Report on Geotechnical Investigation

Newcastle Courthouse Redevelopment

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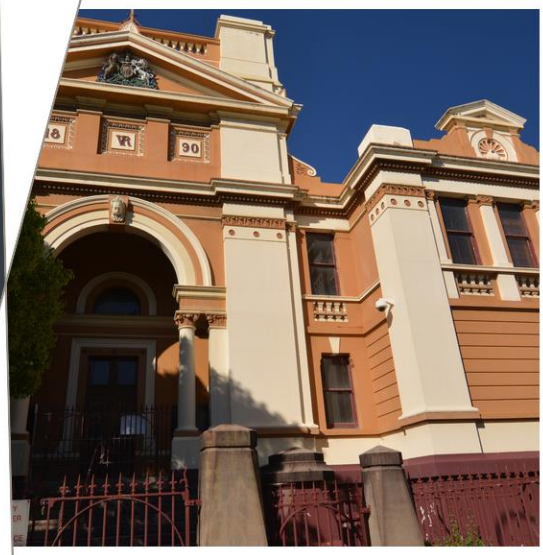

Prepared for

Azusa Sekkei Co Ltd C/- dwp

20 December 2018

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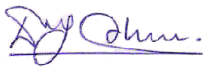

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1 Introduction

1.1 Overview

This report presents the results of geotechnical investigation undertaken by Cardno (NSW/ACT) Pty Ltd (Cardno) at the Newcastle Courthouse redevelopment site, located at 9 Church Street Newcastle.

The geotechnical investigation has been undertaken in accordance with Cardno's proposal (Ref No. 489805190021:BD, dated 30 July 2018) and was commissioned on behalf of the client by Mr Edward Clode of dwp Australia Pty Ltd by email on 14 June 2018, on behalf of Azusa Sekkei and Nihon University.

This geotechnical report has been prepared to assist in the design of two proposed four-storey buildings associated with the redevelopment.

1.2 Proposed Development

The following documents were supplied to Cardno for the purpose of report preparation:

- Draft Architectural Plans (AP) prepared by Azusa Sekkei (Drawing No. A-02 to 06, dated 12 June 2018); and
- Draft Architectural Plans (AP) prepared by Azusa Sekkei off the Nihon University Australia Newcastle Campus Project – Basic Design (Draft) (Drawing No. A-001 to A-118, dated 10/2018).

A review of the supplied plans and verbal advice from the client indicates that the redevelopment of the former Newcastle Courthouse is proposed to comprise:

- New construction of a four-storey residential building in the eastern portion of the site (approx. 3600 m^2), following demolition of an existing structure. Two lift pits are also proposed in the southwest portion of the structure adjacent the existing tunnel.
- Decommissioning of the underground tunnel (formerly used to access adjacent police station) underlying the proposed residential building. Details of the decommissioning method were not available at the preparation of this report.
- New construction of a four-storey educational building in the western portion of the site, including undercroft parking (approx. 2800 m^2) following demolition of an existing structure. The ground floor level undercroft carpark will be accessible from Church Street via a proposed sloping driveway. A lift pit is also proposed in the southeast portion of the structure adjacent the former courthouse structure to be retained; and
- Rehabilitation of the heritage listed former Newcastle Courthouse structure in the middle of the site.

1.3 Objectives

This geotechnical report outlines the investigation findings and provides comments on implication of the geotechnical conditions to design and construction of the proposed development, comprising:

- Recommendations for earthworks procedures and guidelines;
- Foundation conditions for the proposed three-storey buildings, including recommended footing systems and design parameters;
- Soil aggressivity to buried structural elements; and
- Review of available mine subsidence data; and
- Recommendation for further investigation and assessment.

Investigation of the location, extent and condition of the mapped and any unmapped mine workings underlying the site is out of the scope of the following geotechnical report.

2 Site Description

The proposed development is situated on Lot 1 of DP 1199904, located at 9 Church Street Newcastle (referred to herein as the site). The site is bounded by Church Street to the north, existing public and residential properties in all other directions, including Newcastle Police Station to the east and the James Fletcher Hospital to the south and west.

Majority of the site is covered by the former heritage Newcastle Courthouse building, and associated attached three-storey buildings on either side to the east and west (refer Figure 2-1 below). Undercover car parking is present beneath the western three-storey building, which is partially underground at the western extent (due to adjacent ground levels) and undercroft for the remainder.

Site features observed during the investigation are summarised below.

- Topographically, the site is situated within elevated, undulating hilly terrain, on generally east to north east facing slopes. Regionally, the elevated terrain is bordered by coastline to the east, Newcastle harbour to the north and low-lying alluvial plains to the west.
- Surfaces within the site generally ranged from flat to slightly north east and east sloping, as a result of cutting into the natural slopes predominantly in the western (uphill) portion during development. As a result, the floor level of the western existing three-storey building was in the order of up to 2 m below the adjacent footpath and Church Street road formation level.
- As a result of the surrounding landform and slopes, retaining walls have been constructed along the southern and western boundaries of the site ranging from approximately 2 to 5 metres high, which retain structures within the James Fletcher Hospital properties. The retaining walls are of brick construction and are understood to be heritage listed.
- Structures were noted adjoining the brick retaining walls within the south western site corner (refer Figure 2-2 below) that appear to be earth fill supported by a vertical concrete wall at the toe, and the earth fill surface covered in thin concrete slabs. The vertical toe wall was approximately 1.5 m high, and the total (assumed) earth fill height approximately up to 4 m. The structures could be acting as a buttress for the existing heritage brick retaining wall.
- Possible underground fuel storage tank refill point or breather, noted in the northeast portion of the site in the driveway pavement.
- Surface vegetation comprising scattered mature trees, shrubbery and unmaintained grass coverage was noted in the southern and south eastern portion of the site behind the existing structure. The remaining site area was predominantly paved to accommodate driveways, carpark and footpath pavement.
- An existing carpark is present behind the eastern three-storey building. The carpark was observed to be in poor condition, with surface cracking noted and heaving of the surface likely from tree roots associated with trees around the carpark perimeter.

Figure 2-1 General view of the western site portion, with existing three-storey building in centre of photo and heritage building in left

Figure 2-2 Existing retaining structure and brick retaining wall observed in the south west corner of the site

3 Published Data and Background Information

3.1 Soil Landscape Maps

A review of the Office of Environment and Heritage Electronic Soil Profiling Maps (eSPADE) V2.0 [1] indicates that the proposed site is situated within Killingworth soil landscape, however close to the boundary of the Stockton Beach landscape which is located to the east of the site.

Features of the landscapes considered relevant to the investigation and development are summarised below.

- Killingworth landscape (9232ki): Soil profiles typically comprise shallow to moderately deep yellow podzolic, yellow soloths, gleyed podzolic and gleyed soloths on crests and hillslopes.
- Stockton Beach landscape (9232sk): Soils typically comprise deep, well drained calcareous sands on sand dunes.

3.2 Geological Maps

Reference to the 1:100,000 Newcastle Coal Fields Geological Map, Sheet Series 9231, Edition 1, 1995 [2] indicates that the site is generally underlain by the Lambton Subgroup formation (Pnl) of the Newcastle Coal Measures. The Lambton subgroup is known to comprise sandstone, siltstone, claystone, coal and tuff rock types, and residual soils derived from the weathering of these rocks.

3.3 Quaternary Maps

Reference to the 1:100,000 Costal Quaternary Geology of the Newcastle Hunter Area [3] indicates the site is located within the Newcastle Coal measures (Pne) comprising quartz-lithic sandstone, polymictic conglomerate, carbonaceous claystone, coal, laminated mudstone and tuffaceous mudstone rock types, along with abundant plant fossils and bioturbation.

3.4 Acid Sulfate Soil Risk Maps

A review of the Department of Land and Water Conservation, Acid Sulphate Soils Risk Maps [4] indicate that there are no known occurrences of Acid Sulphate Soils (ASS) in the immediate area of the proposed development.

A review of the Newcastle Local Environmental Plan 2012 Acid Sulfate Soils Map – Sheet ASS_004 [5] also indicated that the site is located within a Class 5 Acid Sulfate Soil area.

3.5 Mine Subsidence

3.5.1 Meeting and Preliminary Assessment

A consultation meeting was held with representatives from Subsidence Advisory NSW (SA NSW) prior to the geotechnical investigation to discuss the proposed development and implications of mine workings beneath the site. The meeting was held on 20 September 2018 and included representatives from Cardno, dwp Australia and Azusa Sekkei.

The following was identified by SA NSW during the preliminary meeting:

- The site is mapped as being underlain by bord and pillar workings within the Borehole Seam, at approximately 80 m depth below the site.
- Preliminary calculations indicated that if pillars within the mapped bord and pillar workings located elsewhere are true for the proposed development site, the may not meet the required SA NSW Development Guidelines, unless the mine workings are treated.
- There is the potential for shallow, unmapped convict workings beneath the site in the depth range of 10 - 30 m.

After the preliminary meeting, Cardno were engaged to conduct a preliminary mining impact statement of existing mine workings beneath the site, including comment on existing pillar stability, subsidence parameters and potential for future grouting to render the site suitable for the proposed development.

The preliminary assessment included a desktop study with assessment of critical pillars assessed to have an approximate Factor of Safety of 1.98 or greater, assuming 10% additional loading from the abutment associated with creep and goafing of workings. Based on the preliminary assessment and given the preliminarily calculated low risk ratings, it was concluded that the mapped workings may be long term stable and hence may not require grouting. It was also concluded that further consultation with SA NSW will be required to confirm the conclusion including further investigation into the deep mine workings as well as the unmapped convict workings.

3.5.2 Future Consultation

Based on the preliminary meeting with SA NSW and assessment, the following further consultation is required during detailed design of the proposed buildings, and following demolition of the existing structures where the building footprint locations would be accessible:

- It is essential that the presence, location and conditions of any unmapped convict workings is confirmed due to their apparent proximity to the proposed structure. A procedure to locate the convict workings should be developed.
- Additional detailed geotechnical site investigation post demolition to confirm the presence, location and condition of the workings (this may include drilling to intersect the workings and use of a down-hole camera or similar to inspect the condition of the in-situ coal pillars etc.). This will be required for both the mapped bord and pillar workings (≈ 80m depth) and the potential unmapped convict workings.
- Additional detailed assessment of the predicted long term stability of any mine workings identified during the additional detailed geotechnical site investigation to incorporate information from the future geotechnical investigation.
- Consultation with SA NSW to develop suitable design parameters. This may include:
  - Confirmation that the expected / predicted FoS of the mine workings is acceptable to SA NSW without the need for any mine remediation works (e.g. grouting).
  - Noting that based on preliminary consultation with SA NSW the likelihood of not requiring grouting of the workings is low, the consultant will develop a mine remediation grouting plan for the site, limited to the footprint of the proposed two new structures or as required by SA NSW.
- Design, documentation and final certification of the structural works to ensure the building meets the requirements of SA NSW.
- Submission of all structural and relevant architectural and other project documentation to SA NSW for approval.

4 Investigation Methodology

4.1 Site Investigation

Cardno's site investigation was undertaken on 20 and 21 September 2018 and 04 July 2018, comprising the following:

- A site walkover and visual inspection by a geotechnical engineer from Cardno including site mapping and logging of significant site features.
- Drilling of three (3) boreholes (BH01-BH03) using a track mounted drill rig fitted with both 125 mm Solid Flight Augers and NMLC core barrel to recover rock core specimens. The boreholes were located around the site perimeter given restricted access over majority of the site due to the existing three-storey buildings. The drilling of boreholes comprised:
  - BH01 (RL 22.30 m AHD), drilled to a depth of 14.4 m below ground level (bgl) within the south-eastern portion of the site in the existing carpark pavement. Practical T-C bit refusal was encountered at 8.6 m bgl and rock coring was subsequently undertaken to a depth of 14.4 m bgl using NMLC coring techniques.
  - BH02 (RL 21.75 m AHD), drilled to a depth of 8.5 m bgl closely to the north east of the site in the sealed pavement shoulder of Church Street. Practical T-C bit refusal was encountered at 8.5 m bgl due to slow progression.
  - BH03 (RL 24.23 m AHD), drilled to a depth of 20.45 m bgl closely to the north west of the site in the sealed footpath. The hole was progressed with solid flight augers and T-C bit to a depth of 14.6 m bgl. NMLC rock coring was subsequently undertaken to a depth of 20.45 m bgl.
- Rock core samples were stored in designated core boxes for further assessment and laboratory testing.
- Standard Penetration Tests (SPT) were undertaken within the depth of auger boring at regular intervals in all boreholes to assess soil strength and consistency.
- Disturbed and bulk samples of soil were taken for further laboratory assessment.
- Considering the limited presence of groundwater encountered and access restrictions to majority of the site, installation of groundwater monitoring well(s) was not deemed appropriate.

All fieldwork including logging of subsurface profiles and collection of samples was carried out by a geotechnical engineer from Cardno. Borehole locations are shown on Figure 1 to Figure 3 attached in Appendix A. Subsurface conditions are summarised in Section 5.2 below and detailed in the engineering logs in Appendix B together with explanatory notes and photos of recovered core samples.

Test location elevations (RL's) have been extracted from a client supplied survey plan, and given the locations have not been surveyed they should be considered approximate only.

4.2 Laboratory Testing

Laboratory testing on selected samples recovered during fieldwork comprised the following:

- Two (2) Atterberg limits on representative site soils to aid in material classification.
- Three (3) soil aggressivity tests including pH, Electrical Conductivity (EC), Resistivity, sulfate and chlorides.
- Point load testing of the recovered core specimens at regular intervals to assist in designating rock strength.

Point load testing was undertaken on-site at the time of fieldwork by an experienced geotechnical engineer from Cardno.

Atterberg Limit testing was conducted at Construction Sciences Pty Ltd, a NATA accredited construction materials laboratory and Soil Aggressivity testing conducted at an external NATA accredited chemical testing laboratory. The results of the laboratory testing are detailed in the report sheets attached in Appendix C and summarised in Section 5.4 below.

5 Investigation Findings

5.1 Interpreted Geotechnical Conditions

For the purpose of geotechnical characterisation of the subsurface conditions, the subsurface soil profiles encountered during the investigation have been generalised and characterised into the following geotechnical units as shown below in Table 5-1. The bore logs attached in Appendix B should be referenced for full details of all subsurface profiles encountered.

Table 5-1 Generalised Geotechnical Units

Origin	Unit	Description	Depth Range (m) BGL	Approximate R.L.(4)	Consistency / Inferred Rock Strength[1]	Moisture Condition
FILL	F1	Pavement comprising Asphalt over Sandy GRAVEL and Gravelly SAND filling	0 – 0.25 (BH01) 0 – 0.45 (BH02) 0 – 0.4 (BH03)	22.30 – 22.05 (BH01) 21.75 – 21.30 (BH02) 24.23 – 23.83 (BH03)	Inferred Medium Dense to Dense	Dry to Moist
FILL	F2	SAND and Clayey SAND filling with variable clay, gravel and foreign material	0.25 – 0.7 (BH01) 0.45 – 3.5 (BH02) 0.4 – 2.0 (BH03)	22.05 – 21.60 (BH01) 21.30 – 18.25 (BH02) 23.83 – 22.23 (BH03)	Very loose to medium dense	Dry to Moist
AEOLIAN	A1	Medium grained SAND	2.0 – 4.3 (BH03)	22.23 – 19.93 (BH03)	Loose to Medium Dense	M
RESIDUAL	R1	Fine to medium grained Clayey SAND	4.3 – 5.6 (BH03)	19.93 – 18.63 (BH03)	Loose	M
RESIDUAL	R2	Silty / Sandy / Silty Sandy CLAY and CLAY of generally medium plasticity	0.7 – 3.5 (BH01) 3.5 – 6.5 (BH02)(2) 5.6 – 11.0 (BH03)	21.60 – 18.80 (BH01) 18.25 – 15.25 (BH02)(2) 18.63 – 13.23 (BH03)	Generally Stiff to Very Stiff grading to Hard in BH03 from approximately 11.0 m bgl	Generally MC>PL with increase moisture noted from approximately 8.0 and 12.0 m bgl in BH01 and BH03 respectively
EXTREMELY WEATHERED MATERIAL	XWM	Silty CLAY of generally low to medium plasticity, variable sand component	3.5 – 8.75 (BH01) 6.5 – 8.5 (BH02, DOI)(2) 11.0 – 14.72 (BH03)(3)	18.80 – 13.70 (BH01) 15.25 – 13.25 (BH02, DOI)(2) 13.23 – 9.51 (BH03)(3)	Generally Very Stiff to Hard	Generally MC<PL
WEATHERED BEDROCK	RK1	Slightly Weathered, generally fine grained SANDSTONE and SILTSTONE with extremely weathered seams	8.75 – 12.00 (BH01) 14.72 – 15.65 (BH03)	13.55 – 10.30 (BH01) 9.51 – 8.58 (BH03)	Generally Very Low to Low Strength	-
	RK2	Generally Slightly Weathered to fresh SANDSTONE with a fining up sequence generally observed, and thin laminations of carbonaceous material throughout	12.00 – 14.40 (BH01, DOI) 15.65 – 20.45 (BH03, DOI)	10.3 – 7.90 (BH01, DOI) 8.58 – 3.78 (BH03, DOI)	Generally Medium to High Strength	-

Notes to table:
MC: Moisture Content
PL: Plastic Limit
DOI: Depth of Investigation
(1) Inferred from Standard Penetration Tests (SPT), point loads and tactile assessments.
(2) Depths inferred due to minimal cuttings returned (refer comment in 5.2 below).
(3) Due to significant increase in moisture above rock, the auger drilling techniques utilised and presence of seams, the transition of residual soils into rock was difficult to clearly determine.
(4) The approximated R.L.s have been adopted from the client supplied pdf survey plan (Drawing No. A-005, dated 10/2018).

5.2 Subsurface Conditions

The subsurface conditions encountered in the boreholes excavated across the site are detailed on the engineering logs and attached in Appendix B together with explanatory notes.

Subsurface conditions can be generally characterised as below:

PAVEMENT: Filling associated with Pavement materials comprising Asphalt wearing course over Sandy GRAVEL and Gravelly SAND encountered from surface levels to depths ranging from 0.25 - 0.45 m BGL. The fill materials were estimated to be medium dense to dense based on drill penetration resistance. It should be noted that a component of slag was observed in the majority of borehole locations. Overlying;

FILL: SAND and Clayey SAND fill materials with variable gravel and fines components encountered in all boreholes to depths ranging from 0.7 to 3.5 m bgl. The fill materials were estimated to be generally loose to medium dense (based on limited testing) and dry to moist in condition. Foreign materials including A/C fragments, glass and potentially brick fragments were noted in the fill material encountered in BH03 with possible slag fragments noted in BH01. Overlying;

AEOLIAN: Medium grained SAND of likely wind-blown origin encountered in BH03 to a depth of approximately 4.3 m bgl. The Aeolian sand was generally moist and assessed as loose to medium dense consistency based on field testing conducted. Overlying;

RESIDUAL: Clayey SAND and Silty Sandy / Sandy CLAY overlying silty CLAY and CLAY residual materials encountered in all boreholes up to approximate depths between 3.5 and 14.5 m bgl. The clay materials were generally stiff to very stiff, of medium plasticity and in a moisture condition above the plastic limit. Overlying;

EXTREMELY WEATHERED MATERIAL: Silty CLAYs exhibiting evidence of rock structure and grading to extremely weathered sandstone parent bedrock encountered in all boreholes to depths of up to between 8.6 and 14.72 m bgl. The extremely weathered materials were very stiff to hard and had moisture contents generally below plastic limit except those in proximity and below the encountered groundwater. As noted in the footnotes of Table 5-1, determining exact depths of the material was difficult due to impact of the auger techniques utilised and elevated moisture encountered in some locations (particularly BH03). Overlying;

BEDROCK: Slightly weathered fine-grained SANDSTONE and SILTSTONE, with very thin carbonaceous layers encountered in BH01 and BH03 from depths of 8.75 and 14.72 m bgl respectively. The SANDSTONE included extremely weathered seams and small sections of coreloss encountered throughout. The sandstone was generally very low to low strength grading to medium to high strength in BH01 and BH03 at approximate depths of 12 and 15.65 m bgl respectively. A fining up deposition sequence was also noted to become more evident with depth.

It is worth noting that during drilling of BH02, minimal spoil was returned from a depth of approximately 1.3 m bgl associated with collapsing of the borehole wall. A void was also noted in the hole during backfill between approximate depths of 2.2 m bgl to 2.7 m bgl, which may have been associated with the presence of nearby backfilled service trenches. As a result, changes in materials have been estimated based on drilling resistance and extrapolated from materials encountered in SPTs.

The geological profile across the site has also been interpreted and estimated in the form of cross-sections between boreholes in an attempt to graphically depict the subsurface conditions. It is worth noting that there is significant uncertainty of conditions between boreholes due to the presence of existing structures and limited site access. The geological profile based on the conditions encountered in the boreholes, suggest rock depths may dip to the northwest in the order of 2-4◦. The sections Figure 4 and Figure 5 are contained within Appendix A.

5.3 Groundwater

Groundwater inflow was encountered during drilling of BH01 at a depth of 8 m bgl / RL 14.3 m, and seepage during drilling at BH03 in the order of 12.0 m bgl / RL 11.7 m. Observations were limited due to the soil drilling techniques used, and the subsequent introduction of water during rock coring. As mentioned groundwater wells were not installed, and as such standing groundwater levels were not measured during the investigation.

In any case, groundwater levels are likely to fluctuate with variations in climatic and site conditions, and could vary within the proposed building footprints where investigation access was limited.

It is recommended as part of further geotechnical works following demolition of existing structures that groundwater monitoring wells are installed across the site to monitor groundwater levels and fluctuations.

5.4 Laboratory Test Results

5.4.1 Atterberg Limits Test Results

The results of the Atterberg testing are presented in Table 5-2 below, with the laboratory report sheets attached in Appendix C.

Table 5-2 Summary of Atterberg Limits Test Results

Hole ID	Depth (m)	LL (%)	PL (%)	PI (%)	Material Type
BH01	7.0 – 7.45	42	19	23	Silty CLAY [XW MATERIAL]
BH03	9.5 – 10.0	43	13	30	CLAY

Notes to table:
LL: Liquid Limit
PL: Plastic Limit
PI: Plasticity Index
"XW" = Extremely Weathered

5.4.2 Soil Aggressivity Test Results

The results of the soil aggressivity tests undertaken on representative site soils encountered are summarised below in Table 5-3 with the report sheets attached in Appendix C.

Table 5-3 Summary of Soil Aggressivity Test Results

Hole ID	Depth (m)	Soil Type and (Groundwater Condition)	pH(1:2) (1) for concrete piles	EC (µS/cm)	Resistivity (Ωcm) (2)	Sulfate (mg/kg), Classification for concrete piles	Chloride (mg/kg), Classification for concrete piles
BH01	2.5 - 2.95	CLAY (B)	4.5	99	10000	62	13
BH02	4.0 - 4.45	CLAY (B)	4.4	86	12000	49	13
BH03	4.0 – 4.45	SAND(3) (B)	5.9	34	29000	16	4.1
BH03	7.0 – 7.45	CLAY (B)	5.2	81	12000	52	6.3

Notes to table:
(1) Exposure classification for concrete piles based on pH, the exposure classification for steel piles are slightly different based on pH values and has been discussed in the respective section of this report
(2) Aggressivity classification for Steel Piles based on resistivity
(3) Condition B adopted on the basis of encountered groundwater depth.

Non Aggressive
Mildly Aggressive
Moderately Aggressive
Severely Aggressive
Very Severely Aggressive
– Not Tested/ Not Applicable

Scale of aggressivity obtained from AS2159 – 2009 [6] for concrete piles in soil.

5.4.3 Point Load Test Results

The results of the axial and diametric point load testing undertaken on selected rock core samples obtained from BH01 and BH03 are presented in Appendix D.

6 Earthworks

6.1 Site Formation

A review of the supplied draft Architectural and Survey Plans indicate that minor regrade is proposed to form the proposed multi-storey building design levels either side of the former Courthouse building. The design floor levels across the three attached structures are proposed to be level and therefore around existing levels. Footprints of the multi-storey structures are proposed to extend from the existing building envelopes to within approximately 2-3 m of the brick retaining wall at the southern boundary. The plans indicate construction of three new lift pits, one adjacent the southwest portion of the heritage former courthouse structure and two to the southeast adjacent the existing tunnel.

As a result of the proposed development, majority of excavations will be associated with minor site levelling following demolition, formation of the ground floor carpark and removal of vegetation in the southern portion of the site. These excavations could be expected to be in the range of 0.5 to 1.0 m bgl with excavations expected to be up to approximately 2 to 2.5 m for the installation of the lift pits.

Subsurface materials present within the estimated depth of excavation could be expected to comprise:

- Asphalt pavement and base course gravels/sands (Unit F1) across the southern portion of the site;
- SAND and Clayey SAND fill material (Unit F2);
- SAND Aeolian material (Unit A1);
- Potential Residual Clayey SAND (Unit R1); and
- Potentially Stiff to Very Stiff Residual clays (Unit R2).

6.2 Existing Mine Workings under the Proposed Site

As mentioned in Section 3.5, the site is understood to be underlain by mapped bord and pillar workings at approximately 80 m bgl with potential shallow unmapped convict workings also present. In the event the unmapped shallow convict workings are encountered during earthworks, some issues during construction may result.

As validated spatial details of mine workings located directly under the footprint of the proposed development site are not available, further assessment is necessary to locate the presence of these workings as outlined in Section 3.5.

6.3 Lift Pits

Verbal advice and supplied plans indicate the construction of three new lift pits, one in the southeast portion of the Education Building and two in the southwest portion of the Residential Building with foundation levels expected to be approximately 1.5 m bgl. The proposed lift pits will need to be designed taking into consideration the close proximity to existing heritage-listed structure.

6.4 Tunnel Decommissioning

As noted, the existing police station access tunnel is proposed to be decommissioned, with exact details of associated works not known at the time of report preparation.

Options could comprise complete removal of the tunnel structure and backfilling with controlled fill, or leaving the structure in place and backfilling with grout (or similar suitable material). Removal of the tunnel would require significant excavations to depths in the order of 4-5 m below ground level in proximity to the existing heritage structure, which would require specific geotechnical assessment, design of support systems and an earthworks operation to backfill, and is unlikely to be a cost effective option. Leaving the structure in place and backfilling may be a more suitable option, and Cardno could provide further geotechnical / structural engineering advice in consultation with the client in regards to the decommissioning.

Spanning building footings over the tunnel will be required following backfilling (depending on the option utilised), which could reduce the requirement to backfill all together, and could be considered during the further consultation.

6.5 Excavations and fill placement

Based on the subsurface profile encountered, excavation to ground levels are expected to be readily undertaken using conventional earthmoving equipment.

Where any excavations during construction exceed 1.0 m height and where personnel are to enter excavation, excavations must be battered back at 2H:1V or flatter or appropriately supported.

Any filling is to be undertaken with the following general procedure:

- Filling should be placed on stripped surfaces which are free of topsoil, existing uncontrolled fill or other deleterious material.
- The fill material must be free of vegetation including tree stumps, roots, root fibres or other organic matter.
- Fill should not comprise material with particle sizes of greater than 100 mm or 2/3 of the compacted layer thickness.
- Placement of fill in uniform horizontal layers with compaction of each layer to a minimum dry density ratio of 98% Standard Compaction (Australian Standard AS 1289 Clause 5.1.1) at moisture contents of in the order of 85 - 115% of SOMC or ±2% but generally as close to SOMC as practical.
- Where vibratory equipment is proposed, the potential for vibration transfer to neighbouring structures and potential damage should be considered by the contractor.
- Stripped surfaces should be inspected by an experienced geotechnical consultant prior to the placement of fill to confirm suitability.

6.6 Suitability of Excavated Materials for Reuse and Disposal

6.6.1 Requirements for Waste Classification

Prior to removal of any excavated materials from the site, classification would be required in accordance with the EPA guidelines "*Waste Classification Guidelines, Part 1: Classifying Waste* [7]".

Excavated in-situ filling material should be stockpiled separately to the underlying natural material and should be assessed separately for waste classification and offsite disposal.

6.6.2 Requirements for Reuse in Reconstruction

Generally, excavated granular materials and in-situ clay material could be used as controlled fill on the site and for foundation improvement. However, excavated materials with high silt, reactivity, organic content and/or building rubble (however subject to approval) are not recommended for use as controlled fill. Inspection of proposed fill materials should be made by a geotechnical professional to confirm suitability and for guidance on any potential reconditioning requirements.

7 Foundation Conditions and Footing Design Recommendations

Based on a review of the interpreted geotechnical conditions, and considering anticipated working column loads in the order of 3,000 kN, it is expected that a range of shallow and deep foundations could be utilised to support structural loads and have been considered. Below is a discussion of the geotechnical consideration associated with the possible foundation options.

High-level foundation options in the form of slabs-on-ground with edge beams, strip footings or large pad footings were considered to support structural loads. However, as the proposed foundations are in close proximity to the existing heritage-listed structure to be retained, issues associated with induced settlements of the existing footings may result. It is also worth noting that based on the conditions encountered in the boreholes, the shallow conditions across the site are expected to vary leading to potential problems with differential foundation conditions. As a result, shallow, high-level foundations options are not recommended. Deep foundations alternatives include single bored, cased-bored, screw, driven or continuous flight augured (CFA) piles were also considered.

Driven concrete or timber piles are considered unsuitable due to the proximity of the neighbouring properties and structures, in particularly, vibrations that may be transferred to the existing heritage Courthouse structure. The results of the aggressivity testing indicate that the site soils are of reasonably low pH values with results as low as 4.4. The use of steel screw piles are not recommended in such acidic conditions. The durability of steel screw piles and significantly different pile lengths as a result of the relatively variable geology are also less favourable.

CFA piles may be a suitable option however socketing into medium to high strength rock may pose issues as a result of inadequate equipment and contractor experience. As mentioned in Section 5.2, as a result of the drilling techniques utilised, the presence of seams and variable moisture above rock, conditions in the transition from soil like material to medium to high strength rock (and possibility of shallow coal seams) was uncertain. As a result, the CFA needs further geotechnical investigation and confidence to be considered appropriate.

Bored piles are considered an appropriate foundation option to support structural loads. Casing should be considered where piles are installed through cohesionless sandy soils and/or uncontrolled filling. A sacrificial casing could be installed ahead of drilling into suitable material (i.e. residual and weathered rock clay soils) and should not be withdrawn.

General design parameters and recommendations are presented in the following sections and should be used as guidance for the design, along with any parameters or restrictions placed on the development by SA NSW. The detailed design of foundations should consider the structural loads against both serviceability and ultimate limit state criteria.

7.1 Aggressivity

Based on the summary of analytical results presented in Table 5-3 and on the basis of Chlorides, Sulfates, pH and resistivity, it was found that the residual clays and aeolian sands are predominantly non-aggressive to buried concrete / structural steel elements. The tested residual clay soils indicate however, pH values are in the range of moderately aggressive to concrete elements.

7.2 Foundation Design

7.2.1 Design Criteria

As mentioned in Section 3.5, all foundation systems should be designed to satisfy any requirements or parameters placed on the proposed development by SA NSW. The final foundation design and related documentation should be submitted to SA NSW for approval.

Design of the foundation system should also take into consideration of the existing tunnel underlying the proposed residential building. Depending on the method of decommissioning, this may include designing footings to bridge over the area.

Design of the proposed structure foundations should also be undertaken in accordance with the requirements of the following:

- AS 2159 (2009) Piling – Design & Instillation [6]
- AS 5100 (2007) Bridge Design Set (Parts) [8]
- Other relevant Australian and international standards
- Engineering principles

For the pile foundations, AS 2159-2009 [6] requires that the ultimate design geotechnical strength ($R_{d,g}$) is not less than the design action effect (E_d). The design geotechnical strength is calculated as the ultimate geotechnical strength ($R_{d,ug}$) multiplied by a geotechnical strength reduction factor (ϕ_g).

The value of the geotechnical strength reduction factor is influenced by the following factors:

- ϕ_{gb} – Basic geotechnical strength reduction factor, which is influenced by an assessment of the various risk factors relating to the site, design methodology and the method of pile instillation.
- ϕ_{tf} – Intrinsic testing factor based on the type of pile testing to be undertaken; and
- K – Testing benefit factor dependant on the percentage of piles to be tested.

The assessment of individual risk ratings for risk factors as set out in Table 4.3.2 (A) of AS 2159-2009 [6] will need to be undertaken by the designer of the foundations. However, to assist in the design of foundations, a preliminary assessment of the average risk rating has been undertaken based on the following factors and assumptions:

- The level and quality of the geotechnical investigation that has been undertaken to date which includes in-situ testing limited to SPT's;
- A low-redundancy foundation system (i.e. isolated piles set out at large spacing's);
- No pile load testing is likely to be undertaken;
- Similar experience with the design of foundations into residual soils and rock; and
- A competent and experienced piling contractor to install the piles.

Based on the assessment of the above factors and assumptions, a preliminary Average Risk Rating (ARR) for the design of the piled foundations of 4.10 could be adopted. The designer should reassess the ARR during design.

Based on Table 4.3.2 (C) of AS 2159-2009 [6], an ARR of 4.0 to 4.5 is defined as high risk. The basic geotechnical strength reduction factor (ϕ_g) for single isolated piles founded within the site is assessed to be 0.42.

An increase in the geotechnical strength reduction factor could be adopted by adopting the following procedures:

- Inspection of the foundation conditions by a geotechnical engineer.
- Pile testing regime depending on the type and extent of the testing. Dynamic testing of bored piles are not typically undertaken due the magnitude of column loads. Therefore, an increase on the basic geotechnical strength reduction factor by dynamic testing is not recommended, particular where vibrations could be induced into the heritage-listed structure.

- Adoption of a high redundancy system such as pile rafts or large pile groups under a common pile cap of 4 or more piles.
- Further geotechnical investigation, as indicated in Section 8.

Where a high redundancy system such as pile groups of four or more piles under a common cap are adopted to support the internal column loads, and in consideration of the above individual risk rating adopted for the risk factors set out in Table 4.3.2 (A) of AS 2159-2009 [6], a geotechnical strength reduction factor (ϕ_g) of 0.5 may be adopted subject to the above increases. However, due to the assumed column loads of 3000 kN, it is likely that pile groups are not necessary.

Consideration should be given towards Section 4.4.3 of AS2159-2009 [6] when considering the design of pile groups and that the ultimate design geotechnical strength ($R_{d,ug}$) of a group of piles in compression or uplift should take into account the effects of pile group action. It is recommended that the ultimate geotechnical strength shall be taken as the lesser of:

(a) The sum of the ultimate geotechnical strength capacities of the individual piles in the group; and

(b) The design ultimate geotechnical strength of an equivalent rigid block containing the piles and the soil between them.

Spacing of piles within a pile group should generally be not be less than 2.5 times the pile diameters unless a comprehensive assessment of group interaction is undertaken and indicated that this does not adversely affect the overall pile group.

Ultimate and serviceability limit state of the piles or pile groups should be undertaken during the detailed design phase of the proposed development.

7.2.2 Foundation Conditions

Based on the anticipated column loads provided for the purpose of foundation design, it was deemed that any encountered Aeolian sands (Unit A1), Fill (Unit F1 and F2) or loose residual clayey SAND (Unit R1) are considered generally unsuitable to support footings, and footings founded below these materials is recommended.

Although BH02 and BH03 were located out of the proposed building envelope, the following foundation conditions could be expected to be present across the site:

- Unit R2: Stiff to very stiff residual clays at RL's of 21.60-9.73 m.
- Unit XWM: Very stiff to hard extremely weathered material at RL's of 18.8-9.51 m.
- Unit RK1: Weathered Sandstone with thin carbonaceous laminations and extremely weathered seams at RL's of 13.55-8.58 m.
- Unit RK2: Weathered Siltstone and Interbedded Siltstone and Sandstone at RL's of 10.3-3.78 m.

7.2.3 Rock Classification

Based on previous experience within the greater Sydney basin sandstone and reference to Substance and mass Properties of Engineering Structures in Hawksbury Sandstone & Shale by Pells (P.J.N Pells) [9], Unconfined Compressive Strength (UCS) of Sydney basin Sandstone is generally between 15 to 30 times the point load $I_{S(50)}$ values.

Although this correlation has been suggested based on the laboratory testing of Hawksbury Sandstone, it has been widely used for correlation of UCS and point load testing results of sedimentary rocks of other geological formations.

Following a review of the $I_{S(50)}$ values obtained from point load testing undertaken on representative samples of rock core and based on relevant experience with similar stratigraphy in the local area, an $I_{S(50)}$ to UCS correlation factor of 15 would be considered appropriate.

This correlation factor results in representative average UCS values of approximately 1-3 MPa for Unit RK1 indicating rock strengths of very low to low and approximately 9-20 MPa for Unit RK2 indicating rock strengths of medium to high.

7.2.4 Foundation Parameters for Piles

The following section details design parameters relevant to piles and provides associated construction recommendations.

Design values presented in Table 7-1 and Table 7-2 assume that:

- Pile foundations comprise centrally loaded cased bored, CFA or screw piles suitably embedded into either Unit R2, Unit XWM, Unit RK1 or Unit RK2.
- Piles are constructed using appropriate construction practice.
- General design parameters are presented in the following sections and should be used as guidance for the design.
- Serviceability limit state design is undertaken for the foundation to consider the settlement of the various foundation types and structural tolerances.

Isolated piles required to support the structure, where piles are founded within the underlying clay layers could be designed using the parameters presented in Table 7-1 below.

Table 7-1 Geotechnical Design Parameters for Isolated Piles founded within Clay

Unit	Description	Ultimate End Bearing (kPa)	Ultimate Shaft Adhesion (Compression) within layer (kPa)
R2	Stiff to Very Stiff Residual CLAY / Silty / Sandy and Silty Sandy CLAY	500	25
XWM	Very Stiff to Hard Silty CLAY	900	60

Isolated piles required to support the structure, where piles are founded within the underlying rock could be designed using the parameters presented in Table 7-2 below.

Table 7-2 Geotechnical Design Parameters for isolated Piles embedded into Rock

Unit	Description	Inferred Rock Class [(1)]	Serviceability End Bearing Pressure(MPa)	Ultimate End Bearing (MPa)	Ultimate Shaft Adhesion(Compression) within layer (kPa)	Rock mass modulus E (MPa)
RK1	Very low to low Strength SANDSTONE	Class V Sandstone	1.0	3	100	100
RK2	Medium to High Strength SANDSTONE	Class IV Sandstone	3.5	12	300	500

Notes:
1- The inferred rock classifications are based on P.J.N Pells et al [10].
2- The shaft adhesion value is based on clean socket roughness of R2 [10] or better which must comprise grooves of depth 1-4mm, width greater than 2mm at spacing 50mm to 200mm.
3- At ultimate bearing pressure large settlements greater than 5% of the minimum foundation dimensions are expected.
4- Serviceability bearing pressure is expected to cause settlement of <1% of footing dimension for foundations embedded in weathered rock.
5- For uplift loads, reduce the ultimate shaft adhesion values by 30% subject to confirmation of shaft roughness and cleanness by geotechnical engineer during the construction. Pile uplift design should also take into consideration the cone pull-out failure assuming a cone angle of 90˚ in rock utilising submerged unit weight for long-term. This should also consider the pile group affect and reduced cone volume.
6- Rock socket should be advance to greater than or equal to 5 pile diameters.
7- Where a pile is socketed or founded in proximity to any underlying void created by mine workings, pile end bearing capacity can be reduced greatly. The percentage of reduction is dependent on distance between pile toe and roof of the void and size of the void.

Settlement estimation should be undertaken and compared against serviceability requirements as part of the detailed geotechnical design of the piles.

As discussed, standing groundwater level has not been identified during the investigation, and is recommended to be established prior to finalising pile design / construction.

Installation of piles shall be undertaken in the presence of an experienced geotechnical engineer to confirm that correct construction practice is implemented. All foundation excavations should be kept free of fall-ins and water ponding.

7.2.5 Foundation Parameters for High Level Footings

General design parameters are presented below and should be used as guidance for the design. As mentioned in the previous sections, the surficial Aeolian (Unit A1), fill (Unit F1 and F2) and residual (Unit R1) materials were generally considered unsuitable for foundation due to their variable nature and have not been given design parameters.

Table 7-3 Geotechnical Design Parameters for Shallow Foundations

Unit	Material	Undrained Shear Strength (kPa)	drained Shear Strength (kPa)	Soil friction angle (ϕ°)	γ (kN/m^3)	Effective Elastic Modulus E' (MPa)	Poisson's Ratio (v)
R2	Stiff to Very Stiff Residual CLAY / Silty / Sandy and Silty Sandy CLAY	100	5	25	19	30	0.3

Notes to table:

Consideration should be given to proximity of existing foundations below neighbouring structures during design and construction. Dilapidation surveys are recommended where footing installation would impact neighbouring structures through vibration transfer or excavations.

All footings should be founded below any topsoil, deleterious soils, uncontrolled fill (if encountered) or residual soils with a significant organic component. All footings for the same structure should be founded on strata of similar stiffness and reactivity to minimise the risk of differential movements.

Where any high level footings are to be founded in the residual clays (Unit R2) within shallow depths of less than approximately 2.0 m bgl, it is recommended that shrink swell testing is conducted on the soils and reactive soil movements are considered in the design of the foundations. This nominal depth is on the basis of a typical soil suction change depth in Newcastle where fluctuations in moisture could be expected according to AS2870-2011 [11].

All footings excavations should be inspected prior to installation of reinforcing steel by Cardno or a qualified geotechnical consultant to confirm that the founding conditions are as described in this report. All loose material should be cleared from the footing excavations before concrete is poured.

If preparation for ground slabs and footings encounters materials affected by organics such as tree roots, over excavation to remove the materials may be required

The founding conditions should be assessed by a geotechnical consultant or experienced engineer to confirm suitable conditions.

It is recommended that detailed modelling be undertaken during structural design to assess the feasibility of high-level foundations, to analyse expected settlements and soil-structure interaction.

8 Further Investigation

Considering the nature of the proposed development, current site access limitations and results of the geotechnical investigation, recommendations for further investigation are provided below.

It is noted that economies could be provided by conducting further investigation components concurrently, and Cardno could assist with planning and scoping the components where required.

8.1 Mine Subsidence

The mapped and unmapped mine workings or any coal seams (i.e. the Dudley / Yard Seams) were not encountered during the current investigation at the borehole locations around the site perimeter, to the investigation depths noted; however, this does not indicate the site is not underlain by shallow workings.

Based on the known sporadic distribution of convict workings throughout the surrounding inner Newcastle area, and considering majority of the building footprints have not been investigated due to access restrictions, further consultation with SA NSW and additional desktop study is required.

Preliminary advice from SA NSW indicated that drilling of a closely spaced network of geotechnical boreholes within the building footprints will be required to confirm the presence of the Dudley/Yard Seam and any associated workings.

8.2 Existing Retaining Structure

As mentioned in Section 2, at the time of fieldwork a heritage brick retaining wall structure was noted along the southern and western boundaries of the site as well as a concrete structure in the south western corner.

A review of the supplied architectural plans revealed proposed demolition of the concrete structure in the southwest portion of the site, and extension of the existing building envelopes to within 3 metres of the existing retaining wall the southern boundary.

As a result, two potential issues have been identified:

- Excavations and construction in close proximity to the existing retaining structure could potentially effect the integrity of the wall with potential for failure; and
- It is likely that the existing concrete structure in the southwest portion of the site is acting as a buttress and providing support for the existing retaining wall. Removal of the concrete structure could lead to structural failure.

As a result, it is likely that structural support of the existing wall will be required. Ground anchors could be a suitable option, which would require concurrence with neighbouring properties. Considering the height and nature of the brick retaining wall, a staged process may be required whereby the top of the wall is anchored, the existing buttress structure removed and the lower portion then anchored.

It is recommended that further geotechnical investigation is conducted to identify geotechnical conditions (such as rock levels) in proximity to the wall to inform anchoring options, along with structural assessment and design. Obtaining permission from neighbouring properties could lead to construction sequencing / timing implications, and should be considered well in advance.

8.3 Tunnel Decommissioning

As mentioned in Section 6.4, the exact details of works associated with the decommissioning of the existing police station access tunnel were not known at the time of report preparation.

In the event the decommissioning of the tunnel requires total removal of the tunnel structure, the excavations may impact on existing structures and specific geotechnical assessment including the design of support systems would be necessary.

If the tunnel floor and side walls are left in place (i.e. roof demolished), foundation of new deployment may also be impacted. Spanning building footings over the tunnel will be required following backfilling (depending on the option utilised), which could reduce the requirement to backfill all together, and could be considered during further consultation. Cardno could provide further geotechnical / structural engineering advice in consultation with the client in regards to the decommissioning.

8.4 Contamination

Contamination assessment has not been conducted as part of the current scope. Existing filling identified during the geotechnical investigation and the presence of an underground fuel storage tank within or close to the site could be potential sources of contamination.

Contamination levels within the existing fill could be characterised through further subsurface environmental investigation following demolition, sampling of the fill and underlying natural soils and subsequent laboratory testing. The results could be utilised to prepare recommendations for re use of material on site, or offsite disposal.

Contamination associated with the underground tank could be investigated through conducting a search of available information (such as dangerous goods search, tank registration information), coupled with subsurface environmental investigation. The investigation would likely require soil sampling and laboratory testing, along with installation of groundwater monitoring wells to assess flow direction and groundwater contamination levels.

9 Limitations

Cardno have performed investigation and consulting services for this project in general accordance with current professional and industry standards. The extent of testing was limited to discrete test locations and variations in ground conditions can occur between test locations that cannot be inferred or predicted.

A geotechnical consultant or qualified engineer shall provide inspections during construction to confirm assumed conditions in this assessment. If subsurface conditions encountered during construction differ from those given in this report, further advice shall be sought without delay.

Cardno, or any other reputable consultant, cannot provide unqualified warranties nor does it assume any liability for the site conditions not observed or accessible during the investigations. Site conditions may also change subsequent to the investigations and assessment due to ongoing use.

It should be noted that Cardno have not undertaken detailed geotechnical investigation into the mapped bord and pillar and unmapped convict workings known to be present at the site nor have undertaken detailed calculations or assessment of the mapped and unmapped mine workings. Further consultation is to be made with SA NSW as outlined in this report.

This report and associated documentation was undertaken for the specific purpose described in the report and shall not be relied on for other purposes. This report was prepared solely for the use by Azusa Sekkei Co Ltd C/- dwp and any reliance assumed by other parties on this report shall be at such parties own risk.

10 References

[1] NSW Office of Environment and Heritage, “eSPADE V2.0,” NSW Office of Environment and Heritage, December 2016. [Online]. Available: http://www.environment.nsw.gov.au/eSpade2WebApp#. [Accessed 23 January 2017].

[2] “Newcastle Coalfields 1:100 000 Geological Map, Geological Series Sheet 9231,” Geological Survey of NSW, 1975.

[3] A. L. Troedson, “Newcastle Hunter Area 1:100,000 Coastal Quaternary Geology,” NSW Department of Industrty: Resourses and Energy, 2016.

[4] Department of Land and Water Conservation, “Acid Sulphate Soils Risk Maps - Edition Two,” Crown, 1997.

[5] Newcastle City Council, Acid Sulfate Soils Map - Sheet ASS_004, Newcastle: City of Newcastle, 2014.

[6] Australian Standard AS2159-2009, “Piling - Design & Installation,” Standards Australia, 2009.

[7] NSW Department of Environment and Climate Change (DECC), “Waste Classification Guidelines, Part 1 - Classifying Waste,” Department of Environment and Climate Change NSW, December 2009.

[8] Australian Standard AS5100-2007, “Bridge Design Set,” Standards Australia, 2007.

[9] P. Pells, “Substance and Mass Properties of Engineering Structures in the Hawksbury Sandstone,” Australian Geomechanics Journal Vol 39 No 3, 2004.

[10] P. J. Pells, G. Mostyn and B. F. Walker, “Foundations on Sandstone and Shale in the Sydney Region,” Australian Geomechanics, Dec 1998.

[11] Standards Australia, AS2870-2011: Residential Slabs and Footings, Sydney: Standards Australia, 2011.

Newcastle Courthouse Redevelopment

APPENDIX A

FIGURES

NOTES:

Image underlay adapted from nearmaps aerial imagery.

BHXX Approximate borehole Location and number.

B

BH03

Approximate site extent

Section B -B'

B'

BH02

A'

Section A -A'

A

BH01

0 10 16m

SCALE 1:400 @A3

NORTH

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Drawn	JG	Date 25/09/2018
Checked	DGB	Date 25/09/2018
		Date
Verified		Date
Approved		

Client: Azusa Sekkei Co Ltd C/- DWP

Project: Geotechnical Investigation
Newcastle Courthouse Redevelopment
Church Street, The Hill, 2300

Title: Site Plan With Aerial Image Underlay

Status: FOR INFORMATION ONLY
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Project Number	Scale	Size
81019007	1:400	A3

Drawing Number: Figure 1

Revision: A

DATE PLOTTED: 11 December 2018 1:40 PM BY: JESSE GRACZYK

XREF's:
CAD File: N:\Projects\81\01\FY19\007_NEWCASTLE COURTHOUSE\Drawings\Geotech\dwg files\Geotech Site Plan 81019007.dwg

NOTES:

Underlay adapted from survey conducted by ADW Jonhson Pty Ltd with ref (239815-DET-001-A, drawing A-005, dated 10.09.18).

BHXX Approximate borehole Location and number.

0 10 16m

SCALE 1:400 @A3

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Checked	DGB	Date 30/10/2018
		Date
Verified		Date
Approved		

Client: Azusa Sekkei Co Ltd C/- DWP

Project: Geotechnical Investigation
Newcastle Courthouse Redevelopment
Church Street, The Hill, 2300

Title: Site Plan With Survey Plan Underlay

Status: FOR INFORMATION ONLY
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Project Number	Scale	Size
81019007	1:400	A3

Drawing Number: Figure 2

Revision: A

DATE PLOTTED: 11 December 2018 1:46 PM BY: JESSE GRACZYK

XREF's:
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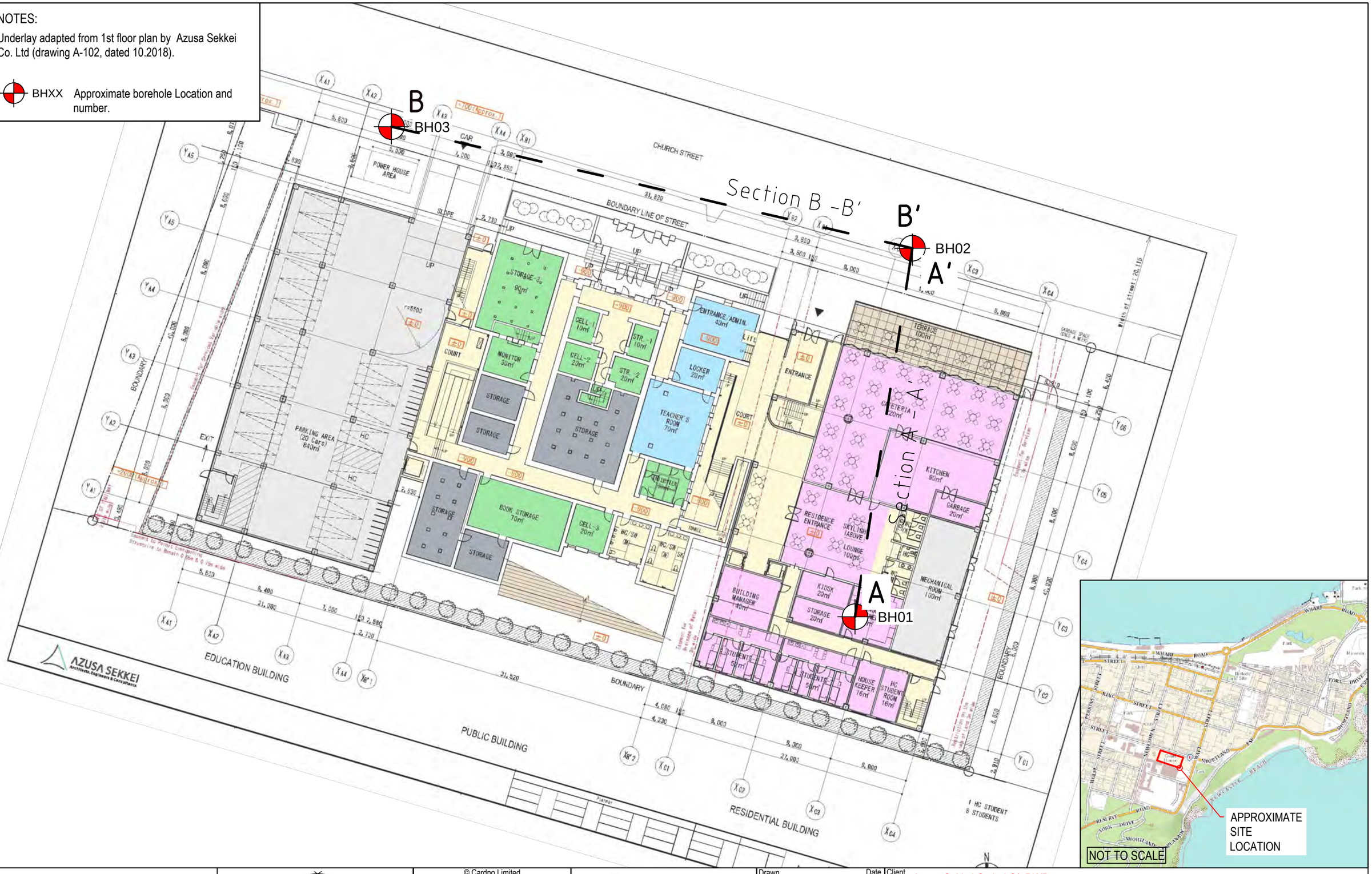
NOTES:

Underlay adapted from 1st floor plan by Azusa Sekkei Co. Ltd (drawing A-102, dated 10.2018).

BHXX Approximate borehole Location and number.



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SCALE 1:400 @A3

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Verified		Date
Approved		

Client: Azusa Sekkei Co Ltd C/- DWP

Project: Geotechnical Investigation
Newcastle Courthouse Redevelopment
Church Street, The Hill, 2300

Title: Site Plan With Ground Floor Plan Underlay

Status: FOR INFORMATION ONLY
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Project Number	Scale	Size
81019007	1:400	A3

Drawing Number: Figure 3

Revision: A

DATE PLOTTED: 11 December 2018 1:49 PM BY: JESSE GRACZYK

XREFs:
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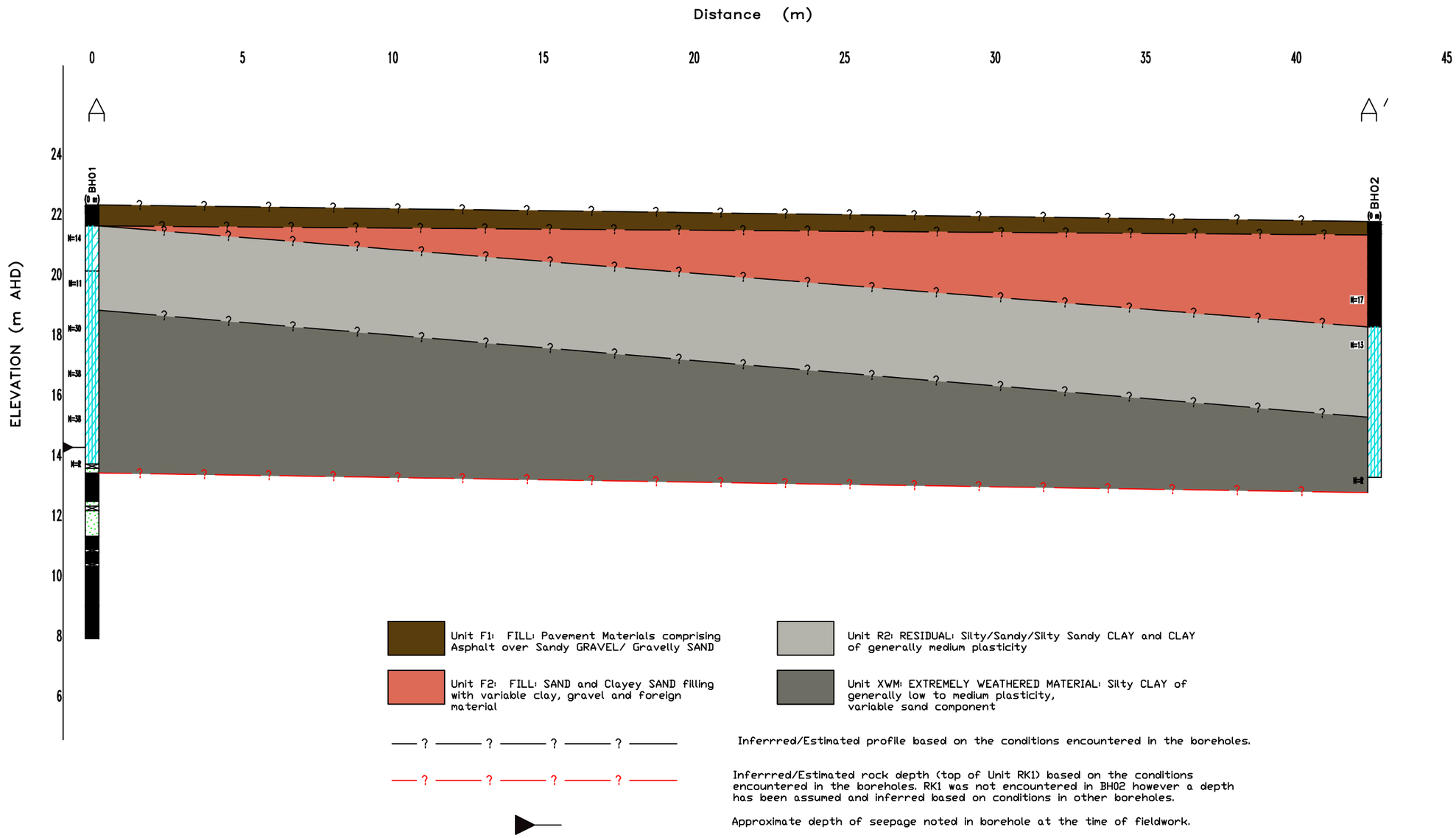
DATE PLOTTED: 13 December 2018 3:57 PM BY: JESSE GRACZYK

NOTES:

Borehole elevantions have been adapted from the supplied survey conducted by ADW Johnson Pty Ltd with ref 239815-DET-001-A,

drawing A-005, dated 10.09.18.
The ground surface between boreholes has been assumed linear in the absence of any dwg survey file.

The conditions between borehole locations are unknown and have been inferrred/assumed. Rock depth may vary between borehole locations, and conditions below the investigated depth are unknown. Further geotechnical investigation following demolition of existing structures is recommended to confirm conditions within the proposed building envelope.



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Approved		

Client: Azusa Sekkei Co Ltd C/- dwp

Project: Geotechnical Investigation
Newcastle Courthouse Redvelopment
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Title: Inferred Geological Section A-A'

Status: FOR INFORMATION ONLY
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Project No. 81019007 | Scale 1:150 | Size A3

Drawing Number: Figure 4

Revision: A

XREF's:
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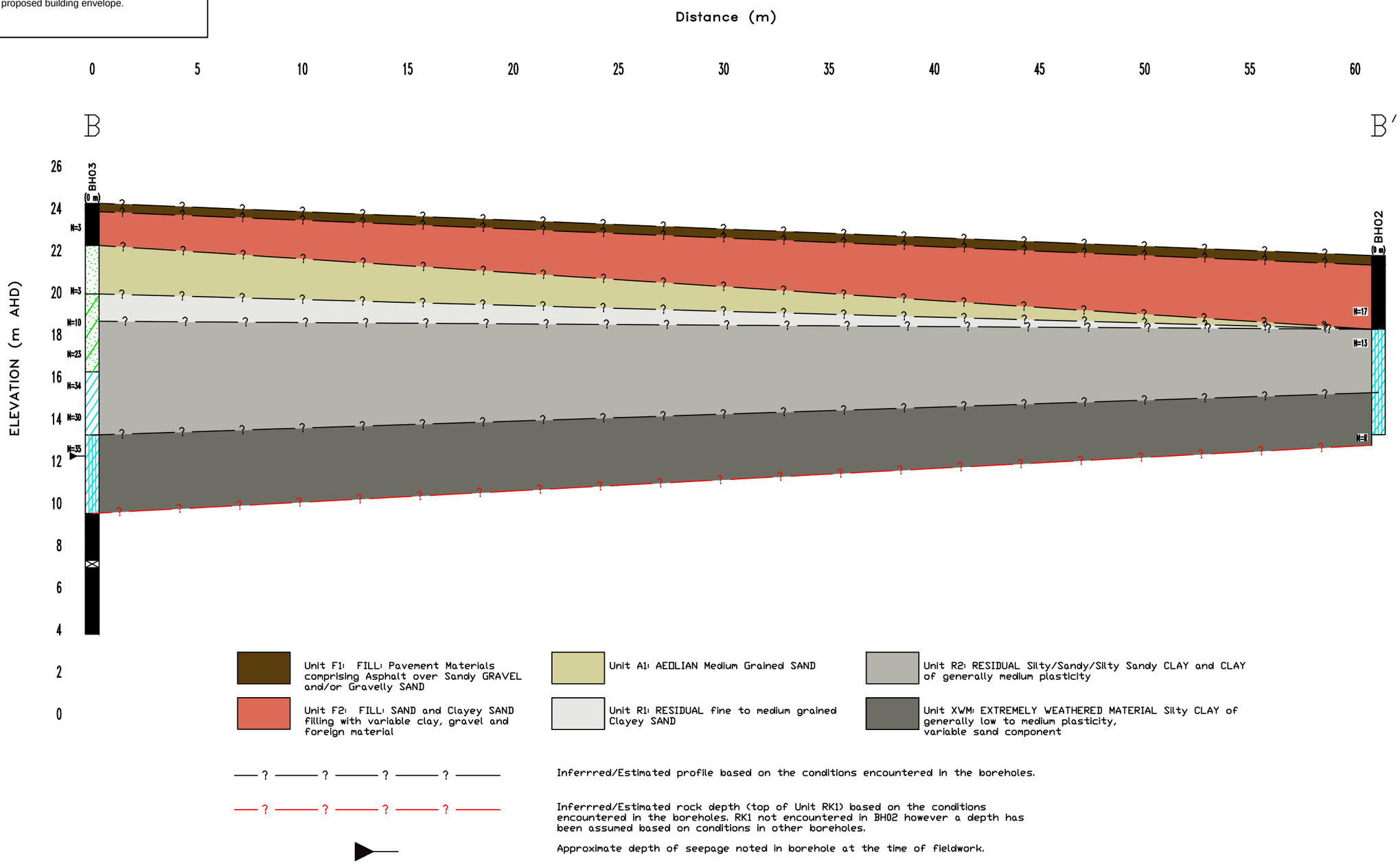
NOTES:

Borehole elevantions have been adapted from the supplied survey conducted by ADW Johnson Pty Ltd with ref 239815-DET-001-A, drawing A-005, dated 10.09.18.
The ground surface between boreholes has been assumed linear in the absence of any dwg survey file.

The conditions between borehole locations are unknown and have been inferrred/assumed. Rock depth may vary between borehole locations, and conditions below the investigated depth are unknown. Further geotechnical investigation following demolition of existing structures is recommended to confirm conditions within the proposed building envelope.



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SCALE 1:200 @A3

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Designed		Date
Verified		Date
Approved		

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Project: Geotechnical Investigation
Newcastle Courthouse Redevelopment
Church Street, The Hill, 2300

Title: Inferred Geological Section B-B'

Status: FOR INFORMATION ONLY
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Project No.	Scale	Size
81019007	1:200	A3

Drawing Number: Figure 5
Revision: A

Newcastle Courthouse Redevelopment

APPENDIX

B

ENGINEERING LOGS & EXPLANATORY NOTES

Cardno

BOREHOLE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH01

Job No: 81019007 **Sheet:** 1 of 4

Position: South of Eastern Building - Refer to Site Plan **Angle from Horizontal:** 90° **Surface Elevation:** 22.300 m AHD
Rig Type: Hanjin D&B 8D **Mounting:** Track **Driller:** MS
Casing Diameter: **Contractor:** Total Drilling
Date Started: 20/9/18 **Date Completed:** 20/9/18 **Logged By:** DGB & JG **Checked By:** IB

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	RL (m AHD)	Depth (m)	Material: Graphic Log	Material: Classification	Material: SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Material: Moisture Condition	Material: Consistency Relative Density	Material: STRUCTURE & Other Observations
AD/T					22.0	0.0			0.05m ASPHALT	D		PAVEMENT
	F-H								PAVEMENT: Gravelly SAND: fine to coarse grained, brown-orange, fine to medium, sub-angular gravel (predominantly crushed rock, possible component of slag) 0.25m	D - M	D	
						0.5			FILL: SAND: fine to coarse grained, brown, trace clay lenses	D	L to MD	FILL
					21.5				0.70m Silty Sandy CLAY: low to medium plasticity, brown-grey mottled orange	M (>PL)	St	RESIDUAL SOIL
				SPT 1.00 - 1.45 m 5, 6, 8 N=14		1.0			1.20m Silty Sandy CLAY: medium plasticity, brown-grey mottled orange and red, trace fine gravel (iron-cemented rock fragments)			
					21.0	1.5				M (>PL)	St	
	F				20.5	2.0			2.20m			
			Groundwater Encountered		20.0				Silty CLAY: medium plasticity, pale grey mottled red			
				SPT 2.50 - 2.95 m 4, 5, 6 N=11		2.5				M (>PL)	St	
					19.5	3.0						
					19.0				3.50m			
						3.5			Silty CLAY: medium plasticity, pale grey-white mottled orange, friable, evidence of rock structure present (Extremely Weathered Siltstone/Sandstone)			EXTREMELY WEATHERED
					18.5	4.0						
				SPT 4.00 - 4.45 m 7, 12, 18 N=30								
	F-H				18.0	4.5				M (<PL)	VSt	
					17.5							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Cardno

BOREHOLE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH01

Job No: 81019007 **Sheet:** 2 of 4

Position: South of Eastern Building - Refer to Site Plan **Angle from Horizontal:** 90° **Surface Elevation:** 22.300 m AHD
Rig Type: Hanjin D&B 8D **Mounting:** Track **Driller:** MS
Casing Diameter: **Contractor:** Total Drilling
Date Started: 20/9/18 **Date Completed:** 20/9/18 **Logged By:** DGB & JG **Checked By:** IB

Drilling			Water	Sampling & Testing	RL (m AHD)	Depth (m)	Material Description				
Method	Resistance	Casing		Sample or Field Test			Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	F-H		Groundwater Encountered	SPT 5.50 - 5.95 m 8, 16, 22 N=38	17.0 16.5 16.0 15.5 15.0 14.5 14.0 13.5 13.0 12.5	5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5			Silty CLAY: medium plasticity, pale grey-white mottled orange, friable, evidence of rock structure present (Extremely Weathered Siltstone/Sandstone) *(continued)* As above: occasional black carbonaceous laminations throughout As above: thin bands of fine grained, dark orange sand bands throughout 8.60m Continued as Cored Drill Hole	M (<PL) W	H	EXTREMELY WEATHERED
	H		groundwater inflow at approx. 8 m during drilling	SPT 7.00 - 7.45 m 4, 15, 23 N=38 SPT 8.50 - 8.55 m ~~30/50mm N=R~~							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
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WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
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U - Thin wall tube 'undisturbed'

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M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
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S - Soft
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L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Cardno

CORE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH01

Job No: 81019007 **Sheet:** 3 of 4

Position: South of Eastern Building - Refer to Site Plan	**Angle from Horizontal:** 90°	**Surface Elevation:** 22.300 m AHD
Rig Type: Hanjin D&B 8D	**Mounting:** Track	**Driller:** MS
Casing Diameter:	**Bit Type:** 125mm Auger **Bit Condition:**	**Contractor:** Total Drilling
Date Started: 20/9/18	**Date Completed:** 20/9/18 **Logged By:** DGB & JG	**Checked By:** IB

Coring						Material Description				Defect Description		
Method	Fluid	TCR (%)	RQD (%)	RL (m AHD)	Depth (m)	Graphic Log	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Estimated Strength $Is_{(50)}$ MPa ● - Axial O - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Visual	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
				17.0	5.5							
				16.5	6.0							
				16.0	6.5							
				15.5	7.0							
				15.0	7.5							
				14.5	8.0							
				14.0	8.5							
							8.60m START CORING AT 8.60m					
NMLC		87	25				CORE LOSS 0.15m (8.60-8.75)					8.60: Practical T-Cbit refusal
				13.5			8.75m (EXTREMELY WEATHERED)	XW				
					9.0		8.90m SANDSTONE, fine grained, grey, thin carbonaceous siltstone laminations throughout	SW				9.13 m: BP-Closed, 10°, PR, CN
				13.0			As above: no laminations					9.30 m: SM, 0°, CT, 4 mm, clay 9.39 m: BP, 5°, PR, RF, VNR, iron-stained
					9.5							9.46 - 9.55 m: FZ, 5°, CT, clay coating 9.56 m: JT, 45°, PR, S, CN 9.55 - 9.61 m: SM, 5°, CT, extremely weathered seam, clay coating
				12.5			9.85m					
							10.00m (EXTREMELY WEATHERED)	XW				

DRILLING
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller
PQ Rotary core (85mm)
HQ Rotary core (63.5mm)
NMLC Rotary core (51.94mm)
DT Diatube concrete coring
PT Push tube
PS Percussion sampling
SON Sonic drilling
AH Air hammer

WATER
Water Level on date shown
water inflow
water outflow

ROCK QUALITY DESCRIPTIONS
RQD Rock Quality Designation (%)
TCR Total Core Recovery (%)

ROCK STRENGTH
EH Extremely High
VH Very High
H High
M Medium
L Low
VL Very Low

ROCK WEATHERING
FR Fresh
SW Slightly Weathered
DW Distinctly Weathered
MW Moderately Weathered
HW Highly Weathered
XW Extremely Weathered

DEFECT TYPE
JT Joint
SZ Sheared zone
BP Bedding Parting
SM Seam
FL Foliation
VN Vein
CL Cleavage
CS Crushed Seam
FZ Fracture Zone
DL Drift Lift
HB Handing Break
DB Drilling Break

PLANARITY
CU Curved
DIS Discontinuous
IR Irregular
PR Planar
ST Stepped
UN Undulose

ROUGHNESS
VR Very Rough
RF Rough
S Smooth
SL Slockensided
POL Polished

COATING
CN Clean
SN Stained
VNR Veneer (thin or patchy)
CT Coating (up to 1mm)

INFILL MATERIALS
X Carbonaceus
MU Unidentified minteral
MS Secondary mineral
KT Chlorite
CA Calcite
Fe Iron Oxide
Qz Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Cardno

CORE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH01

Job No: 81019007 **Sheet:** 4 of 4

Position: South of Eastern Building - Refer to Site Plan **Angle from Horizontal:** 90° **Surface Elevation:** 22.300 m AHD
Rig Type: Hanjin D&B 8D **Mounting:** Track **Driller:** MS
Casing Diameter: **Bit Type:** 125mm Auger **Bit Condition:** **Contractor:** Total Drilling
Date Started: 20/9/18 **Date Completed:** 20/9/18 **Logged By:** DGB & JG **Checked By:** IB

Coring						Material Description			Defect Description		
Method	Fluid	TCR (%)	RQD (%)	RL (m AHD)	Depth (m)	Graphic Log	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Estimated Strength $Is_{(50)}$ MPa ● - Axial O - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Visual	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
NMLC				12.0	10.15m		CORE LOSS 0.15m (10.00-10.15)					
		87	25		10.5		(EXTREMELY WEATHERED)	XW				
				11.5	11.00m							
				11.0			SANDSTONE, medium to coarse grained, grey	SW				11.34 m: BP-Closed, 10°, PR, RF, CN
				11.0	11.43m							11.42 m: BP-Closed, 10°, PR, RF, CN
					11.53m		CORE LOSS 0.10m (11.43-11.53)					11.43: Water loss noted at 11.43 m bgl, no return after
		88	45	10.5			SANDSTONE, medium to coarse grained, grey, trace fine gravel and orange brown coloured bands	SW				11.62 m: JT, 0°, PR, RF, SN, iron-stained
					11.90m							11.83 - 11.90 m: FZ
					12.00m		CORE LOSS 0.10m (11.90-12.00)					
				12.0			SANDSTONE, medium to coarse grained, grey	SW				12.06 m: BP, 5 - 10°, PR, RF, CT, iron-stained
												12.12 m: BP, 5°, PR, RF
				10.0			As above: fine to medium grained					12.25 - 12.30 m: FZ, 5 - 10°, PR, S, SN, iron-stained
					12.5							12.30: 700-800 mm into core run, strign drop noted, used to utilised to estiamte core loss location
												12.30 - 12.50 m: JT, 80 - 90°, UN, RF, CN
												12.58 m: BP, 0°, ST, RF, carbonaceous
				9.5								12.61 - 12.64 m: FZ, IR, RF, CT, carbonaceous and quartz/calcite
					13.0							12.78 - 12.82 m: FZ, 10°, PR, SN, iron-stained
												12.82 m: JT, 10°, PR, S, VNR, Carbonaceous
							As above: medium to coarse grained					12.96 m: BP-Closed, 5 - 10°, PR, S, CN
					13.27m							13.11 m: BP, 15°, PR, RF, SN, iron-stained
				9.0	13.32m		CORE LOSS 0.05m (13.27-13.32)					13.32 - 13.34 m: FZ, PR
		97	68				SANDSTONE, medium to coarse grained, grey, laminations and very thinly bedding of orange brown colour & thin laminations of dark brown-black carbonaceous material	SW				
					13.5							13.58 m: BP, 10°, PR, S, SN, Carbonaceous
												13.69 m: BP, 10 - 15°, PR, RF, VNR, iron-stained
				8.5			As above: fine to medium grained					13.86 m: JT, 15 - 20°, UN, S, SN, Carbonaceous
					14.0		As above: fine grained					13.96 m: JT, 10 - 15°, PR, S, CN
												14.00 - 14.09 m: FZ, IR, carbonaceous and quartz/calcite
												14.14 m: BP, 5°, PR, S, CN
				8.0	14.40m							14.35 m: SM, 10 - 15°, PR, SN, extremely weathered seam, iron-stained
					14.5		TERMINATED AT 14.40 m Target depth					
				7.5								

DRILLING
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller
PQ Rotary core (85mm)
HQ Rotary core (63.5mm)
NMLC Rotary core (51.94mm)
DT Diatube concrete coring
PT Push tube
PS Percussion sampling
SON Sonic drilling
AH Air hammer

WATER
Water Level on date shown
water inflow
water outflow

ROCK QUALITY DESCRIPTIONS
RQD Rock Quality Designation (%)
TCR Total Core Recovery (%)

ROCK STRENGTH
EH Extremely High
VH Very High
H High
M Medium
L Low
VL Very Low

ROCK WEATHERING
FR Fresh
SW Slightly Weathered
DW Distinctly Weathered
MW Moderately Weathered
HW Highly Weathered
XW Extremely Weathered

DEFECT TYPE
JT Joint
SZ Sheared zone
BP Bedding Parting
SM Seam
FL Foliation
VN Vein
CL Cleavage
CS Crushed Seam
FZ Fracture Zone
DL Drift Lift
HB Handing Break
DB Drilling Break

PLANARITY
CU Curved
DIS Discontinuous
IR Irregular
PR Planar
ST Stepped
UN Undulose

ROUGHNESS
VR Very Rough
RF Rough
S Smooth
SL Slockensided
POL Polished

COATING
CN Clean
SN Stained
VNR Veneer (thin or patchy)
CT Coating (up to 1mm)

INFILL MATERIALS
X Carbonaceous
MU Unidentified minteral
MS Secondary mineral
KT Chlorite
CA Calcite
Fe Iron Oxide
Qz Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Cardno

BOREHOLE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH02

Job No: 81019007 **Sheet:** 1 of 2

Position: North of Eastern Building (in pavement)- Refer to Site Plan **Angle from Horizontal:** 90° **Surface Elevation:** 21.750 m AHD
Rig Type: Hanjin D&B 8D **Mounting:** Track **Driller:** MS
Casing Diameter: **Contractor:** Total Drilling
Date Started: 20/9/18 **Date Completed:** 20/9/18 **Logged By:** DGB & JG **Checked By:** IB

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T			Not Encountered	D 0.10 - 0.20 m	21.5	0.5			0.10m ASPHALT	D		PAVEMENT
									PAVEMENT: Sandy GRAVEL: fine to coarse, sub-rounded to sub-angular, grey (component of slag noted)	D		
				D 0.50 - 0.60 m	21.0	1.0			0.45m FILL: Clayey SAND: fine to coarse grained, brown-orange, trace gravel, highly variable pockets of clay	D - M		FILL
					20.5	1.5			1.50m FILL: Clayey SAND: fine to coarse grained, red, with gravel (cemented sand fragments of variable strength); interbedded with sandy and silty clay seams			1.50 m: Possible FILL
					20.0	2.0						
					19.5	2.5						2.20 m: Void noted southern wall of hole to 2.7 m bgl during backfill
				SPT 2.50 - 2.95 m 5, 12, 5 N=17	19.0	3.0				D - M	L - MD	
					18.5	3.5						3.00 m: Minimal to no cutting return following SPT
				SPT 4.00 - 4.45 m 4, 6, 7 N=13	18.0	4.0			3.50m Silty CLAY: medium to high plasticity, pale grey mottled red-brown and orange, bands of red-brown iron staining			RESIDUAL SOIL
					17.5	4.5				M (>PL)	St	
					17.0							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
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MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
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SOIL CONSISTENCY
VS - Very Soft
S - Soft
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RELATIVE DENSITY
VL - Very Loose
L - Loose
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D - Dense
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Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Cardno

BOREHOLE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH02

Job No: 81019007 **Sheet:** 2 of 2

Position: North of Eastern Building (in pavement)- Refer to Site Plan **Angle from Horizontal:** 90° **Surface Elevation:** 21.750 m AHD
Rig Type: Hanjin D&B 8D **Mounting:** Track **Driller:** MS
Casing Diameter: **Contractor:** Total Drilling
Date Started: 20/9/18 **Date Completed:** 20/9/18 **Logged By:** DGB & JG **Checked By:** IB

Drilling			Water	Sampling & Testing	RL (m AHD)	Depth (m)	Material Description					
Method	Resistance	Casing		Sample or Field Test			Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T			Not Encountered		16.5	5.5			Silty CLAY: medium to high plasticity, pale grey mottled red-brown and orange, bands of red-brown iron staining *(continued)*	M (>PL)	St	RESIDUAL SOIL
					16.0	6.0						
					15.5	6.5			6.50m			
					15.0	7.0			Silty CLAY: low to medium plasticity, pale grey mottled orange, evident of rock structure (Extremely Weathered Sandstone)		St - VSt	EXTREMELY WEATHERED
					14.5	7.5			As above: with sand and orange-brown sand bands, friable, increase in rock structure	M (<PL)		7.50 m: Consistency inferred based on resistance
					14.0	8.0					VSt - H	
					13.5	8.5			8.50m			
				SPT 8.50 - 8.65 m 35 N=R	13.0	9.0			TERMINATED AT 8.50 m Practic Refusal Due to Slow Progression			
					12.5	9.5						
					12.0							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
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HP - Hand/Pocket Penetrometer
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VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

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D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

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PL - Plastic limit
LL - Liquid limit
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SOIL CONSISTENCY
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S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Cardno

BOREHOLE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH03

Job No: 81019007 **Sheet:** 1 of 6

Position: North of Western Building (in footpath) - Refer to Site Plan **Angle from Horizontal:** 90° **Surface Elevation:** 24.230 m AHD
Rig Type: Hanjin D&B 8D **Mounting:** Track **Driller:** MS
Casing Diameter: **Contractor:** Total Drilling
Date Started: 21/9/18 **Date Completed:** 21/9/18 **Logged By:** DGB & JG **Checked By:** IB

Drilling			Water	Sampling & Testing		RL (m AHD)	Depth (m)	Material Description					
Method	Resistance	Casing		Sample or Field Test	DCP (blows per 150 mm) 1 3 6 12			Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T			Groundwater Encountered	SPT 1.00 - 1.45 m 1, 1, 2 N=3		24.0	0.5			0.06m ASPHALT PAVEMENT: Gravelly SAND: fine to coarse grained, dark brown, fine to coarse, sub-angular to angular gravel (component of A/C and slag fragments) 0.40m	D D - M		PAVEMENT
						23.5	1.0			FILL: SAND: fine to medium grained, grey-brown, trace gravel (component of A/C and glass fragments)	M	VL - L	Possibly FILL
				D 2.40 - 2.60 m		23.0	1.5						1.50 m: DCP conducted using cone-tip
				D 2.80 - 3.00 m		22.5	2.0			2.00m SAND: medium grained, pale grey-white			AEOLIAN
						22.0	2.5					L - MD	
						21.5	3.0		SP		M		
						21.0	3.5			As above: possible band of indurated sand		D - VD	
				SPT 4.00 - 4.45 m 2, 1, 2 N=3		20.5	4.0					L	
						20.0	4.5			As above: colour change to dark grey 4.30m			
						19.5			SC	Clayey SAND: fine to medium grained, orange-brown	M	L	RESIDUAL SOIL

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Cardno

BOREHOLE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH03

Job No: 81019007 **Sheet:** 2 of 6

Position: North of Western Building (in footpath) - Refer to Site Plan **Angle from Horizontal:** 90° **Surface Elevation:** 24.230 m AHD
Rig Type: Hanjin D&B 8D **Mounting:** Track **Driller:** MS
Casing Diameter: **Contractor:** Total Drilling
Date Started: 21/9/18 **Date Completed:** 21/9/18 **Logged By:** DGB & JG **Checked By:** IB

Drilling				Sampling & Testing				Material Description					
Method	Resistance	Casing	Water	Sample or Field Test	DCP (blows per 150 mm) 1 3 6 12	RL (m AHD)	Depth (m)	Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T			Groundwater Encountered	SPT 5.50 - 5.95 m 3, 4, 6 N=10		19.0	5.5		SC	Clayey SAND: fine to medium grained, orange-brown *(continued)* As above: mottled grey with iron-cemented lenses	M	L	RESIDUAL SOIL
				D 6.00 - 6.30 m		18.5	6.0			5.60m Sandy CLAY: medium plasticity, pale grey-white mottled orange, medium to coarse grained sand			
				SPT 7.00 - 7.45 m 6, 10, 13 N=23		18.0	6.5		CI		M (>PL)	St - VSt	
						17.5	7.0						
						17.0	7.5			increase in silt content			
						16.5	8.0			8.00m CLAY: medium to high plasticity, pale grey white mottled purple and orange, with silt, occasional iron cemented purple-brown lenses			
				SPT 8.50 - 8.95 m 10, 16, 18 N=34		16.0	8.5						
						15.5	9.0		CI-CH		M (<LL)	VSt - H	9.00 m: Increased in moisture condition of spoil
				D 9.50 - 10.00 m		15.0	9.5						
						14.5							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
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CARDNO (NSW/ACT) PTY LTD

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BOREHOLE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH03

Job No: 81019007 **Sheet:** 3 of 6

Position: North of Western Building (in footpath) - Refer to Site Plan **Angle from Horizontal:** 90° **Surface Elevation:** 24.230 m AHD
Rig Type: Hanjin D&B 8D **Mounting:** Track **Driller:** MS
Casing Diameter: **Contractor:** Total Drilling
Date Started: 21/9/18 **Date Completed:** 21/9/18 **Logged By:** DGB & JG **Checked By:** IB

Drilling				Sampling & Testing		RL (m AHD)	Depth (m)	Material Description					
Method	Resistance	Casing	Water	Sample or Field Test	DCP (blows per 150 mm) 1 3 6 12			Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T			seepage inflow Ground water encountered during drilling	SPT 10.00 - 10.45 m 6, 13, 17 N=30		14.0	10.5		CI-CH	CLAY: medium to high plasticity, pale grey white mottled purple and orange, with silt, occasional iron cemented purple-brown lenses *(continued)*	M (<LL)	VSt - H	RESIDUAL SOIL
						13.5							
						13.0	11.0			11.00m			
				SPT 11.50 - 11.95 m 12, 14, 21 N=35		12.5	11.5		CI-CH	Silty CLAY: medium to high plasticity, pale grey-white mottled purple and orange brown, occasional iron stained orange-brown lenses (Extremely Weathered Siltystone/Sandstone)	M (<LL) - M (≈LL)	H	EXTREMELY WEATHERED 11.80 m: Possible decomposed organics notes
						12.0	12.0						
						11.5	12.5						
						11.0	13.0						
						10.5	13.5						13.70 m: Increase in resistance noted 13.90 m: Easy drilling again 14.00 m: Easy drilling resistance to 14.6 m, possible water perched on bedrock
						10.0	14.0						
						9.5	14.5			14.60m			
										Continued as Cored Drill Hole			

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

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Water Level on Date shown
water inflow
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Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

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CORE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH03

Job No: 81019007 **Sheet:** 4 of 6

Position: North of Western Building (in footpath) - Refer to Site Plan **Angle from Horizontal:** 90° **Surface Elevation:** 24.230 m AHD
Rig Type: Hanjin D&B 8D **Mounting:** Track **Driller:** MS
Casing Diameter: **Bit Type:** 125mm Auger **Bit Condition:** **Contractor:** Total Drilling
Date Started: 21/9/18 **Date Completed:** 21/9/18 **Logged By:** DGB & JG **Checked By:** IB

Coring						Material Description				Defect Description			
Method	Fluid	TCR (%)	RQD (%)	RL (m AHD)	Depth (m)	Graphic Log	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Estimated Strength $Is_{(50)}$ MPa ● - Axial O - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Visual	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
				14.0	10.5								
				13.5	11.0								
				13.0	11.5								
				12.5	12.0								
				12.0	12.5								
				11.5	13.0								
				11.0	13.5								
				10.5	14.0								
				10.0	14.5								
							14.60m START CORING AT 14.60m						
NMLC		95	56	9.5			14.72m (EXTREMELY WEATHERED) SANDSTONE, fine grained, grey, very thin carbonaceous laminations	XW SW				14.67 - 14.72 m: SM, Extremely weathered seam 14.90 m: DB, 0°, PR, S, CN	

DRILLING
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller
PQ Rotary core (85mm)
HQ Rotary core (63.5mm)
NMLC Rotary core (51.94mm)
DT Diatube concrete coring
PT Push tube
PS Percussion sampling
SON Sonic drilling
AH Air hammer

WATER
Water Level on date shown
water inflow
water outflow

ROCK QUALITY DESCRIPTIONS
RQD Rock Quality Designation (%)
TCR Total Core Recovery (%)

ROCK STRENGTH
EH Extremely High
VH Very High
H High
M Medium
L Low
VL Very Low

ROCK WEATHERING
FR Fresh
SW Slightly Weathered
DW Distinctly Weathered
MW Moderately Weathered
HW Highly Weathered
XW Extremely Weathered

DEFECT TYPE
JT Joint
SZ Sheared zone
BP Bedding Parting
SM Seam
FL Foliation
VN Vein
CL Cleavage
CS Crushed Seam
FZ Fracture Zone
DL Drift Lift
HB Handing Break
DB Drilling Break

PLANARITY
CU Curved
DIS Discontinuous
IR Irregular
PR Planar
ST Stepped
UN Undulose

ROUGHNESS
VR Very Rough
RF Rough
S Smooth
SL Slickensided
POL Polished

COATING
CN Clean
SN Stained
VNR Veneer (thin or patchy)
CT Coating (up to 1mm)

INFILL MATERIALS
X Carbonaceus
MU Unidentified minteral
MS Secondary mineral
KT Chlorite
CA Calcite
Fe Iron Oxide
Qz Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

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CORE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH03

Job No: 81019007 **Sheet:** 5 of 6

Position: North of Western Building (in footpath) - Refer to Site Plan **Angle from Horizontal:** 90° **Surface Elevation:** 24.230 m AHD
Rig Type: Hanjin D&B 8D **Mounting:** Track **Driller:** MS
Casing Diameter: **Bit Type:** 125mm Auger **Bit Condition:** **Contractor:** Total Drilling
Date Started: 21/9/18 **Date Completed:** 21/9/18 **Logged By:** DGB & JG **Checked By:** IB

Coring						Material Description			Defect Description		
Method	Fluid	TCR (%)	RQD (%)	RL (m AHD)	Depth (m)	Graphic Log	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Estimated Strength $Is_{(50)}$ MPa ● - Axial O - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Visual	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
NMLC							15.06m					15.06 m: SM, 0 - 5°, PR, 10 mm, extremely weathered seam, carbonaceous
							CARBONACEOUS SILTSTONE, grey	SW to MW				15.18 - 15.21 m: SM, Extremely weathered seam, crumbling weathered material
				9.0								15.25 m: JT, 10°, IR, CT, clay coating
					15.5							15.37 - 15.40 m: SM, 0°, extremely weathered seam
							15.65m					15.45 m: JT, 90°, CU, S, CN, curved to planar
		95	56	8.5			SANDSTONE, fine grained, grey	SW to F				15.50 m: BP-Clsoed, 5 - 10°, IR, RF, CN
												15.53 m: JT, 80°, CU, CN
												15.56 m: BP, 10°, PR, S, CN
												15.56 - 15.64 m: SM, SM or FZ, numerous joints and clay material
					16.0		As above: increase in very thin carbonaceous laminations					15.75 m: BP-Closed, 5 - 10°, PR, RF, CN
												15.87 m: BP, 10°, PR, RF, CN
				8.0								15.88 m: BP-Closed, 5 - 10°, PR, RF, CN
												16.32 m: BP, 10°, PR, RF, CT, carboonaceous coating
					16.5							16.48 - 16.52 m: JT5, 10°, ST, RF, set of three joints, 10 mm spacing
												16.56 m: FZ, block joints with dark brown carbonaceous material
				7.5								16.67 m: SM, 20°, extremely weathered seam, residual clay
							As above: medium grained, no laminations	MW to SW				16.70 m
							16.95m					16.95: Driller noted very easy coring near end of run suggestign a sandy seam, core run termianted early due to bogging
		63	26		17.0		CORE LOSS 0.35m (16.95-17.30)					16.90 - 17.30 m: SM, extremely weathered seam (sand), assuming 0.35m core loss is located here
				7.0			17.30m					
							SANDSTONE, medium grained, grey	MW to SW				17.40 m: JT, 10°, IR, RF, CN
					17.5			SW to F				
				6.5								17.90: Fining up depositon sequence from 17.90
							17.95m					
					18.0		SANDSTONE, fine to medium grained, grey, lamination to very thin beds of siltstone at approximately 100mm-150mm fining up sequence present	SW to F				18.02 m: BP, 5°, PR, S, CN
				6.0								18.19 m: BP, 10°, PR, S, CN, thin siltstone band
					18.5		As above: siltstone laminations and very thin beds, increase in spacing to approximately 300-600 mm spacing					
		100	94	5.5								18.62 m: JT, 5°, PR, RF, VNR, carbonaceous veneer
												18.92 m: BP, 0°, PR, S, VNR, slick to smooth, clay veneer
					19.0							19.15 m: BP, 0°, PR, S, CN
				5.0								
					19.5		As above: thin laminations of coal					
				4.5								19.68 m: BP, 0°, ST, RF, carbonaceous
												19.86 m: BP, 5°, IR, RF, carbonaceous

DRILLING
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller
PQ Rotary core (85mm)
HQ Rotary core (63.5mm)
NMLC Rotary core (51.94mm)
DT Diatube concrete coring
PT Push tube
PS Percussion sampling
SON Sonic drilling
AH Air hammer

WATER
Water Level on date shown
water inflow
water outflow

ROCK QUALITY DESCRIPTIONS
RQD Rock Quality Designation (%)
TCR Total Core Recovery (%)

ROCK STRENGTH
EH Extremely High
VH Very High
H High
M Medium
L Low
VL Very Low

ROCK WEATHERING
FR Fresh
SW Slightly Weathered
DW Distinctly Weathered
MW Moderately Weathered
HW Highly Weathered
XW Extremely Weathered

DEFECT TYPE
JT Joint
SZ Sheared zone
BP Bedding Parting
SM Seam
FL Foliation
VN Vein
CL Cleavage
CS Crushed Seam
FZ Fracture Zone
DL Drift Lift
HB Handing Break
DB Drilling Break

PLANARITY
CU Curved
DIS Discontinuous
IR Irregular
PR Planar
ST Stepped
UN Undulose

ROUGHNESS
VR Very Rough
RF Rough
S Smooth
SL Slockensided
POL Polished

COATING
CN Clean
SN Stained
VNR Veneer (thin or patchy)
CT Coating (up to 1mm)

INFILL MATERIALS
X Carbonaceus
MU Unidentified minteral
MS Secondary mineral
KT Chlorite
CA Calcite
Fe Iron Oxide
Qz Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Cardno

CORE LOG SHEET

Client: Azusa Sekkei Co. Ltd C/- DWP
Project: Geotechnical Investigation
Location: Newcastle Courthouse - Church Street, Newcastle

Hole No: BH03

Job No: 81019007 **Sheet:** 6 of 6

Position: North of Western Building (in footpath) - Refer to Site Plan **Angle from Horizontal:** 90° **Surface Elevation:** 24.230 m AHD
Rig Type: Hanjin D&B 8D **Mounting:** Track **Driller:** MS
Casing Diameter: **Bit Type:** 125mm Auger **Bit Condition:** **Contractor:** Total Drilling
Date Started: 21/9/18 **Date Completed:** 21/9/18 **Logged By:** DGB & JG **Checked By:** IB

Coring						Material Description			Defect Description		
Method	Fluid	TCR (%)	RQD (%)	RL (m AHD)	Depth (m)	Graphic Log	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Estimated Strength $Is_{(50)}$ MPa ● - Axial O - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Visual	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
NMLC		100	94	4.0			SANDSTONE, fine to medium grained, grey, lamination to very thin beds of siltstone at approximately 100mm-150mm fining up sequence present *(continued)*	SW to F				20.20 m: JT, 30°, UN, RF, VNR, carbonaceous 20.28 m: JT, 0°, CU, RF, carbonaceous 20.38 m: SM, 0°, ST, RF, carbonaceous material
					20.5		20.45m TERMINATED AT 20.45 m Target depth - Change to NMLC Coring					
				3.5								
					21.0							
				3.0								
					21.5							
				2.5								
					22.0							
				2.0								
					22.5							
				1.5								
					23.0							
				1.0								
					23.5							
				0.5								
					24.0							
				0.0								
					24.5							
				-0.5								

DRILLING
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RQD Rock Quality Designation (%)
TCR Total Core Recovery (%)

ROCK STRENGTH
EH Extremly High
VH Very High
H High
M Medium
L Low
VL Very Low

ROCK WEATHERING
FR Fresh
SW Slightly Weathered
DW Distinctly Weathered
MW Moderately Weathered
HW Highly Weathered
XW Extremly Weathered

DEFECT TYPE
JT Joint
SZ Sheared zone
BP Bedding Parting
SM Seam
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VN Vein
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CS Crushed Seam
FZ Fracture Zone
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MS Secondary mineral
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CA Calcite
Fe Iron Oxide
Qz Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Explanatory Notes

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. Material descriptions are deduced from field observation or engineering examination, and may be appended or confirmed by in situ or laboratory testing. The information is dependent on the scope of investigation, the extent of sampling and testing, and the inherent variability of the conditions encountered.

Subsurface investigation may be conducted by one or a combination of the following methods.

Method	
Test Pitting: excavation/trench	
BH	Backhoe bucket
EX	Excavator bucket
R	Ripper
H	Hydraulic Hammer
X	Existing excavation
N	Natural exposure
Manual drilling: hand operated tools	
HA	Hand Auger
Continuous sample drilling	
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
Hammer drilling	
AH	Air hammer
AT	Air track
Spiral flight auger drilling	
AS	Auger screwing
AD/V	Continuous flight auger: V-bit
AD/T	Continuous spiral flight auger: TC-Bit
HFA	Continuous hollow flight auger
Rotary non-core drilling	
WB	Washbore drilling
RR	Rock roller
Rotary core drilling	
PQ	85mm core (wire line core barrel)
HQ	63.5mm core (wire line core barrel)
NMLC	51.94mm core (conventional core barrel)
NQ	47.6mm core (wire line core barrel)
DT	Diatube (concrete coring)

Sampling is conducted to facilitate further assessment of selected materials encountered.

Sampling method	
Soil sampling	
B	Bulk disturbed sample
D	Disturbed sample
C	Core sample
ES	Environmental soil sample
SPT	Standard Penetration Test sample
U	Thin wall tube ‘undisturbed’ sample
Water sampling	
WS	Environmental water sample

Field testing may be conducted as a means of assessment of the in situ conditions of materials.

Field testing		
SPT	Standard Penetration Test	
HP/PP	Hand/Pocket Penetrometer	
Dynamic Penetrometers (blows per noted increment)		
	DCP	Dynamic Cone Penetrometer
	PSP	Perth Sand Penetrometer
MC	Moisture Content	
VS	Vane Shear	
PBT	Plate Bearing Test	
IMP	Borehole Impression Test	
PID	Photo Ionization Detector	

If encountered, refusal (R), virtual refusal (VR) or hammer bouncing (HB) of penetrometers may be noted.

The quality of the rock can be assessed by the degree of natural defects/fractures and the following.

Rock quality description	
TCR	Total Core Recovery (%) (length of core recovered divided by the length of core run)
RQD	Rock Quality Designation (%) (sum of axial lengths of core greater than 100mm long divided by the length of core run)

Notes on groundwater conditions encountered may include.

Groundwater	
Not Encountered	Excavation is dry in the short term
Not Observed	Water level observation not possible
Seepage	Water seeping into hole
Inflow	Water flowing/flooding into hole

Perched groundwater may result in a misleading indication of the depth to the true water table. Groundwater levels are also likely to fluctuate with variations in climatic and site conditions.

Notes on the stability of excavations may include.

Excavation conditions	
Stable	No obvious/gross short term instability noted
Spalling	Material falling into excavation (minor/major)
Unstable	Collapse of the majority, or one or more face of the excavation

Explanatory Notes: General Soil Description

The methods of description and classification of soils used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. In practice, a material is described as a soil if it can be remoulded by hand in its field condition or in water. The dominant component is shown in upper case, with secondary components in lower case. In general descriptions cover: soil type, plasticity or particle size/shape, colour, strength or density, moisture and inclusions.

In general, soil types are classified according to the dominant particle on the basis of the following particle sizes.

Soil Classification		Particle Size (mm)
CLAY		< 0.002
SILT		0.002 0.075
SAND	fine	0.075 to 0.21
	medium	0.21 to 0.6
	coarse	0.6 to 2.36
GRAVEL	fine	2.36 to 6.7
	medium	6.7 to 19
	coarse	19 to 63
COBBLES		63 to 200
BOULDERS		> 200

Soil types may be qualified by the presence of minor components on the basis of field examination methods and/or the soil grading.

Terminology	In coarse grained soils		In fine soils
	% fines	% coarse	% coarse
Trace	≤5	≤15	≤15
With	>5, ≤12	>15, ≤30	>15, ≤30

The strength of cohesive soils is classified by engineering assessment or field/lab testing as follows.

Strength	Symbol	Undrained shear strength
Very Soft	VS	≤12kPa
Soft	S	12kPa to ≤25kPa
Firm	F	25kPa to ≤50kPa
Stiff	St	50kPa to ≤100kPa
Very Stiff	VSt	100kPa to ≤200kPa
Hard	H	>200kPa

Cohesionless soils are classified on the basis of relative density as follows.

Relative Density	Symbol	Density Index
Very Loose	VL	<15%
Loose	L	15% to ≤35%
Medium Dense	MD	35% to ≤65%
Dense	D	65% to ≤85%
Very Dense	VD	>85%

The plasticity of cohesive soils is defined by the Liquid Limit (LL) as follows.

Plasticity	Silt LL	Clay LL
Low plasticity	≤ 35%	≤ 35%
Medium plasticity	N/A	> 35% ≤ 50%
High plasticity	> 50%	> 50%

The moisture condition of soil (*w*) is described by appearance and feel and may be described in relation to the Plastic Limit (PL), Liquid Limit (LL) or Optimum Moisture Content (OMC).

Moisture condition and description	
Dry	Cohesive soils: hard, friable, dry of plastic limit. Granular soils: cohesionless and free-running
Moist	Cool feel and darkened colour: Cohesive soils can be moulded. Granular soils tend to cohere
Wet	Cool feel and darkened colour: Cohesive soils usually weakened and free water forms when handling. Granular soils tend to cohere

The structure of the soil may be described as follows.

Zoning	Description
Layer	Continuous across exposure or sample
Lens	Discontinuous layer (lenticular shape)
Pocket	Irregular inclusion of different material

The structure of soil layers may include: defects such as softened zones, fissures, cracks, joints and root-holes; and coarse grained soils may be described as strongly or weakly cemented.

The soil origin may also be noted if possible to deduce.

Soil origin and description	
Fill	Anthropogenic deposits or disturbed material
Topsoil	Zone of soil affected by roots and root fibres
Peat	Significantly organic soils
Colluvial	Transported down slopes by gravity/water
Aeolian	Transported and deposited by wind
Alluvial	Deposited by rivers
Estuarine	Deposited in coastal estuaries
Lacustrine	Deposited in freshwater lakes
Marine	Deposits in marine environments
Residual soil	Soil formed by in situ weathering of rock, with no structure/fabric of parent rock evident
Extremely weathered material	Formed by in situ weathering of geological formations, with the structure/fabric of parent rock intact but with soil strength properties

The origin of the soil generally cannot be deduced solely on the appearance of the material and the inference may be supplemented by further geological evidence or other field observation. Where there is doubt, the terms ‘possibly’ or ‘probably’ may be used

Explanatory Notes: General Rock Description

The methods of description and classification of rocks used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. In practice, if a material cannot be remoulded by hand in its field condition or in water, it is described as a rock. In general, descriptions cover: rock type, grain size, structure, colour, degree of weathering, strength, minor components or inclusions, and where applicable, the defect types, shape, roughness and coating/infill.

Rock types are generally described according to the predominant grain or crystal size, and in groups for each rock type as follows.

Rock type	Groups
Sedimentary	Deposited, carbonate (porous or non), volcanic ejection
Igneous	Felsic (much quartz, pale), Intermediate, or mafic (little quartz, dark)
Metamorphic	Foliated or non-foliated
Duricrust	Cementing minerology (iron oxides or hydroxides, silica, calcium carbonate, gypsum)

Reference should be made to AS1726 for details of the rock types and methods of classification.

The classification of rock weathering is described based on definitions in AS1726 and summarised as follows.

Term and symbol		Definition
Residual Soil	RS	Soil developed on rock with the mass structure and substance of the parent rock no longer evident
Extremely weathered	XW	Weathered to such an extent that the rock has 'soil-like' properties. Mass structure and substance still evident
Distinctly weathered	DW	The strength is usually changed and may be highly discoloured. Porosity may be increased by leaching, or decreased due to deposition in pores. May be distinguished into MW (Moderately Weathered) and HW (Highly Weathered).
Slightly weathered	SW	Slightly discoloured; little or no change of strength from fresh rock
Fresh Rock	FR	The rock shows no sign of decomposition or staining

The rock material strength can be defined based on the point load index as follows.

Term and symbol		Point Load Index I_s50 (MPa)
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1.0
High	H	1.0 to 3
Very High	VH	3 to 10
Extremely High	EH	> 10

It is important to note that the rock material strength as above is distinct from the rock mass strength which can be significantly weaker due to the effect of defects.

A preliminary assessment of rock strength may be made using the field guide detailed in AS1726, and this is conducted in the absence of point load testing.

The defect spacing measured normal to defects of the same set or bedding, is described as follows.

Definition	Defect Spacing (mm)
Thinly laminated	< 6
Laminated	6 to 20
Very thinly bedded	20 to 60
Thinly bedded	60 to 200
Medium bedded	200 to 600
Thickly bedded	600 to 2000
Very thickly bedded	> 2000

Terms for describing rock and defects are as follows.

Defect Terms			
Joint	JT	Sheared zone	SZ
Bedding Parting	BP	Seam	SM
Foliation	FL	Vein	VN
Cleavage	CL	Drill Lift	DL
Crushed Seam	CS	Handling Break	HB
Fracture Zone	FZ	Drilling Break	DB

The shape and roughness of defects in the rock mass are described using the following terms.

Planarity		Roughness	
Planar	PR	Very Rough	VR
Curved	CU	Rough	RF
Undulose	UN	Smooth	S
Irregular	IR	Slickensided	SL
Stepped	ST	Polished	POL
Discontinuous	DIS		

The coating or infill associated with defects in the rock mass are described as follows.

Infill and Coating		
Clean	CN	
Stained	SN	
Carbonaceous	X	
Minerals	MU	Unidentified mineral
	MS	Secondary mineral
	KT	Chlorite
	CA	Calcite
	Fe	Iron Oxide
	Qz	Quartz
Veneer	VNR	Thin or patchy coating
Coating	CT	Infill up to 1mm

Graphic Symbols Index

CLAY	SILT	SAND	GRAVEL
Silty CLAY	Clayey SILT	Clayey SAND	Clayey GRAVEL
Sandy CLAY	Sandy SILT	Silty SAND	Silty GRAVEL
Gravelly CLAY	Gravelly SILT	Gravelly SAND	Sandy GRAVEL
Silty Gravelly CLAY	Clayey Sandy SILT	Clayey Silty SAND	Clayey Silty GRAVEL
Silty Sandy CLAY	Clayey Gravelly SILT	Clayey Gravelly SAND	Clayey Sandy GRAVEL
Sandy Gravelly CLAY	Sandy Gravelly SILT	Silty Gravelly SAND	Silty Sandy GRAVEL

COBBLES & BOULDERS	Sedimentary rock: fine, mostly clay (CLAYSTONE)	Igneous rock: Felsic, fine (RHYOLITE)
PEAT, highly organic soil	Sedimentary rock: fine, mostly silt (SILTSTONE)	Igneous rock: Felsic, coarse (GRANITE)
TOPSOIL	Sedimentary rock: fine, silt and clay (MUDSTONE, SHALE, LAMINITE)	Igneous rock: Mafic, fine to medium (BASALT, DOLERITE)
FILL	Sedimentary rock: medium (SANDSTONE, GREYWACKE)	Igneous rock: Mafic, coarse (GABBRO)
FILL: Asphalt or Bituminous Seal	Sedimentary rock: fine to coarse, angular (BRECCIA)	Metamorphic rock: Foliated, fine to medium (SLATE, PHYLLITE, SHIST)
FILL: Ballast	Sedimentary rock: coarse, rounded (CONGLOMERATE)	Metamorphic rock: Foliated, coarse (GNEISS)
FILL: Concrete	Sedimentary rock: Organic (COAL)	Metamorphic rock: Non-foliated (QUARTZITE, HORNFELS, MARBLE)
FILL: Roadbase	Sedimentary rock: Carbonate (LIMESTONE, DOLOMITE)	
	Sedimentary rock: Volcanic (TUFF, VOLCANIC BRECCIA, AGGLOMERATE)	

Newcastle Courthouse Redevelopment

APPENDIX C

LABORATORY RESULTS

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	David Bastian
Client	CARDNO (NSW/ACT) PTY LTD
Address	Unit 1 10 Denney Street Broadmeadow NSW 2292
Telephone	61 2 4940 5516
Facsimile	61 2 4965 4666
Email	david.bastian@cardno.com.au
Project	**81019007**
Order Number	**81019007**
Samples	4

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE185065 R0**
Date Received	16/10/2018
Date Reported	23/10/2018

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

Dong Liang
Metals/Inorganics Team Leader

pH in soil (1:2) [AN101] Tested: 22/10/2018

PARAMETER	UOM	LOR	BH01/2.50-2.95 SOIL - 20/9/2018 SE185065.001	BH02/4.00-4.45 SOIL - 20/9/2018 SE185065.002	BH03/4.00-4.45 SOIL - 21/9/2018 SE185065.003	BH03/7.00-7.45 SOIL - 21/9/2018 SE185065.004
pH (1:2)	pH Units	-	**4.5**	**4.4**	**5.9**	**4.2**

Conductivity (1:2) in soil [AN106] Tested: 22/10/2018

PARAMETER	UOM	LOR	BH01/2.50-2.95 SOIL - 20/9/2018 SE185065.001	BH02/4.00-4.45 SOIL - 20/9/2018 SE185065.002	BH03/4.00-4.45 SOIL - 21/9/2018 SE185065.003	BH03/7.00-7.45 SOIL - 21/9/2018 SE185065.004
Conductivity (1:2) @25 C*	µS/cm	1	99	86	34	81
Resistivity (1:2)*	ohm cm	-	10000	12000	29000	12000

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography [AN245] Tested: 22/10/2018

PARAMETER	UOM	LOR	BH01/2.50-2.95 SOIL - 20/9/2018 SE185065.001	BH02/4.00-4.45 SOIL - 20/9/2018 SE185065.002	BH03/4.00-4.45 SOIL - 21/9/2018 SE185065.003	BH03/7.00-7.45 SOIL - 21/9/2018 SE185065.004
Chloride	mg/kg	0.25	**13**	**13**	**4.1**	**6.3**
Sulfate	mg/kg	0.5	**62**	**49**	**16**	**52**

Moisture Content [AN002] Tested: 18/10/2018

PARAMETER	UOM	LOR	BH01/2.50-2.95 SOIL - 20/9/2018 SE185065.001	BH02/4.00-4.45 SOIL - 20/9/2018 SE185065.002	BH03/4.00-4.45 SOIL - 21/9/2018 SE185065.003	BH03/7.00-7.45 SOIL - 21/9/2018 SE185065.004
% Moisture	%w/w	0.5	**20.9**	**16.5**	**11.0**	**12.6**

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:2 and the pH determined and reported on the extract after 1 hour extraction (pH 1:2) or after 1 hour extraction and overnight aging (pH (1:2) aged). Reference APHA 4500-H+.
AN106	Conductivity : Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos /cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:2 and the EC determined and reported on the extract basis after the 1 hour extraction (EC(1:2)) or after the 1 hour extraction and overnight aging (EC(1:2) aged). Reference APHA 2510 B.
AN106	Resistivity of the extract is reported on the extract basis and is the reciprocal of conductivity. Salinity and TDS can be calculated from the extract conductivity and is reported back to the soil basis.
AN245	Anions by Ion Chromatography: A water sample or extract is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
		NVL	Not validated.	LOR	Limit of Reporting.
**	Indicative data, theoretical holding time exceeded.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/ Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

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ABN: 98 153 268 896

Material Test Report

Report No: MAT:NEW18W-3333--S01
Issue No: 1

Client: Cardno (NSW/ACT) Pty Ltd
Unit 1, 10 Denney Street
Broadmeadow NSW 2292

Principal:
Project No.: NEW18P-0212
Project Name: Various Material Testing

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.
This report shall not be reproduced except in full.

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 24/10/2018

Sample Details

Sample ID: NEW18W-3333--S01
Sampling Method: Sample submitted by client
Date Sampled: 20/09/2018
Source: On Site
Material: Silty Clay
Specification: No Specification
Project Location: Church Street, Newcastle, NSW
TRN 81019007
Sample Location: BH01 - (7.0 - 7.45m)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	10.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	42	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	23	

Comments

N/A

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Material Test Report

Report No: MAT:NEW18W-3333--S02
Issue No: 1

Client: Cardno (NSW/ACT) Pty Ltd
Unit 1, 10 Denney Street
Broadmeadow NSW 2292

Principal:
Project No.: NEW18P-0212
Project Name: Various Material Testing

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.
This report shall not be reproduced except in full.

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 24/10/2018

Sample Details

Sample ID: NEW18W-3333--S02
Sampling Method: Sample submitted by client
Date Sampled: 21/09/2018
Source: On Site
Material: Clay
Specification: No Specification
Project Location: Church Street, Newcastle, NSW
TRN 81019007
Sample Location: BH03 - (9.5 - 10.0m)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	43	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	13	
Plasticity Index (%)	AS 1289.3.3.1	30	

Comments

N/A

Newcastle Courthouse Redevelopment

APPENDIX D

POINT LOAD TESTING RESULTS

POINT LOAD STRENGTH TEST RESULTS

CLIENT: Azusa Sekkei
PROJECT: Geotechnical Investigation
LOCATION: Newcastle Courthouse

DATE: 21/9/18
PROJECT No: 81019007
CLIENT REF:

Bore	Depth (m)	Sample length (mm)	Sample diameter (mm)	Minimum cross-sectional area of plane (mm)	Separation at failure (mm)	Orientation (A = axial, D = diametrical, I = irregular, AS = Anisotropic rock)	Load at failure (kN)	Point load strength, I_s	Point load index, $I_{s(50)}$	Rock type & structure	Moisture content & storage history	Failure mechanism (M = massive, B = bedded, J = jointed)	Strength
BH01	8.90	58.0	52.0	2124	49.5	D	0.20	0.08	0.08		Stored in core box	B	Very Low
BH01	8.95	32.0	52.0	1664	31.0	A	0.25	0.1	0.1		Stored in core box	M	Low
BH01	9.00	65.0	52.0	2124	48.0	D	0.44	0.2	0.2		Stored in core box	B	Low
BH01	9.07	49.0	52.0	2548	46.0	A	0.56	0.2	0.2		Stored in core box	M	Low
BH01	9.38	56.0	52.0	2124	49.0	D	0.40	0.2	0.2		Stored in core box	M	Low
BH01	9.44	34.0	52.0	1768	32.0	A	0.36	0.2	0.2		Stored in core box	M	Low
BH01	9.70	75.0	52.0	2124	47.0	D	0.43	0.2	0.2		Stored in core box	B	Low
BH01	9.78	45.0	52.0	2340	43.0	A	0.38	0.1	0.1		Stored in core box	M/J	Low
BH01	11.00	82.0	52.0	2124	48.0	D	0.50	0.2	0.2		Stored in core box	B	Low
BH01	11.09	45.0	52.0	2340	43.0	A	0.91	0.3	0.3		Stored in core box	M	Medium
BH01	11.33	50.0	52.0	2124	48.0	D	0.30	0.1	0.1		Stored in core box	B	Low
BH01	11.33	34.0	52.0	1768	32.0	A	0.32	0.1	0.1		Stored in core box	M	Low
BH01	11.70	73.0	52.0	2124	49.0	D	0.23	0.10	0.09		Stored in core box	B	Very Low
BH01	11.77	36.0	52.0	1872	33.0	A	0.96	0.4	0.4		Stored in core box	M	Medium
BH01	11.54	60.0	52.0	2124	49.0	D	0.15	0.06	0.06		Stored in core box	B	Very Low
BH01	11.57	45.0	52.0	2340	43.0	A	0.98	0.3	0.3		Stored in core box	M	Medium
BH01	12.00	46.0	52.0	2392	44.0	A	0.88	0.3	0.3		Stored in core box	M	Medium
BH01	12.13	44.0	52.0	2288	41.0	A	1.10	0.4	0.4		Stored in core box	M	Medium
BH01	12.65	87.0	52.0	2124	48.0	D	1.90	0.8	0.8		Stored in core box	B	Medium
BH01	12.72	45.0	52.0	2340	43.0	A	1.82	0.6	0.6		Stored in core box	M	Medium

Test Methods: AS4133.4.1-1993 Cl 3.2 - Diametrical test
AS4133.4.1-1993 Cl 3.3 - Axial test
AS4133.4.1-1993 Cl 3.2 - Block and irregular lump test
AS4133.4.1-1993 Cl 3.5 - Anisometrical rock test

Cardno Pty Ltd	**Calculated by: GE**	**Date: 31/10/2018**
Office: Broadmeadow	**Checked by: JG**	**Date: 31/10/2018**

POINT LOAD STRENGTH TEST RESULTS

CLIENT: Azusa Sekkei
PROJECT: Geotechnical Investigation
LOCATION: Newcastle Courthouse

DATE: 21/9/18
PROJECT No: 81019007
CLIENT REF:

Bore	Depth (m)	Sample length (mm)	Sample diameter (mm)	Minimum cross-sectional area of plane (mm)	Separation at failure (mm)	Orientation (A = axial, D = diametrical, I = irregular, AS = Anisotropic rock)	Load at failure (kN)	Point load strength, I_s	Point load index, $I_{s(50)}$	Rock type & structure	Moisture content & storage history	Failure mechanism (M = massive, B = bedded, J = jointed)	Strength
BH01	12.81	78.0	52.0	2124	48.0	D	1.41	0.6	0.6		Stored in core box	B	Medium
BH01	12.90	44.0	52.0	2288	42.0	A	2.00	0.7	0.7		Stored in core box	M	Medium
BH01	13.00	65.0	52.0	2124	49.0	D	0.80	0.3	0.3		Stored in core box	M	Medium
BH01	13.00	47.0	52.0	2444	44.0	A	1.92	0.6	0.6		Stored in core box	M	Medium
BH01	13.37	67.0	52.0	2124	48.0	D	0.68	0.3	0.3		Stored in core box	M	Low
BH01	13.44	47.0	52.0	2444	45.0	A	1.78	0.6	0.6		Stored in core box	M	Medium
BH01	13.59	58.0	52.0	2124	48.0	D	1.32	0.6	0.6		Stored in core box	M	Medium
BH01	13.65	35.0	52.0	1820	33.0	A	1.63	0.7	0.7		Stored in core box	M	Medium
BH01	13.85	62.0	52.0	2124	48.0	D	0.96	0.4	0.4		Stored in core box	M	Medium
BH01	13.91	32.0	52.0	1664	30.0	A	1.44	0.7	0.7		Stored in core box	M	Medium
BH01	14.12	65.0	52.0	2124	48.0	D	1.06	0.5	0.5		Stored in core box	M	Medium
BH01	14.12	35.0	52.0	1820	33.0	A	2.56	1.1	1.1		Stored in core box	M	High
BH01	14.22	69.0	52.0	2124	48.0	D	1.35	0.6	0.6		Stored in core box	M	Medium
BH01	14.30	40.0	52.0	2080	37.0	A	1.32	0.5	0.5		Stored in core box	M	Medium

Test Methods: AS4133.4.1-1993 Cl 3.2 - Diametrical test
AS4133.4.1-1993 Cl 3.3 - Axial test
AS4133.4.1-1993 Cl 3.2 - Block and irregular lump test
AS4133.4.1-1993 Cl 3.5 - Anisometrical rock test

Cardno Pty Ltd	**Calculated by: GE**	**Date: 31/10/2018**
Office: Broadmeadow	**Checked by: JG**	**Date: 31/10/2018**

POINT LOAD STRENGTH TEST RESULTS

CLIENT: Azusa Sekkei
PROJECT: Geotechnical Investigation
LOCATION: Newcastle Courthouse

DATE: 21/9/18
PROJECT No: 81019007
CLIENT REF:

Bore	Depth (m)	Sample length (mm)	Sample diameter (mm)	Minimum cross-sectional area of plane (mm)	Separation at failure (mm)	Orientation (A = axial, D = diametrical, I = irregular, AS = Anisotropic rock)	Load at failure (kN)	Point load strength, I_s	Point load index, $I_{s(50)}$	Rock type & structure	Moisture content & storage history	Failure mechanism (M = massive, B = bedded, J = jointed)	Strength
BH03	14.85	105.0	52.0	2124	48.00	D	0.54	0.2	0.2		Stored in core box	M	Low
BH03	14.83	43.0	52.0	2236	39.00	A	0.72	0.3	0.3		Stored in core box	M	Low
BH03	15.14	100.0	52.0	2124	50.00	D	0.78	0.3	0.3		Stored in core box	M/B	Medium
BH03	15.14	33.0	52.0	1716	30.00	A	0.49	0.2	0.2		Stored in core box	M	Low
BH03	15.71	110.0	52.0	2124	50.00	D	1.65	0.7	0.7		Stored in core box	M	Medium
BH03	15.71	38.0	52.0	1976	36.00	A	4.27	1.7	1.7		Stored in core box	M	High
BH03	15.98	125.0	52.0	2124	51.00	D	2.09	0.8	0.8		Stored in core box	M	Medium
BH03	15.98	31.0	52.0	1612	29.00	A	2.48	1.2	1.2		Stored in core box	M	High
BH03	16.26	115.0	52.0	2124	51.00	D	1.21	0.5	0.5		Stored in core box	B	Medium
BH03	16.26	33.0	52.0	1716	31.00	A	2.51	1.1	1.1		Stored in core box	M	High
BH03	16.64	90.0	52.0	2124	50.00	D	4.04	1.6	1.6		Stored in core box	M	High
BH03	16.64	40.0	52.0	2080	35.00	A	5.39	2.0	2.1		Stored in core box	M	High
BH03	16.83	140.0	52.0	2124	50.00	D	0.33	0.1	0.1		Stored in core box	M	Low
BH03	16.83	32.0	52.0	1664	29.00	A	0.67	0.3	0.3		Stored in core box	M	Medium
BH03	17.37	100.0	52.0	2124	50.00	D	0.68	0.3	0.3		Stored in core box	M	Low
BH03	17.37	34.0	52.0	1768	28.00	A	0.69	0.3	0.3		Stored in core box	M	Low
BH03	17.65	550.0	52.0	2124	51.00	D	5.79	2.2	2.2		Stored in core box	M	High
BH03	17.65	39.0	52.0	2028	37.00	A	6.67	2.6	2.6		Stored in core box	M	High
BH03	18.18	50.0	52.0	2124	50.00	D	2.52	1.0	1.0		Stored in core box	M	High
BH03	18.16	32.0	52.0	1664	28.00	A	3.27	1.5	1.5		Stored in core box	M	High

Test Methods: AS4133.4.1-1993 Cl 3.2 - Diametrical test
AS4133.4.1-1993 Cl 3.3 - Axial test
AS4133.4.1-1993 Cl 3.2 - Block and irregular lump test
AS4133.4.1-1993 Cl 3.5 - Anisometrical rock test

Cardno Pty Ltd	**Calculated by: GE**	**Date: 31/10/2018**
Office: Broadmeadow	**Checked by: JG**	**Date: 31/10/2018**

POINT LOAD STRENGTH TEST RESULTS

CLIENT: Azusa Sekkei
PROJECT: Geotechnical Investigation
LOCATION: Newcastle Courthouse

DATE: 21/9/18
PROJECT No: 81019007
CLIENT REF:

Bore	Depth (m)	Sample length (mm)	Sample diameter (mm)	Minimum cross-sectional area of plane (mm)	Separation at failure (mm)	Orientation (A = axial, D = diametrical, I = irregular, AS = Anisotropic rock)	Load at failure (kN)	Point load strength, I_s	Point load index, $I_{s(50)}$	Rock type & structure	Moisture content & storage history	Failure mechanism (M = massive, B = bedded, J = jointed)	Strength
BH03	18.58	155.0	52.0	2124	50.0	D	2.39	1.0	1.0		Stored in core box	M	Medium
BH03	18.58	45.0	52.0	2340	43.0	A	2.33	0.8	0.8		Stored in core box	M	Medium
BH03	18.90	310.0	52.0	2124	51.0	D	2.39	0.9	0.9		Stored in core box	M	Medium
BH03	19.90	37.0	52.0	1924	35.0	A	4.00	1.6	1.6		Stored in core box	M	High
BH03	19.10	105.0	52.0	2124	50.0	D	4.20	1.7	1.7		Stored in core box	M	High
BH03	19.10	35.0	52.0	1820	30.0	A	5.56	2.4	2.4		Stored in core box	M	High
BH03	19.50	525.0	52.0	2124	51.0	D	3.38	1.3	1.3		Stored in core box	M	High
BH03	19.46	37.0	52.0	1924	35.0	A	3.02	1.2	1.2		Stored in core box	M	High
BH03	19.65	190.0	52.0	2124	51.0	D	4.30	1.7	1.7		Stored in core box	M	High
BH03	19.65	37.0	52.0	1924	33.0	A	5.58	2.3	2.3		Stored in core box	M	High
BH03	14.90	130.0	52.0	2124	51.0	D	1.76	0.7	0.7		Stored in core box	M	Medium
BH03	14.90	34.0	52.0	1768	31.0	A	2.32	1.0	1.0		Stored in core box	M	High
BH03	20.33	85.0	52.0	2124	50.0	D	2.64	1.1	1.1		Stored in core box	M	High
BH03	20.33	35.0	52.0	1820	34.0	A	2.44	1.1	1.0		Stored in core box	M	High
BH03	20.04	200.0	52.0	2124	50.0	D	2.12	0.8	0.8		Stored in core box	M	Medium
BH03	20.04	44.0	52.0	2288	42.0	A	2.54	0.9	0.9		Stored in core box	M	Medium

Test Methods: AS4133.4.1-1993 Cl 3.2 - Diametrical test
AS4133.4.1-1993 Cl 3.3 - Axial test
AS4133.4.1-1993 Cl 3.2 - Block and irregular lump test
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