
Specialist Advice

Report on Geotechnical Investigation

Proposed Mixed Use Development

378-398 Pacific Highway, Crows Nest NSW

**Prepared for Freecity Group Holdings Pty
Ltd**

Project 224162.01

9 April 2025

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

Signature

Date

Author



9 April 2025

Reviewer



9 April 2025

Executive Summary

This geotechnical investigation report (reference Douglas report 224162.01.R.001.Rev5) has been prepared by Douglas Partners Pty Ltd (Douglas) to accompany a detailed State Significant Development Application (SSDA) for the mixed use development at 378-398 Pacific Highway, Crows Nest. The site is made up of seven lots. The legal description of the site is outlined in Table 1.

Table 1: Legal Description

Property Address	Title Description
378 Pacific Highway	Lot 1 / DP577047
382 Pacific Highway	Lot 5 / 32 / DP4320
-	Lot 1 / DP573543
388 Pacific Highway	Lot 4 / DP663560
390 Pacific Highway	Lot 1 / DP177051
-	Lot 1 / DP724930
398 Pacific Highway	Lot 1 / DP1258791
Total site area	1,980 m ²

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (SSD-79240223).

This report includes the results of geotechnical investigation which comprised the drilling of four boreholes, installation of four groundwater monitoring wells, and laboratory testing of selected samples.

The site is feasible from a geotechnical perspective for the proposed development, provided the comments and recommendations in the report are adopted.

Table of Contents

		Page No
1.	Introduction.....	1
2.	Site description.....	2
3.	Previous investigations.....	4
4.	Published data.....	4
4.1	Geology.....	4
4.2	Hydrogeology.....	5
4.3	Acid sulfate soils.....	5
4.4	Salinity.....	5
4.5	Groundwater dependant ecosystems (GDEs).....	5
4.6	Riparian lands.....	5
5.	Field work.....	5
5.1	Field work methods.....	5
5.2	Field work results.....	6
6.	Laboratory testing.....	7
6.1	Laboratory methods.....	7
6.2	Laboratory results.....	7
7.	Geotechnical model.....	8
8.	Proposed development.....	9
9.	Comments.....	10
9.1	Excavation.....	10
9.2	Excavation support and vertical rock faces.....	11
9.3	Ground movement and stress relief.....	14
9.4	Excavation monitoring adjacent to TfNSW and Sydney water assets.....	15
9.5	Foundations.....	15
9.6	Groundwater.....	16
9.7	Aggressivity.....	17
9.8	Seismic design.....	17
9.9	Recommended further investigation.....	17
10.	Limitations.....	18

- Appendix A:** About This Report
- Appendix B:** Drawings
- Appendix C:** Borehole Logs
- Appendix D:** Laboratory Results
- Appendix E:** Architectural Drawing - Cross Sections

Report on Geotechnical Investigation Proposed Mixed Use Development 378-398 Pacific Highway, Crows Nest NSW

1. Introduction

This Specialist Advice report prepared by Douglas Partners Pty Ltd (Douglas) presents the results of a geotechnical investigation undertaken for a proposed mixed use development at 378-398 Pacific Highway, Crows Nest NSW (the site). The investigation was commissioned by Zoe Zhang of Freecity Group Holdings Pty Ltd and was undertaken in accordance with Douglas' proposal 224162.01.P.002.Rev0 dated 12 June 2024.

The application seeks development consent for a mixed use development comprising 40-storeys plus one level of plant at 378-398 Pacific Highway, Crows Nest. Specifically, the SSDA seeks development consent for:

- Demolition of the existing structures on the portion of the site at 378-390 Pacific Highway;
- Construction of a mixed use development comprising 40-storeys plus one level of plant on the portion of the site at 378-390 Pacific Highway, comprising;
 - A 3-storey commercial / retail podium with residential apartments in a tower form above;
 - Communal open space and amenities on Level 20;
 - 8 basement levels for car parking, bicycle parking and end-of-trip facilities;
- Affordable housing contribution equivalent to 10% of new residential GFA proposed on the site;
- Stratum subdivision of the airspace above the existing development at 398 Pacific Highway;
- Vehicular access from Hume Street; and
- Associated landscaping and public domain works.

The purpose of the project is to facilitate the delivery of high-quality housing at a strategically located site and deliver a built form outcome that is consistent with the desired future character of Crows Nest, as established by the finalised Crows Nest Transit Oriented Development (TOD) rezoning controls.

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) dated 15/01/2025 and issued for the SSDA (SSD-79240223). Specifically, this report has been prepared to respond to the SEARs requirement issued below.

Table 2: SEARs requirements

Item	Description of Requirement	Section Reference (this Report)
12. Ground and Water Conditions	Data and comments in relation to groundwater with respect to the proposed development are provided in Sections 5.1.3 and 9.5, as relevant. Groundwater assessment will be prepared in separate report on the completion of groundwater monitoring. This report does not address the surface water assessment.	Section 5.1.3 and 9.5
13. Ground Conditions	This report considers soil and rock conditions on the site as relevant to the proposed development.	Section 4 to 9

The investigation included the drilling of four boreholes, installation of four groundwater monitoring wells and laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on the geotechnical aspects of the project.

This report must be read in conjunction with all appendices including the notes provided in Appendix A.

2. Site description

The site is located at 378-398 Pacific Highway, Crows Nest, within the North Sydney local government area (LGA). The site is made up of the following lots:

Table 3: Site identification

Lot	Address	Site Area
Lot 1 / DP577047	378 Pacific Highway	335.93 m ²
Lot 5 / 32 / DP4320	382 Pacific Highway	331.13 m ²
Lot 1 / DP573543	-	81.65 m ²
Lot 4 / DP663560	388 Pacific Highway	250.37 m ²
Lot 1 / DP177051	390 Pacific Highway	310.77 m ²
Lot 1 / DP724930	-	4.77 m ²
Lot 1 / DP1258791	398 Pacific Highway	660.72 m ²

The site has a frontage of approximately 57 m to Pacific Highway and approximately 32 m to Hume Street. The site has a total area of 1,980 m².

The site is located immediately opposite (to the west of) the Crows Nest Metro Station. The immediate urban context surrounding the site is characterised by a mix of commercial, retail, residential and recreational land uses. The area is undergoing transition in response to the finalised Crows Nest TOD rezoning proposal which permits tall, high-density mixed use development along Pacific Highway.

The site is currently occupied by four 2 and 3-storey commercial and retail buildings at 378-390 Pacific Highway which will be demolished, and a recently constructed 5-storey shop top housing development at 398 Pacific Highway which will be retained.

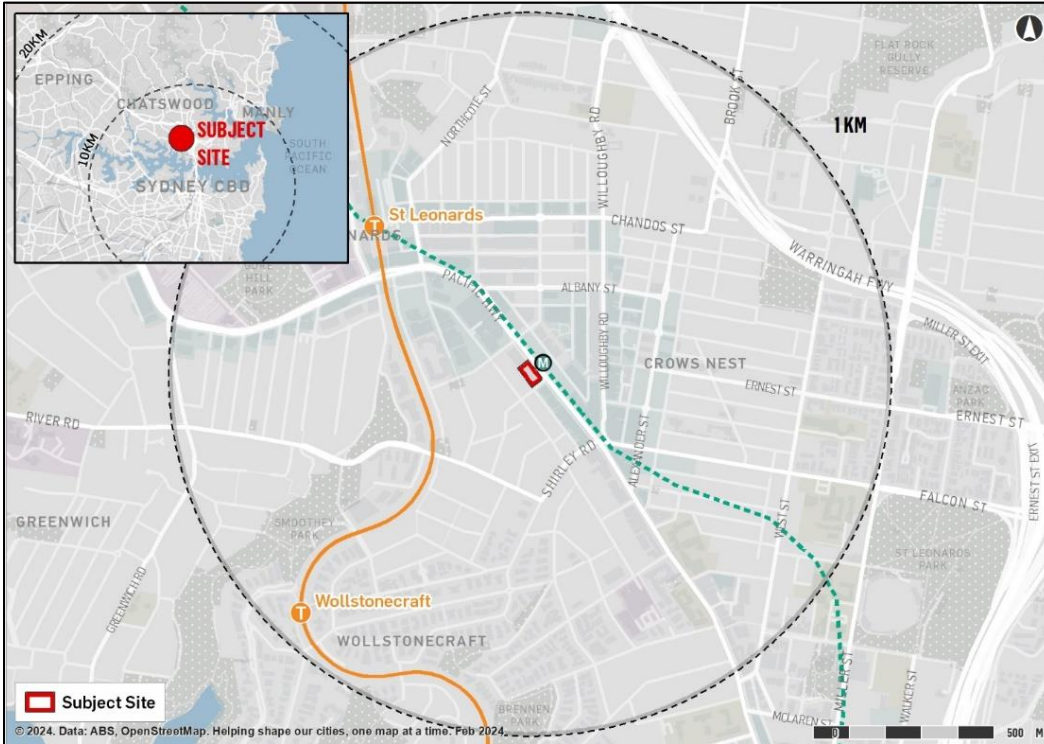


Figure 1: Site Location (source: Urbis GIS, 2024)



Figure 2: Aerial Photograph (source: Urbis GIS, 2024)

3. Previous investigations

Douglas has undertaken several previous investigations near the subject site and on the subject site. A summary of finding of the investigations is presented below:

- Douglas Report 7856, dated February 1983 - The investigation at 402 – 420 Pacific Highway encountered relatively uniform ground conditions across the site. The investigation included the drilling of four augured only boreholes to depths of 5 – 6 m and three rock cored boreholes to depths of 14 – 17 m. The boreholes typically encountered a shallow layer of fill over residual clays and weathered ‘extremely weak’ and ‘very weak’ shale to about 12 – 13 m depth over typically low to medium strength sandstone. No free groundwater was observed whilst auguring in any of the boreholes and the use of groundwater for rock-coring purposes precluded the observation of any groundwater in deeper bores; and
- Douglas Report 72923.00, dated May 2012 - The investigation at 521 Pacific Highway was conducted on what is now the north-western portion of the current Crows Nest Sydney Metro Station. This investigation included the drilling of four rock cored boreholes to depths of about 16 – 17 m. The bores typically encountered a thin layer of fill over residual clay to about 4 – 6 m depth over very low to medium strength shale and sandstone to about 14 m over consistent medium strength and stronger sandstone to the borehole termination depth. Groundwater was encountered between depths of 3.0 m to 6.5 m during augering the boreholes. Groundwater level measurements from wells installed by others in 2012 showed groundwater depths in a range between 1.5 m to 3.5 m within the soil profile. There is no information available regarding the depth of these wells.

4. Published data

4.1 Geology

Reference to the Sydney 1:100,000 Geological Series Sheet indicates that the site is underlain by Ashfield Shale.

The Ashfield Shale overlies the Hawkesbury Sandstone and, in some areas, there is a transitional geological unit between these two main rock formations known as the Mittagong Formation.

The units typically comprise:

- Ashfield Shale – Black to dark grey shale, siltstone and laminite (finely interbedded sandstones and siltstones);
- Mittagong Formation – Interbedded shale, laminite and fine grained sandstone. This unit is a relatively thin formation that varies in thickness, typically between 3 m and 8 m thick, and is not always present; and
- Hawkesbury Sandstone – medium to coarse grained quartz sandstone, very minor shale and laminite lenses.

This investigation confirmed the mapping encountering Ashfield Shale and Mittagong Formation bedrock over Hawkesbury Sandstone.

4.2 Hydrogeology

A groundwater bore search of the WaterNSW database was conducted for any bores registered within a 500 m radius of the site. The search was undertaken to assess possible water levels and potential uses of groundwater in the vicinity of the site. There are no registered bores and available public groundwater data within a 500 m radius of the site.

4.3 Acid sulfate soils

Reference to Department of Land and Water Conservation NSW Acid Sulphate Soil Risk Mapping indicates that the site is not within an area mapped as at risk of acid sulphate soil occurrence.

Given the elevation (RL 88 m to RL 91 m) and the known geology of the site, it is expected that acid sulfate soils are not present on the site.

4.4 Salinity

Regional mapping of salinity potential in Western Sydney was undertaken in 2002 by the former Department of Infrastructure, Planning and Natural Resources, now the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW). The site is located outside the mapped area of salinity potential.

Reference to the NSW DCCEEW information system (eSPADE) indicates that soils in the surrounding area have shown 'no salting evident' within available soil profiles.

4.5 Groundwater dependant ecosystems (GDEs)

A review of the Bureau of Meteorology Groundwater Dependiant Ecosystems Atlas indicates that there are no aquatic, subterranean or terrestrial GDEs within 1 km of the site.

4.6 Riparian lands

Reference to the NSW Riparian Lands and Watercourses Map indicates that the site is not within an area mapped as a protection area.

5. Field work

5.1 Field work methods

Field work for the geotechnical investigation was carried out on 16th to 18th May and 27th to 29th June 2024 and included:

- Electronic scanning for buried services at the proposed borehole locations;
- Drilling of four (4) cored boreholes using a track mounted drilling rig. The boreholes were drilled down to weathered rock using solid flight augers. The boreholes were then extended to depths from 17 m to 30 m below existing surface level using NMLC diamond coring equipment to recover continuous rock core samples;
- Standard Penetration Tests (SPTs) were carried out at regular intervals through the soil profile at BH01 and BH02;

- Soil samples were collected for laboratory testing in each borehole; and
- Installation of groundwater monitoring wells in all four boreholes.

The locations of the boreholes are shown on Drawing 1 in Appendix B.

5.2 Field work results

A summary of the subsurface conditions encountered at the boreholes is presented in the following sections. Detailed descriptions of the subsurface conditions encountered are given in the borehole logs included in Appendix C alongside photographs of the rock core. Notes defining classification methods and descriptive terms used in the preparation of the borehole logs are also included within Appendix A.

5.2.1 Boreholes

The general strata encountered in the boreholes is summarised as follows:

Concrete Slab:	Concrete slab or asphaltic concrete thickness of 110 mm to 350 mm, except at BH03; overlying
Fill:	Variably comprising clay, clayey sand with some ironstone, igneous and sandstone gravels encountered to depths ranging from 2.0 m to 1.0 m. An organic / hydrocarbon odour was noted in BH02.; overlying
Residual Soil:	Low to medium plasticity, stiff to hard residual silty clay with a trace of shale gravels encountered to depths ranging from 2.0 m to 5.0 m; overlying
Extremely Weathered Bedrock:	High plasticity, hard silty clay with ironstone and shale gravels encountered to depths ranging from 7.0 m to 9.2 m; overlying
Very Low to Low Strength Bedrock:	Highly to moderately weathered, fragmented to highly fractured shale, siltstone and laminite encountered to depths ranging from 12.4 m to 19.3 m; overlying
Medium Strength Bedrock:	Moderately to slightly weathered, slightly fractured, medium strength laminite, siltstone and sandstone encountered to termination depths, except at BH01. At BH01, fresh medium to high strength sandstone was encountered from 23.6 m to termination depth. The rock was generally slightly fractured and unbroken.

5.2.2 Groundwater

Groundwater was not observed during auger drilling of any of the boreholes. The necessary introduction of water to the borehole while coring precluded any further groundwater observations during drilling.

A groundwater monitoring well screened in the bedrock was installed at all borehole locations. Details of well construction are shown on the borehole log in Appendix C. A summary of the measured groundwater level in the monitoring wells is provided in the Table 4. Groundwater levels fluctuate with weather and rainfall. The data loggers were installed in BH01, BH03 and BH04 for long term monitoring to assess likely fluctuations.

Table 4: Manual groundwater measurements

Date of Reading	Measured Depth to Groundwater (m) [Groundwater Level (m, AHD)]			
	BH01 (17/05/2024) ¹	BH02 (18/05/2024) ¹	BH03 (27/06/2024) ¹	BH04 (29/06/2024) ¹
24/05/2024	13.05 [77.35]	11.77 [76.25]	-	-
11/06/2024	12.9 [77.5]	-	-	-
25/06/2024	12.85 [77.55]	10.95 [77.07]	-	-
10/07/2024	-	-	7.2 [82.2]	4.8 [84.6]
15/07/2024	12.7 [77.7]	10.95 [77.07]	8.57 [80.83]	5.27 [84.13]
7/08/2024	13.01 [77.39]	10.91 [77.11]	9.7 [79.7]	6.62 [82.78]

Note: ¹Groundwater monitoring well installation date

6. Laboratory testing

6.1 Laboratory methods

Laboratory testing was carried out on selected soil and rock samples to determine:

- Soil aggressivity and rock strength.

The results are summarised below, and detailed laboratory test reports are provided in Appendix D.

6.2 Laboratory results

Four (4) soil samples were tested for aggressivity to buried concrete and steel. A summary of the results is presented below in Table 5.

Table 5: Analytical results for aggressivity in soil

Location ID	Depth (m)	Material	pH	EC ($\mu\text{S}/\text{cm}$)	Cl (mg/kg)	SO_4^{2-} (mg/kg)
BH01	2.5-2.7	Silty CLAY	5.0	37	10	43
BH02	1.0-1.45	Silty CLAY	4.9	44	26	44
BH03	2.2-2.5	Silty CLAY	4.9	26	<10	20
BH04	3.4-3.5	Silty CLAY	4.6	110	120	23

6.2.1 Point load strength index testing

The results of point load strength index testing ($I_{s(50)}$), carried out at regular intervals on rock cores, are shown on the borehole logs in Appendix C. The $I_{s(50)}$ results range from less than 0.1 MPa to 1.4 MPa in the underlying bedrock, indicating rock strengths of between very low to high strength.

7. Geotechnical model

The observed subsurface profile during the investigation has been grouped into six geotechnical units (1 to 6).

Based on the investigation, the site is generally underlain by fill over stiff to hard residual soils which grades to extremely weathered shale bedrock with depth. Very low to low strength shale and laminite was encountered improving to medium strength with depth in all boreholes.

The interpreted depths and RL's at the top of the various units from the investigation at each test location are shown in Table 6. An interpreted geotechnical cross-section is provided in Appendix B (Drawing 2).

Reference should be made to the borehole logs in Appendix C for more detailed information and description for the soil and rock profile.

Table 6: Summary of geotechnical model

Unit	Material	Depth to Top of Unit (m) [Reduced Level of Top of Unit (m, AHD)]*			
		BH01	BH02	BH03	BH04
1	Fill	0.2 [90.2]	0.35 [87.67]	0.7 [88.7]	0.82 [88.58]
2	st to h Residual Clay	2.0 [88.4]	1.0 [87.02]	1.2 [88.2]	1.0 [88.4]
3	Extremely Weathered Shale	5.0 [85.4]	2.0 [86.2]	4.0 [85.4]	5.0 [84.4]

Unit	Material	Depth to Top of Unit (m) [Reduced Level of Top of Unit (m, AHD)]*			
		BH01	BH02	BH03	BH04
4	VL to L Shale / Laminite / Siltstone (Ashfield Shale)	7.0 [83.4]	9.2 [78.82]	9.0 [80.4]	8.0 [81.4]
5	M Sandstone / Laminite / Siltstone (Mittagong Formation)	16.3 [74.1]	12.4 [75.62]	14.8 [74.6]	19.3 [70.1]
6	M to H Sandstone (Hawkesbury Sandstone)	23.6 [66.8]	NE	NE	NE

Notes: st = Stiff, h = Hard, VL = Very Low Strength,
L = Low Strength, M = Medium Strength, H = High Strength,
NE = Not Encountered

Groundwater was not observed in the augered sections of the boreholes and the use of water for drilling precluded observation in the cored section.

The current groundwater measurements in wells do not indicate an obvious flow direction, but water levels typically fall from about RL 79.7 m to RL 84.6 m on the northern boundary to RL 77.1 m on the southern boundary. It is considered likely that some of the measured water is associated with perched seepage within the rock and not necessarily a permanent groundwater table. Based on the lowest proposed basement floor level (RL 65 m AHD), it is possible that the proposed basement level 8 will extend about 12 m to 20 m below the measured water levels.

8. Proposed development

Reference to the architectural drawings provided (prepared by: COX Architecture, project No.: 223146.01, dated: 7 March 2025), indicate that the proposed building comprises of forty-storey plus one level of plant building with eight basement levels. It is understood that the existing buildings on the site will be demolished, except for 398 Pacific Highway.

The provided drawings indicate that the lowest proposed floor level of the basement 8 is RL 65.0 m AHD. Based on the survey drawings provided, it is anticipated that the excavation depth to the lowest basement level will be up to approximately 26.0 m below the existing surface level at the south-east corner of the building, with an additional 5 m localised excavation expected for the lift pits. The provided architectural cross section drawings of the proposed building are included in Appendix E of this report.

9. Comments

9.1 Excavation

9.1.1 Dilapidation surveys

Dilapidation surveys should be carried out on adjacent buildings, existing buildings, pavements and infrastructure that may be affected by the excavation works. The dilapidation surveys should be undertaken before the commencement of any excavation or demolition work to document any existing defects so that claims for damage due to construction related activities can be accurately assessed.

9.1.2 Excavation conditions

Based on the borehole logs, the proposed excavation works are anticipated to extend through Units 1 to 5 (soil and rock) outlined in Table 6, with the base of the excavation extending to the medium strength Unit 5 rock and the medium to high strength Unit 6 rock.

Excavation in fill, residual soil and very low strength rock should be readily achievable using conventional earthmoving equipment such as bulldozers and hydraulic excavators with bucket attachments.

Excavation in low strength and stronger rock will require the use of heavy ripping equipment, hydraulic rock hammers, milling heads and / or rock saws. High strength rock will require very large hammers and / or heavy ripping tynes on large (45 tonne plus) excavators and bulldozers, and low productivity can be expected. Potential excavation contractors should make their own assessment of the rock strength and equipment required based on the information contained on the borehole logs as well as an inspection of the rock cores from the current boreholes (stored at Douglas for six months).

9.1.3 Vibration

Noise and vibration will be caused by excavation work in rock, the demolition of the existing structures and by the operation of large excavation equipment, particularly for the removal of medium strength or stronger rock. The level of acceptable vibration is dependent on various factors including the type of building / structure (e.g. reinforced concrete, brick, etc), its structural condition, the frequency range of the vibrations produced by the construction equipment, the natural frequency of the building and the vibration transmitting medium (i.e., soil or rock).

The use of large excavation (and demolition) equipment will cause vibrations which could possibly result in damage to nearby structures. It is suggested that vibrations be provisionally limited to a peak particle velocity (PPVi) of 8 mm/s at the foundation level of the adjacent buildings to protect the architectural features of the buildings and to reduce discomfort for the occupants. Stricter tolerances for vibrations may be imposed by other asset owners such as Sydney Water.

A site-specific vibration monitoring trial will be required to determine vibration attenuation once excavation plan and methods have been finalised. Rock sawing along the boundaries may be required in stronger rock to reduce vibrations on adjacent sites.

9.1.4 Disposal of excavated material

All excavated materials to be removed from site will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the Waste Classification Guidelines (NSW EPA, 2014). Reference should be made to the preliminary site assessment for contamination report (reference Douglas report 224162.02.R.001.Rev4).

9.2 Excavation support and vertical rock faces

Vertical excavation in fill, residual soil, and very low to low strength bedrock cannot be relied upon to remain stable and will require lateral support.

Battering of the sides of the excavation may not be feasible as the proposed excavation is expected to extend to the boundaries of the site. Both temporary and permanent lateral support will therefore be required for all vertical excavation faces in the overlying fill / soils and weathered rock and sandstone / laminite.

9.2.1 Retaining walls

Anchored soldier pile walls are often used to provide temporary retaining support in these ground conditions (i.e., clay over shale). The soldier piles are usually spaced at approximately 2 m to 2.5 m centres and should preferably be founded at least 1 m or two pile diameters below the lowest excavation level (including detailed excavation). More closely spaced piles may be required to reduce wall movements, or prevent collapse of infill materials, particularly where pavements, structures or services are located in close proximity to the excavation. The rock will break down over time and will require shotcrete protection for the long term.

Details of existing footings near the shoring walls should be confirmed prior to detailed design and shoring wall spacing and design loads selected to control deflections.

At the completion of each 1.5 m to 2.0 m drop in excavation level, reinforced shotcrete infill panels should be constructed. At no stage should progressive vertical excavation proceed beyond 2 m without infill panel support being constructed. Regular inspections by a geotechnical professional should be carried out following each progressive drop in excavation level to confirm that the conditions encountered are consistent with the design assumptions.

It may be possible to terminate the shoring piles within unsupported medium or better strength laminite / sandstone (Unit 5 and Unit 6). If piles are founded at higher levels in competent rock, it will be important for a geotechnical engineer to assess the stability of the rock directly beneath each pile. The toe of the piles which terminate above bulk excavation level will also need to be restrained with rock bolts or anchors.

Suitably powered piling rigs will be required to penetrate the medium and high strength rock, and this should be considered by the piling contractor. Consideration should also be given to the potential for groundwater inflow into the piles which may be heavy where fractured zones and faults are encountered. This may require the use of cleaning buckets and possibly tremmie pouring methods.

Medium strength or better laminite / sandstone (Unit 5 and Unit 6) will generally be stable when cut vertically provided there are no adversely oriented joints or other defects present. All vertical faces in rock should be inspected by an experienced geotechnical engineer at 1.5 m depth intervals to check for adversely inclined joints and to assess whether additional stabilisation measures (such as rock bolts or shotcrete) are required.

9.2.2 Shoring design

It is suggested that the preliminary design of cantilevered shoring systems (or shoring systems with one row of anchors or propping) be based on a triangular earth pressure distribution using the earth pressure coefficients provided in Table 7. 'Active' earth pressure coefficient (K_a) values may be used where some wall movement is acceptable. 'At Rest' earth pressure coefficient (K_o) values should be used where the wall movement needs to be limited. For this site however it is generally expected that multiple rows of anchors or bracing will be required for the shoring system.

Table 7: Recommended design parameters for retaining walls

Unit	Material	Unit Weight (kN/m ³)	Effective Stress Parameters		Earth Pressure Coefficient	
			Φ' (°)	c' (kPa)	Active (K_a)	At Rest (K_o)
1	Fill	19	25	0	0.4	0.6
2	st to h Residual Clay	20	26	3	0.3	0.45
3	Extremely Weathered Shale	20	26	5	0.3	0.45
4	VL to L Shale / Laminite (Class IV)	22	30	15	0.25 ¹	0.4 ^{1,2}
5, 6	M and M to H Laminite / Sandstone (Class III or better)	24	40	100	0 ¹	0.1 ^{1,2}

Notes: ¹Provided that adverse jointing is not encountered in the rock.

²Does not account for stress relief movements.

For braced walls or where two or more rows of anchors are used, the shoring can be designed using a rectangular or trapezoidal earth pressure distribution. For preliminary purposes a trapezoidal earth pressure distribution with a maximum pressure calculated based on 4H kPa where H is equal to the retained height (m) of soil and very low to low strength shale, laminite and siltstone may be assumed. The maximum pressure should be increased to 6H kPa where wall movement needs to be reduced. In each case the maximum pressure generally acts over the central 60% of the wall height, reducing to zero at the top and base.

The design of temporary (and possibly permanent) support will also need to consider the possibility that moderately to steeply dipping joints in the weathered rock and Ashfield Shale / Mittagong Formation will 'daylight' near the base of the excavation leading to wedges of rock requiring support by the temporary (and permanent) shoring / retaining structures. For the temporary case, the required forces are generally provided by temporary 'tie-back' ground anchors and prudent, conservative design of deep excavations in shale generally involves shoring piles extending below the bulk excavation level to provide passive restraint to the shoring / retaining walls. As a guide, an anchor force equal to $4.2H^2$ kN per meter length of wall would be required for a continuous 45 degree joint daylighting at the toe of the excavation, and this often governs the shoring / anchor design for deep excavations in jointed shale (this assumes anchors at 10 degrees).

Lateral pressures due to surcharge loads from adjacent buildings, sloping ground surfaces, pavements and construction machinery should be included where relevant. Hydrostatic pressure acting on retaining walls should also be included in the design where adequate drainage is not provided behind the full height of the walls.

Passive resistance for piles founded below the base of the bulk excavation may be based on an ultimate passive pressure of 1,000 kPa in very low to low strength rock and 4,000 kPa in medium strength or better rock, provided that the rock is not adversely affected by discontinuities. A factor of safety of at least 2 should be applied to limit wall movements. The passive restraint of the first 0.5 m of rock socket below the bulk excavation level should be ignored. The minimum socket depth should be equal to the greater of one pile diameter or 1.0 m below the lowest level of any nearby excavation (including any detailed excavations), but subject to analysis.

9.2.3 Ground anchors

It is anticipated that the building will support the shoring wall in the long term and therefore any ground anchors are expected to be temporary only. The use of permanent anchors, if required, would need careful attention to corrosion protection for which further geotechnical advice should be sought.

It should be noted that permission from adjacent property owners will be required, prior to installing rock bolts / anchors below their land. Due consideration should also be given to buried services and any excavations nearby. TfNSW, Sydney Water and other service providers may require assessment on the effects that excavations and rock bolts and anchors may have on their assets.

Reference to available public information, indicates the site boundary does not appear to be within the second reserve of the Sydney Metro tunnel. However, the designer should request detailed information from Sydney Metro regarding the location of the tunnel and corridor protection zone for consideration in the design. Approval from Sydney Metro will be required to install the anchor within the corridor protection zone (i.e., Second Reserve).

Pre-stressed ground anchors, rock bolts and dowels (support elements) can be used to laterally support new shoring walls or unstable rock masses. These support elements should preferably be bonded into the stronger rock, inclined as required, but preferably not steeper than 30° below the horizontal.

Shorter support elements (rock bolts and dowels) may be required to support unstable rock wedges, slivers or blocks in the excavation faces between shoring piles. Short dowels and pins may be required to support feather edges where sub-parallel joints intersect the face. Shotcrete or mesh may be required where beds/seams of extremely or very low strength rock are encountered within higher strength rock, secured with rock bolts, dowels and pins, as required.

The design of temporary and permanent ground anchors / rock bolts / dowels may be carried out using the bond stresses given in Table 8.

Table 8: Recommended bond stresses for rock anchor design

Unit	Material	Allowable Bond Stress (kPa)	Ultimate Bond Stress (kPa)
4	VL to L Shale / Laminite (Class IV)	100	200
5, 6	M and M to H Laminite / Sandstone (Class III or better)	400	800

These values should be confirmed by pull-out tests prior to full scale installation of support elements. Ultimately, it is the contractor's responsibility to ensure that the correct design values (specific to the support system and method of installation) are used and that the support element holes are carefully cleaned prior to grouting.

After temporary support elements have been installed, it is recommended that they are tested to 125% of their nominal working load. Where stress relief or further unavoidable movement of the shoring is expected, it is recommended that the support elements are locked-off between 60% and 80% of their working loads to accommodate the additional movement and subsequent increase in stress in the support elements. Consideration should, however, be given to the immediate design requirements. Checks should be carried out to confirm that the load in the support elements has been maintained and that losses due to creep effects or other causes have not occurred.

Care should be exercised to ensure that anchors are installed progressively during excavation and stressed prior to excavation of the next drop to ensure that stability is maintained at all times.

9.3 Ground movement and stress relief

Horizontal movements due to stress relief of the Hawkesbury Sandstone and to a lesser extent the Ashfield Shale will occur during the excavation works. Based on published literature and Douglas's experience, the lateral deflections associated with stress relief in rock may be in the order of 0.05% to 0.2% of the excavation height, depending on the various factors such as rock strength, orientation of the face, a degree of fracturing. The predicted deflections would generally be greatest at the centre of the excavated faces and would reduce with distance from the excavation face / boundary.

It is unlikely to be practicable to provide restraint (i.e., anchoring) for the relatively high *in-situ* horizontal stresses associated with stress relief movements. Therefore, it is recommended that appropriate allowance be made for movements of this order in construction and planning.

9.4 Excavation monitoring adjacent to TfNSW and Sydney water assets

Reference should be made to the “TfNSW Technical Direction on Excavation adjacent to Transport for NSW Infrastructure guideline (GTD 2020/001 | Version No. 01 – 2 July 2020)” with regards to excavation/shoring adjacent to Pacific Highway. This document outlines requirements for excavations adjacent to TfNSW infrastructure and includes the level of geotechnical investigation required, dilapidation surveying, instrumentation and monitoring during construction, trigger levels and contingency plans.

Instrumentation (e.g., inclinometers) and monitoring is typically required where the excavation exceeds 3 m in height (for cantilevered shoring walls) or 6 m in height (for anchored or propped shoring walls). A geotechnical monitoring plan may be required by TfNSW prior to construction of the development.

In addition, a Specialist Engineering Assessment (SEA) of any Sydney Water assets within the zone of the influence of the excavation will be required with reference to the Sydney Water guidelines.

It is understood that the site is outside the Second Reserve of Sydney Metro however details of the protection zones should be obtained from Sydney Metro and considered in the design. No works (including anchors) are allowed in the Second Reserve without assessment and approval.

9.5 Foundations

9.5.1 Footings and bored piles

Based on available information it is likely that medium strength sandstone (Class III or better, Unit 5 and Unit 6) will be exposed across most of the site.

Pad footings may be suitable, subject to further geotechnical investigations to confirm rock strength across the site at the bulk excavation level. Typical parameters for the design of foundations on sandstone, based on the classification methods of Pells et al. (2019) are provided in Table 9, and are subject to spoon testing / proof coring, where required. Shaft adhesion values for uplift (tension) in piles may be taken as being equal to 70% of the values for compression, provided that adequate socket roughness is achieved. Values are provided for very low to low strength (Class IV) rock, however, it is suggested that the new building should be uniformly founded on medium strength (Class III) or better rock.

Alternatively, piles could be used to found on the Unit 6 medium to high strength Hawkesbury Sandstone for higher bearing pressures of about 6,000 kPa, subject to further geotechnical investigation and testing. This would require additional cored boreholes and spoon testing in 50% of footings. Spoon testing involves drilling a 50 mm diameter hole below the base of the footing, to a depth of 1.5 times the footing width, followed by testing to check for the presence of weak/clay bands. If weak seams are detected, then footings may need to be taken deeper to reach suitable foundation material. It should be noted that the depth to Unit 6 rock is not well defined across the site and would require additional deeper boreholes.

Table 9: Recommended parameters for foundation design

Unit	Foundation Stratum	Maximum Allowable Pressure		Maximum Ultimate Pressure		Young's Modulus, E (MPa)
		End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	
4	VL to L Shale / Laminites (Class IV)	1,000	100	3,000	150	100
5, 6	M and M to H Sandstone / Laminites (Class III or better)	3,500	350	10,000	600	600

Note: Shaft adhesion applicable to the design of bored piles, uncased over the rock socket length, where adequate sidewall cleanliness and roughness are achieved.

Foundations proportioned on the basis of the allowable bearing pressures in Table 9 would be expected to experience total settlements of less than 1% of the pile diameter or footing width under the applied working load, with differential settlements between adjacent columns expected to be less than half of this value. Footings designed using the ultimate values in Table 9 will also need to consider serviceability criteria which will probably govern the design.

Consideration should be given to the existing footings for the neighbouring residential building to the west and a mixed use building to the north (398 Pacific Highway), as it is likely to be within the zone of influence of the proposed excavation. The zone of influence may be taken as a 45° line drawn up from the base of the proposed bulk excavation level. An assessment of the bearing capacity beneath these neighbouring footings should be undertaken to ensure the foundation remains within their serviceability design limits. Progressive inspections of the excavated face below the neighbouring footings will be necessary in 1.0 m drops to check whether there are defects or adversely dipping joints that may affect the neighbouring foundation performance.

All foundations should be inspected by a geotechnical engineer to confirm that foundation conditions are suitable for the design parameters, and proof drilled, or spoon tested as appropriate. If weak seams or defects are encountered, footings may need to be deepened until suitable foundation material is reached. Alternatively, the footing can be enlarged, or redesigned for a lower bearing pressure.

9.6 Groundwater

The groundwater level measured in the monitoring wells ranged from approximately RL 77.1 m to 84.6 m AHD. It is considered likely that some of the measured water is associated with perched seepage within the rock and not necessarily a permanent groundwater table. Seepage should be expected along the top of the rock (particularly after periods of wet weather) and through the rock mass, joints and bedding planes in the rock. The seepage may vary depending on the climatic variations. The seepage may be relatively minor during dry periods and will increase following and during wet periods.

During construction it is anticipated that seepage into the excavation could be controlled by perimeter drains connected to a "sump-and-pump" system. For SSDA, approval from the Natural Resources Access Regulator (NRAR), will be required prior to design and construction of a drained basement. A drained basement, if approved by NRAR, will require permanent subfloor drainage to direct seepage to the stormwater drainage system.

Should approval for a drained basement not be possible a tanked or partially tanked basement may be required to prevent groundwater inflow during the operational period of the proposed development. Tanked basements would need to be designed for hydrostatic pressures and are relatively expensive and significant additional resources and materials.

Previous experience in Sydney is that seepage will likely contain relatively high levels of soluble iron that will form a precipitate in the form of a gelatinous 'sludge' when exposed to oxygen. This 'sludge' has the potential to block-up subsoil (gravel) drains and 'seize-up' pumps. Therefore, detailing of subfloor drains, sumps and pumps should incorporate provision for regular maintenance such as flushing and 'rodding' of drains and / or "baffle" pits.

9.7 **Aggressivity**

In accordance with AS2159-2009: Piling-Design and Installation, the results of the soil aggressivity testing indicate that the tested soils are:

- Mildly aggressive to buried concrete; and
- Non-aggressive to buried steel.

It is suggested that an exposure classification of at least 'mild' (as per AS2159) is adopted for all buried structural elements.

9.8 **Seismic design**

In accordance with AS1170-2007 "Structural Design Actions, Part 4: Earthquake Actions in Australia", a hazard factor (Z) of 0.08 and a site subsoil Class C_e (shallow soil site) is considered to be appropriate for the site.

9.9 **Recommended further investigation**

The geotechnical factual information and interpretation provided above are considered sufficient for the SSDA stage. It is recommended that supplementary investigations be carried out once the existing buildings are demolished, or at least vacated, when the project progresses to the detailed design stage.

The supplementary investigation will involve the drilling of a minimum of four boreholes extending below the proposed basement level to confirm subsurface conditions, particularly the depth of medium to high strength sandstone (Unit 6). The investigation will also include the installation of groundwater monitoring wells for long term monitoring, permeability testing, and a groundwater impact assessment based on the long term groundwater monitoring data.

10. Limitations

Douglas Partners Pty Ltd (Douglas) has prepared this report for this project at 378-398 Pacific Highway, Crows Nest NSW in line with Douglas' proposal dated 12 June 2024 and acceptance received from Zoe Zhang of Freecity Group Holdings Pty Ltd. The work was carried out under Douglas' Engagement Terms. This report is provided for the exclusive use of Freecity Group Holdings Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas has necessarily relied upon information provided by the client and / or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and / or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after Douglas' field testing has been completed.

Douglas' advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by Douglas in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and / or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. Douglas cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by Douglas. This is because this report has been written as advice and opinion rather than instructions for construction.

This report provides specialist advice only and no part of it is considered a Regulated Design under the Design and Building Practitioner Act 2020 (NSW).

Appendix A

About This Report

Introduction

These notes have been provided to amplify Douglas' report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

Douglas' reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Engagement Terms for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather

changes. They may not be the same at the time of construction as are indicated in the report; and

- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, Douglas will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, Douglas cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, Douglas will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, Douglas requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. Douglas would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

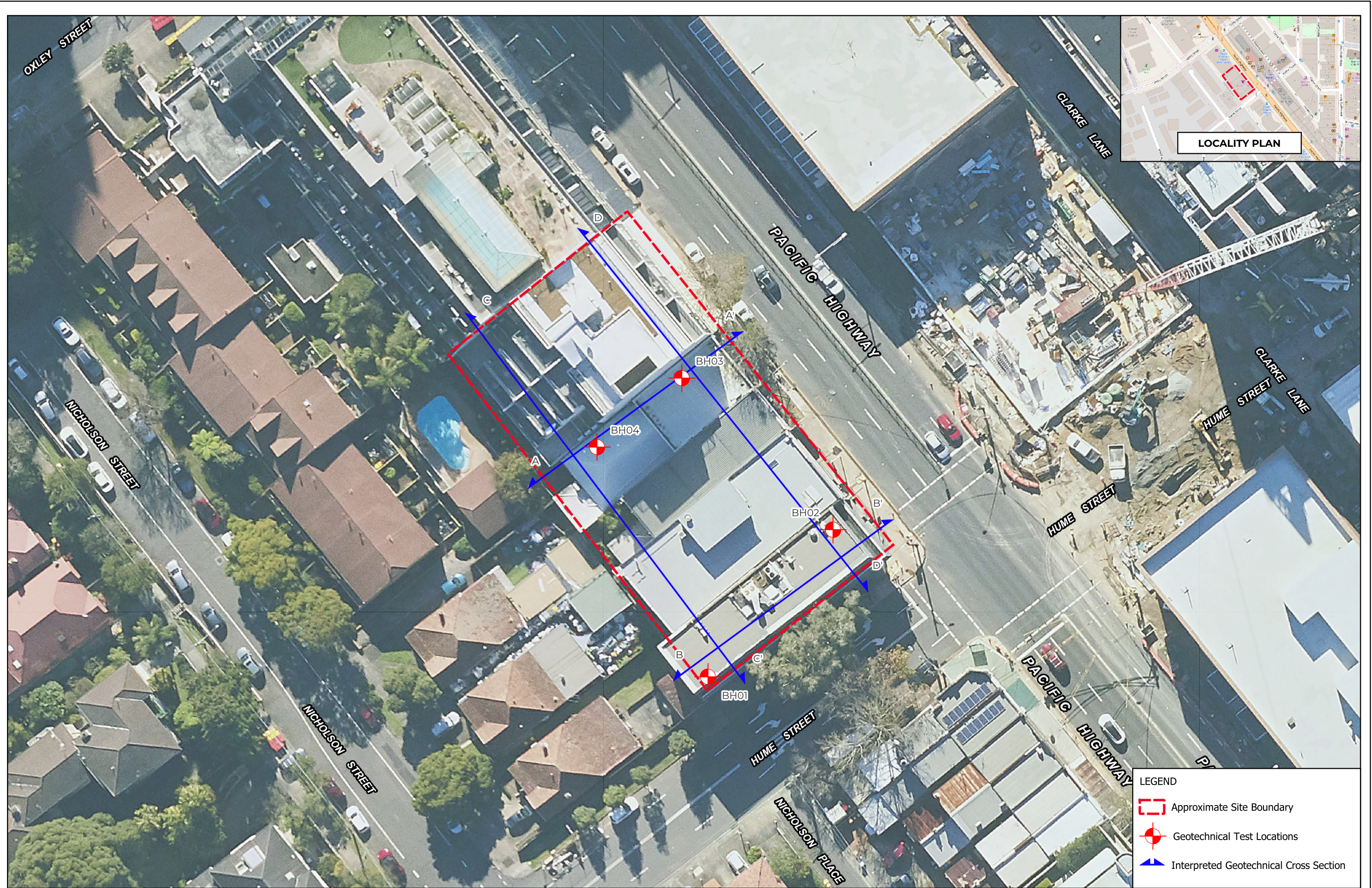
Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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Appendix B

Drawings



LEGEND

- Approximate Site Boundary
- ⊕ Geotechnical Test Locations
- ↔ Interpreted Geotechnical Cross Section

REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	INITIAL ISSUE	18.06.2024	YG
1	SITE BOUNDARY & TEST LOCATION UPDATE	18.07.2024	YG
2	TEST LOCATION & CROSS SECTION UPDATE	15.08.2024	YG

SCALE: 1:500 @ A3

Douglas
PARTNERS
OFFICE: SYDNEY
96-98 Hermitage Rd, West Ryde NSW 2114
(02)9809 0666

CLIENT:
Freecity Group Holdings Pty Ltd

NOTE:
1: Basemap from Metromap (Dated 19.11.2023)

COORDINATE REFERENCE SYSTEM: GDA2020 / MGA zone 56

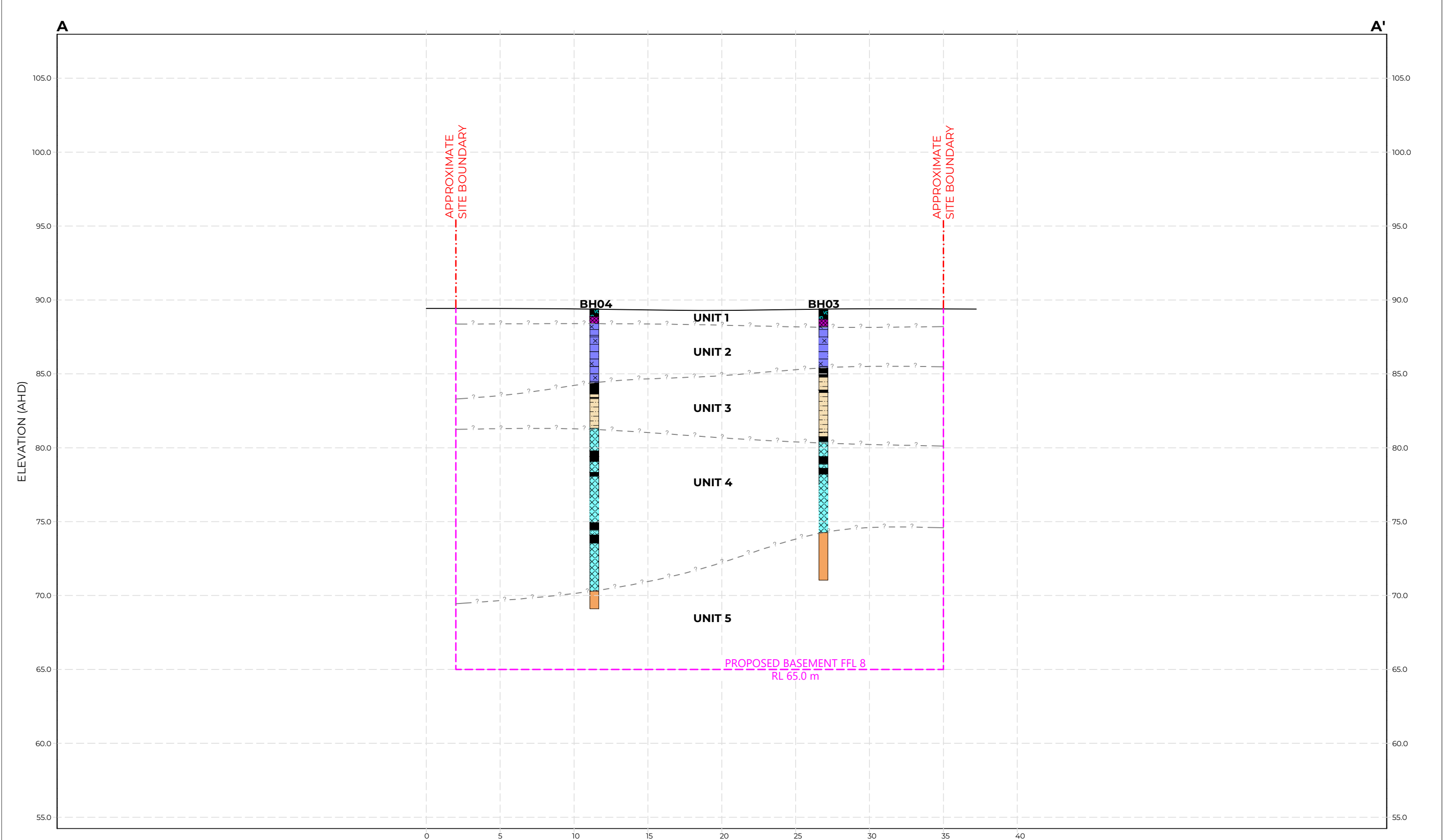
PROJECT NAME:
Proposed Mixed Use Development
PROJECT ADDRESS:
378-398 Pacific Highway, Crows Nest

DRAWING TITLE:
TEST LOCATION PLAN

PROJECT NO:
224162.01

DRAWING NO:
1

REVISION:
2



LEGEND		TESTS / OTHER	
UNIT 1: FILL	UNIT 4: VL-L SHALE/LAMINITE/SILTSTONE	Void	- ? - - - Interpreted geotechnical boundary
UNIT 2: St-h RESIDUAL CLAY	UNIT 5: M SANDSTONE/LAMINITE/SILTSTONE		
UNIT 3: XW SHALE	NO CORE		

REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	INITIAL ISSUE	24.02.2025	EC
1	Basement RL's Update	01.04.2025	MN

SCALE: 1:250 @ A3
Vertical Exaggeration = 1.0

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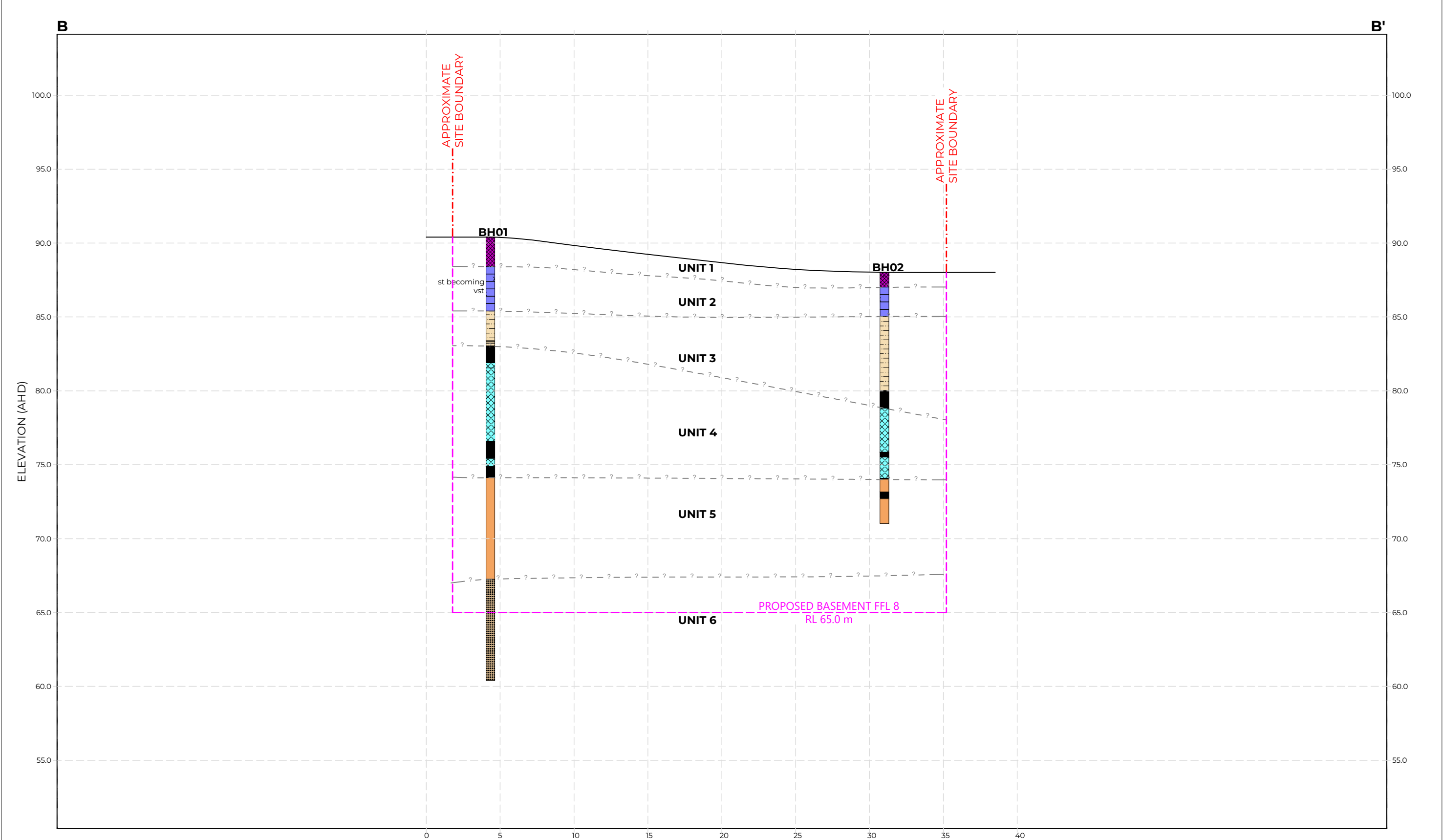
NOTES
1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Proposed basement levels from Cox Architecture, Project No.223146.1, Drawing No. A-DA-4000, Revision 1 (Dated 07.03.2025)

PROJECT NAME:
Proposed Mixed Use Development

PROJECT ADDRESS:
378-398 Pacific Highway, Crows Nest

DRAWING TITLE:
INTERPRETED GEOTECHNICAL CROSS SECTION A-A'

PROJECT No:	224162.01
DRAWING No:	2
REVISION:	1

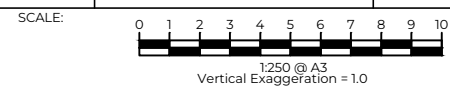


LEGEND

- UNIT 1: FILL
- UNIT 2: St-h RESIDUAL CLAY
- UNIT 3: XW SHALE
- UNIT 4: VL-L SHALE/LAMINITE/SILTSTONE
- UNIT 5: M SANDSTONE/LAMINITE/SILTSTONE
- UNIT 6: M-H SANDSTONE
- NO CORE

TESTS / OTHER DISTANCE ALONG PROFILE (m)
 - ? - - - Interpreted geotechnical boundary

REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	INITIAL ISSUE	24.02.2025	EC
1	Basement RL's Update	01.04.2025	MN



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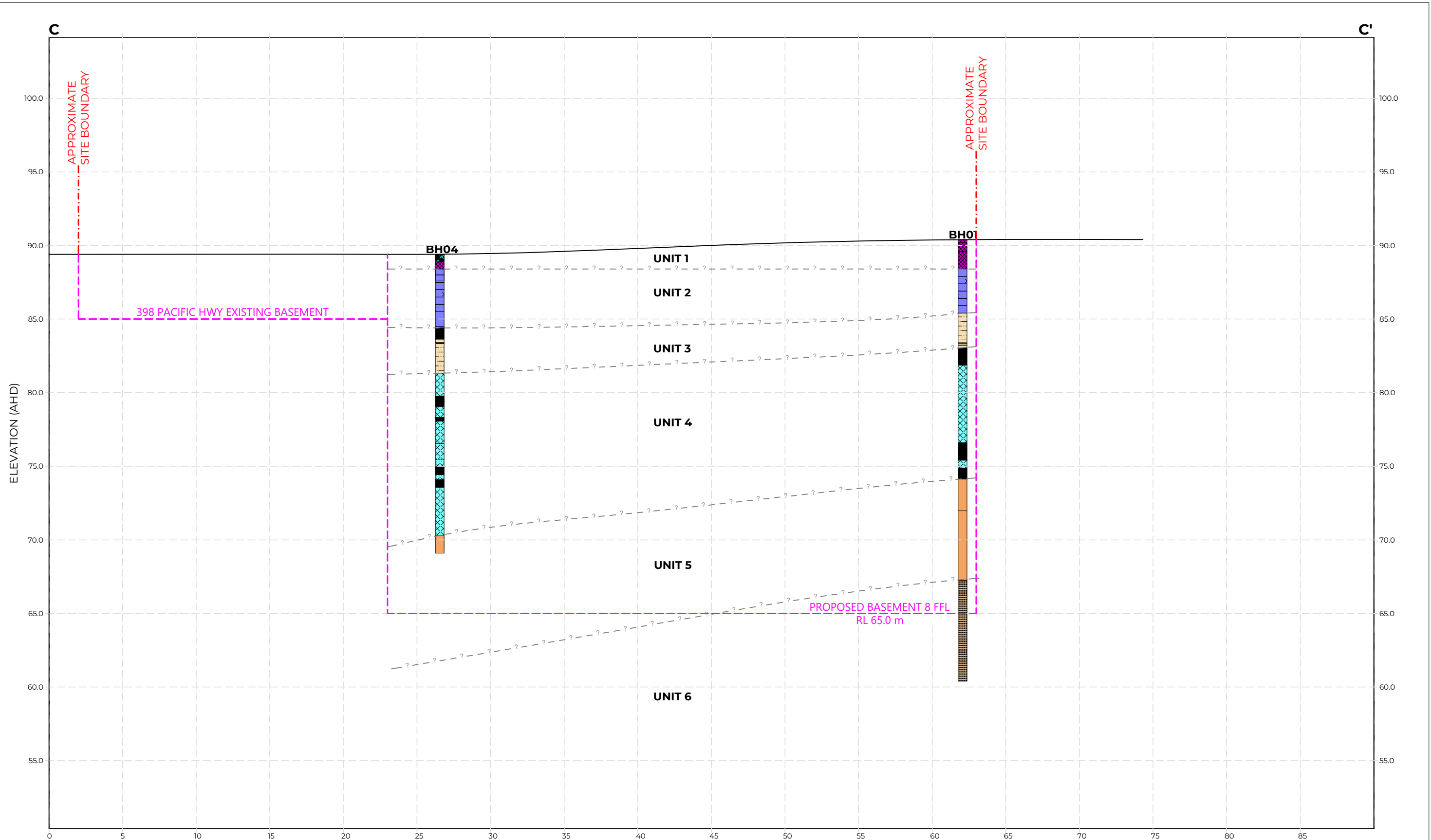
CLIENT:
Freecity Group Holdings Pty Ltd

NOTES
 1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
 2. Summary logs only and should be read in conjunction with detailed logs.
 3. Proposed basement levels from Cox Architecture, Project No.223146.1, Drawing No. A-DA-4000, Revision 1 (Dated 07.03.2025)

PROJECT NAME:
Proposed Mixed Use Development
 PROJECT ADDRESS:
378-398 Pacific Highway, Crows Nest

DRAWING TITLE:
INTERPRETED GEOTECHNICAL CROSS SECTION B-B'

PROJECT No: **224162.01**
 DRAWING No: **3**
 REVISION: **1**



LEGEND		TESTS / OTHER	
UNIT 1: FILL	UNIT 4: VL-L SHALE/LAMINITE/SILTSTONE	NO CORE	- ? - - - Interpreted geotechnical boundary
UNIT 2: St-h RESIDUAL CLAY	UNIT 5: M SANDSTONE/LAMINITE/SILTSTONE	Void	
UNIT 3: XW SHALE	UNIT 6: M-H SANDSTONE		

REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	INITIAL ISSUE	24.02.2025	EC
1	Basement RL's Update	01.04.2025	MN

SCALE: 1:250 @ A3
Vertical Exaggeration = 1.0

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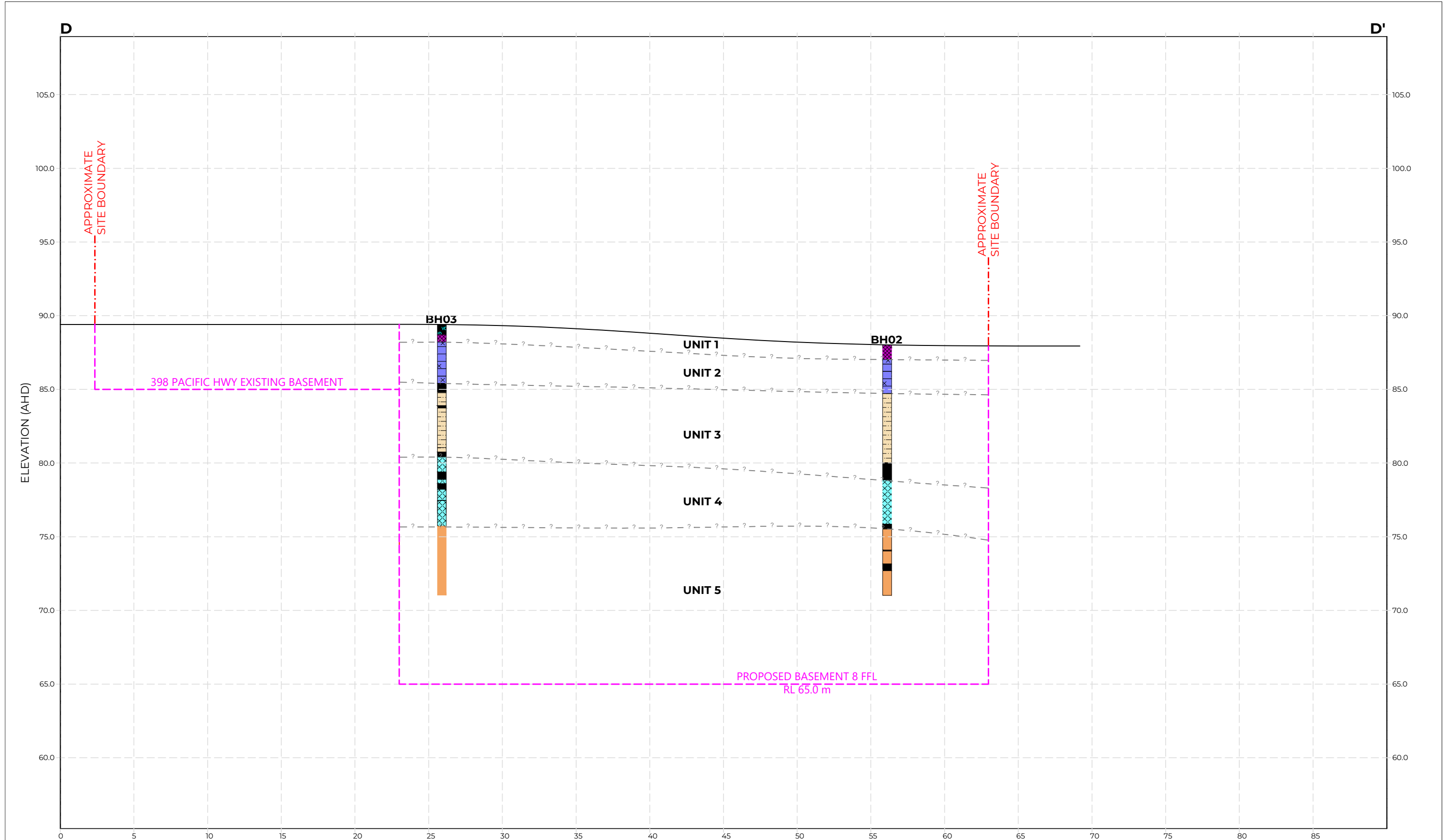
CLIENT:
Freecity Group Holdings Pty Ltd

NOTES
1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Proposed basement levels from Cox Architecture, Project No.223146.1, Drawing No. A-DA-4000, Revision 1 (Dated 07.03.2025)

PROJECT NAME:
Proposed Mixed Use Development
PROJECT ADDRESS:
378-398 Pacific Highway, Crows Nest

DRAWING TITLE:
INTERPRETED GEOTECHNICAL CROSS SECTION C-C'

PROJECT No:	224162.01
DRAWING No:	4
REVISION:	1

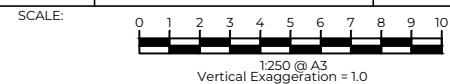


LEGEND

- UNIT 1: FILL
- UNIT 2: St-h RESIDUAL CLAY
- UNIT 3: XW SHALE
- UNIT 4: VL-L SHALE/LAMINITE/SILTSTONE
- UNIT 5: M SANDSTONE/LAMINITE/SILTSTONE
- NO CORE
- Void

TESTS / OTHER
 - ? - - - Interpreted geotechnical boundary

REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	INITIAL ISSUE	24.02.2025	EC
1	Basement RL's Update	01.04.2025	MN



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NOTES
 1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
 2. Summary logs only and should be read in conjunction with detailed logs.
 3. Proposed basement levels from Cox Architecture, Project No.223146.1, Drawing No. A-DA-4000, Revision 1 (Dated 07.03.2025)

PROJECT NAME:
Proposed Mixed Use Development
 PROJECT ADDRESS:
378-398 Pacific Highway, Crows Nest

DRAWING TITLE:
INTERPRETED GEOTECHNICAL CROSS SECTION D-D'

PROJECT No:	224162.01
DRAWING No:	5
REVISION:	1

Appendix C

Borehole Logs



Introduction to Terminology, Symbols and Abbreviations

Douglas Partners' reports, investigation logs, and other correspondence may use terminology which has quantitative or qualitative connotations. To remove ambiguity or uncertainty surrounding the use of such terms, the following sets of notes pages may be attached Douglas Partners' reports, depending on the work performed and conditions encountered:

- Soil Descriptions;
- Rock Descriptions; and
- Sampling, insitu testing, and drilling methodologies

In addition to these pages, the following notes generally apply to most documents.

Abbreviation Codes

Site conditions may also be presented in a number of different formats, such as investigation logs, field mapping, or as a written summary. In some of these formats textual or symbolic terminology may be presented using textual abbreviation codes or graphic symbols, and, where commonly used, these are listed alongside the terminology definition. For ease of identification in these note pages, textual codes are presented in these notes in the following style **XW**. Code usage conforms with the following guidelines:

- Textual codes are case insensitive, although herein they are generally presented in upper case; and
- Textual codes are contextual (i.e. the same or similar combinations of characters may be used in different contexts with different meanings (for example `PL` is used for plastic limit in the context of soil moisture condition, as well as in `PL(A)` for point load test result in the testing results column)).

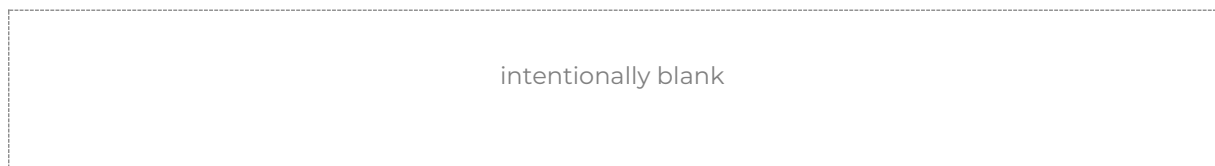
Data Integrity Codes

Subsurface investigation data recorded by Douglas Partners is generally managed in a highly structured database environment, where records "span" between a top and bottom depth interval. Depth interval "gaps" between records are considered to introduce ambiguity, and, where appropriate, our practice guidelines may require contiguous data sets. Recording meaningful data is not always appropriate (for example assigning a "strength" to a concrete pavement) and the following codes may be used to maintain contiguity in such circumstances.

Term	Description	Abbreviation Code
Core loss	No core recovery	KL
Unknown	Information was not available to allow classification of the property. For example, when auguring in loose, saturated sand auger cuttings may not be returned.	UK
No data	Information required to allow classification of the property was not available. For example if drilling is commenced from the base of a hole predrilled by others	ND
Not Applicable	Derivation of the properties not appropriate or beyond the scope of the investigation. For example providing a description of the strength of a concrete pavement	NA

Graphic Symbols

Douglas Partners' logs contain a "graphic" column which provides a pictorial representation of the basic composition of the material. The symbols used are directly representing the material name stated in the adjacent "Description of Strata" column, and as such no specific graphic symbology legend has been provided in these notes.





Introduction

All materials which are not considered to be “in-situ rock” are described in general accordance with the soil description model of AS 1726-2017 Part 6.1.3, and can be broken down into the following description structure:



The “classification” comprises a two character “group symbol” providing a general summary of dominant soil characteristics. The “name” summarises the particle sizes within the soil which most influence its behaviour. The detailed description presents more information about composition, condition, structure, and origin of the soil.

Classification, naming and description of soils require the relative proportion of particles of different sizes within the whole soil mixture to be considered.

Particle size designation and Behaviour Model

Solid particles within a soil are differentiated on the basis of size.

The engineering behaviour properties of a soil can subsequently be modelled to be either “fine grained” (also known as “cohesive” behaviour) or “coarse grained” (“non cohesive” behaviour), depending on the relative proportion of fine or coarse fractions in the soil mixture.

Particle Size Designation	Particle Size (mm)	Behaviour Model	
		Behaviour	Approximate Dry Mass
Boulder	>200	Excluded from particle behaviour model as “oversize”	
Cobble	63 - 200		
Gravel ¹	2.36 - 63	Coarse	>65%
Sand ¹	0.075 - 2.36		
Silt	0.002 - 0.075	Fine	>35%
Clay	<0.002		

¹ – refer grain size subdivision descriptions below

The behaviour model boundaries defined above are not precise, and the material behaviour should be assumed from the name given to the material (which considers the particle fraction which dominates the behaviour, refer “component proportions” below), rather than strict observance of the proportions of particle sizes. For example, if a material is named a “Sandy CLAY”, this is indicative that the material exhibits fine grained behaviour, even if the dry mass of coarse grained material may exceed 65%.

Component proportions

The relative proportion of the dry mass of each particle size fraction is assessed to be a “primary”, “secondary”, or “minor” component of the soil mixture, depending on its influence over the soil behaviour.

Component Proportion Designation	Definition ¹	Relative Proportion	
		In Fine Grained Soil	In Coarse Grained Soil
Primary	The component (particle size designation, refer above) which dominates the engineering behaviour of the soil	The clay/silt component with the greater proportion	The sand/gravel component with the greater proportion
Secondary	Any component which is not the primary, but is significant to the engineering properties of the soil	Any component with greater than 30% proportion	Any granular component with greater than 30%; or Any fine component with greater than 12%
Minor ²	Present in the soil, but not significant to its engineering properties	All other components	All other components

¹ As defined in AS1726-2017 6.1.4.4

² In the detailed material description, minor components are split into two further sub-categories. Refer “identification of minor components” below.

Composite Materials

In certain situations, a lithology description may describe more than one material, for example, collectively describing a layer of interbedded sand and clay. In such a scenario, the two materials would be described independently, with the names preceded or followed by a statement describing the arrangement by which the materials co-exist. For example, “INTERBEDDED Silty CLAY AND SAND”.

Classification

The soil classification comprises a two character group symbol. The first character identifies the primary component. The second character identifies either the grading or presence of fines in a coarse grained soil, or the plasticity in a fine grained soil. Refer AS1726-2017 6.1.6 for further clarification.

Soil Name

For most soils, the name is derived with the primary component included as the noun (in upper case), preceded by any secondary components stated in an adjective form. In this way, the soil name also describes the general composition and indicates the dominant behaviour of the material.

Component ¹	Prominence in Soil Name
Primary	Noun (eg "CLAY")
Secondary	Adjective modifier (eg "Sandy")
Minor	No influence

¹ – for determination of component proportions, refer component proportions on previous page

For materials which cannot be disaggregated, or which are not comprised of rock or mineral fragments, the names "ORGANIC MATTER" or "ARTIFICIAL MATERIAL" may be used, in accordance with AS1726-2017 Table 14.

Commercial or colloquial names are not used for the soil name where a component derived name is possible (for example "Gravelly SAND" rather than "CRACKER DUST").

Materials of "fill" or "topsoil" origin are generally assigned a name derived from the primary/secondary component (where appropriate). In log descriptions this is preceded by uppercase "FILL" or "TOPSOIL". Origin uncertainty is indicated in the description by the characters (?), with the degree of uncertainty described (using the terms "probably" or "possibly" in the origin column, or at the end of the description).

Identification of minor components

Minor components are identified in the soil description immediately following the soil name. The minor component fraction is usually preceded with a term indicating the relative proportion of the component.

Minor Component Proportion Term	Relative Proportion	
	In Fine Grained Soil	In Coarse Grained Soil
With	All fractions: 15-30%	Clay/silt: 5-12% sand/gravel: 15-30%
Trace	All fractions: 0-15%	Clay/silt: 0-5% sand/gravel: 0-15%

The terms "with" and "trace" generally apply only to gravel or fine particle fractions. Where cobbles/boulders are encountered in minor proportions (generally less than about 12%) the term "occasional" may be used. This term describes the sporadic distribution of the material within the confines of the investigation excavation only, and there may be considerable variation in proportion over a wider area which is difficult to factually characterise due to the relative size of the particles and the investigation methods.

Soil Composition

Plasticity

Descriptive Term	Laboratory liquid limit range	
	Silt	Clay
Non-plastic materials	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35 and ≤50
High plasticity	>50	>50

Note, Plasticity descriptions generally describe the plasticity behaviour of the whole of the fine grained soil, not individual fine grained fractions.

Grain Size

Type	Particle size (mm)	
	Gravel	Coarse
	Medium	6.7 - 19
	Fine	2.36 - 6.7
Sand	Coarse	0.6 - 2.36
	Medium	0.21 - 0.6
	Fine	0.075 - 0.21

Grading

Grading Term	Particle size (mm)
Well	A good representation of all particle sizes
Poorly	An excess or deficiency of particular sizes within the specified range
Uniformly	Essentially of one size
Gap	A deficiency of a particular size or size range within the total range

Note, AS1726-2017 provides terminology for additional attributes not listed here.

Soil Condition

Moisture

The moisture condition of soils is assessed relative to the plastic limit for fine grained soils, while for coarse grained soils it is assessed based on the appearance and feel of the material. The moisture condition of a material is considered to be independent of stratigraphy (although commonly these are related), and this data is presented in its own column on logs.

Applicability	Term	Tactile Assessment	Abbreviation code
Fine	Dry of plastic limit	Hard and friable or powdery	w<PL
	Near plastic limit	Can be moulded	w=PL
	Wet of plastic limit	Water residue remains on hands when handling	w>PL
	Near liquid limit	"oozes" when agitated	w=LL
	Wet of liquid limit	"oozes"	w>LL
Coarse	Dry	Non-cohesive and free running	D
	Moist	Feels cool, darkened in colour, particles may stick together	M
	Wet	Feels cool, darkened in colour, particles may stick together, free water forms when handling	W

The abbreviation code **NDF**, meaning "not-assessable due to drilling fluid use" may also be used.

Note, observations relating to free ground water or drilling fluids are provided independent of soil moisture condition.

Consistency/Density/Compaction/Cementation/Extremely Weathered Material

These concepts give an indication of how the material may respond to applied forces (when considered in conjunction with other attributes of the soil). This behaviour can vary independent of the composition of the material, and on logs these are described in an independent column and are generally mutually exclusive (i.e it is inappropriate to describe both consistency and compaction at the same time). The method by which the behaviour is described depends on the behaviour model and other characteristics of the soil as follows:

- In fine grained soils, the "consistency" describes the ease with which the soil can be remoulded, and is generally correlated against the materials undrained shear strength;
- In granular materials, the relative density describes how tightly packed the particles are, and is generally correlated against the density index;
- In anthropogenically modified materials, the compaction of the material is described qualitatively;
- In cemented soils (both natural and anthropogenic), the cemented "strength" is described qualitatively, relative to the difficulty with which the material is disaggregated; and
- In soils of extremely weathered material origin, the engineering behaviour may be governed by relic rock features, and expected behaviour needs to be assessed based the overall material description.

Quantitative engineering performance of these materials may be determined by laboratory testing or estimated by correlated field tests (for example penetration or shear vane testing). In some cases, performance may be assessed by tactile or other subjective methods, in which case investigation logs will show the estimated value enclosed in round brackets, for example **(VS)**.

Consistency (fine grained soils)

Consistency Term	Tactile Assessment	Undrained Shear Strength (kPa)	Abbreviation Code
Very soft	Extrudes between fingers when squeezed	<12	VS
Soft	Mouldable with light finger pressure	>12 - ≤25	S
Firm	Mouldable with strong finger pressure	>25 - ≤50	F
Stiff	Cannot be moulded by fingers	>50 - ≤100	St
Very stiff	Indented by thumbnail	>100 - ≤200	VSt
Hard	Indented by thumbnail with difficulty	>200	H
Friable	Easily crumbled or broken into small pieces by hand	-	Fr

Relative Density (coarse grained soils)

Relative Density Term	Density Index	Abbreviation Code
Very loose	<15	VL
Loose	>15 - ≤35	L
Medium dense	>35 - ≤65	MD
Dense	>65 - ≤85	D
Very dense	>85	VD

Note, tactile assessment of relative density is difficult, and generally requires penetration testing, hence a tactile assessment guide is not provided.

Compaction (anthropogenically modified soil)

Compaction Term	Abbreviation Code
Well compacted	WC
Poorly compacted	PC
Moderately compacted	MC
Variably compacted	VC

Cementation (natural and anthropogenic)

Cementation Term	Abbreviation Code
Moderately cemented	MOD
Weakly cemented	WEK

Extremely Weathered Material

AS1726-2017 considers weathered material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. less than very low strength rock). These materials may be identified as “extremely weathered material” in reports and by the abbreviation code **XWM** on log sheets. This identification is not correlated to any specific qualitative or quantitative behaviour, and the engineering properties of this material must therefore be assessed according to engineering principles with reference to any relic rock structure, fabric, or texture described in the description.

Soil Origin

Term	Description	Abbreviation Code
Residual	Derived from in-situ weathering of the underlying rock	RS
Extremely weathered material	Formed from in-situ weathering of geological formations. Has strength of less than ‘very low’ as per as1726 but retains the structure or fabric of the parent rock.	XWM
Alluvial	Deposited by streams and rivers	ALV
Fluvial	Deposited by channel fill and overbank (natural levee, crevasse splay or flood basin)	FLV
Estuarine	Deposited in coastal estuaries	EST
Marine	Deposited in a marine environment	MAR
Lacustrine	Deposited in freshwater lakes	LAC
Aeolian	Carried and deposited by wind	AEO
Colluvial	Soil and rock debris transported down slopes by gravity	COL
Slopewash	Thin layers of soil and rock debris gradually and slowly deposited by gravity and possibly water	SW
Topsoil	Mantle of surface soil, often with high levels of organic material	TOP
Fill	Any material which has been moved by man	FILL
Littoral	Deposited on the lake or seashore	LIT
Unidentifiable	Not able to be identified	UID

Cobbles and Boulders

The presence of particles considered to be “oversize” may be described using one of the following strategies:

- Oversize encountered in a minor proportion (when considered relative to the wider area) are noted in the soil description; or
- Where a significant proportion of oversize is encountered, the cobbles/boulders are described independent of the soil description, in a similar manner to composite soils (described above) but qualified with “MIXTURE OF”.

intentionally blank



Rock Strength

Rock strength is defined by the unconfined compressive strength, and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $I_{s(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Unconfined Compressive Strength (MPa)	Point Load Index ¹ $I_{s(50)}$ MPa	Abbreviation Code
Very low	0.6 - 2	0.03 - 0.1	VL
Low	2 - 6	0.1 - 0.3	L
Medium	6 - 20	0.3 - 1.0	M
High	20 - 60	1 - 3	H
Very high	60 - 200	3 - 10	VH
Extremely high	>200	>10	EH

¹ Rock strength classification is based on UCS. The UCS to $I_{s(50)}$ ratio varies significantly for different rock types and specific ratios may be required for each site. The point load Index ranges shown above are as suggested in AS1726 and should not be relied upon without supporting evidence.

The following abbreviation codes are used for soil layers or seams of material “within rock” but for which the equivalent UCS strength is less than 0.6 MPa.

Scenario	Abbreviation Code
The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The properties of the material encountered over this interval are described in the “Description of Strata” and soil properties columns.	SOIL
The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The prominence of the material is such that it can be considered to be a seam (as defined in Table 22 of AS1726-2017) and the properties of the material are described in the defect column.	SEAM

Degree of Weathering

The degree of weathering of rock is classified as follows:

Weathering Term	Description	Abbreviation Code
Residual Soil ¹	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.	RS
Extremely weathered ¹	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible	XW
Highly weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching or may be decreased due to deposition of weathering products in pores.	HW
Moderately weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable but shows little or no change of strength from fresh rock.	MW
Slightly weathered	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.	SW
Fresh	No signs of decomposition or staining.	FR
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.	DW

¹ The parent rock type, of which the residual/extremely weathered material is a derivative, will be stated in the description (where discernible).

Degree of Alteration

The degree of alteration of the rock material (physical or chemical changes caused by hot gasses or liquids at depth) is classified as follows:

Term	Description	Abbreviation Code
Extremely altered	Material is altered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.	XA
Highly altered	The whole of the rock material is discoloured, usually by staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is changed by alteration. Some primary minerals are altered to clay minerals. Porosity may be increased by leaching or may be decreased due to precipitation of secondary materials in pores.	HA
Moderately altered	The whole of the rock material is discoloured, usually by staining or bleaching to the extent that the colour of the original rock is not recognisable but shows little or no change of strength from fresh rock.	MA
Slightly altered	Rock is slightly discoloured but shows little or no change of strength from fresh rock	SA
Note: If HA and MA cannot be differentiated use DA (see below)		
Distinctly altered	Rock strength usually changed by alteration. The rock may be highly discoloured, usually by staining or bleaching. Porosity may be increased by leaching or may be decreased due to precipitation of secondary minerals in pores.	DA

Degree of Fracturing

The following descriptive classification apply to the spacing of natural occurring fractures in the rock mass. It includes bedding plane partings, joints and other defects, but excludes drilling breaks. These terms are generally not required on investigation logs where fracture spacing is presented as a histogram, and where used are presented in an unabbreviated format.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$RQD \% = \frac{\text{cumulative length of 'sound' core sections} > 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e., drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

These terms may be used to describe the spacing of bedding partings in sedimentary rocks. Where used, these terms are generally presented in an unabbreviated format

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Rock Descriptions

Terminology
Symbols
Abbreviations

Defect Descriptions

Defect Type

Term	Abbreviation Code
Bedding plane	B
Cleavage	CL
Crushed seam	CS
Crushed zone	CZ
Drilling break	DB
Decomposed seam	DS
Drill lift	DL
Extremely Weathered seam	EW
Fault	F
Fracture	FC
Fragmented	FG
Handling break	HB
Infilled seam	IS
Joint	JT
Lamination	LAM
Shear seam	SS
Shear zone	SZ
Vein	VN
Mechanical break	MB
Parting	P
Sheared Surface	S

Rock Defect Orientation

Term	Abbreviation Code
Horizontal	H
Vertical	V
Sub-horizontal	SH
Sub-vertical	SV

Rock Defect Coating

Term	Abbreviation Code
Clean	CN
Coating	CT
Healed	HE
Infilled	INF
Stained	SN
Tight	TI
Veneer	VNR

Rock Defect Infill

Term	Abbreviation Code
Calcite	CA
Carbonaceous	CBS
Clay	CLAY
Iron oxide	FE
Manganese	MN
Pyrite	Py
Secondary material	MS
Silt	M
Quartz	Qz
Unidentified material	MU

Rock Defect Shape/Planarity

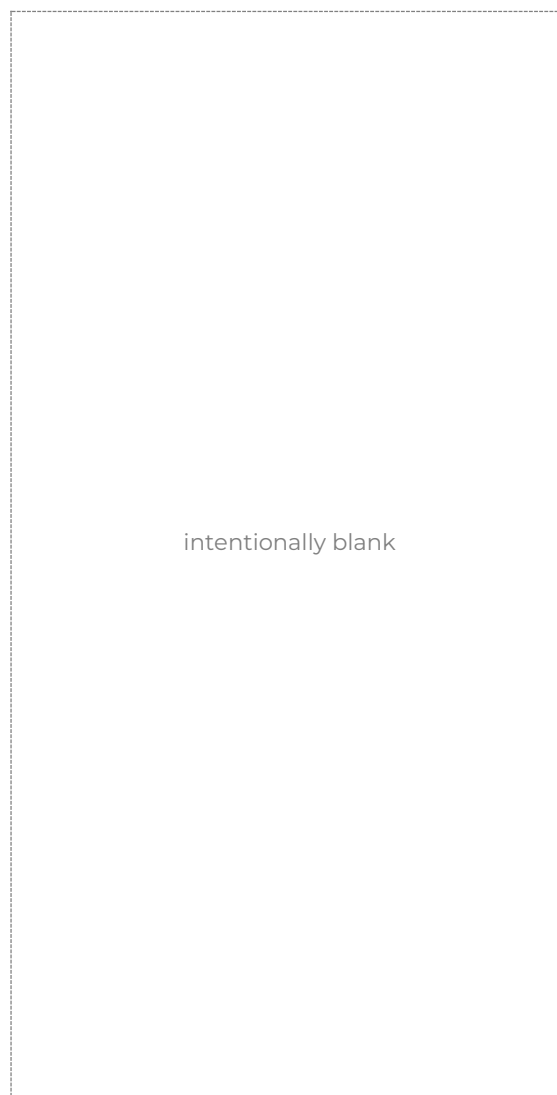
Term	Abbreviation Code
Curved	CU
Discontinuous	DIS
Irregular	IR
Planar	PR
Stepped	ST
Undulating	UN

Rock Defect Roughness

Term	Abbreviation Code
Polished	PO
Rough	RF
Smooth	SM
Slickensided	SL
Very rough	VR

Defect Orientation

The inclination of defects is always measured from the perpendicular to the core axis.



Appendix D

Laboratory Results

CERTIFICATE OF ANALYSIS 352327

Client Details

Client	Douglas Partners Pty Ltd
Attention	Yeongbin Gim
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	<u>224162.01 Crows Nest</u>
Number of Samples	2 Soil
Date samples received	27/05/2024
Date completed instructions received	27/05/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
 Samples were analysed as received from the client. Results relate specifically to the samples as received.
 Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	03/06/2024
Date of Issue	31/05/2024
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By
 Jenny He, Senior Chemist

Authorised By
 Nancy Zhang, Laboratory Manager

Misc Inorg - Soil			
Our Reference		352327-1	352327-2
Your Reference	UNITS	BH01	BH02
Depth		2.5-2.7	1.0-1.45
Date Sampled		16/05/2024	17/05/2024
Type of sample		Soil	Soil
Date prepared	-	28/05/2024	28/05/2024
Date analysed	-	28/05/2024	28/05/2024
pH 1:5 soil:water	pH Units	5.0	4.9
Electrical Conductivity 1:5 soil:water	µS/cm	37	44
Chloride, Cl 1:5 soil:water	mg/kg	10	26
Sulphate, SO4 1:5 soil:water	mg/kg	43	44

Client Reference: 224162.01 Crows Nest

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

Client Reference: 224162.01 Crows Nest

QUALITY CONTROL: Misc Inorg - Soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			28/05/2024	1	28/05/2024	28/05/2024		28/05/2024	[NT]
Date analysed	-			28/05/2024	1	28/05/2024	28/05/2024		28/05/2024	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	5.0	4.9	2	99	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	37	38	3	104	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	10	10	0	100	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	43	43	0	114	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	
The recommended maximums for analytes in urine are taken from "2018 TLVs and BEIs", as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.	
Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2	

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

Samples were out of the recommended holding time for this analysis. pH/EC

CERTIFICATE OF ANALYSIS 355333

Client Details

Client	Douglas Partners Pty Ltd
Attention	Yeongbin Gim
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	<u>224162.01 Crows Nest</u>
Number of Samples	2 Soil
Date samples received	01/07/2024
Date completed instructions received	01/07/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
 Samples were analysed as received from the client. Results relate specifically to the samples as received.
 Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	08/07/2024
Date of Issue	04/07/2024
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Diego Bigolin, Inorganics Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil			
Our Reference		355333-1	355333-2
Your Reference	UNITS	BH03	BH04
Depth		2.2-2.5	3.4-3.5
Date Sampled		27/06/2024	25/06/2024
Type of sample		Soil	Soil
Date prepared	-	02/07/2024	02/07/2024
Date analysed	-	02/07/2024	02/07/2024
pH 1:5 soil:water	pH Units	4.9	4.6
Electrical Conductivity 1:5 soil:water	µS/cm	26	110
Chloride, Cl 1:5 soil:water	mg/kg	<10	120
Sulphate, SO4 1:5 soil:water	mg/kg	20	23

Client Reference: 224162.01 Crows Nest

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

Client Reference: 224162.01 Crows Nest

QUALITY CONTROL: Misc Inorg - Soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			02/07/2024	[NT]	[NT]	[NT]	[NT]	02/07/2024	[NT]
Date analysed	-			02/07/2024	[NT]	[NT]	[NT]	[NT]	02/07/2024	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	99	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	101	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	111	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	110	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	
The recommended maximums for analytes in urine are taken from "2018 TLVs and BEIs", as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.	
Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2	

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Appendix E

Architectural Drawings - Cross Sections

Rev	Description	By	Date
1	For SSDA Issue	KH	07/03/2025



Cox Architecture
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 Australia
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 coxarchitecture.com.au

Nominated Architects:
 Joe Agius no. 6491
 Ramin Jahromi no. 10000

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- Urbis** Town Planner
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 Tel: (+61) 2 8233 9900
- Collecting Engineering** Mechanical/Electrical/Hydraulic/Environmental Engineer
 Level 2/ 68 King St, Sydney, NSW 2000
 1300 409 923
- Orion** Civil/Stormwater Engineer
 Suite 9/05, 25 Martin Pl, Sydney, NSW 2000
 Tel: (02) 9580 0036
- TW** Structural Engineer
 Level 6/73 Miller St, North Sydney NSW 2060
 Tel: (02) 9439 7288
- JMT Consulting** Traffic
 Tel: (+61) 0415 563 177
- Arcadis Landscape Architecture** Landscape Architect
 Suite 70, 26/32 Pirrama Rd, Pyrmont, NSW 2009
 Tel: (+61) 2 8571 2900
- Elephants Foot Consulting** Waste Management
 112/118 Carlebury Rd, Bankstown, NSW 2200
 Tel: 1300 433 374

- LEGEND**
- 1 BED
 - 2 BED
 - 3 BED
 - 4 BED
 - PENTHOUSE
 - RESIDENTIAL AMENITY
 - PLANT
 - PLANTER
 - APARTMENT ENTRY

Client Freecity

Project No. 223146.01

Project 378-398 Pacific Highway
 378-398 Pacific Highway, Crows Nest, NSW 2065

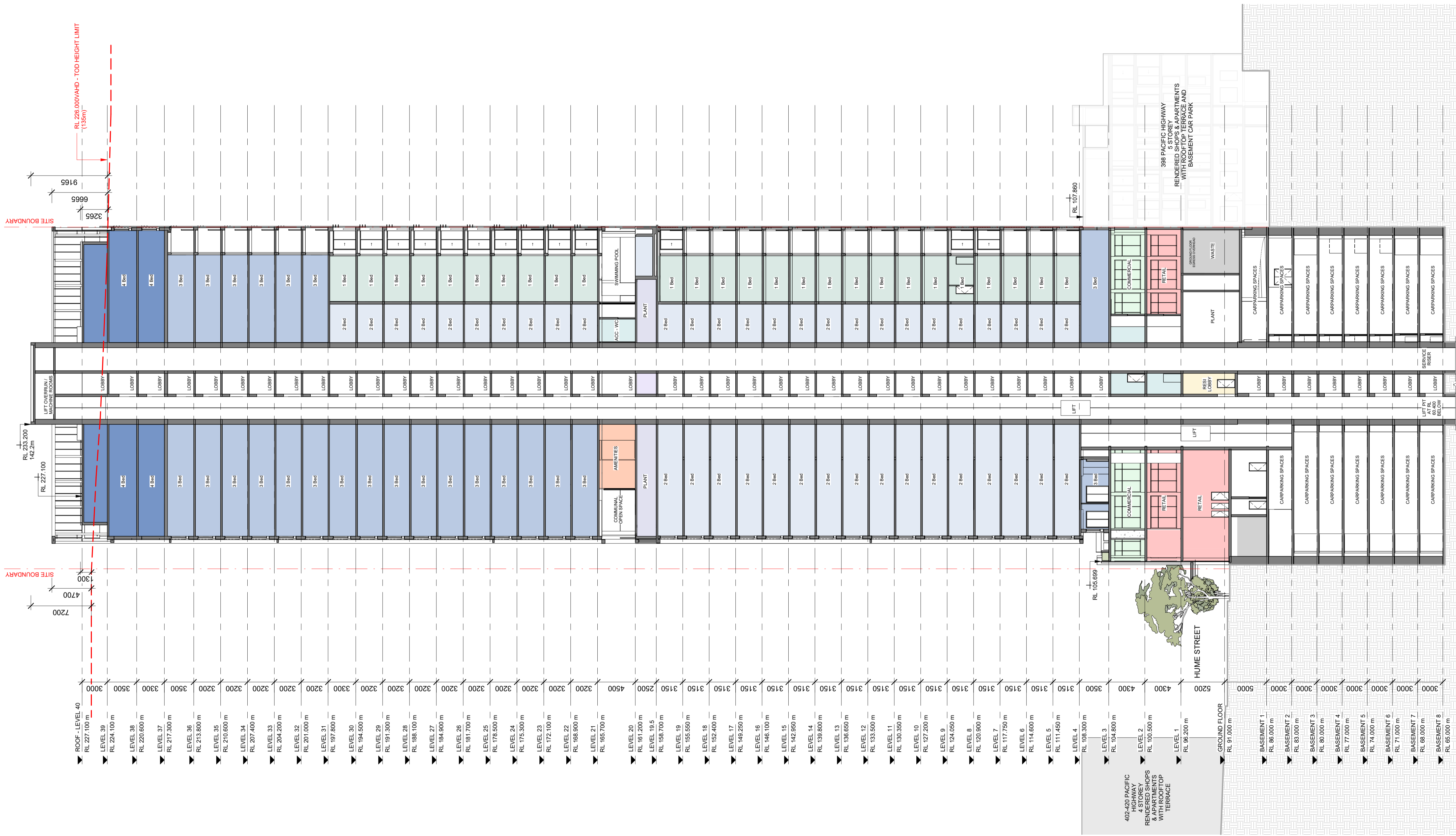
Acknowledgement

Drawing Title SECTION A

Document Control Status:
 SSDA SUBMISSION

Co-ordinated: KH
Project Architect: AK
Project Director: FM
Drawing Number: A-DA-4000

Drawn: KH, BC, AW
Scale: As indicated @ A1
Date: 07/03/2025
Revision: 1



Rev	Description	By	Date
1	For SSDA Issue	KH	07/03/2025



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Company Name	Role
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Collecting Engineering Level 2/ 68 King St, Sydney, NSW 2000 1300 409 923 Tel: (02) 9580 0036	Mechanical/ Electrical/ Hydraulic/ Environmental Engineer
Orion Suite 9/ 05, 25 Martin Pl, Sydney, NSW 2000 Tel: (02) 9439 7288	Civil/ Stormwater Engineer
TW Level 6/73 Miller St, North Sydney NSW 2060 Tel: (02) 9439 7288	Structural Engineer
JMT Consulting Tel: (+61) 0415 563 177	Traffic
Arcadia Landscape Architecture Suite 70, 2632 Pirrama Rd, Pyrmont, NSW 2009 Tel: (+61) 2 8571 2900	Landscape Architect
Elephants Foot Consulting 112/118 Carlebury Rd, Bankstown, NSW 2200 Tel: 1300 433 374	Waste Management

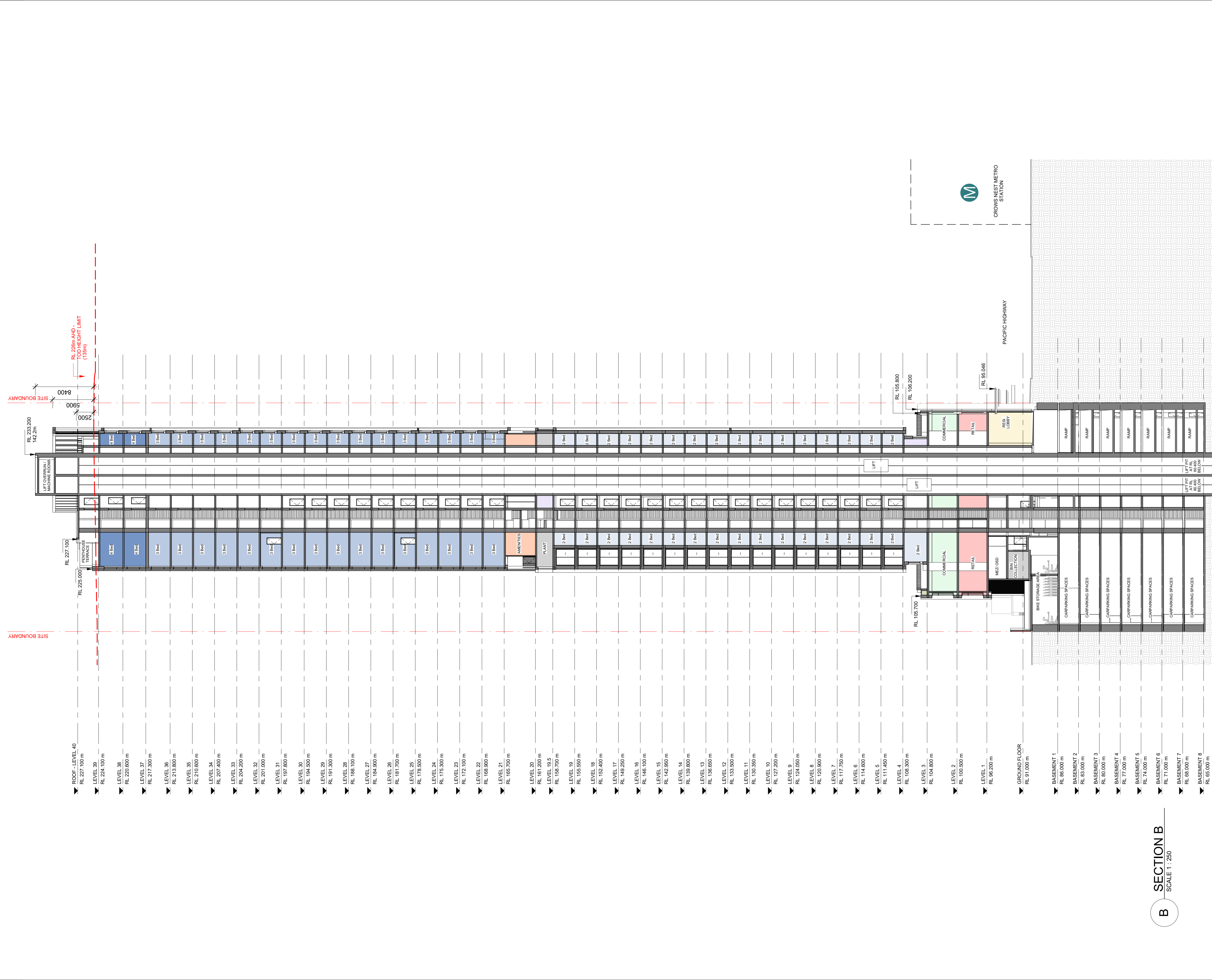
LEGEND

[Light Blue Box]	1 BED
[Medium Blue Box]	2 BED
[Dark Blue Box]	3 BED
[Darkest Blue Box]	4 BED
[Blue Box with Diagonal Lines]	PENTHOUSE
[Orange Box]	RESIDENTIAL AMENITY
[Purple Box]	PLANT
[Green Box]	PLANTER
[Red Arrow]	APARTMENT ENTRY

Client	Freecity
Project No.	223146.01
Project	378-398 Pacific Highway
	378-398 Pacific Highway, Crows Nest, NSW 2065
Drawing Title	SECTION B

Document Control Status:
 SSDA SUBMISSION

Co-ordinated:	Drawn:
KH	KH, BC, AW
Project Architect:	Scale:
AK	As indicated @ A1
Project Director:	Date:
FM	07/03/2025
Drawing Number:	Revision:
A-DA-4001	1



B
 SECTION B
 SCALE 1 : 250