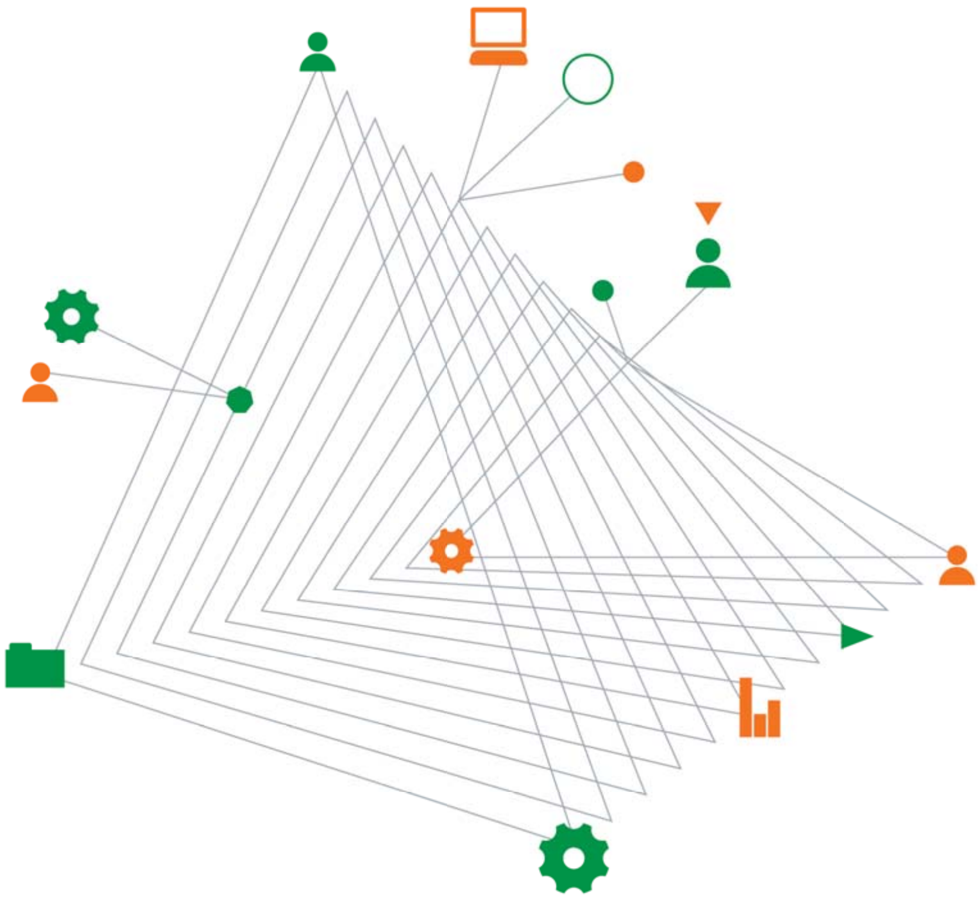
coffey

Lend Lease Development Pty Limited

Lend Lease Circular Quay

174-182 George Street and 33-35 Pitt Street,
Sydney
Geotechnical Desk Study Report

October 2015



Experience
comes to life
when it is
powered by
expertise

This page has been left intentionally blank

Lend Lease Circular Quay

Prepared for
Lend Lease Development Pty Limited

Prepared by
Coffey Geotechnics Pty Ltd
Level 19, Tower B, 799 Pacific Highway
Chatswood NSW 2067 Australia
t: +61 2 9406 1025 f: +61 2 9406 1002
ABN: 93 056 929 483

October 2015

Our ref: GEOTLCOV24730AA-BC

Attention: Warwick Bowyer

Dear Warwick,

Coffey Geotechnics Pty Ltd (Coffey) is pleased to present the findings of this revised geotechnical desk study carried out for the proposed Lend Lease Circular Quay redevelopment of 174-182 George Street and 33-35 Pitt Street, Sydney. If you have any questions regarding our report please contact the undersigned on 9406 1000.

For and on behalf of Coffey

B. Rotter

Ben Rotter
Senior Engineer

Table of contents

Tables

Figures

1. Introduction

At the request of Lend Lease Developments Pty Limited (Lend Lease), Coffey Geotechnics Pty Ltd (Coffey) has carried out a geotechnical desk study for the proposed Lend Lease Circular Quay redevelopment of 174-182 George Street and 33-35 Pitt Street, Sydney.

The objectives of the desk study were to develop a preliminary geotechnical model for the redevelopment site in order to provide preliminary assessment and subsequent recommendations for the following aspects of the proposed redevelopment:

- Excavation conditions
- Groundwater conditions and issues likely to arise
- Retention system requirements and design parameters
- Rock face support requirements
- Expected excavation induced ground movements
- Expected foundations and design parameters for commercial office tower, columns and core, up to 200 m in height
- Expected soil aggressivity
- Expected seismic design parameters
- Expected tank stream precautions during construction.

2. Proposed Redevelopment

A Planning Proposal submission for the LLCQ project will be lodged by Lend Lease with the City of Sydney. The purpose of the LLCQ Planning Proposal submission is to facilitate the lodgement of a development application for the LLCQ scheme in 2016.

The Planning Proposal relates to the land parcels listed in Table 1 and shown in Figure 1, together with the boundary of the redevelopment area.

The redevelopment site (the site) is located towards the northern end of Pitt Street, bounded to the south by Underwood Street, to the north by Rugby Place and to the west by George Street. There are existing multi-storey developments adjacent to the site's northern, southern and western boundaries.

The LLCQ scheme contemplates:

- Demolition of existing commercial office buildings at 182 George Street and 33-35 Pitt Street (and possibly Rugby Club), including the removal and disposal of hazardous materials (where relevant)
- The retention, modification and adaptive reuse of Jacksons on George
- Site preparatory works including (where relevant):
    - The erection of hoardings and overhead protection structures

    - Remediation of contamination
    - Undertaking of archaeological investigation and protection works
    - Augmentation and diversion of existing infrastructure services.

- The erection of a multi-storey commercial office tower up to 248 m in height, up to 70,000 m^2 of gross floor area, and approximately three basement levels.
- Delivery of new public realm consisting of a public plaza on George Street and new interconnecting laneway extensions between Underwood Street and Rugby Place
- The construction of shared laneway and plaza retail for the purpose of activating the new public realm
- Internal traffic amendments to Rugby Place.

Table 1: Land Parcels Covered by the Planning Proposal

Informal Title	Address	Lot and DP	Ownership
The Pitt Street Property	33-35 Pitt Street	Lot 7 DP 629694	Lend Lease (Circular Quay) Pty Ltd
The George Street Property	182 George Street	Lot 182 DP 606865	Lend Lease (Circular Quay) Pty Ltd
Jacksons on George	174-176A George Street	Lot 181 DP 606865	Lend Lease Development is the owner of Jacksons on George
Mirvac Triangle	Part of 200 George Street development site	Lot 1 in DP 69466 and Lot 4 in DP 57434. The part of these Lots to which the Planning Proposal relates is referred to as Lot 2 in the draft plan of subdivision 13 November 2012 (Issue 7) contained in the executed VPA between the City of Sydney and Mirvac	Mirvac owns the land. Mirvac will transfer the new Lot 2 to the City of Sydney who will then transfer to Lend Lease in return for an equivalent area of completed public realm
Crane Lane including walkway (aerial bridge)	Crane Lane extending east from George St, then north to Rugby Place	Lot 1 and 2 in DP 880891. Lot 1 is in stratum above Lot 2	City of Sydney
Rugby Club (Optional Site)	Rugby Place	Lot 180 DP 606866	Wanda One Sydney Pty Ltd

3. Desk Study Information

3.1. Geology

The 1:100,000 Sydney Geological Sheet indicates the site is situated in the vicinity of the boundary between Fill, estuarine alluvium and Hawkesbury Sandstone, described on the geological sheet as follows:

- Fill: dredged estuarine sand and mud, demolition rubble, industrial and household waste
- Alluvium: silty to peaty quartz sand silt and clay with common shell layers
- Sandstone: medium to coarse grained with minor shale and laminite lenses.

A plan of near vertical structural features in the Sydney CBD by Pells et al (2004) indicates the site is remote from mapped structural features such as major fault zones or igneous intrusions. The nearest mapped features are:

- The Pittman LIV dyke (a near vertical structure, often weathered to clay), mapped approximately 70m to the south of the site, trending generally east to west
- The GPO Fault Zone (typically highly weathered sandstone with near vertical parallel shear zones, clay infilled joints, with some seepage) is mapped approximately 250m east of the site, trending approximately north-north east to south-south west.

Sandstone bedrock within the Sydney CBD typically follow a dominant NNE trending sub-vertical joint set, with a less dominant joint set observed running perpendicular.

3.2. Site Historical Background

The locality is close to the initial European settlement of Sydney, which occupied the areas close to the freshwater creek, known as the Tank Stream. The Tank Stream originally ran from the site of Hyde Park, parallel to the present day Pitt and George Streets, entering Sydney Cove at the location of the present day Bridge Street. As Sydney grew in the early 19th century the Tank Stream was progressively covered forming the current stormwater channel.

Ongoing development of the Sydney Cove area through the 19th and 20th centuries has resulted in significant land reclamation over the estuarine mud flats, creating the present day street levels towards Circular Quay. The Tank Stream now runs underground parallel to and immediately adjacent to the eastern site boundary along Pitt Street. For more information on the Tank Stream, refer to Coffey's *Tank Stream Conservation Report* for the redevelopment (report reference GEOTLCOV24730AA-AS, dated 17 October 2013).

The eastern boundary of the site is likely to lie within the margins of the valley formed by the Tank Stream. On this basis, alluvium may be present in eastern areas of the site.

3.3. Coffey Investigations in the Locality

Coffey local experience includes the following sites:

- 190 George Street, 200 George Street and 4 Dalley Street
- Pitt Street Hotel
- Electricity Substation at 16 Dalley Street.

The sandstone encountered at these nearby sites generally has sub-horizontal bedding with dips of up to 10°, with some cross bedding within the sandstone units of about 5° to 30°. Defects in more competent rock (Class II sandstone or better) are typically spaced at 0.3 m to 1 m, except where shear zones/crushed zones are present. Clay seams may be encountered but are typically less than 10 mm to 15 mm in thickness.

3.4. Other Available Information

To assist with preparation of this desk study, Coffey was supplied with the following information for the former development at 33-35 Pitt Street:

- Geotechnical report by Jeffery and Katauskas Pty Ltd, Foundation Investigation form Proposed Commercial Development, 33-35 Pitt Street, Sydney. Report reference 1836, dated 12 October 1981
- Geotechnical report by Jeffery and Katauskas Pty Ltd, Additional Borehole at Column C72 Location, 33-35 Pitt Street, Sydney. Report reference 1836, dated 8 February 1982
- A plan and five borehole logs, drilled at 6-8 Underwood St, Sydney, provided by Lend Lease
- A drawing provided by Lend Lease for a development at 19 Pitt Street dated 1968 showing borehole logs.

The above investigations indicate the site to be underlain by a variable thickness of fill overlying sandstone bedrock towards the western site boundary. Alluvial deposits overly the sandstone bedrock towards the eastern site boundary with Pitt Street.

No reduced level information is available for the boreholes drilled at 6-8 Underwood Street. We have estimated a surface level of 2.5 m AHD for all five boreholes at this site, using rock level correlation from the nearby borehole JBH3 and considering that the holes were drilled with a truck mounted rig, so the ground level was likely to be relatively level and somewhat similar to the road pavement level. Similarly there is no reduced level information for the boreholes drilled at 19 Pitt Street.

4. Preliminary Geotechnical Model

Table 2 presents the inferred stratigraphy at the site based on the Jeffery and Katauskas Pty Ltd geotechnical reports and the boreholes from 6-8 Underwood Street.

The stratigraphic units are defined in terms of their origin and rock mass characteristics based on the system presented in Pells et al (1998).

Table 2: Geotechnical Units

Geotechnical Unit	General Description	Estimated Thickness
1. Fill	▪ Fill comprised of variable sand, gravel and boulders, clay and construction materials	1.5 m to 5 m
2. Alluvium/Marine Deposits	▪ Silty and sandy clay ▪ Typically soft to firm ▪ Containing occasional shell beds	1 m to 3 m
3a. Sandstone Class IV and Class III	▪ Moderately weathered ▪ Medium to high strength strength but containing clay seams and defects	1 m to 2 m
3b. Sandstone Class II or better	▪ Slightly weathered to fresh ▪ High strength ▪ Moderately to widely spaced defects	Unproven

Based on review of the available information, plans have been developed to show inferred levels of each of the respective units within the site and immediate environs as follows:

- Figure 2 - Base of fill contours
- Figure 3 - Top of rock contours (Unit 3a – Class IV and Class III Sandstone)
- Figure 4 - Expected extent of alluvial deposits.

Coffey expects bedrock levels across the site to vary between approximately 0.5 m AHD and 1.5 m AHD at the western extent of the site, falling in an easterly direction to approximately -4 m AHD at the eastern boundary. The bedrock level falls towards the palaeochannel coinciding with the original course of the Tank Stream. We note that site investigations undertaken near the western extent of the site encountered bedrock between 0 m AHD and 0.5 m AHD. Some or all of these investigations may be influenced by basement excavations.

Borehole logs provided for 19 Pitt Street from 1968 were compared to the top of rock contours shown in Figure 3. Ground surface elevations are not available for those boreholes and Coffey has assumed ground surface elevations consistent with those available in 2012. Given this assumption, the elevation of the top of rock (“soft sandstone”) is approximately one metre shallower at the location of Bore 2 (at the centre of the northern boundary of the proposed 33-35 Pitt Street development site) and approximately 0.5 m deeper at the location of Bore 3 (at the north eastern boundary of the proposed development site) than those shown in Figure 3. These elevations are relatively consistent with those shown in Figure 3. Given the uncertainty regarding ground surface elevations at the site in 1968, the recent borehole data is considered to be more reliable and therefore Figure 3 has not been adjusted to incorporate the 1968 data.

Figure 5 presents three inferred geological cross sections through the site showing the stratigraphic units relative to the proposed building footprint and bulk excavation level.

Borehole information from previous investigations around the site locality indicates that the bedrock surface is typically moderately weathered sandstone (Unit 3a), grading to slightly weathered and fresh sandstone (Unit 3b) with depth.

Groundwater levels measured in previous investigations vary between -0.4 m AHD and 0.2 m AHD. Groundwater is likely to be encountered within the Unit 2 Alluvium and Unit 1 Fill that has been placed to raise site levels from what was probably low lying swampy ground. Groundwater may also be encountered within the bedrock in joints and bedding partings.

5. Preliminary Discussion and recommendations

5.1. Excavation Conditions

Based on a proposed basement floor level of about -5 m AHD, excavations are likely to penetrate through Unit 1 fill, Unit 2 alluvial soils, Unit 3a sandstone and into Unit 3b sandstone. Unit 1 and Unit 2 soils should be able to be excavated using an excavator bucket. Some of the weathered upper Unit 3a sandstone may also be excavated with a large excavator fitted with rock teeth.

The lower Unit 3a and Unit 3b are predominantly Class II or higher strength sandstone with widely spaced defects, and will be relatively difficult to excavate. Ripping, is likely to be difficult and will require excavation plant such as Class 300/400C dozers, Cat D10 (or equivalent) or larger. In confined spaces such plant may require the use of rock saws and impact hammers to assist by opening up trenches between which ripping could be attempted.

If practicable, ripping productivity rates in the high strength sandstone will be low and may produce blocky material. If ripping proves to be impracticable, rock saws, impact hammers and milling machines could be used for all bulk and detailed excavation and trimming works.

The use of hydraulic impact hammers for bulk excavation, trimming the sides of excavations, and detailed excavation, will cause vibrations that could damage vibration sensitive structures and services. Rock saws may be required to avoid both overbreak and excessive vibrations below the existing basement walls and adjacent to vibration sensitive structures and services.

The proximity of the excavations to the Heritage listed Tank Stream should be taken into consideration when selecting suitable excavation methods. Planning for the excavation of the basement is to include mitigation measures to reduce the impact of the redevelopment works on the Tank Stream. Refer to the Coffey *Tank Stream Conservation Report* (report reference GEOTLCOV24730AA-AS, dated 17 October 2013) for further discussion in relation to protection of the Tank Stream.

5.2. Groundwater Conditions

Proposed basement excavations will extend below the groundwater table observed at between -0.4 m AHD and 0.2 m AHD (approximately 5 m above proposed bulk excavation levels).

It is possible that there are two separate aquifers at the site: a shallow aquifer within the fill/alluvium, perched on top of the bedrock, and a deeper groundwater system within the sandstone bedrock. This dual aquifer system is typical of environments in the vicinity of deep building basements within the Sydney CBD.

Groundwater inflows will likely occur through the lower Unit 1 Fill and Unit 2 Alluvium, with seepage expected through joints and defects in the underlying Unit 3 Sandstone. Groundwater inflows during excavation within the bedrock may be managed by a drainage system. Where unacceptable groundwater inflows occur in the rock mass, targeted grouting may be used to reduce inflows.

Extensive dewatering of the alluvial soils is not desirable as this could lead to consolidation settlement of the fill and alluvium, and special permits may be required to discharge collected water off-site. Cut-off walls will be required during excavation works and the final basement should be designed as tanked to maintain standing groundwater levels within the alluvial channel and prevent groundwater ingress into the basement.

Groundwater inflows through the bedrock may not be significant if there is not a strong hydraulic connection to the alluvium, and it may be possible to design those portions of the basement excavated into rock as drained with adequate slab and perimeter drainage layers discharging to sumps. Impermeable temporary support systems and/or a fully tanked permanent basement could result in partial damming of groundwater flow through the site, with a rise in groundwater upstream, and a lowering of groundwater downstream.

The detailed assessment and design of groundwater management is beyond the scope of this desk study and should be addressed by a hydrogeological investigation.

5.3. Excavation Induced Ground Movements

Walls retaining soil strength material are expected to laterally deflect up to 1% of the retained height, depending on the stiffness of the retaining wall system. Horizontal stress relief in the bedrock will result in additional movement.

Based on past excavation experience in Hawkesbury Sandstone in the Sydney CBD, typical lateral ground movements at the excavation face are of the order of 0.5 mm to 2 mm per metre depth of excavation, depending on rock quality and bedding.

The potentially damaging effects of stress redistribution in the vicinity of excavations should be assessed as part of the detailed design. Lateral displacements of retaining walls due to stress redistribution may also result in settlements. For preliminary assessment of impacts, we recommend that potential settlement be assumed to be equal to predicted lateral displacements.

Typically, ground movements (lateral displacement and settlement) are greatest at the excavation face and decrease to negligible values at a distance of up to 3 times the excavation depth.

For preliminary impact assessment purposes, the above guidelines on displacements may be used. For other sensitive receptors, retaining walls should be designed for higher earth pressures. For tolerances relating to the Tank Stream, refer to the Coffey *Tank Stream Conservation Report* (report reference GEOTLCOV24730AA-AS, dated 17 October 2013).

Depending on the specific retention system, basement excavation details and the nature of adjacent structures, detailed analysis will be required.

5.4. Excavation Support

5.4.1. Retaining Walls

Based on the preliminary geotechnical model for the site as summarised in Section 4, it is expected that a retaining wall will be required where Unit 1 Fill and/or Unit 2 Alluvial soils are present.

Depending on project requirements for a sufficiently watertight and/or stiff retention system, the following options could be considered:

- Driven sheet piles
- Secant pile wall.

For a sheet piled wall, overlapping or interlocking sheets would be vibrated or driven into the ground around the proposed basement perimeter prior to excavation. As the excavation proceeds, the sheet pile wall would require stiffening with horizontal beams, cross struts and/or temporary anchors. The steel sheet piles could be used to provide formwork for the permanent basement walls, but this would preclude their recovery. Sheet piles would likely refuse on the weathered bedrock, and groundwater seepage would be expected to occur through the clutches and toe of the wall.

Secant piling involves drilling “soft” piles using low strength concrete at centres of 1.5 × pile diameter. Normal strength “hard” piles are then drilled between the soft piles, cutting into the soft piles to form a relatively water-tight seal. The secant pile wall would be installed into bedrock around the proposed basement perimeter prior to excavation and would likely require the progressive installation of ground anchors or internal bracing to provide additional lateral stability to the wall as the excavation proceeds. Unless bored carefully, secant piles can deviate from vertical centre during installation, creating gaps between the piles and resulting in groundwater seepage and ground loss.

For the preliminary assessment of existing and new retaining walls, the parameters in Table 3 should be adopted.

Table 3: Preliminary Retaining Wall Design Parameters

Material Type	Bulk Density (kN/m^3)	Coefficient of Active Earth Pressure, K_a	Coefficient of Passive Earth Pressure, K_p
Fill	18	0.4	2.5
Alluvium	18	0.36	2.8
Class IV Sandstone or stronger*	24	0.2	5

*Class IV or stronger sandstone will not need to be supported by a retaining wall. However, retaining wall footings that penetrate into rock will develop passive resistance in the rock sockets.

Retaining walls should be designed for appropriate hydrostatic and surcharge loads.

Where cantilevered walls are not practicable, lateral stability could be provided by anchors installed progressively as the excavation proceeds. Anchors would need to be installed beneath adjacent properties and would need the permission of adjacent property owners and Council.

For discussion of excavation support in relation to the boundaries of the site adjacent to the Tank Stream refer to the Coffey *Tank Stream Conservation Report* (report reference GEOTLCOV24730AA-AS, dated 17 October 2013).

5.4.2. Support of Rock Excavation

It is difficult to accurately assess rock support requirements from vertical borehole data. Hawkesbury Sandstone typically contains sub-vertical joints and bedding planes that can form potentially unstable blocks and wedges. However, given the relatively good quality sandstone encountered at the borehole locations, support is likely to be limited to isolated spot rock bolting of the basement faces. In some boreholes the upper few metres of rock comprises Class III and Class IV Sandstone, which is more fractured and hence is more likely to require spot bolting or localised pattern bolting.

An experienced geotechnical engineer should be engaged to observe the excavation faces after each 2 m depth of excavation to assess support requirements. Allowance should be made for 3 m long rock bolts, double encapsulated rock bolts (CT bolt or equivalent) to provide long term support to blocks or wedges.

The permission of adjacent landowners will be required to install support such as rock anchors and rock bolts, where such support extends beyond the site boundaries.

5.4.3. Existing Basements

Based on Coffey's previous studies at 190 George Street, the nature of subsurface conditions in the vicinity of 190 George Street is expected to differ from those at 33-35 Pitt Street. We are unaware of the drainage details of the existing retaining walls at 190 George Street. However, an under-slab drainage system was observed in the boreholes. Coffey recommended that if significant amounts of water flow through fill or natural soils above the rock, it may be necessary to design a semi-tanked basement, with new and existing retaining walls designed as tanked structures capable of resisting hydrostatic pressures.

The existing basement retaining walls below 1 Alfred Street are thought to currently act as a cut-off structure to groundwater within the fill and alluvial soils founded on or within sandstone bedrock. Where excavations extend below the toe of existing retaining walls, appropriate treatment of joints or other defects near the base of the walls may be required to reduce the hydraulic connection to groundwater within the alluvium.

5.5. Foundations

Bulk excavations for the redevelopment are expected to expose predominantly Unit 3b sandstone with some possible minor exposure of Unit 3a sandstone towards the eastern site boundary.

It is likely that column loads for the proposed redevelopment may be supported using pad, strip or piled footings founded on Unit 3 sandstone bedrock. Ultimate limit state geotechnical design parameters are provided in Table 4 for various classes of sandstone. Foundation design should be consistent with the limit state design methodology presented in Australian Standards.

Table 4: Preliminary Foundation Design Parameters

Rock Class	Limit State Design		
	Ultimate End Bearing Capacity (kPa)	**Ultimate Shaft Adhesion (kPa)[a]**	**Elastic Modulus (MPa)**
Class IV and Class III Sandstone	10,000	500	350
Class II Sandstone or stronger	40,000	2,000	1,000

[a]Shaft adhesion should be ignored for pad footings.

For limit state design of pile foundations, a geotechnical reduction factor, ϕ_g, has been assessed in accordance with the Australian Standard AS2159-2009. The assessment takes into consideration the following:

- A moderately variable subsurface profile
- A drilling program within the footprint of the site, with cored boreholes extending a sufficient distance below founding level
- Detailed information on strength and compressibility of the rock material
- An experienced piling contractor used to install piles
- Assessment of design parameters using site-specific correlations
- Use of well-established design methods
- Design that adopts lower quartile test values
- A moderate level of construction control
- No pile testing.

For superstructure supports with a high level of redundancy, the assessed geotechnical strength reduction factor for bored piles is 0.7. For superstructure supports with a low level of redundancy, the assessed geotechnical strength reduction factor for bored piles is 0.61. For uplift, ultimate shaft friction values should also be multiplied by an additional factor of 0.7.

Class IV and Class III sandstone are presented as one Unit. Where higher bearing capacities are required at bulk excavation level, we recommend further geotechnical investigation (such as cored boreholes) be carried out at the site to further characterise subsurface conditions and assess the presence and extent of Class III sandstone. Where confirmed, higher bearing capacities may be available for the lower extent of Unit 3a.

All footing excavations should be observed by a geotechnical engineer to assess the foundation. Where ultimate limit state bearing capacities greater than 3,500 kPa are adopted, foundation defects should be assessed by cored boreholes or spoon testing in jackhammer holes and/or observation of rock exposures in lift wells (if available). The number of tests for verification will depend on the number and layout of footings, and the number of existing cored boreholes. For the purposes of a preliminary estimate, we recommend allowance for testing at least 30% of footing locations.

5.6. Monitoring of Effects on Adjacent Structures

A geotechnical monitoring programme should be implemented during the construction phase as a check of design assumptions and to enable excavation support to be installed progressively as required by the revealed conditions. The programme should include, as a minimum, the following components:

- Monitoring of surface survey points located on existing structures, on any retaining wall, and on the ground surface at lateral distance from the excavation. Survey monitoring should be undertaken on a weekly basis during construction. Monitoring points should provide for accurate recording of both vertical and horizontal movements
- Undertake regular geotechnical assessments of exposed rock faces at depth-intervals no greater than 2 m. Install rock face support as required
- Vibration monitoring on vibration sensitive structures located close to the excavation, such as the adjacent masonry buildings and Tank Stream structure.

5.7. Soil Aggressivity and Acid Sulfate Soils

A review of the Acid Sulfate Soils Risk Maps available on the Australian Soils Resource Information System (ASRIS) website (http://www.asris.csiro.au) indicates that there is an extremely low probability of the presence of acid sulfate soils at the site. However, the map also indicates that there is very low confidence in this estimate. This very low confidence is likely due to the history of unrecorded earthworks in the vicinity of the site, and the historical placement of uncontrolled/unknown fill which may contain Potential Acid Sulfate Soils (PASS) or Acid Sulfate Soils (ASS).

Consistent with the criteria provided in the Acid Sulfate Soils Assessment Guidelines (Ahern et al., 1998), the potential estuarine/marine origins of the fill and alluvium at the site, their Holocene geological age, and the presence of soil horizons below 5 m AHD, indicate that it is nevertheless possible that ASS may be present.

Based on the above information, Coffey consider it unlikely (though not impossible) that PASS or ASS are present at the site.

The site lies within both Class 2 and Class 5 lands as described in the City of Sydney Local Environmental Plan 2012 and shown on the City of Sydney Local Environmental Plan 2012 Acid Sulfate Soils Map. Since the proposed redevelopment involves excavation below natural ground surface, and the watertable may be lowered during construction works, an ASS Management Plan is required to be developed in accordance with the City of Sydney Local Environmental Plan 2012.

Coffey consider that the risk of exposing PASS or ASS (if at all present) during construction can be effectively managed by the development and implementation of an ASS Management Plan. The Plan should nominate practices for identifying PASS and ASS, to be undertaken prior to and as part of the redevelopment. The Plan should consider (i) groundwater cut-off (utilising a retention system such as a secant pile wall) through the fill and alluvium to reduce the risk of oxidising ASS outside the site boundary, and (ii) appropriate management of PASS within the excavated material during earthworks.

Both (i) and (ii) can be successfully managed through the implementation of proven industry standard engineering design and construction techniques. In the event that ASS and/or PASS are encountered, the plan should be implemented.

5.8. Seismic Design

Based on our interpretation of site conditions and review of AS1170.4-2007, we recommend the following parameters be adopted for seismic design where two basement levels are proposed:

- Seismic Hazard Factor (Z) 0.08
- Sub-Soil Class B_e.

6. Conclusions

Coffey has assessed the proposed redevelopment scheme in the context of the existing geotechnical conditions at the site and conclude that the site is suitable for its intended use.

Coffey is satisfied that the geotechnical challenges posed by the site conditions, including the high/perched groundwater water, potential presence of ASS, and potential impact of ground movements due to excavation on adjacent sensitive structures, can be adequately addressed through the utilisation of industry-standard design and construction techniques and practices.

7. Limitations and Further Geotechnical Investigations

The preliminary geotechnical assessment and recommendations presented in this report are based on a desk study with limited borehole data. Ground conditions can vary over relatively short distances and site specific investigation and construction stage geotechnical assessments should be considered to manage geotechnical risk.

The attached document entitled "Important Information about your Coffey Report" provides additional information on the uses and limitations of this report.

8. References

Ahern, C.R., Y. Stone, and B. Blunden (1998). Acid Sulfate Soils Assessment Guidelines, Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia.

Pells, P.J.N., G. Mostyn, and B.F. Walker (1998), Foundations on Sandstone and Shale in the Sydney Region, Australian Geomechanics, December 1998, pp17-29.

Pells, P.J.N. (2004), Substance and Mass Properties for the Design of Engineering Structures in the Hawkesbury Sandstone, Australian Geomechanics, 39:3.

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

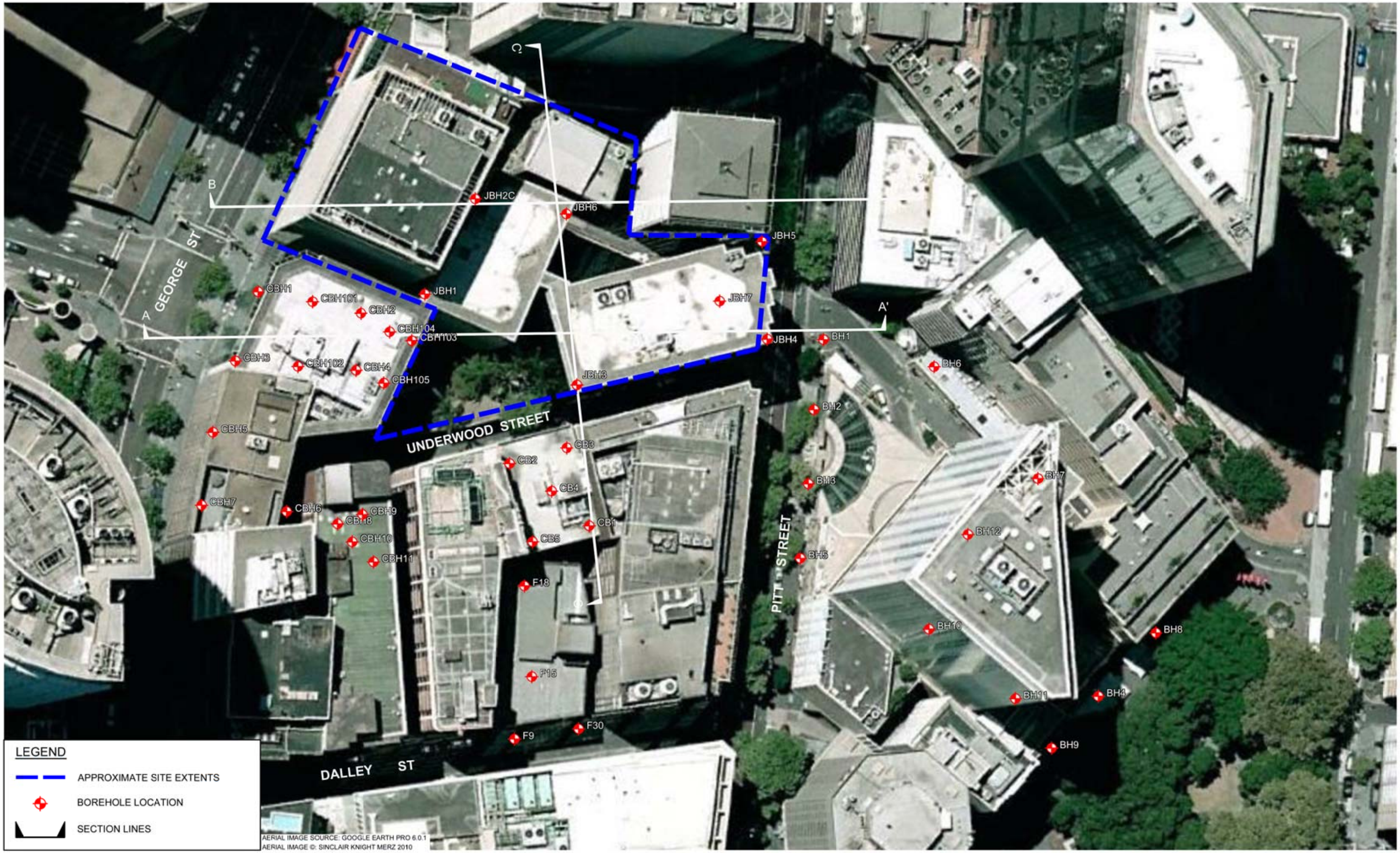
Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Figures



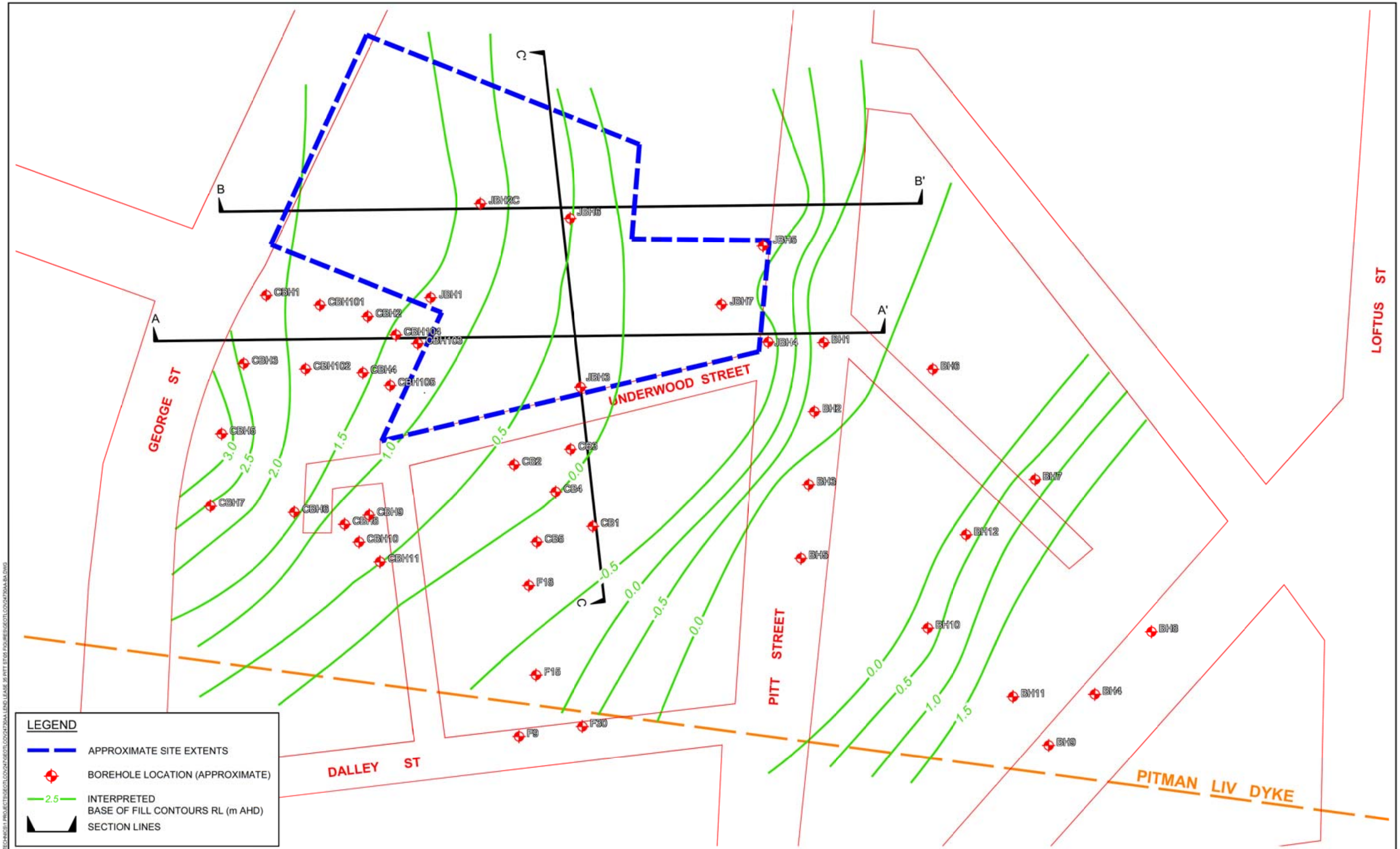
revision	description	drawn	approved	date

Scale (metres) 1:750

drawn	BR / LH
approved	FB
date	06 / 06 / 14
scale	1:750
original size	A3

coffey

client:	LEND LEASE DEVELOPMENT
project:	LEND LEASE CIRCULAR QUAY 174-182 GEORGE STREET AND 33-35 PITT STREET
title:	SITE LOCATIONS AND BOREHOLE LOCATIONS
project no:	GEOTLCOV24730AA-BA
figure no:	FIGURE 1

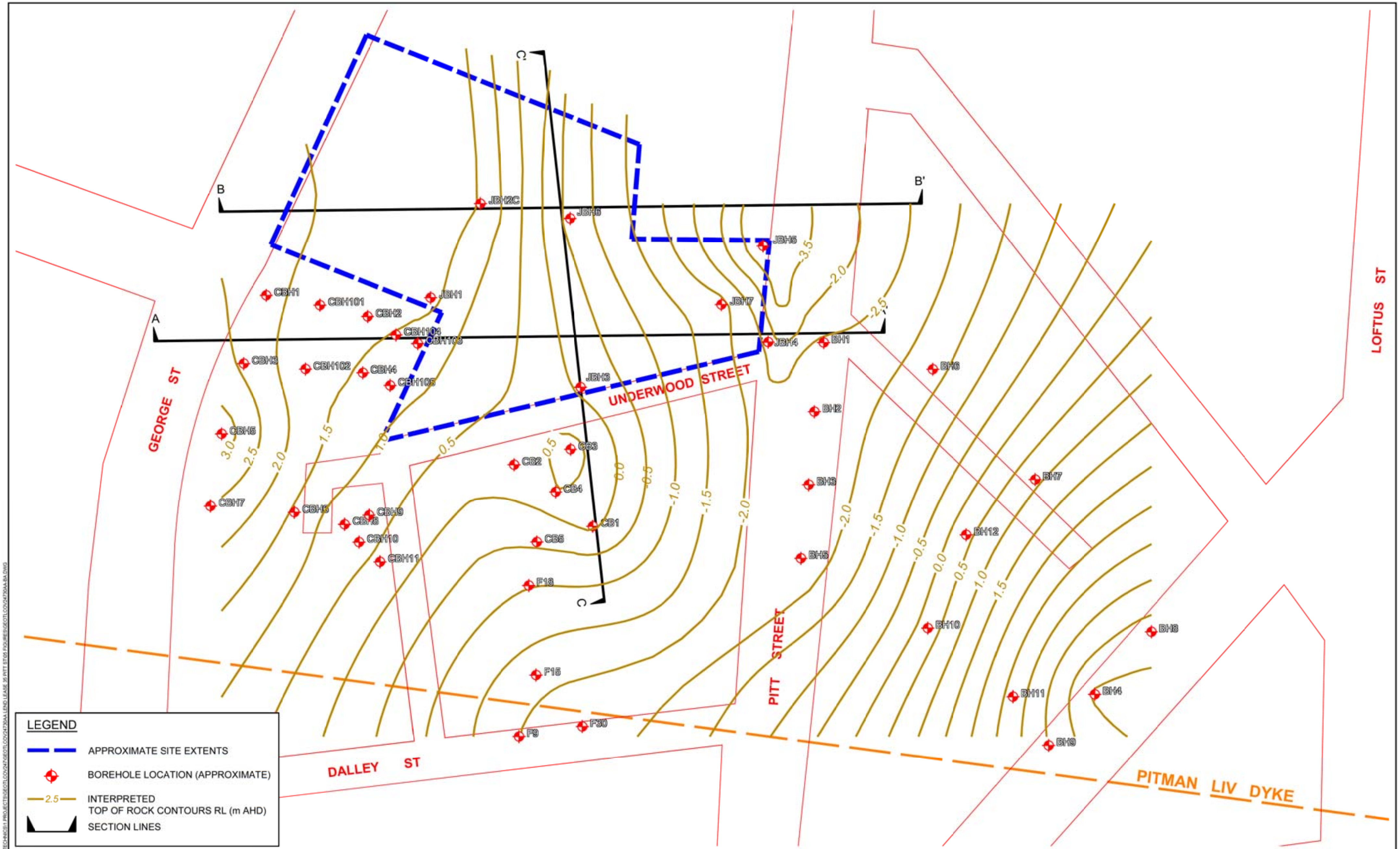


revision	description	drawn	approved	date

drawn	BR / LH
approved	FB
date	06 / 06 / 14
scale	1:750
original size	A3

coffey

client:	LEND LEASE DEVELOPMENT
project:	LEND LEASE CIRCULAR QUAY 174-182 GEORGE STREET AND 33-35 PITT STREET
title:	INTERPRETED RL BASE OF FILL CONTOURS
project no:	GEOTLCOV24730AA-BA
figure no:	FIGURE 2



revision	description	drawn	approved	date

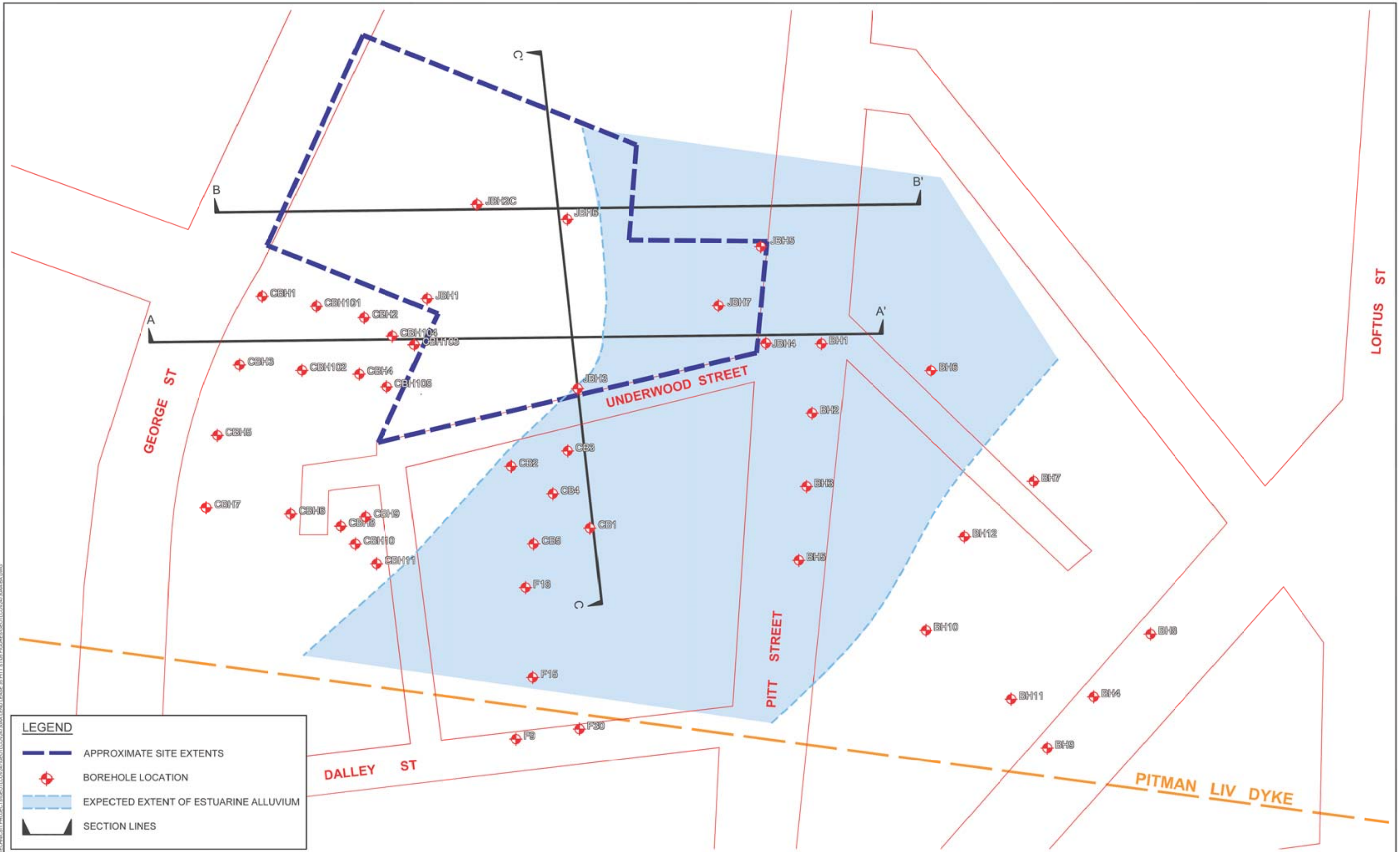
N

Scale (metres) 1:750 — 10 0 10 20 30 40

drawn	BR / LH
approved	FB
date	06 / 06 / 14
scale	1:750
original size	A3

coffey

client:	LEND LEASE DEVELOPMENT
project:	LEND LEASE CIRCULAR QUAY 174-182 GEORGE STREET AND 33-35 PITT STREET
title:	INTERPRETED RL TOP OF CLASS IV AND CLASS III SANDSTONE ROCK CONTOURS
project no:	GEOTLCOV24730AA-BA
figure no:	FIGURE 3



revision	description	drawn	approved	date

N

10 0 10 20 30 40

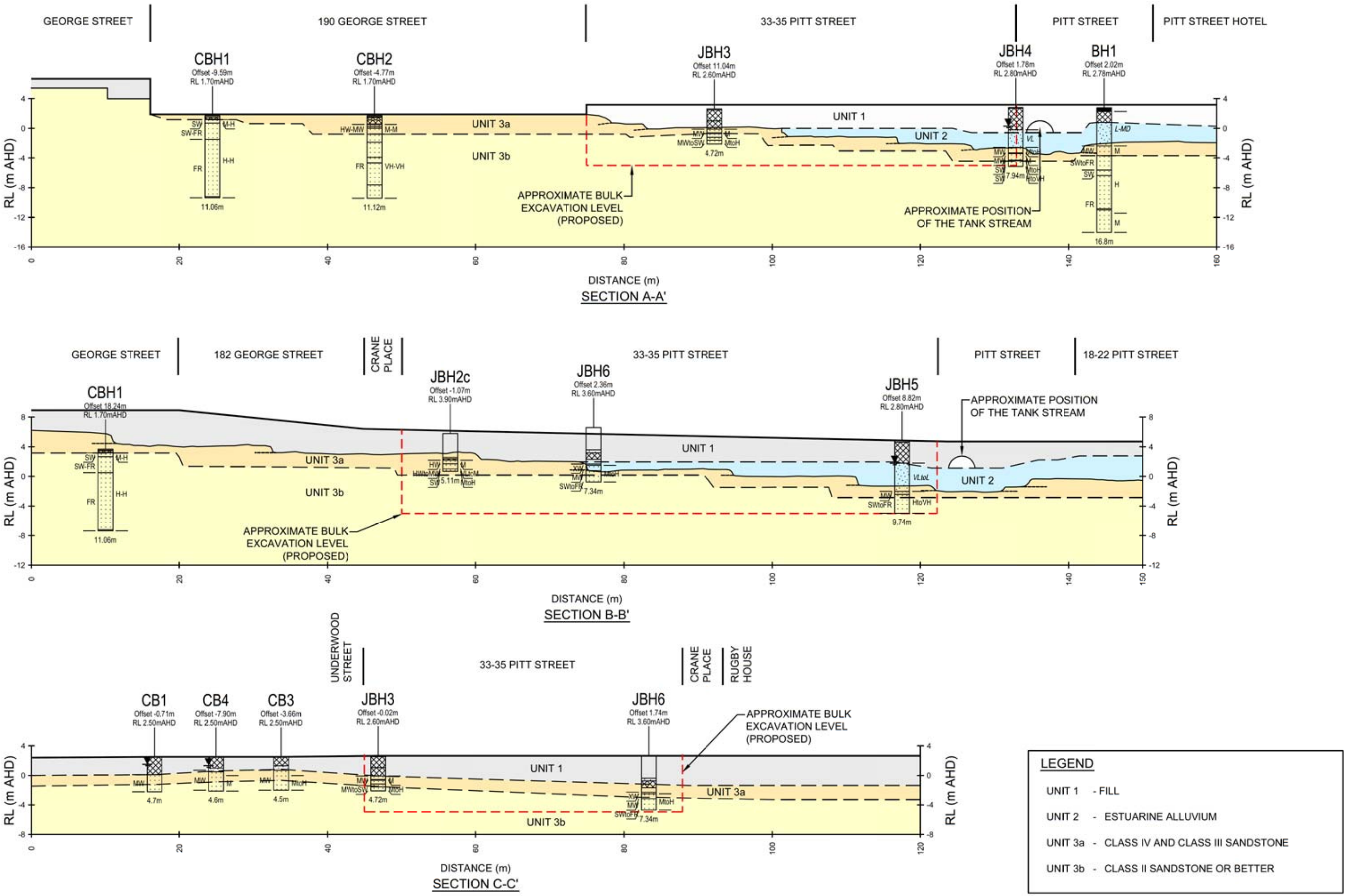
Scale (metres) 1:750

drawn	BR / LH
approved	FB
date	06 / 06 / 14
scale	1:750
original size	A3

coffey

client:	LEND LEASE DEVELOPMENT
project:	LEND LEASE CIRCULAR QUAY 174-182 GEORGE STREET AND 33-35 PITT STREET
title:	INTERPRETED EXTENT OF ESTUARINE ALLUVIUM
project no:	GEOTLCOV24730AA-BA
figure no:	FIGURE 4

PLOT DATE: 5/06/2014 5:57:03 PM DWG FILE: F:\GEOTECHNIC\01 PROJECTS\GEOTLCOV\24730\GEOTLCOV24730AA LEND LEASE 35 PITT ST\05 FIGURES\GEOTLCOV24730AA-BA.DWG



LEGEND

- UNIT 1 - FILL
- UNIT 2 - ESTUARINE ALLUVIUM
- UNIT 3a - CLASS IV AND CLASS III SANDSTONE
- UNIT 3b - CLASS II SANDSTONE OR BETTER

revision	description	drawn	approved	date

Horizontal Scale (metres) 1:500

Vertical Scale (metres) 1:500

drawn	BR / LH
approved	FB
date	06 / 06 / 14
scale	AS SHOWN
original size	A3

coffey

client:	LEND LEASE DEVELOPMENT
project:	LEND LEASE CIRCULAR QUAY 174-182 GEORGE STREET AND 33-35 PITT STREET
title:	INTERPRETED SECTION A-A', B-B' AND C-C'
project no:	GEOTLCOV24730AA-BA
figure no:	FIGURE 5

PLOT DATE: 5/06/2014 5:57:05 PM DWG FILE: F:\GEOTECHNICS\1 PROJECTS\GEOTLCOV\24730AA LEND LEASE 35 PITT ST\05 FIGURES\GEOTLCOV24730AA-BA.DWG

This page has been left intentionally blank