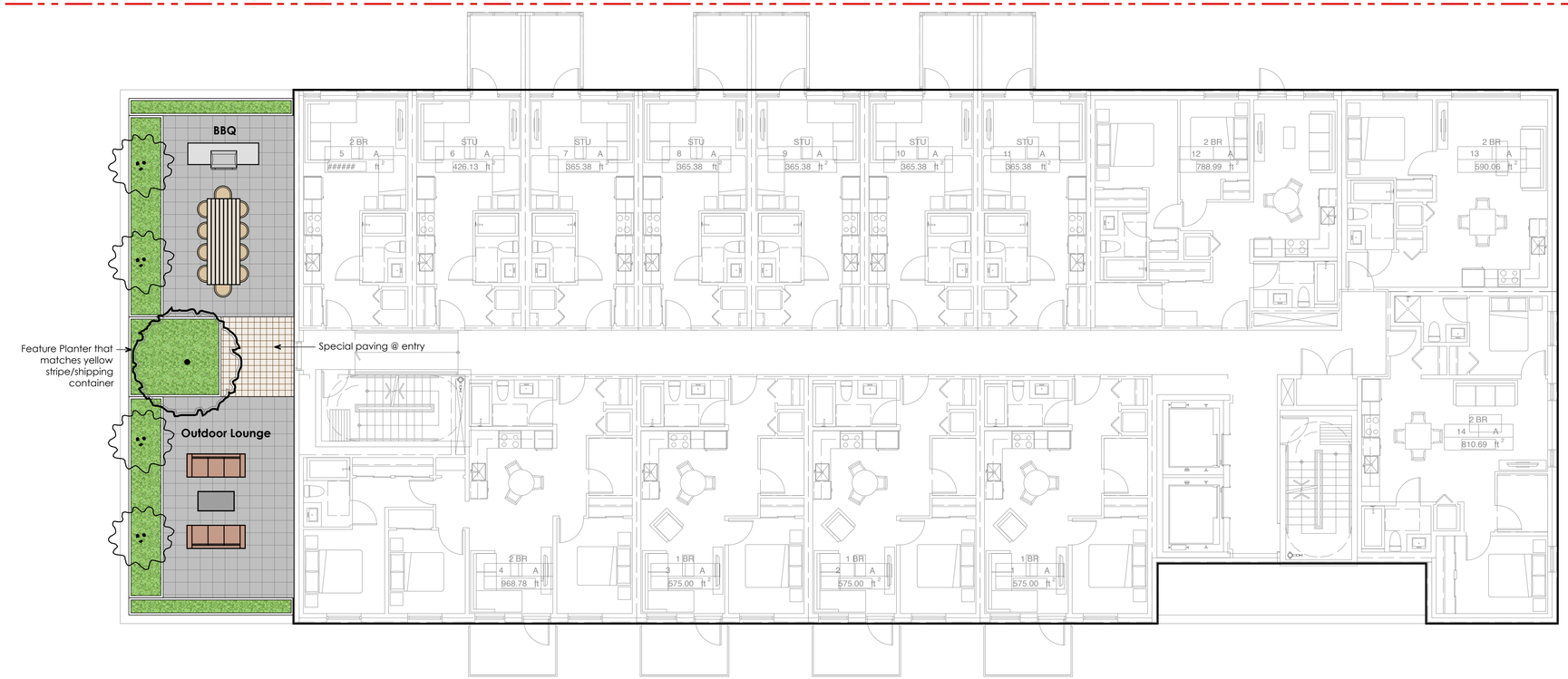
Drawing Title:

Level 5
Overall Landscape Plan

Project No.:
20036

Sheet No.:

L03



North

no.:	1	date:	Sep---20
item:	Rezoning		

Revisions:

Durante Kreuk Ltd.
102 - 1637 West 5th Avenue
Vancouver BC V6J 1N5

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Project:

LAKEWOOD + DUNDAS MIXED-USE COMMERCIAL AND RENTAL RESIDENTIAL DEVELOPMENT

57 LAKEWOOD DRIVE,
VANCOUVER, BC

Drawn by:	WH
Checked by:	DC
Date:	Aug 26. 2020
Scale:	1/8" = 1'-0"

Drawing Title:

Level 6
Overall Landscape Plan

Project No.:
20036

Sheet No.:

L04