Attachment A9

Preliminary Geotechnical Assessment
187 Thomas Street, Haymarket

Your ref 187 Thomas St
Our ref 270416-02
File ref 270416-RPT-001

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13 March 2020

Dear Peter

187 Thomas Street Planning Proposal - Reference Scheme Option 5E - Geotechnical Desktop Assessment

1 Introduction

Arup have been engaged by Greaton Development to undertake a geotechnical desktop study assessment, to inform Planning Proposal of the redevelopment at 187 Thomas Street, Sydney New South Wales. This assessment is only to inform the current Reference Scheme. The current building comprises a 15-storey office building, inclusive of two basement levels. A detailed project description for the proposed structure is in Section 2.

This technical note summarises the findings of the desk top study, which included a review of published geological information and previous ground investigation. Based on the information obtained during the study, gaps in available/reviewed data have been identified and high-level recommendations for any additional geotechnical investigation are also provided.

2 Reference Scheme Project Description

The proposal seeks to amend planning controls applying to the Site to allow a future development that will comprise an integrated community and destination for the innovation and technology sectors in the form of a vertical innovation village with an overall maximum height of 49 storeys (RL 209.80) and approximate commercial GFA of 51,700m^2.

Within a hybrid tower the concept will deliver approximately 51,700m^2 of GFA to a maximum height of RL 207. As illustrated in the reference scheme the hybrid tower will comprise flexible interconnected floorplates of approximately: 1000m^2 on the ground level; 1,700m^2 within the podium; 610 - 760m^2 within the void tower; 1,200m^2 within the low and high rise tower; and 900m^2 GFA within the sky rise tower thereby catering to the full range of enterprises within the sector.

Key components of the reference scheme for the hybrid tower include:

- Innovation tech hub (approximately 8,600m^2 GFA) within the basement, podium and void tower with lobby off Valentine Street including:
- tech workshop with shared equipment, facilities and services (including education, business support, programming, safety management and training)
- co-working space for the innovation industries that utilise provided technology and equipment, that changes in space and floor plate design to accommodate growing businesses, and
- terrace on Level 4 of the Void Tower providing an indoor / outdoor workspace
- facilities and services shared with the tech hotel.
- Commercial office space (approximately 33,100m^2 GFA) for the corporate tech sector within the low and high rise tower with lobby off Quay Street
- 4 star Tech Hotel (approximately 9,800m^2 GFA / 234 keys with 26 rooms per floor) within the sky rise tower with sky lobby, pool and bar with drop off and lobby off Thomas Street
- Meeting, forum, gym, pool, hospitality and other spaces integrated throughout the building and shared (and co-managed) between the innovation hub, commercial tenancies and tech hotel
- A retail offering of approximately 220m^2 GFA, including food and beverage which will be located on the ground level
- Upgraded (and widened) through site connection connecting Thomas Street to the west with George Street to the east via an activated retail arcade connection
- Redeveloped public space on Thomas, Quay and Valentine Street including an expanded pedestrian plaza at the corner of Thomas and Quay Streets and widening of the Valentine Street footpath
- Integration with the proposed Quay Street public domain works to accommodate increased pedestrian movement from existing and future pedestrian connections to various modes of transport, and
- Five (5) basement levels beneath the building with access off Thomas Street in the north west of the site.

The proposed basement levels will provide:

- Reduced car park provision totalling 79 car parking spaces (including 23 small car spaces,2 car share spaces and 1 electric charging station) *(Note: maximum parking allowed 107 spaces however reduced provision proposed as transport demand strategy. 86 spaces currently provided on site)*
- 14 motorbike parking spaces
- 382 bicycle parking spaces for staff and visitors as well as end of trip (EoT) facilities
- Hotel back of house areas
- loading dock and waste storage room, and
- plant and equipment areas.

It should be noted that while the reference scheme represents one design for the proposed hybrid tower, the project will be subject to a full competitive design process in accordance with the requirements of Sydney LEP 2012.

3 Site Summary

3.1 Topography and Land Use

The site is located in the Central Business District (CBD) of Sydney, which is a dense urban area comprised mainly multi-storey buildings and sparse green space. Central Station is located approximately 150m to the South of the site. Darling Harbour lies approximately 1km to the North. A location map and aerial images of the site and surrounds are shown in Figure 1 and Figure 2 below.

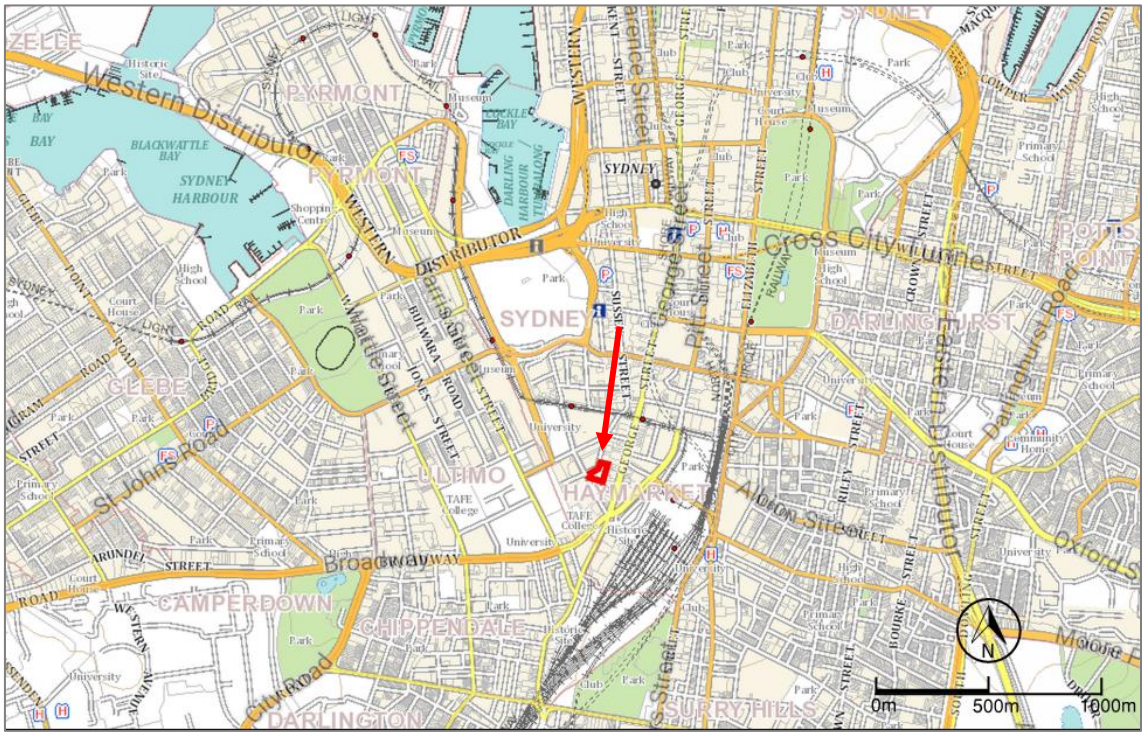

Figure 1: Location map of 187 Thomas Street in the Sydney CBD, noted by the red arrow.

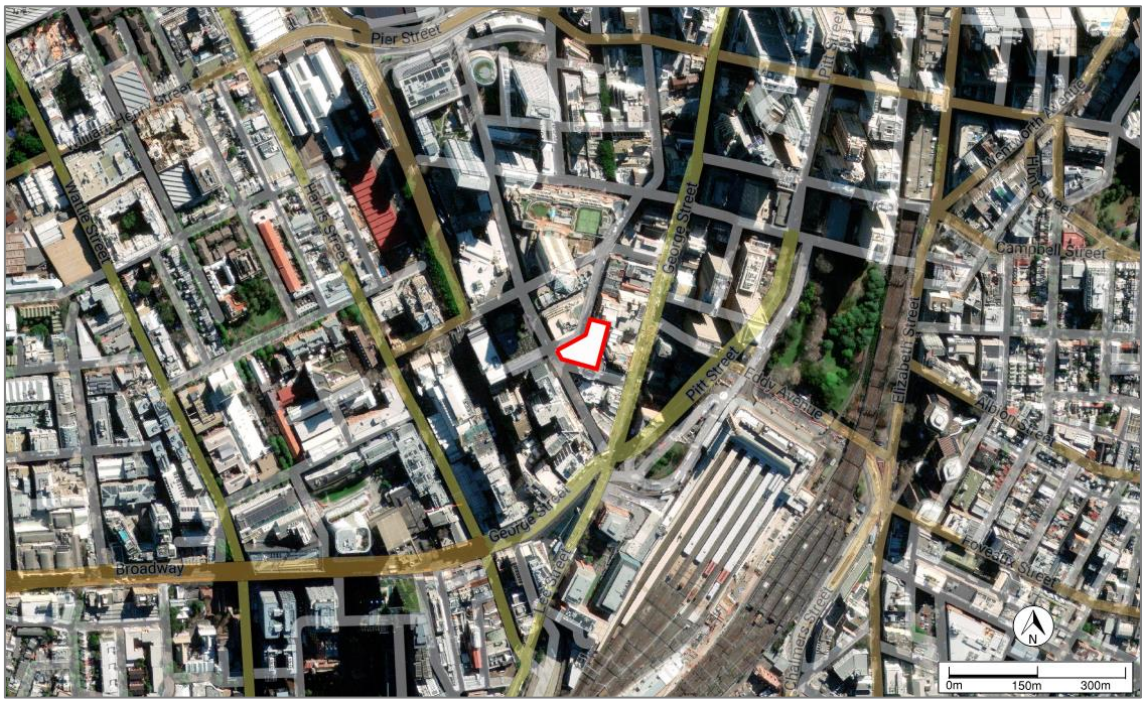

Figure 2: Aerial image of 187 Thomas Street in the Sydney CBD, with the building site noted by the red boundary.

The land in proximity to the site is generally flat, sloping down gradually (less than 5% grade, or a change of 5m in elevation over a 100m distance) to North-West, leading towards the Darling Harbour. The existing ground levels for the site indicate the lowest level of approximately 9mAHD North-East of the property and the highest ground level of approximately 12mAHD South-East of the property.

The site has frontages to Thomas Street to the North, Quay Street to the West, and Valentine Street to the South. Existing multi-storey buildings lie immediately to the East of the site, and then are bounded by George Street. From a visual assessment and review of available development applications for the adjacent buildings (Ref [1]), there do not appear to be basements in proximity to the site. A Dial Before You Dig (DBYD) search was conducted within the proposed building footprint and indicated that there are utility connections into the existing building which will have to be relocated prior to demolition. Other services, such as fibre optic and power, have been identified adjacent to the building and may be impacted by the construction. A detailed physical services search will need to be conducted prior to construction to identify any utilities or other connections that have not been shown in the DBYD.

3.2 Summary of Historical Information

No existing information about the current building, geotechnical or environmental investigations were made available to Arup at the time of writing this desktop study. The information summarised in this report comprises a search of the publicly available site studies and published geotechnical/environmental maps.

3.2.1 Geological Conditions

The site lies within the Sydney Basin, and is dominated by Hawkesbury Sandstone bedrock. The interface between the Hawkesbury Sandstone (green) and Ashfield Shale (pale blue) bedrock is located immediately to the East of the site. It is envisaged that the

surface of the site may be overlain by thin layers of man-made fill overlying residual soil, and then grading into Sandstone bedrock. Undefined Holocene sediments are located to the North of the site (orange area, moving towards the Darling Harbour) and fluvial Quaternary Silcrete soils to the West of the site (red area). An extract of the geological map is shown in Figure 3 below.

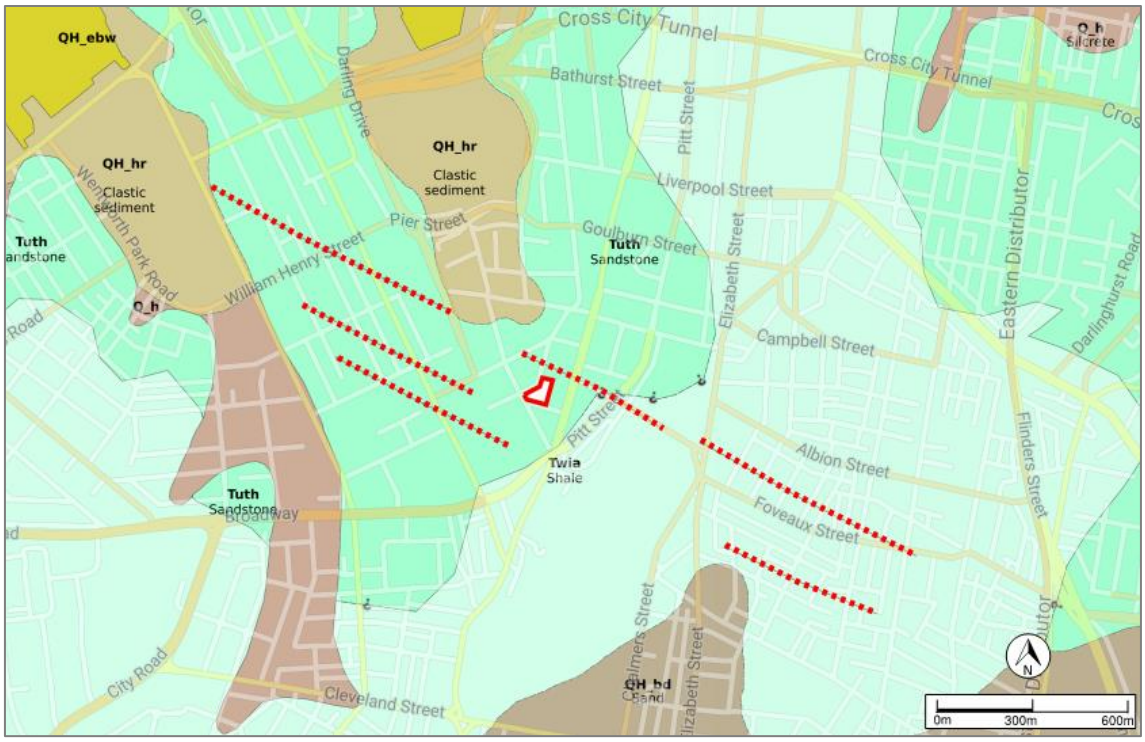

Figure 3: Summary of surface geology and structures (red dashed lines) for the building site (Ref [1]).

Several dykes may intersect the building site, as indicated in Figure 3 above (red dashed lines). The dykes in the Sydney CBD are typically characterised by a deep weathering clay profile with remnant doleritic fragments. The Sandstone at the margins of the dykes is locally indurated due to the thermal effects of the dyke during emplacement and often highly fractured (Ref [5]). The GPO Fault Zone will also likely intersect the site, as shown in the figure below.

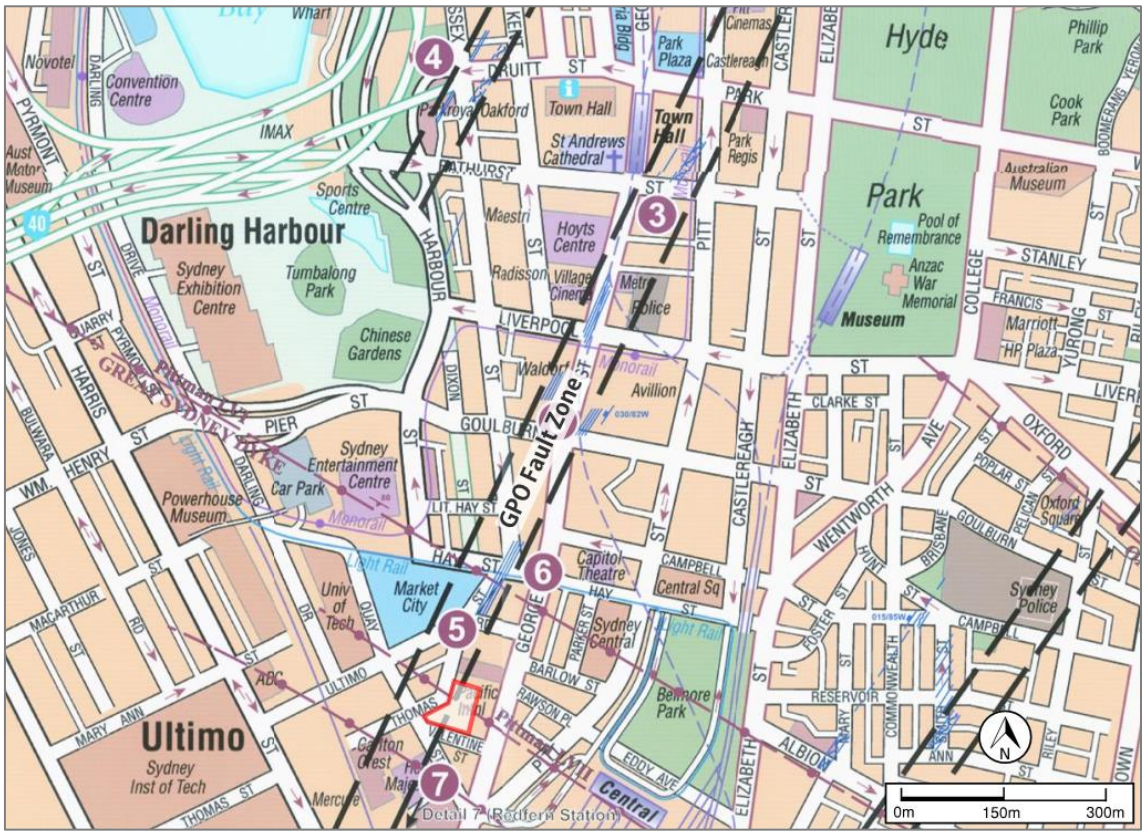

Figure 4: Extract from the of known geological faults and dykes in the Sydney CBD (Ref [5]), where the building site is indicated in the red boundary.

The GPO Fault Zone is characterised by multiple ‘crushed’ zones of Sandstone bedrock, and closely spaced jointing and faulting with normal and reverse fault offset. It has been encountered in many sites within the Sydney CBD. An image of a supported vertical excavation through the fault zone is shown in Figure 5 below.

Figure 5: View from the first stage of excavation for a basement within the GPO Fault Zone ([6]).

3.2.2 Available Site Investigation

Historical reports undertaken by the NSW Public Works Advisory were able to be accessed on the NSW MinView. Additionally, geotechnical reports were reviewed as part of the Development Application (DA) for the adjacent building at 757-763 George Street, bounded by Valentine Street and George Street (D/2017/353). The reports in proximity to the building site are shown in Figure 6 below.

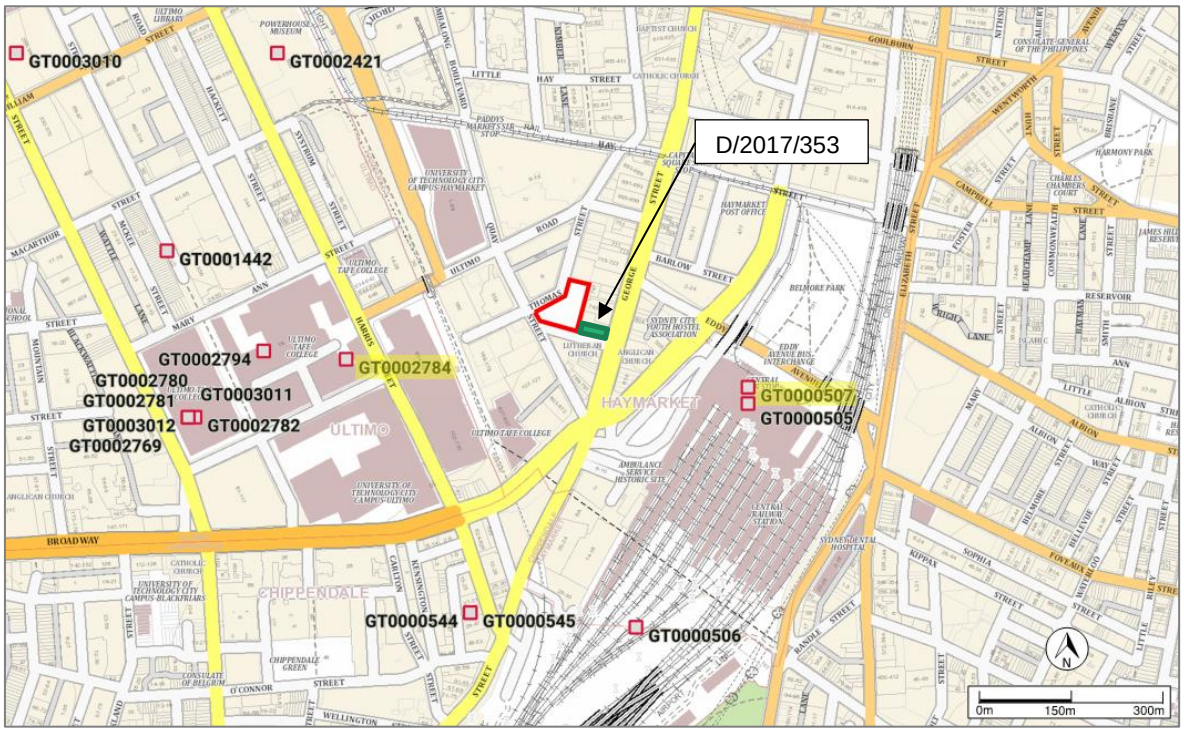

Figure 6: Summary of available geotechnical reports from the NSW Public Works Advisory (relevant reports highlighted in yellow) and DA for 761 George Street (green box).

The reports that contained relevant geotechnical investigation are summarised in Table 1 below. Note that the report GT0000505 was a material assessment for building facade, and not relevant to this study.

Table 1: Summary of relevant geotechnical reports in proximity to the building site.

Report and date	Investigation type and methodology	Relevant information
GT0000507, 250m South-East of the site "Central Station Redevelopment, Geotechnical Investigation" (1994)	Geotechnical investigation used to identify the subsurface profiles and bedrock levels for a concourse upgrade in Central Station. The investigation comprised 4 no. boreholes augered through soil until refusal, then NMLC size rock coring. Groundwater was not encountered.	The investigation encountered: • FILL (1 to 3.8m thick) comprising silty clay with lenses of silty sand, clayey sand and occasional sandstone fragments; overlying • RESIDUAL SOIL (1.1 to 1.2m thick), comprising silty clay and sandy silty with some minor ironstone gravel; overlying • BEDROCK (encountered at depths ranging from 2.1 to 5.05m below the ground surface), comprising Sandstone, highly to moderately weathered, very weak to weak, and generally increasing to medium strong to strong with depth (maximum depth drilled 6.5m below ground surface).

Report and date	Investigation type and methodology	Relevant information
GT0002784, 300m South-West of the site "Sydney Institute, Ultimo Campus, Building D Geotechnical Investigations" (2003)	Geotechnical investigation used to identify the subsurface information for a building development within the Sydney Institute campus. The investigation comprised 4 no. boreholes augered through soil until refusal, then NMLC size rock coring. Groundwater was not encountered.	The investigation encountered: • FILL (0.3 to 3.0m thick) comprising gravelly silty sand with concrete rubble and metal; overlying • RESIDUAL SOIL (0.5 to 2.5m thick) comprising silty clay, clayey silt with ironstone gravel; overlying • BEDROCK (encountered at depths ranging from 2.3 to 3.0m below the ground surface), comprising extremely weathered to highly weathered Sandstone, extremely weak to very weak and improving to slightly weathered with depth (maximum depth drilled 8.75m below ground surface).
D/2017/353, report No. E22293 AA_Rev 0, adjacent to 187 Thomas St (south-east corner) "Detailed Site Investigation Report, 757 – 763 George Street, Haymarket NSW" (2014) (Ref [7])	Geotechnical investigation comprising 2 no. boreholes augered through soil to refusal, then NMLC size rock coring to 12.0 and 14.95m below ground level. 3 no. additional shallow boreholes for environmental sampling. Contamination testing of soil and groundwater. Groundwater was not encountered during drilling, however estimated to be 6.0m below ground level from subsequent sampling.	The generalised subsurface profile in the report is summarised as: • FILL (0.7 to 0.8m thick, 7.25m at BH2) comprising concrete paving, silty sand/ sandy clay with construction debris (concrete, bricks, shale and sandstone); overlying • RESIDUAL SOIL (approx. 2.2m thick from BH1) comprising clay / silty clay with trace rootlets; overlying • BEDROCK (encountered at depths ranging from 3.0 to 7.25m below the ground surface), comprising extremely weathered to slightly weathered Sandstone (maximum depth drilled 14.95m below ground surface). Contaminates were encountered in the groundwater test results (BTEX/TRH), and uncontrolled and possibly contaminated fill were encountered in all boreholes across the site.

3.2.3 Groundwater

A review of the available groundwater bores within 500m of the site included 48 bores from Water NSW. A summary of the bores with recorded water levels is shown in Table 2 below.

Table 2: Summary of groundwater bores and water level measurements within 500m of the project site.

GW Bore ID	Elevation (mAHD)	Groundwater Measurements Depths (mBGL)	Groundwater Elevation (mAHD)	Type of Groundwater Strike
GW109502	21.19	2.18	19.01	During well construction
GW109648	15.1	5.23	9.87	During well construction
GW109649	15.05	2.95	12.1	During well construction
GW109646	15.05	5.93	9.12	During well construction
GW109501	20.55	2.3	18.25	During well construction
GW109500	23.96	2.3	21.66	During well construction
GW109503	22.92	2.24	20.68	During well construction

Groundwater was estimated to be around 6.0m below ground level (approximately 4mAHD) from the adjacent site investigation report for 757 – 763 George St.

Perched groundwater tables may be encountered within the Hawkesbury Sandstone, in particular around areas of highly fractured rock such as the dykes and GPO Fault Zone.

3.2.4 Aggressive and Acid Sulfate Soils

A Phase 1 (Preliminary Site Investigation) Assessment has not been undertaken at this stage of works. A review of the Sydney Local Environmental Plan Acid Sulfate Soil (ASS) Risk Map (Ref [4]) for the Sydney Region indicates that the risk of ASS on the site is Class 5. An ASS Assessment would be required where works within 500m of adjacent Class 1, 2, 3 or 4 land that is below 5mAHD, and where the water table is likely to be lowered below 1mAHD on the adjacent Class 1, 2, 3 or 4 lands. A Class 2 site is located within 500m of the site, as shown in Figure 7 below.

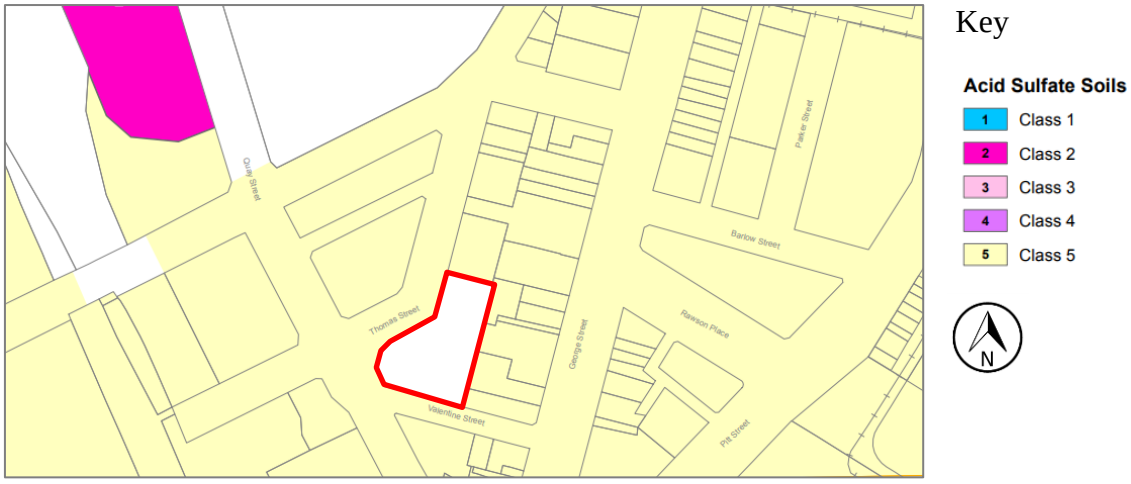

Figure 7: Extract from Sydney Local Environmental Plan ASS Map - Sheet ASS_015, with the project highlighted in red.

Information about the aggressivity of the soil and groundwater (pH, chloride, sulfate content and electrical conductivity) was not encountered during this assessment.

3.2.5 Proposed Foundations

The results of the geotechnical desktop assessment of existing information and local engineering experience firmly suggest the suitability of existing ground condition for the proposed development of the proposed building and basement construction. The assessment was conducted based on the available information at the time of preparation of this report. This assessment will need to be confirmed once a more detailed geotechnical investigation is completed at later stages of the design. This is further described in Section 5.

4 Geotechnical and Construction Risks

A summary of the geotechnical risks that should be considered for the detailed design and construction are summarised in the points below. Additional recommended geotechnical investigation is summarised in Section 5.

- Unknown subsurface conditions: Only publicly available historical reports and two boreholes from the adjacent site (Ref [7]), have been made available for the project. The available geotechnical investigation does not extend to sufficient depth below the proposed basement level (-7.3mRL). The material thickness, quality, proximity to various known structures (dykes, faults, joint swarms) will impact the detailed design for the foundations and any basement retention structures/rock support at depth.

- Fractured bedrock: Several dykes and the GPO Fault Zone will likely be encountered within the footprint of the building site and require additional retaining solutions to be designed for the basement excavations. The exact location and strength of the materials within these structures will need to be identified with a geotechnical investigation.

- In-situ stresses: “A number of studies have demonstrated the existence of large horizontal stresses that are locked into the sandstone rock in Sydney” (Ref 12). Once released through excavations, they can cause large deformations which have potential to impact on surrounding infrastructure and structures if not properly assessed and mitigated. The potential for ground movement may also place a limitation on basement depth should calculated impacts not be acceptable to third parties (such as utility asset managers and underground transport infrastructure).

- Proximity to adjacent foundations and underground structures: Foundations for the adjacent buildings and underground structures, such as utility tunnels, may be located around the building footprint. Excavation of the basement at the project site may induce horizontal movement and impact the adjacent structures. A full analysis of the basement excavation will be required to assess the magnitude of deflection and impact on the surrounding structures.

- Groundwater: May be encountered on the site due to the depth of excavation required for the basements. There is also the possibility of perched groundwater tables being encountered through dykes and the GPO Fault Zone intersecting the site. The fractured bedrock encountered in dykes and fault zones will potentially impact groundwater flow. Additional information regarding the groundwater levels, fluctuations and flow rates for dewatering and basement design will need to be obtained. Management of groundwater and retention systems may be required for the proposed basements.

- Aggressivity: Aggressive soils and groundwater may be encountered on site, which could impact the design life of buried structures (foundations, retaining structures). Additional testing of the soil and groundwater would be required to determine if aggressivity will impact any structural design.
- Acid Sulfate Soils: Due to the proximity of the site to a Class 2 site, and the depth of disturbance/ potential dewatering during proposed basement construction, an Acid Sulfate Soil Assessment may need to be undertaken.

5 Recommended Geotechnical Investigation

Geotechnical investigation will be required to inform the design for the foundations and basements. The building site is likely intersected by dykes and the GPO Fault Zone. The site is also in proximity interface with potential alluvial/ fluvial deposits to the North and West of the site (Section 3.2.1). A geotechnical investigation comprising boreholes and inclined boreholes will be required to identify the type and spatial variability of the subsurface materials. The quantity, type and depth of the boreholes will need to be further developed to adequately assess the requirements of the design. In general, the geotechnical investigation should cover:

- Sufficient geotechnical investigation to provide confidence in the location, thickness, material strength of the materials for the entire footprint of the building. This will be critical in determining the location of the known structures (dykes, faults) across the site. The total depth of investigation should cover all the basement levels (up to -7.3mRL), with sufficient depth along the entire length of the foundations, and nominally up to five times the depth of the pile or width of shallow foundation used to support the superstructure.
- The physical geotechnical investigation should include at a minimum:
    - Material type, strength, weathering (for rock);
    - Measurement of groundwater encountered and installation of groundwater monitoring wells;
    - In-situ testing (described below); and
    - Samples for laboratory testing.
- In-situ testing should include at a minimum:
    - Standard Penetration Testing (SPT) within soil units;
    - Pump testing, where fractures or groundwater are encountered to assess the flow rate through fractures within the rock mass, for dewatering and groundwater recharge assessments;
    - Pressure meter testing for the determination of the horizontal stresses in the rock mass for retention design; and
    - Inspection of the rock jointing and structure.
- Laboratory testing should include at a minimum:
    - Classification testing for soil units encountered (Atterberg Limits, Particle Size Distribution, Moisture Condition); and

  - Rock strength testing (Uniaxial compressive strength [UCS] and Point Load Index [PLI]).

- Where groundwater or perched groundwater tables are encountered, additional long-term monitoring or testing may be required. A qualified geotechnical engineer should be engaged to assess the required geotechnical investigations as per the detailed design.

Contamination was noted in the investigation report for 757 – 763 George Street (Ref [7]). An environmental and contamination investigation should be undertaken by a qualified environmental engineer for the site and include at a minimum:

- Identification of contamination;
- Presence of aggressive soils and/or groundwater; and
- Presence of Acid Sulfate Soils (ASS).

6 References

[1] City of Sydney Development Applications, accessed 18 January 2020, <online2.cityofsydney.nsw.gov.au>

[2] NSW Statewide Seamless Geology, Version 1.1, 1:25,000 scale Surface Geology, accessed via NSW MinView 18 January 2020, <www.minview.geoscience.nsw.gov.au>

[3] NSW Seatewide Seamless Geology, Version 1.1, 1:25,000 scale Great Soil Group Outcrop, accessed via NSW MinView 18 January 2020, <www.minview.geoscience.nsw.gov.au>

[4] Sydney Local Environmental Plan 2012 Acid Sulfate Risk Map, NSW Legislation, Sheet ASS_015 (last updated 29 November 2019)

[5] Pells, P.J. N., Braybrooke, J.C., Och, D.J. (2004). "Geological faults and dykes in the Sydney CBD"

[6] Oliveria, D. and Chan, G. (2016). "Ground control for a deep basement excavation in Sydney's GPO fault zone"

[7] "Detailed Site Investigation Report, 757 – 763 George Street, Haymarket NSW" (2014), Report No E22293 AA_Rev 0, Environmental Investigations Australia, accessed through City of Sydney Development Application Portal (application number D/2017/353)

7 Assumptions and Limitations

This report has been prepared by Arup for Greaton Development and may only be used and relied on by Greaton Development for the purpose agreed between Arup and Greaton Development as set out in in the Proposal Letter dated 27 November 2019, "187 Thomas Street –Support".

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Yours sincerely

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