Memo

Date:	Friday, September 30, 2022
Project:	Ontario Line TA
To:	Liana Bresler, Andrea Gaus
From:	Mohamed Hosney, David Kantor, Masoud Manzari,
Subject:	Geotechnical Desktop Study for Transit Oriented Communities (TOC) North - Cosburn North and South Sites, Ontario Line

1 Introduction

This memorandum provides a summary of the currently available subsurface geotechnical condition for the TOC North Cosburn in conjunction with preliminary geotechnical recommendations for the design of the subject development. Furthermore, recommendations are provided for additional geotechnical and hydrogeological investigation which needs to be performed by the prospective TOC developers (DevCo). This memorandum is prepared as part of the TOC submission package to the City of Toronto for the subject development.

The preliminary geotechnical recommendations provided herein are based on our interpretation of the available subsurface data, obtained from the geotechnical investigation conducted at the site by Metrolinx and TTC, by means of a limited number of boreholes, non-continuous sampling, in-situ testing, and laboratory testing on selected soil/rock samples. The recommendations contained in this memorandum rely on the accuracy of the factual subsurface data supplied by others and the authors are not responsible for the accuracy and correctness of the subsurface data provided by others.

The data interpretations and the preliminary recommendations contained in this memorandum pertain to a specific project as described herein and are not applicable to any other project or site location. If the project is modified in concept, location, or elevation, the recommendations provided in this memorandum may not be valid.

The preliminary recommendations presented in this memorandum must not be used for detail design of the subject TOC as the recommendations are subject to confirmation/modification when the detailed final investigation is completed. The scope of the additional geotechnical investigation provided herein is the recommended minimum scope of investigation to further progress the design of the TOC for City's approval purposes. DevCo and its designers shall append this scope of investigation, as required in accordance with their design and complete the investigation before detail design of the subject TOC.

It is a condition of this document that the performance of professional services provided herein is subject to the attached Statement of Limitation and condition.

2 Project and Site Description

The proposed OL Cosburn Station is located to the west of the Pape Avenue, extending between Gowan Avenue and Gamble Avenue, in Toronto, Ontario. The station box is approximately 130 m long, 23 m wide, 22.5 m deep, and aligned in the north-south direction.

Based on the information provided by SvN on August 25, 2022, two new high-rise buildings, denoted herein as TOC Cosburn North and Site Sites, are planned to be constructed over the north and south portions of Cosburn Station, respectively. The general arrangement drawings of the proposed buildings are included in Appendix A for information only.

The North Site will consist of 5 to 28 levels above the ground surface. The new building will be predominantly supported on the OL Cosburn Station structure, except for the portion of the building north of Axis N13 and between Axis N11-N13-A-A2. The northern portion of the building which is not supported over Cosburn Station will include one basement level.

The South Site will consist of 6 to 29 levels above the ground surface. The new building will be predominantly supported on the OL Cosburn Station structure, except for the portion of the building south of Axis S6. The southern portion of the building which is not supported over Cosburn Station will include one basement level.

3 Sources of Geotechnical Data

A geotechnical investigation is on-going for the OL Project and the results of the subsurface investigation at TOC North Cosburn are provided in the reports listed below:

- Stage 2 North Tunnel Geotechnical Data Report (GDR), Ontario Line – East of Lower Don River Bridge, Toronto, Ontario, prepared by WSP, dated October 22nd, 2021.
- Geophysical Investigation, Ontario Line – Pape Segment, Toronto, Ontario, prepared by Geophysics GPR International Inc., dated June 2021.

Reference is made to the above noted reports for the details of the currently available factual geotechnical and hydrogeological data, in conjunction with geophysical survey. The subsurface investigation for the project is currently ongoing and updated/new version of the above noted reports with additional data would be issued for the project, once all the planned scope of the investigation is concluded.

The following laboratory tests have been conducted in representative soil samples:

1. Moisture content
2. Bulk density
3. Specific gravity
4. Grain size and hydrometer analyses
5. Atterberg limits
6. One dimensional consolidation (Oedometer)
7. Unconfined compressive strength

8. Consolidated drained triaxial compression
9. Direct shear
10. Unconsolidated Undrained triaxial compression

The following laboratory tests have been conducted on representative rock samples:

1. Unconfined compressive strength (UCS)
2. Point load
3. Elastic Moduli of intact rock core in uniaxial compression
4. Slake durability
5. Cerchar Abrasivity

The following field tests have been conducted during the field investigations:

1. Standard penetration (SPT).
2. In-situ pressuremeter
3. Combined Seismic Refraction and MASW geophysical survey
4. Downhole acoustic and optical televiewer survey
5. Collection of subsurface gases
6. Single well response hydraulic conductivity assessment
7. Packer hydraulics conductivity assessment
8. Measurement of subsurface gas concentrations in monitoring well headspace

The following laboratory tests have been conducted on representative groundwater samples:

1. Environmental groundwater quality analyses (e.g., metals and inorganics, PHCs, VOCs, SVOCs or PAHs, PCBs, dioxins and furans, methane, and Toronto Sewer Use Bylaw parameters).

The following laboratory tests have been conducted on representative monitoring well headspace gas samples:

1. Environmental subsurface gas analyses [e.g., light hydrocarbons, VOCs, and matrix gases, which are also referred to as permanent or fixed gases (i.e., carbon dioxide, carbon monoxide, methane, nitrogen, oxygen, hydrogen, and hydrogen sulphide).

4 Subsurface Conditions

Seven boreholes (i.e., OL-11001, OL-11101, OL-11002, OL-11007, OL-11102, OL-11008, and OL-11103) have been drilled in vicinity of the TOC North Cosburn. The boreholes were advanced to depths ranging from about 40 m to 55 m below the existing ground surface. Four boreholes included coring of about 10 m to 12 m of bedrock. The on-going geotechnical investigation includes advancing six additional boreholes (EW4-17, EW4-18, EW4-26, EW4-19, EW4-20, and EW4-27) to depths between 5 m to 8 m.

The advanced and planned borehole locations, the stratigraphy encountered at the borehole locations, the preliminary interpreted stratigraphy and piezometric head measurements are shown in the Interpreted Stratigraphic Profile in Appendix B. The profile is a simplification of the subsurface conditions encountered at the borehole locations. The information is inferred from generally non-continuous sampling, observations of drilling progress and results of Standard Penetration Tests. The stratigraphic boundaries shown on the profile represent transitions between soil types rather than exact planes of geologic change. Since these

boundaries have been interpolated between boreholes, the actual locations of the stratigraphic boundaries may vary from those shown on the profiles.

The stratigraphic profile in the area of the proposed development generally consisted of approximately 42 m to 46 m thick overburden soils overlying Georgian Bay Formation shale bedrock. The overburden at the general area of the proposed development consists of surficial pavement structure overlying a 3 to 4 m thick layer of sand to silty sand to silty clay fill. The native soil below the fill comprises of approximately 9 m thick layer of very stiff to hard glaciolacustrine silty clay followed by approximately 28 m thick hard silty clay with sand to sandy silty clay till interbedded by approximately 1.8 m hard glaciolacustrine silty clay. The cohesive native soil layer is underlain by approximately 6 m thick layer of very dense silty sand to sandy silt till interchanged with interstadial gravel with sand and silt to silty sand/sandy silt.

Intermediate and deep monitoring wells have been installed in the advanced boreholes as shown in Appendix B. Shallow monitoring wells are planned to be installed at boreholes EW4-17 and EW4-19 at depth of 4 to 6 m below ground surface. The current information on the groundwater level at the site is not adequate to create a complete groundwater pressure distribution profile. However, the profile presented in Appendix B can be used as a simplified preliminary groundwater pressure distribution prepared for this stage of the investigation and design.

5 Recommended Scope for Additional investigation

Additional geotechnical and hydrogeological investigation is required to further progress the design of the subject TOC. The minimum recommended scope of the additional investigation is presented in Table 1 of Appendix C. The associated locations of the recommended additional boreholes are shown in Appendix B. DevCo and its designers shall append the scope of additional investigation presented herein, as required in accordance with their design and shall complete the investigation before detail design of the subject TOC.

The scope of the environmental testing for groundwater and for the excess soil management shall be designed by DevCo to satisfy all codes, regulations, and guidelines requirements, including, but not limited to, O-Reg 406/19.

6 Preliminary Engineering Recommendations

6.1 Geotechnical Design Parameters

Preliminary geotechnical engineering parameters for the engineering groups encountered in the boreholes drilled at the area of TOC North Cosburn, that may influence the design of the TOC, are provided in the table included in Appendix D. Average values are typically listed in the table. Although in certain instances the average values may be appropriate for design purposes, if the designs are sensitive to a minimum and maximum values and/or variation of average values with depth, the range in values must be requested by the designer and considered in their design.

The average values are typically not appropriate for selection of the construction equipment. The contractors/subcontractors should consider the full range of property values when evaluating the selection of equipment and construction methods.

6.2 Temporary Shoring Walls

Temporary support to retain excavation walls within the overburden soil will be required for the excavation of the proposed one level of basements for the two buildings. The design of the temporary support must be in accordance with the 4th edition of the Canadian Engineering Foundation Manual (CFEM), and all other applicable codes and standards having jurisdiction over the development. Control of the ground movement should be a design criterion and considered by the shoring designer in order to limit the potential impact on the existing adjacent infrastructures, including the Cosburn Station structures, and utilities.

Basic soil properties for the design of the temporary shoring system are provided in Preliminary Geotechnical Design Parameters in Appendix D. Recommended lateral earth pressure to be used in the analytical design of the shoring are provided in Figures D.1 and D.2 of Appendix D. The preliminary design groundwater pressure on the shoring should be calculated using the groundwater profile presented in Appendix D plus adding 1 m to consider seasonal variation and flood events.

6.3 Permanent Structures

6.3.1 Lateral Earth and Groundwater Pressures

The preliminary recommendation for the earth pressure to be used in the design of the underground basements is provided in Figure D.3 of Appendix D. An earth pressure coefficient (K) of 0.5 is recommended for the preliminary stage design. The preliminary design groundwater pressure on the basement wall should be calculated using the groundwater profile presented in Appendix D plus adding 1 m to consider seasonal variation and flood events.

6.3.2 Foundations

Based on the available subsurface condition, the site seismic classicisation for the subject development is Site Class “C” with an average shear wave velocity (V_{s30}) of 368 m/s.

Majority of the proposed TOC development will be supported over OL Cosburn Station structures, as noted in Section 2. Therefore, the Cosburn Station shall be designed to accommodate the anticipated additional loads from the future TOC development. The additional loads applied by the TOC developments will results in post construction settlement and potentially subsequent differential settlement of the OL subway structures. The differential settlement may lead to serviceability issues (e.g., track operation), and potential damage to the wall covering and utility conduits that extend between the structure units, if any. Therefore, all of these aspects must be considered in design of the subway station (i.e., Cosburn Station) foundations and associated structures. It is our understanding that the Cosburn Station will be designed and constructed by the Design-Build contractor.

It is our understanding that DevCo will be responsible to design the foundations for the portions of the TOC which is not supported by the subway station structures. These portions of the TOC can be either supported by raft foundation or deep caissons, herein after referred to as new foundations. Selection of the appropriate option for the new foundations depends on the design of the above grade structure which dictates the required performance criteria for the new foundations such as differential settlement between the new foundations and portion of the TOC supported by subway structure.

As noted above, there is potential for differential settlement between the portion of the new development which is supported on the subway station and the portion supported by the new foundations. A proper joint

should be designed for all the building elements (e.g., slab, roof, walls) at the interface between the foundation systems, unless the building elements are designed to stand the differential settlement.

Raft Foundation:

The raft foundation for the TOC buildings to the north and south of the subway structures can be founded on undisturbed native soils, mainly very stiff to hard plastic silty clay [soil Group 6/7]. If fill material is encountered at the foundation elevation, then the entire fill layer below the foundation shall be excavated and backfilled with compacted engineered fill or lean concrete. The factored geotechnical resistances provided in Table 1 below may be assumed for the preliminary design of the raft foundations.

Table 1. Preliminary Factored Geotechnical Resistances

Structure	Base of foundation Elevation (m)	Anticipated Founding Material	ULS Factored Geotechnical Resistance (kPa)	SLS Factored Geotechnical Resistance (kPa)	Vertical Modulus of Subgrade Reaction Kv (MPa/m)
Portion of the TOC which is not supported by the station foundations	~117.5	• Very Stiff to hard Silty Clay soil	375(1)	180(1)	9

(1) If engineered fill is placed below the slab, the geotechnical resistances provided in this table may need to be revised.

The geotechnical resistances for the raft foundation are based on a 15 m to 25 m wide slab subjected to vertical concentric loading. Where eccentric or inclined loads are applied, the resistance used in the design must be reduced in accordance with the Canadian Highway Bridge Design Code (CHBDC) Clauses 6.7.3 and 6.7.4 [9].

The geotechnical resistances at SLS provided is based on an estimated settlement on the structure not exceeding 25 mm.

The effect of the new development loads at the foundation elevation on the station permanent structure must be evaluated.

Caissons:

Caissons must be extended at least 2.5 times caisson diameter into the slightly weathered to fresh bedrock to provide adequate socket support. A minimum centre-to-centre spacing of 2.5 times caisson diameter should be maintained between caissons.

The recommended factored axial geotechnical resistances at ULS in compression for caissons of selected diameters and rock socket lengths are presented in Tables 2. The geotechnical resistances provided in Table 2 are estimated based on the assumption that no pile load test will be conducted at the site. Given the sensitivity of the caisson performance to the construction means and method, higher geotechnical resistances can be provided if the axial resistance of the caissons will be verified by a properly designed and implemented pile load testing program prior to construction.

The performance of caissons will depend to a large degree on the quality of construction such as final cleaning at the base and condition of the shaft.

The settlement of the caissons at the top of the rock socket, under the SLS load, is anticipated to be less than 10 mm.

The upper approximately 1.5 m of the shale at the site is generally found to be highly to moderately weathered and containing fragmented zones and clay seams. As such, it is recommended that the upper 1.5 m of the bedrock be discounted when calculating the required socket length of the caissons/wall to achieve the target axial resistance.

Table 2 Preliminary Factored Geotechnical Resistances at ULS for Rock Socket of a Single Caisson

Caisson Rock Socket Diameter (m)	Socket Length** (m)	Factored Geotechnical Resistance in Compression at ULS (kN)*	Factored Geotechnical Resistance in Tension at ULS (kN)*
0.9	4	4,800	1,070
	6	6,450	1,600
	8	7,890	2,140
1.2	4	6,810	1,400
	6	9,580	2,140
	8	11,490	2,860

* The structural capacity of the caissons should be evaluated by the structural engineer.
** Socket Length is the embedment depth of the caisson into the slightly weathered to fresh bedrock and should not include the upper highly weathered portion of the caissons.

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a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

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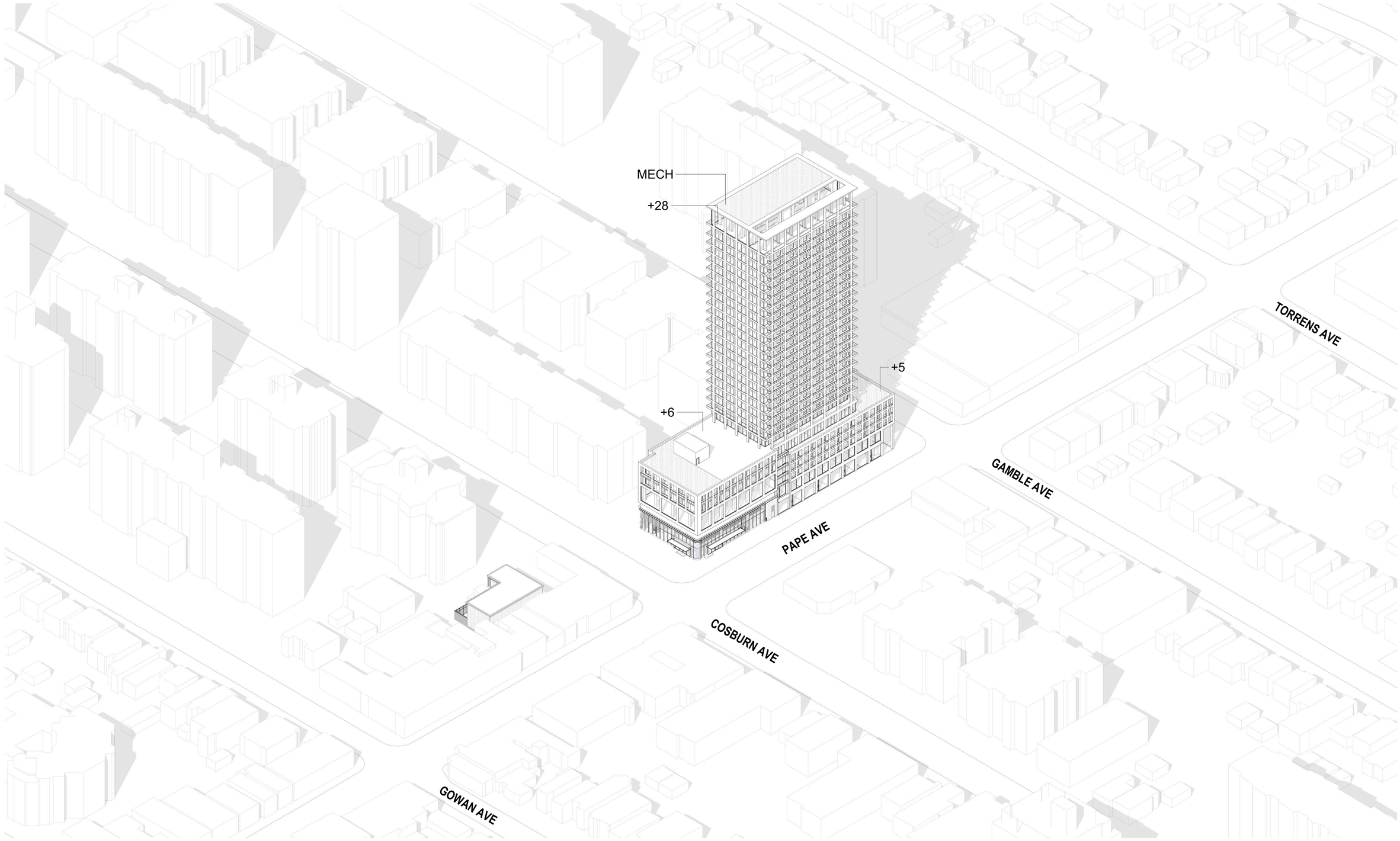
ONTARIO LINE TECHNICAL ADVISOR

Appendix A: General Arrangement Drawings



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2	2022-11-04	REISSUED FOR QA/QC
3	2022-11-18	ISSUED FOR REZONING

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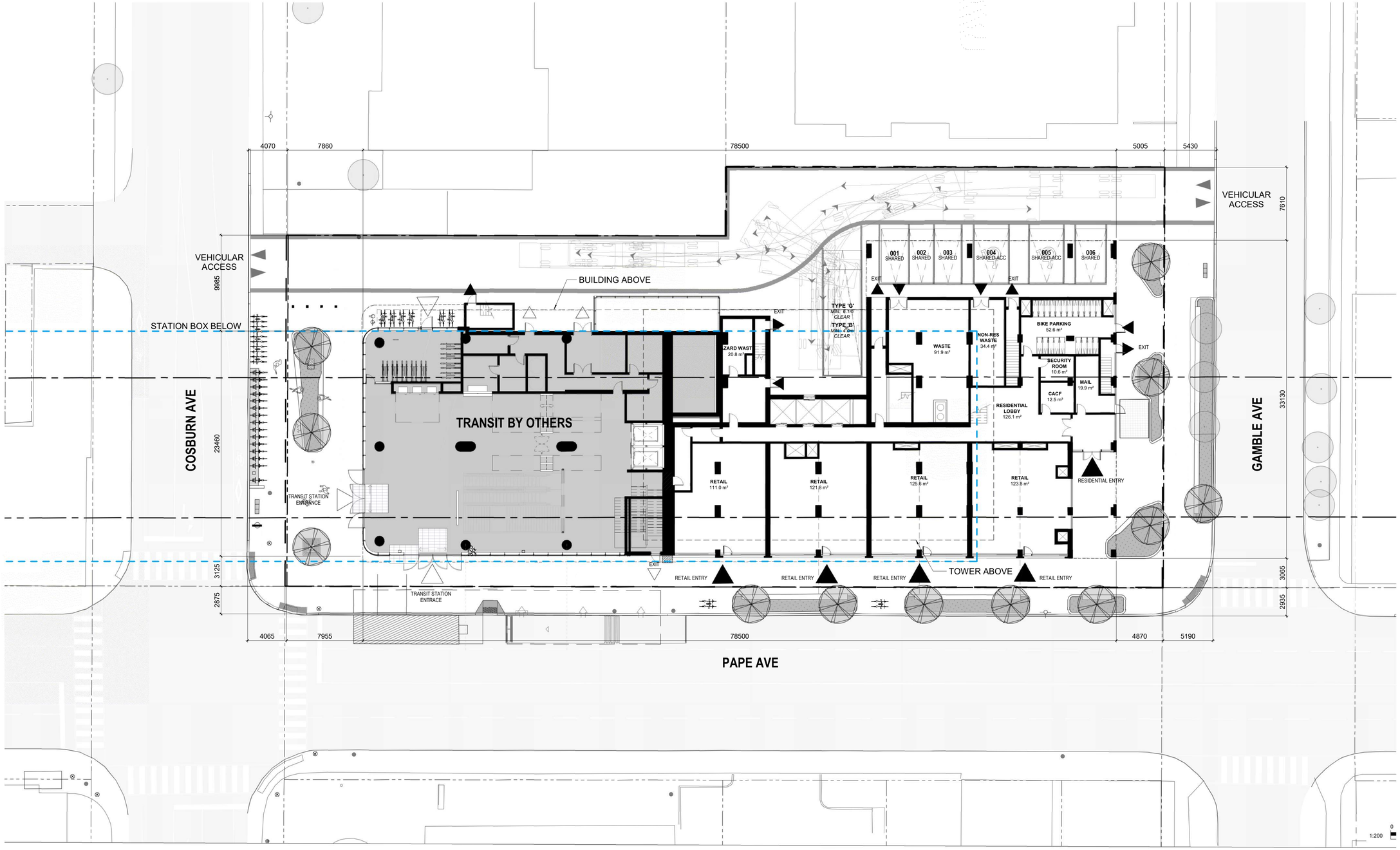

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SITE PLAN

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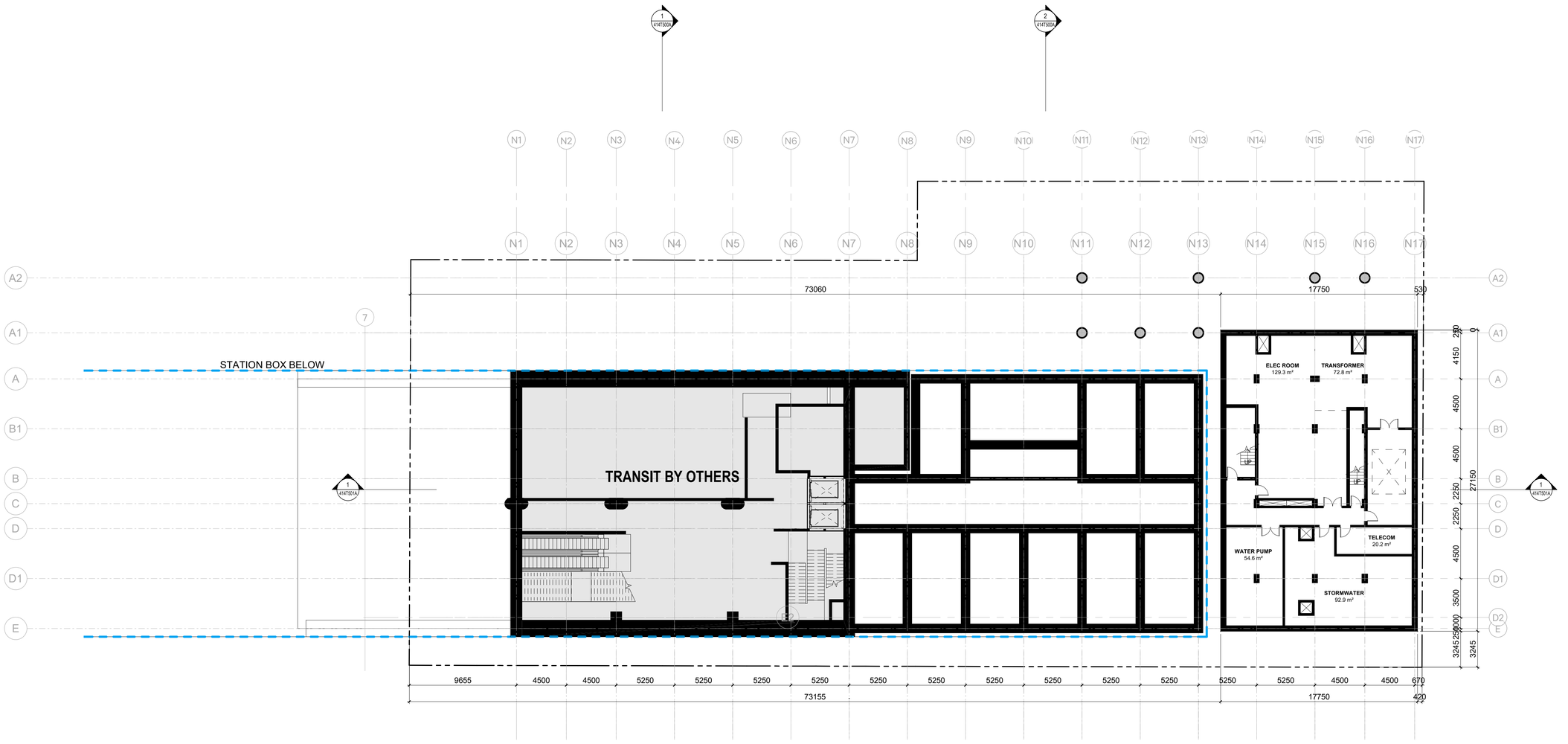

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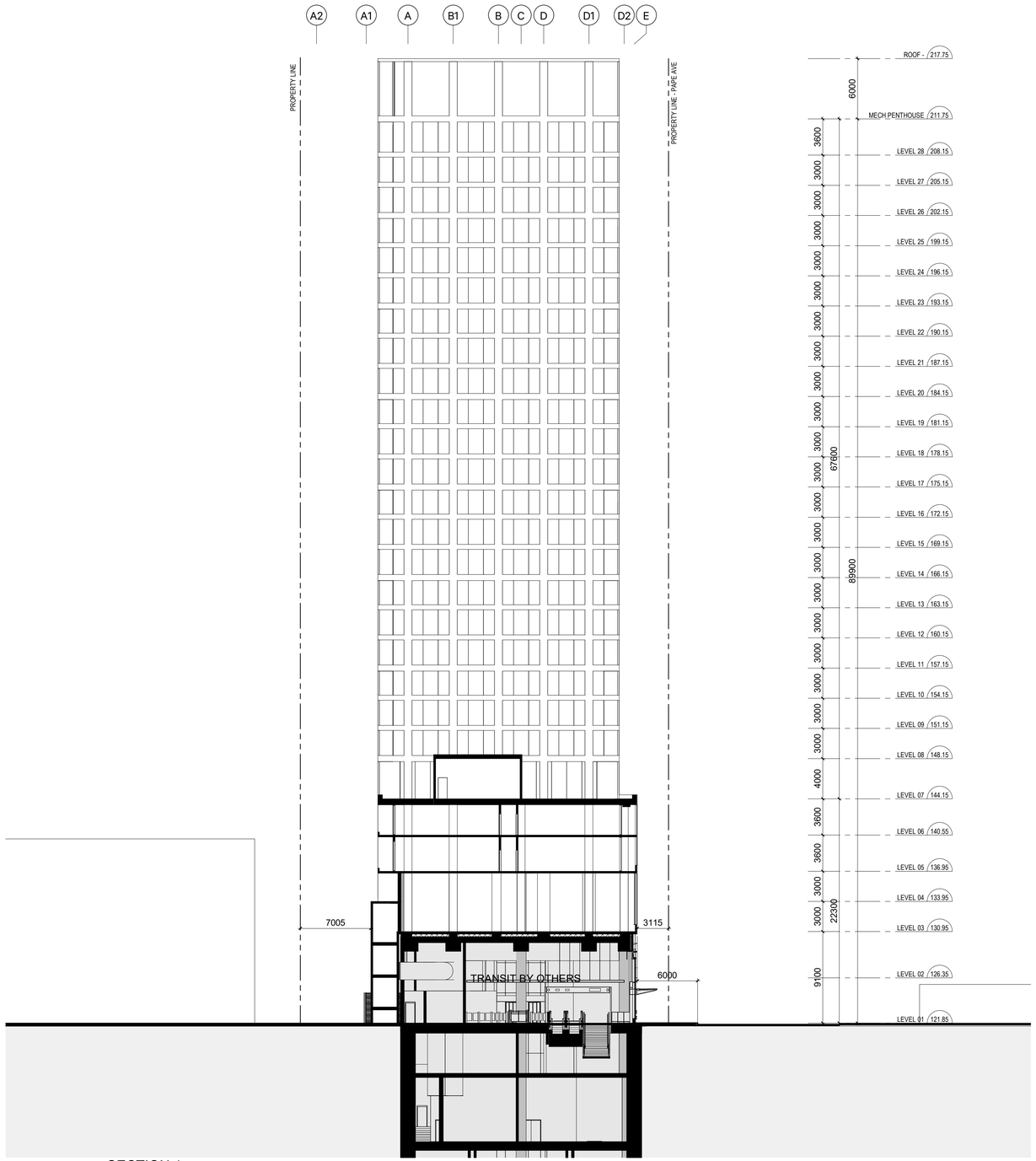

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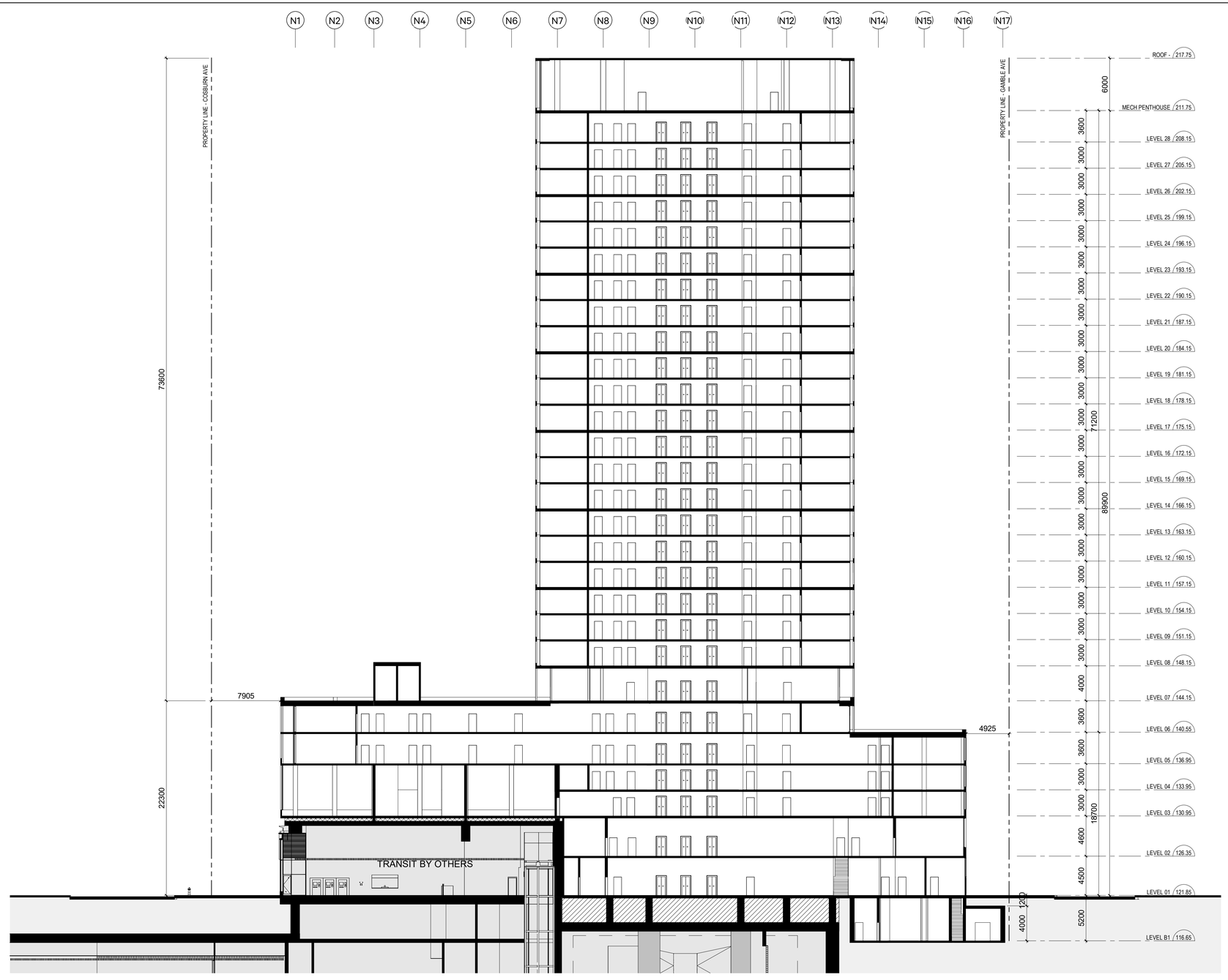

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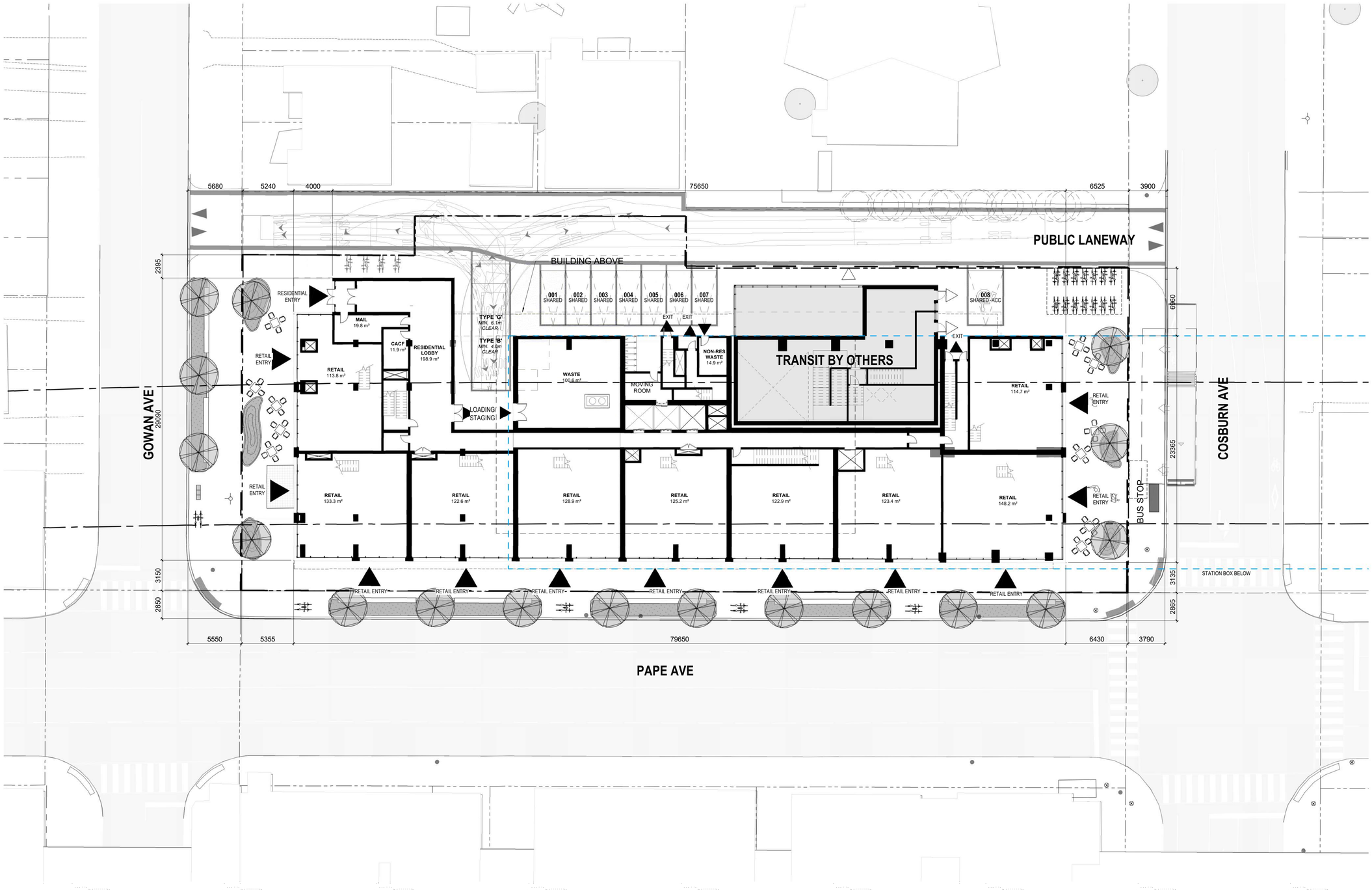

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1	2022-10-28	ISSUED FOR QA/QC
2	2022-11-04	REISSUED FOR QA/QC
3	2022-11-18	ISSUED FOR REZONING

ARCHITECTURE AND LANDSCAPE SET - REZONING

NOT FOR ESTIMATING OR BIDDING
NOT FOR CONSTRUCTION

SvN

ONETEAM
ONTARIO LINE TECHNICAL ADVISOR

ONTARIO ASSOCIATION OF ARCHITECTS
LIANA BRESLER
LICENCE
8272

DESIGNED L. QUEZADA
DRAWN L. QUEZADA
CHECKED J. RODRIGUEZ-VILLA
APPROVED L. BRESLER

ONTARIO LINE

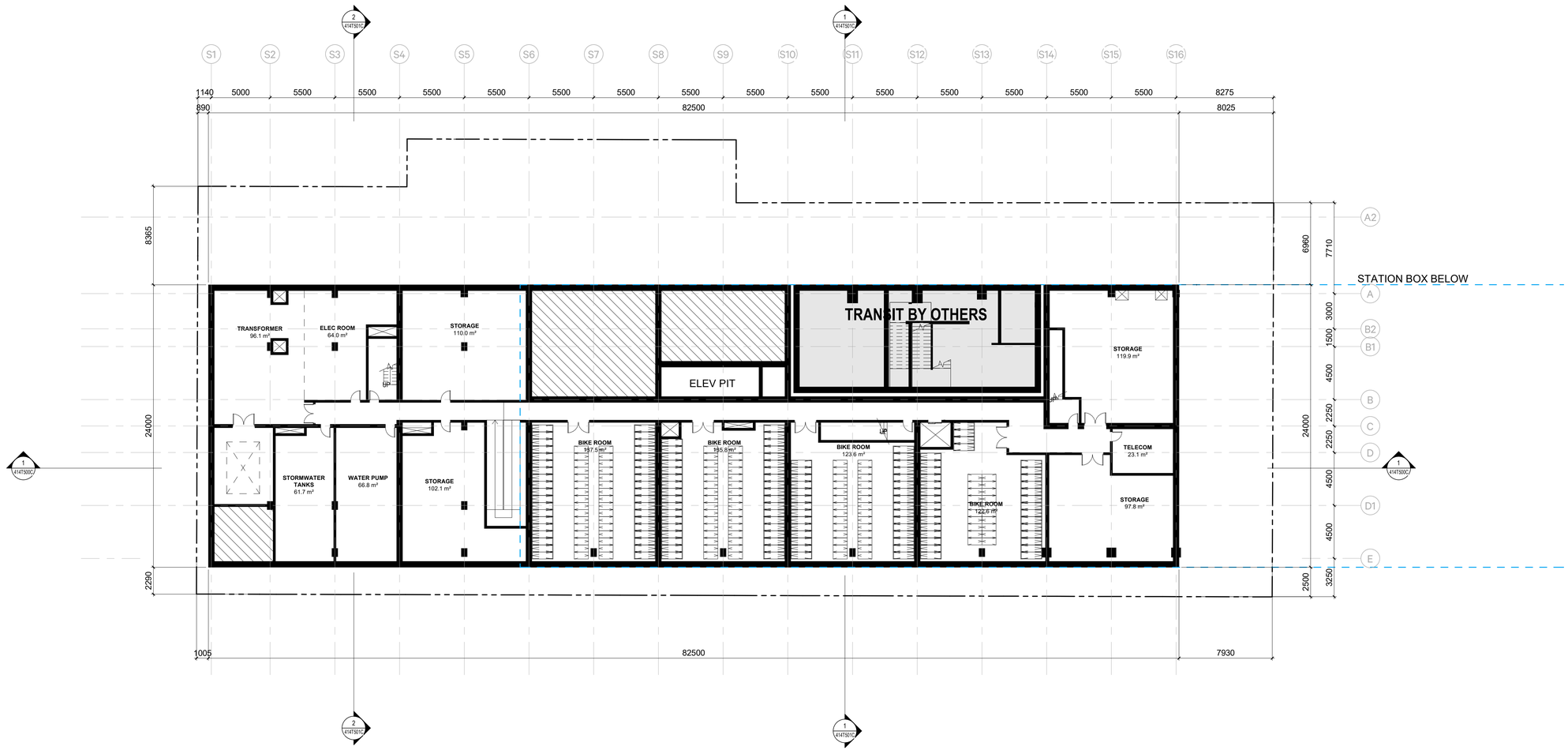
TITLE
TOC
PAPE | COSBURN
SITE PLAN

Plot Date: 2022-11-18 9:01:43 AM

METROLINX
Infrastructure Ontario

SCALE 1 : 200

DRAWING NUMBER 414T005C



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2	2022-11-04	REISSUED FOR QA/QC
3	2022-11-18	ISSUED FOR REZONING

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DESIGNED L. QUEZADA
DRAWN L. QUEZADA
CHECKED J. RODRIGUEZ-VILLA
APPROVED L. BRESLER

ONTARIO LINE

TITLE
TOC
PAPE | COSBURN
LEVEL B1

Plot Date: 2022-11-18 8:43:03 AM

METROLINX
Infrastructure Ontario

SCALE 1 : 200

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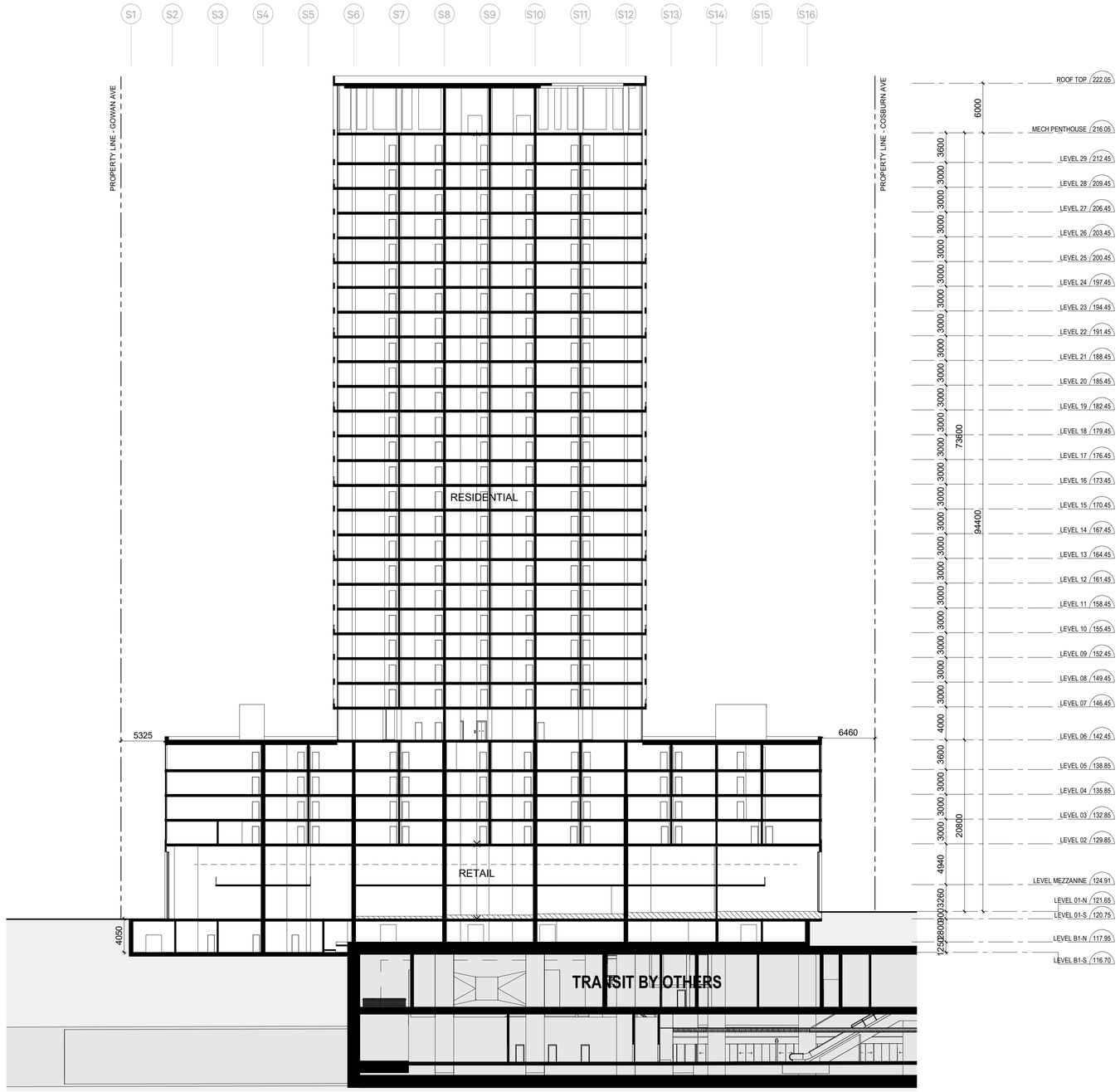

1 SECTION 1
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REVISIONS		
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3	2022-11-18	ISSUED FOR REZONING

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DRAWN L. QUEZADA
CHECKED J. RODRIGUEZ-VILLA
APPROVED L. BRESLER

ONTARIO LINE

TITLE
TOC
PAPE | COSBURN
SECTION 1

Plot Date: 2022-11-18 8:44:10 AM

METROLINX
Infrastructure Ontario

SCALE	DRAWING NUMBER
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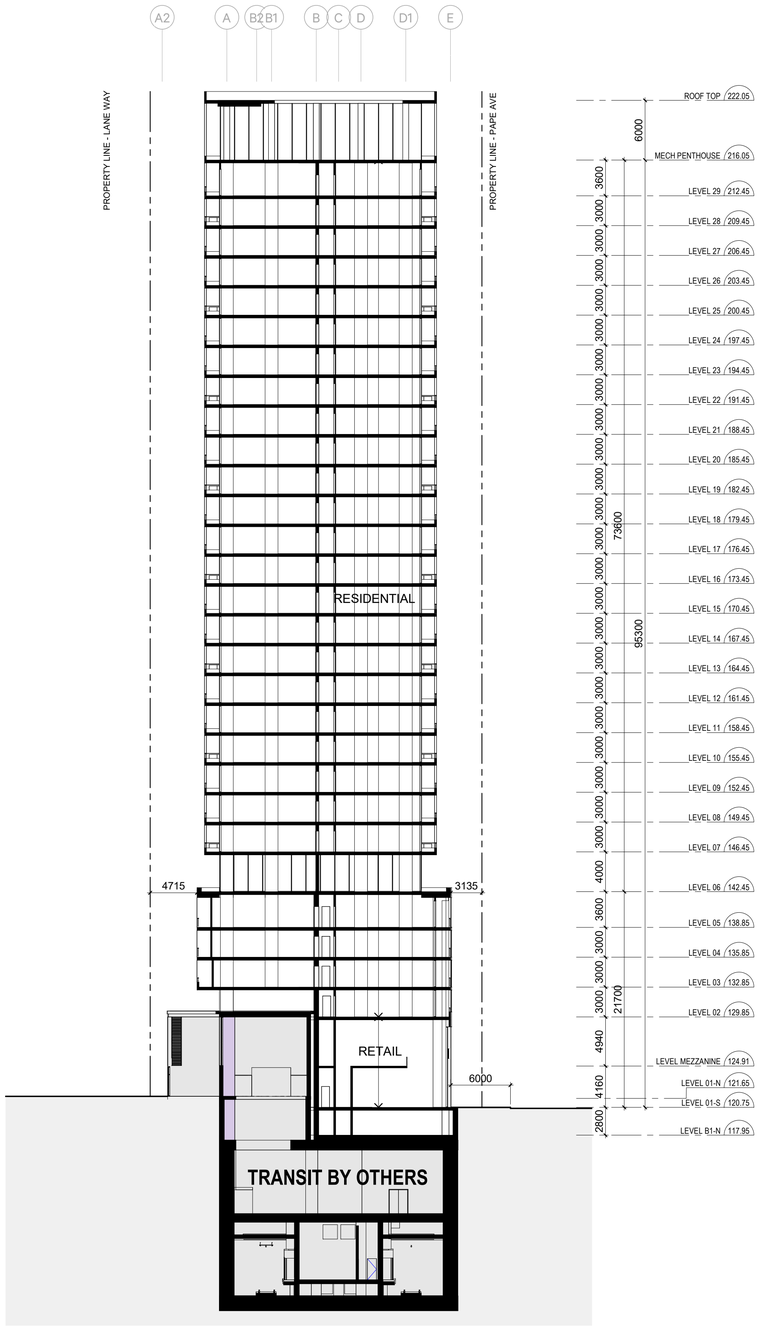

1 SECTION 2

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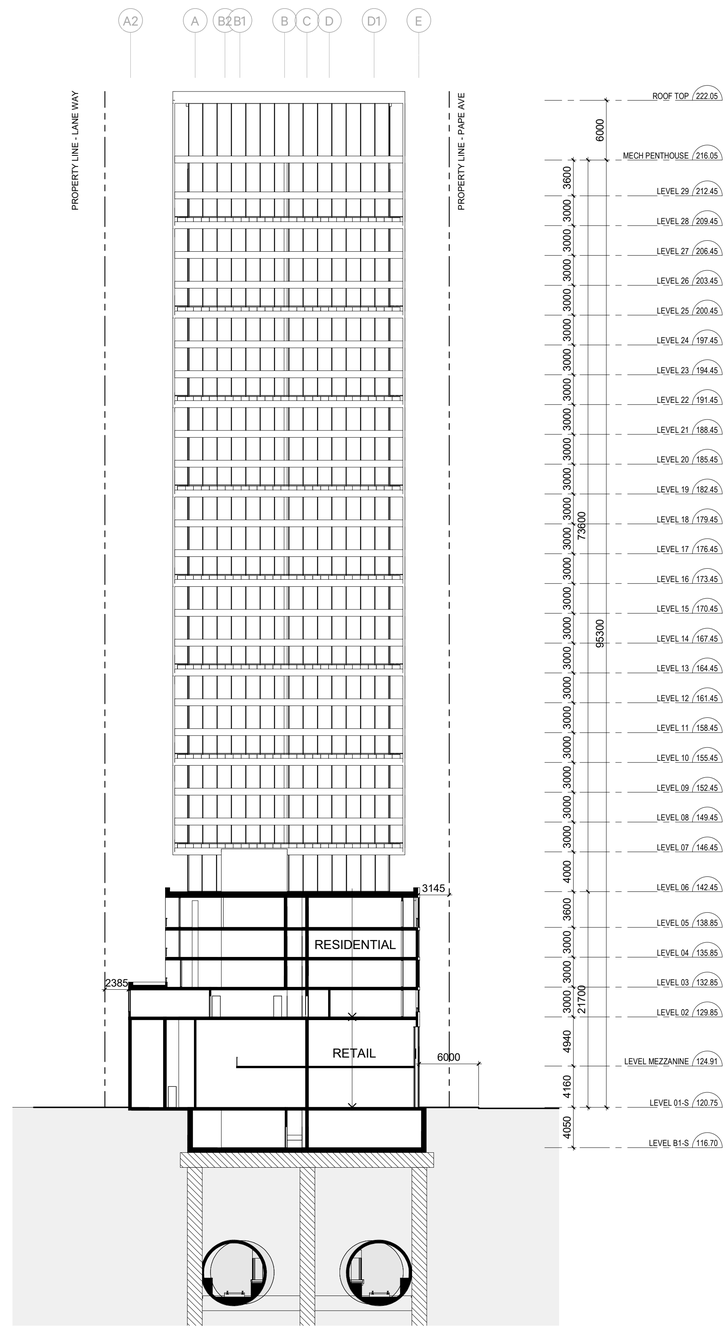

2 SECTION 3

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SHEET No. 414T501CFILE: BIM 360://10206938_OLTA_Planning/10206938-TD014C-PAPE-COSBURN.rvt

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2	2022-11-04	REISSUED FOR QA/QC
3	2022-11-18	ISSUED FOR REZONING

ARCHITECTURE AND LANDSCAPE SET - REZONING

NOT FOR ESTIMATING OR BIDDING
NOT FOR CONSTRUCTION

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CHECKED J. RODRIGUEZ-VILLA
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ONTARIO LINE

TITLE
TOC
PAPE | COSBURN
SECTION 2 AND SECTION 3

Plot Date: 2022-11-18 8:44:22 AM

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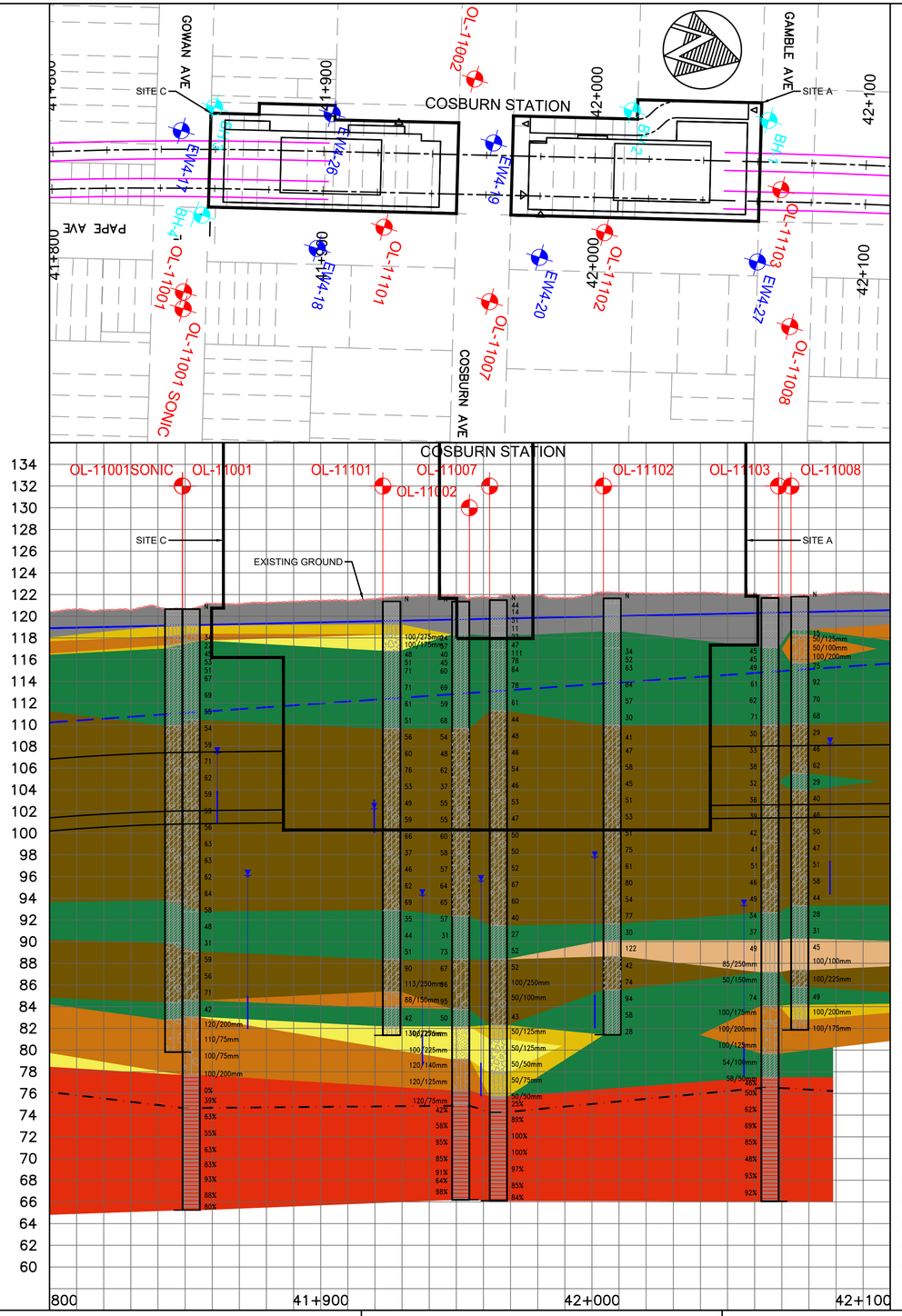
Infrastructure Ontario

SCALE 1 : 300

DRAWING NUMBER 414T501C

Appendix B: Interpreted Stratigraphic Profile and Proposed Boreholes for Cosburn TOC



ENGINEERING GROUP - MAJOR SOIL DEPOSIT:

- F1 FILL
- F2 RECENT ALLUVIAL AND FLUVIAL DEPOSITS
- 1/2 INTERSTADIAL GRAVEL TO SAND
- 3N NON-PLASTIC TILL
- 3C PLASTIC TILL
- 4 INTERSTADIAL SILTY SAND TO SANDY SILT
- 5 GLACIOLACUSTRINE LOW-PLASTICITY CLAYEY SILT TO NON-PLASTIC SILT
- 6/7 GLACIOLACUSTRINE INTERMEDIATE TO HIGH PLASTICITY SILTY CLAY TO CLAY
- B BEDROCK

LITHOLOGY GRAPHIC SYMBOLS AND MATERIAL TYPES:

- 1 TOPSOIL
- 1 PEAT
- 1 ORGANIC SOIL
- 1 FILL
- 2 SANDY GRAVEL
- 3 GRAVELLY SAND
- 4 SAND
- 5 SILTY SAND
- 6 SILT
- 7 SANDY SILT
- 8 SANDY SILT TILL
- 9 SILTY SAND TILL
- 10 CLAY
- 11 SILTY CLAY
- 12 CLAYEY SILT
- 13 CLAY TILL
- 14 SILTY CLAY TILL
- 15 CLAYEY SILT TILL
- 16 COMPLETELY WEATHERED BEDROCK (RESIDUAL SOIL)
- 17 HIGHLY WEATHERED TO FRESH BEDROCK
- INTERFACE BETWEEN TYPE 16 AND 17 BEDROCK

BOREHOLE SYMBOLS:

- EXISTING ONTARIO LINE BOREHOLES
- PROPOSED BOREHOLES FOR THE TOC
- PLANNED SHALLOW ONTARIO LINE BOREHOLES

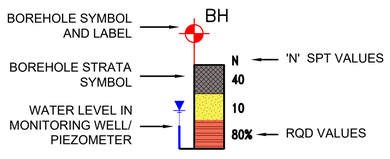
INTERPRETED PIEZOMETRIC LEVELS:

- INTERPRETED SHALLOW OVERBURDEN GROUNDWATER LEVEL
- INTERPRETED TUNNEL HORIZON GROUNDWATER LEVEL

NOTES:

1. SOIL AND GROUNDWATER CONDITIONS BETWEEN BOREHOLES ARE INTERPRETED AND MAY DIFFER FROM CONDITIONS SHOWN. BOREHOLE WIDTH IN PROFILE IS NOT TO SCALE.
2. ALL BOREHOLE LOCATIONS AND SITE FEATURES ARE APPROXIMATE.
3. SHAFT AND TUNNEL OUTLINES ARE SHOWN FOR GENERAL ILLUSTRATION PURPOSES ONLY AND DO NOT NECESSARILY INDICATE THE EXTENTS OF THE EXCAVATIONS.
4. ALL ELEVATIONS ARE IN GEODETIC METRES UNLESS OTHERWISE SHOWN.
5. INTERPRETED TUNNEL HORIZON GROUNDWATER LEVEL REPRESENTS INTERPRETED HIGH GROUNDWATER LEVEL OF SOIL WITHIN APPROXIMATE TUNNEL ZONE.

GENERAL LEGEND:



MAY 12, 2021
RAIL ALIGNMENT
NOT FOR CONSTRUCTION

SCALE(S) 0 10 20 30 40m HOR; 0 2.5 5 7.5 10m VER

STATUS

PRELIMINARY DRAFT

ONE TEAM
ONTARIO LINE TECHNICAL ADVISOR

ONTARIO LINE SUBWAY

TOC - NORTH COSBURN

PLAN AND STRATIGRAPHIC PROFILE ALONG EASTBOUND TRACK

Plot Date: 20 September 2022

METROLINX
Infrastructure Ontario

FIGURE 1

FILE: 10206938-ge1000-04-bhpp.dwg
PLOTTED BY: DRAFTING01

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ONTARIO LINE TECHNICAL ADVISOR

Appendix C: Preliminary Geotechnical and Hydrogeological Scope of Investigation

TABLE 1
TOC - North - Cosbrun

Preliminary Scope of Work for Geotechnical and Hydrogeological Investigation

1- The preliminary locations of the boreholes are shown in Appendix B. The preliminary borehole locations are based on the TOC development footprint obtained from the drawings provided by SvN on August 25th, 2022. The borehole locations shall be finalized by DevCo.
2- The field investigation and laboratory testing must be completed in accordance with the best practices for geotechnical investigation and in conformance with all applicable regulations, codes, and standards.
3- The scope of investigation presented herein is the recommended minimum scope of investigation to further progress the design of TOC. Dev Co. and their designers must add to the scope of investigation presented herein, as required, for the final design of the TOC.

Borehole ID	Depth	Field Investigation	Laboratory Investigation
2 boreholes (BH-2 and BH-3)	**55 [10 m of rock coring]**	**Scope of Work** '- **SPT** within overburden soil at 0.75 m interval up to 6 m depth, increasing to 1.5 m interval up to borehole termination. - Photo of each recovered soil sample showing a sample, measuring tape and sample identification. - If very soft to firm plastic soil is encountered (i.e. N<10), collect Shelby Tube samples, one for every 3 m thickness of the layer, minimum one per layer (Shelby Tube, immediately followed by SPT, followed by VST). - **Pressuremeter testing (PMT**) and Sonic/PQ Drilling at BH-1. **Monitoring Wells:** **- BH-1 --> Install one monitoring wells with screen tip at 4 m and one Vibration Wire Piezometer at 10 m below ground surface,** **- BH-2 --> Install one monitoring wells with screen tip at 6 m and one Vibration Wire Piezometer at 20 m below ground surface,**	**Geotechnical Soil Testing** - Moisture content test on all soil samples - Index Properties test (Sieve, hydro, Atterberg) on 30% of the soil samples, minimum one per layer in each borehole. - Unit Weight/Density Test on 5 samples; minimum two tests at each site location. - The following advance testing should be carried out on undisturbed soil samples obtained from the sonic drilling/PQ coring at BH-1: i- minimum of 2 CD triaxial tests and 2 UU triaxial tests for soil samples from each borehole. ii- minimum of 2 consolidation test for soil samples from each borehole. - Rock testing: Unconfined Compressive Strength (UCS) for each run of collected rock cores. Point Load Tests as required.
2 boreholes (BH-1 and BH-4)	**45 [drill to auger refusal on the top of bedrock]**	**- BH-3 --> Install one monitoring wells with screen tip at 4 m and one Vibration Wire Piezometer at 25 m below ground surface,** **- BH-4 --> Install one monitoring wells with screen tip at 4 m and one Vibration Wire Piezometer at 15 m below ground surface,** - Install 50 mm well with 3-m long screen in the aforementioned boreholes. Monitoring wells to be screened within the most permeable zone, with general bias towards the tip elevations mentioned above. - Groundwater level measurements to be completed during drilling and on a bi-weekly basis after installation until the water levels are stabilized, for a minimum of 3 readings. - Single well response test at the above shallow monitoring well locations.	

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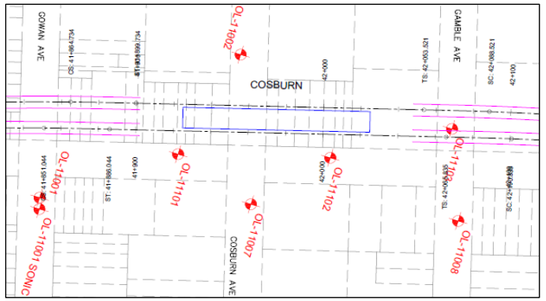
ONTARIO LINE TECHNICAL ADVISOR

Appendix D: Preliminary Geotechnical Engineering Parameters

SITE PLAN



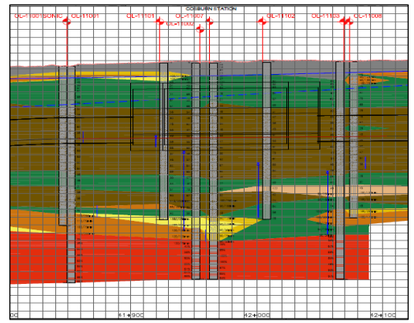
BOREHOLE SYMBOLS:

EXISTING ONTARIO LINE BOREHOLES

STRATIGRAPHIC PROFILE

ENGINEERING GROUP - MAJOR SOIL DEPOSIT:

- F1 FILL
- F2 RECENT ALLUVIAL AND FLUVIAL DEPOSITS
- 1/2 INTERSTADIAL GRAVEL TO SAND
- 3C PLASTIC TILL
- 3N NON-PLASTIC TILL
- 4 INTERSTADIAL SILTY SAND TO SANDY SILT
- 5 GLACIOLACUSTRINE LOW-PLASTICITY CLAYEY SILT TO NON-PLASTIC SILT
- 6/7 GLACIOLACUSTRINE INTERMEDIATE TO HIGH PLASTICITY SILTY CLAY TO CLAY
- B BEDROCK (TYPE 16)
- B BEDROCK (TYPE 17)



GEOTECHNICAL PROPERTIES

Soil Group	Soil Type Description	Zone 1 - Sta. 41+840 to Sta. 41+990				Zone 2 - Sta. 41+990 to Sta. 42+090				Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Water Content (%)	Unit Weight, γ (kN/m^3) [E]	Young's Modulus, E_{50} (MPa) [A]	Young's Modulus (Unload / Reload), E_{ur} (MPa) [B]	Poisson's Ratio [C]	Undrained Shear Strength, S_u (kPa) [G]	Effective Friction Angle, ϕ' (deg)	Effective Cohesion, c' (kPa)	Earth Pressure Coeffiecient	
		Elevation (m)		Depth (m)		Elevation (m)		Depth (m)													Active (K_A)	Passive (K_P)
		To	From	To	From	To	From	To	From													
F	Fill	121.2	117.8	0.0	3.4	121.7	118.2	0.0	3.5	-	-	-	13	20	6	18	0.20 - 0.25	-	28	-	0.36	2.8
6/7	Very Stiff to Hard Silty Clay	117.8	110.3	3.4	10.9	118.2	110.0	3.5	11.7	32	16	16	18	21.5	50	150	0.20 - 0.25	140	28	5	0.36	2.8
3C	Hard Silty Clay to Clayey Silt Till	110.3	92.4	10.9	28.8	110.0	92.0	11.7	29.7	23	13	10	13	22	65	175	0.20 - 0.25	400	33	10	0.29	3.4
6/7	Very Stiff to Hard Silty Clay	92.4	88.6	28.8	32.6	92.0	90.2	29.7	31.5	33	13	20	20	22	65	175	0.20 - 0.25	140	28	5	0.36	2.8
5	Very Dense to Dense Silt	-	-	-	-	90.2	87.7	31.5	34.0	-	-	-	19	22	70	210	0.20 - 0.25	-	38	-	0.24	4.2
3C / 6/7	Hard Silty Clay to Clayey Silt Soil/Till	88.6	82.8	32.6	38.4	87.7	84.1	34.0	37.6	33	16	17	17	22	65	175	0.20 - 0.25	140	28	5	0.36	2.8
1/2 / 4 / 3N	Very Dense Gravel to Sand to Sandy Silt to Non-Plastic Till	82.8	76.2	38.4	45.0	84.1	79.7	37.6	42.0	-	-	-	12	22	85	255	0.20 - 0.25	-	40	-	0.22	4.6
6/7	Very Stiff to Hard Silty Clay to Clay	-	-	-	-	79.7	77.5	42.0	44.2	31	15	16	22	22	80	250	0.20 - 0.25	140	28	5	0.36	2.8

[A] Secant modulus at 50% of the failure stress. Secant modulus should be increased by 20% to 50% for settlement calculation.

[B] Average Secant Modulus for Unload/Reload condition

[C] Long-term Effective Poisson's Ratio

[E] The unit weight values are for the intact condition and do not include bulking factor after excavation.

THURBER

ONE TEAM
ONTARIO LINE TECHNICAL ADVISOR

Ontario Line

TOC - NORTH
Cosburn
Preliminary Stratigraphic Profile and Geotechnical Properties

Infrastructure Ontario

METROLINX

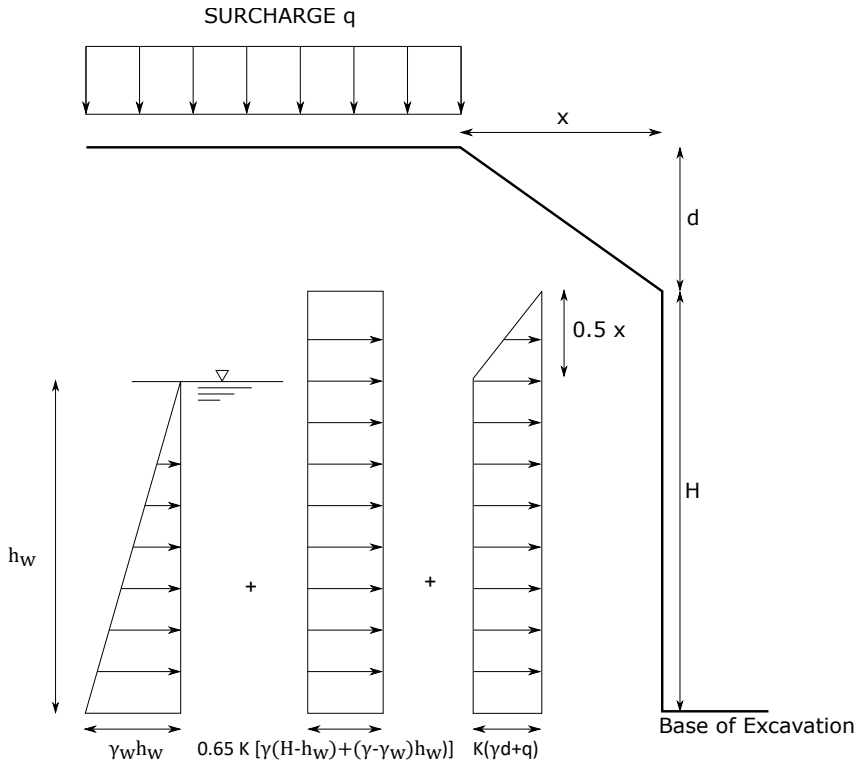
ENGINEER: MH

DRAWN: MM

DATE: 2022-09-30

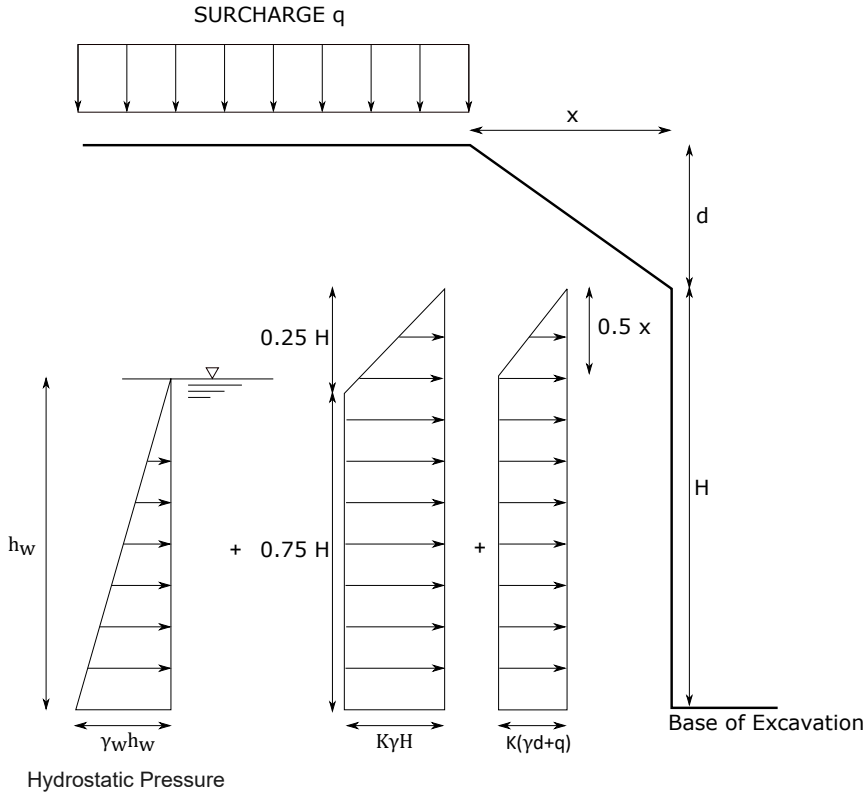
SCALE: NTS

DRAFT



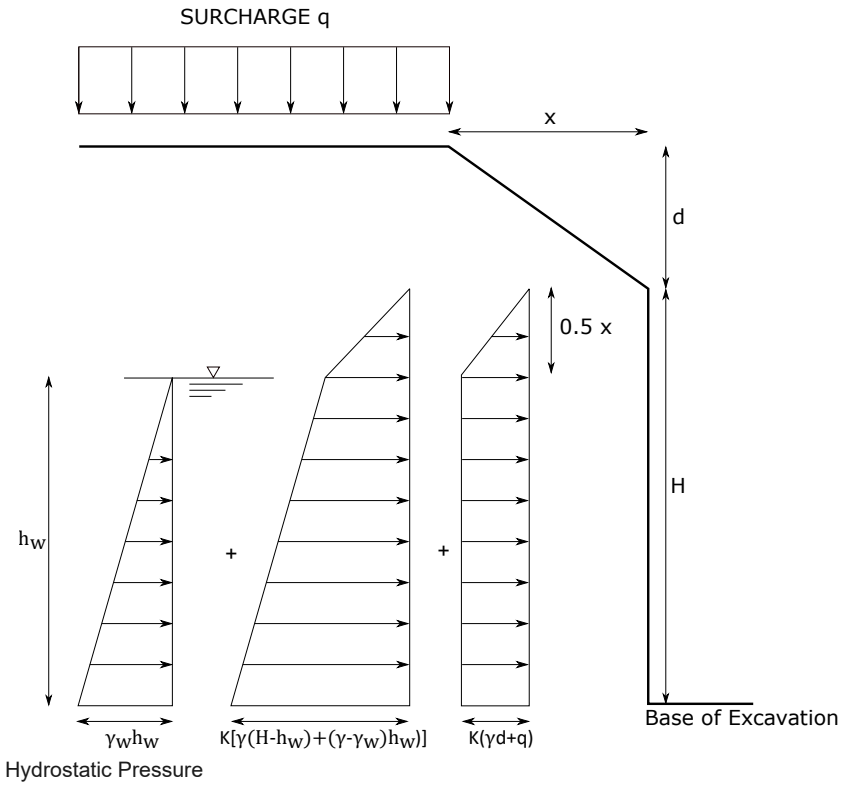
γ = unit weight of soil
γ_w = unit weight of water
K = earth pressure coefficient
= Ka (where controlling ground deformation is not a concern) - Ka is the active coefficient of earth pressure
= 0.4 to 0.5 (to support semi-sensitive to sensitive structures)

ONE TEAM ONTARIO LINE TECHNICAL ADVISOR	SITE: TOC - North - Cosburn	TITLE: Lateral Earth Pressure Distribution Temporary Braced Excavation in Cohesionless Soils
PROJECT: Ontario Line	DOCUMENT OWNER: Thurber	
DATE: 2020-11-13		FIGURE: D-1



γ = unit weight of soil
γ_w = unit weight of water
s_u = undrained shear strength
K = earth pressure coefficient
= 0.2 (where controlling ground deformation is not a concern)
= 0.3 to 0.4 (to support semi-sensitive to sensitive infrastructure)

ONE TEAM ONTARIO LINE TECHNICAL ADVISOR	SITE: TOC - North - Cosburn	TITLE: Lateral Earth Pressure Distribution Temporary Braced Excavation Stiff to Hard Cohesive Soils
PROJECT: Ontario Line	DOCUMENT OWNER: Thurber	
DATE: 2020-11-13		FIGURE: D-2



γ = unit weight of soil
γ_w = unit weight of water
K = earth pressure coefficient as indicated in the report

ONE TEAM ONTARIO LINE TECHNICAL ADVISOR	SITE: TOC - North - Cosburn	TITLE: Lateral Earth Pressure Distribution Permanent Structures
PROJECT: Ontario Line	DOCUMENT OWNER: Thurber	
DATE: 2020-11-13		FIGURE: D-3