Our Ref: 304100230_RPA_Western Campus_HLS Carpark_Lift_ver2:BD
Contact: Bikesh Deoju

9 November 2022

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Dear Mr. Hearne,

ROYAL PRINCE ALFRED HOSPITAL STAGE 1 REDEVELOPMENT WORKS FOR HELICOPTER LANDING SITE

1 INTRODUCTION

Cardno now Stantec Pty Ltd ("Cardno") was engaged by TSA Management (TSA) ("the Client"), on behalf of NSW Health Infrastructure, to undertake a geotechnical investigation to determine the in-situ ground conditions for the following location:

- Helicopter Landing Site (HLS) – Multistorey Car Park – Lift Pit

The carpark is situated at the corner of Grose Street and Hospital Road as part of the Royal Prince Alfred Hospital (RPA) – Western Campus (the 'site').

The contents of this letter report detail the ground investigation, methodology, presentation of factual data obtained and interpretation of data appropriate for the design and construction of the lift pit area.

This investigation was carried out concurrently with contamination investigation and hazmart survey of the subject area, reported separately to this report.

This report addresses the SEARs requirements as detailed in the table below:

Table 1-1 SEARs Requirements

Item	SEARs Requirements	Relevant Section of Report
13	Ground and Water Conditions	
	• Assess potential impacts on soil resources and related infrastructure and riparian lands on and near the site, including soil erosion, salinity, and acid sulfate soils.	Section 2.4 & 2.5
	• Provide a Surface and Groundwater Impact Assessment that assesses potential impacts on:	
	o surface water resources (quality and quantity) including related	Refer Note A
	o infrastructure, hydrology, dependent ecosystems, drainage lines, downstream assets and watercourses.	Refer Note A
	o groundwater resources in accordance with the Groundwater Guidelines.	Section 5.2

Notes:

A) Cardno (2022). Draft Detailed Site Investigation, *Royal Prince Alfred Hospital, East Campus*, Job Reference 80022026 R001, Revision B, dated 4 November 2022. Sections 7.2, 7.8 and 8.2

1.1 Available Information

The following information has been provided by the client as part of this assessment:

- Temporary HLS Options Set of Plans prepared by Jacobs
  - 220808_RPAH_MW_Temporary HLS_Options_v3_r (7 pages)

1.2 Purpose and Scope of works

The purpose of this investigation was to provide the client with geotechnical advice on the in-situ subsurface conditions encountered within the proposed lift pit.

The scope of works undertaken is presented below:

- Site Investigation carried out in accordance with AS 1726:2017 Geotechnical Investigation.
- Preliminary work, Safe Work Method Statements (SWMS) and site-specific paperwork and inductions as required;
- Undertaking a Dial-Before-You-Dig search and check the site using an electronic services locator and GPR (ground penetrating radar);
- Provision of traffic management for supervising traffic and pedestrians during the fieldwork;
- Nominate an experienced geotechnical engineer/geologist professional to manage the field investigation component of the work. The engineer to supervise, collect samples and complete a detailed log of the boreholes. The engineer to also undertake an assessment of the existing site conditions, and take note of any anomalies encountered during investigation that could be of geotechnical risk during future construction activities;
- Drilling of boreholes using a track/truck mounted track mounted drill rig fully equipped for geotechnical investigation. The drilling of the upper soil layer to be carried out using solid flight auger with Tungsten Carbide (TC) bit. The rock coring to be carried out using NMLC rock coring techniques;
  - Two Investigatory boreholes to 2m into medium strength rock for the lift pit;
- Standard penetration tests (SPTs) at 1.5 m depth intervals in all boreholes to assess subgrade consistency and recover disturbed soil samples;
- Logging encountered subsurface conditions by and experienced Geotechnical Engineer in accordance with AS1726-Geotechnical Site Investigation;
- Point Load Testing to be carried out within recovered rock core at 1.0m intervals;
- Collection of soil/rock samples for material classification, moisture content, aggressivity suite and Uniaxial Compressive Strength (UCS) testing purposes; and
- The boreholes to be backfilled with excavated spoils, topped with clean sand and reinstated with cold mix/quick set concrete.

1.3 Background and Project Context

The Royal Prince Alfred (RPA) Hospital campus is located in Sydney's inner west suburb of Camperdown, within the City of Sydney Local Government Area. The campus is situated between the University of Sydney to the east and the residential area of Camperdown to the west. A north-south arterial road (Missenden Road) divides the campus into two distinct portions, known as the East and West Campuses. The northern boundary of the campus is defined by the Queen Elizabeth II Rehabilitation Centre and the southern extent of the campus is defined by Carillon Avenue.

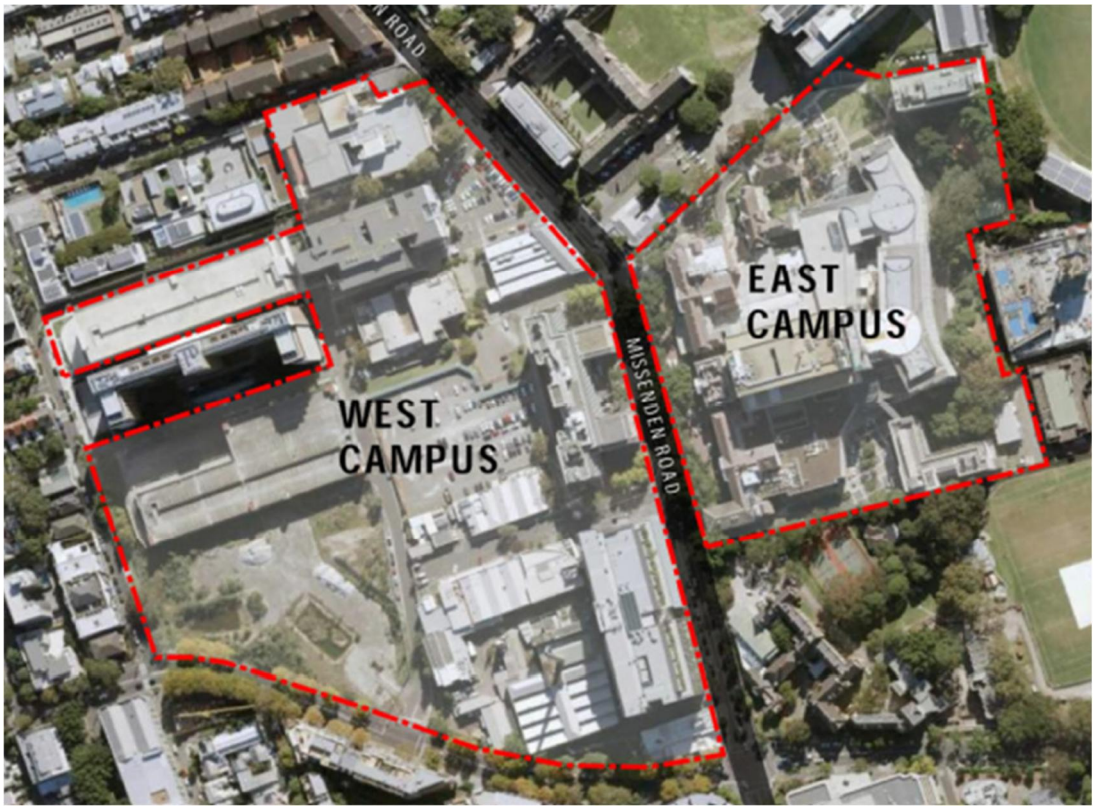

Figure 1-1 RPA Hospital Campus

The subject area consisting of multi storey carpark is shown on **Figure 1-2** below

Figure 1-2 Proposed Development Zone – West Campus

2 SITE DESCRIPTION

2.1 HLS – Multi Storey Carpark

The multistorey carpark is situated at the corner of Grose Street and Hospital Road, Camperdown. The carpark is bounded by Church Street to the west, New Hospital Road to the east, Grose Street to the north and a vacant lot to the south.

The lift pit is planned to be situated at the north of the carpark building at Grose Street. Grose Street consisted of asphaltic pavement and the footpath immediately to the north of the carpark consisted of part concrete and part asphaltic pavement. There is also a garden bed between the northern boundary and the footpath.

The investigatory boreholes undertaken for the HLS lift pit are shown in **Figure 2-1** below, which are also attached in **Appendix A – Site Plan**.

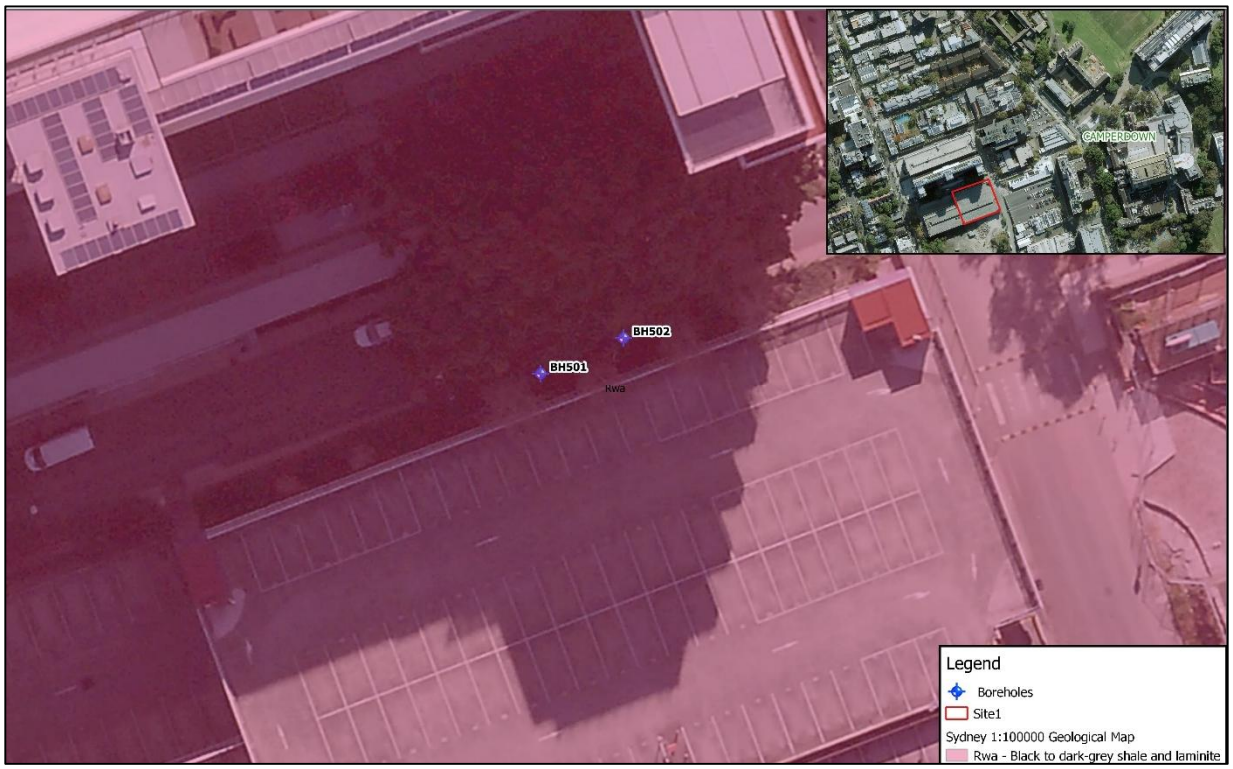

Figure 2-1 Approximate Borehole Locations within HLS Lift Pit Area

2.2 Topography and Drainage

2.2.1 HLS – Multi Storey Carpark

Based on elevation contours shown on Enviro Screen Report (ESR) prepared by LandInsight Pty Ltd, as part of the *Enviro (Ref:* LI-02930 ESR dated 9 September 2022), the ground surface of the carpark area generally falls to the south-west with elevation levels varying from approx. RL 34 m AHD (north-west) to RL 26 m AHD (south-west). The proposed lift well locations sit at an RL of approximately 32mAHD.

No surface water bodies were observed. Drainage would likely concentrate in the stormwater infrastructure onsite.

2.3 Regional Geology

The Sydney 1:100 000 Geological Map, Herbert C, 1983, illustrates that the area is underlain by Ashfield Shale (Rwa) of Wianamatta Group from Middle Triassic period of Mesozoic era. The map shows the site is underlain by Ashfield Shale (Rwa) which is charactered as Black to dark-grey shale and laminite.

Regional geology of the site area is also overlaid on the site plan as shown in **Figure 2-1** above.

Based on the locality of the site, there are no potential risks surrounding the building that may cause landslip risks. There is no existing landslip prone area map available for Camperdown which suggests that the site is not located within an area of known landslip occurrence. There are no natural cliff features, rock outcrop or rock shelves surrounding the site.

2.4 Acid Sulfate Soils and Salinity

The NSW Government Planning Industry and Environment online mapping tool, eSPADE Version 2.1, indicates that the site is not mapped as being situated within or near an ASS risk area. The nearest mapped ASS risk area is approximately 600m northwest in the vicinity of Johnstons Creek.

Previous contamination investigation carried out for the main works also suggested that there are no indicators of acid sulfate soils and salinity within the sampled soils.

3 INVESTIGATION WORKS

3.1 Borehole Locations

The ground coordinates of test location were not picked up due to poor survey signal from weather conditions. However, based on the aerial imagery, the coordinates of the location in reference to GDA2020, Zone 56 is approximately provided below:

Table 3-1 Borehole Co-ordinates

ID	Easting (m)	Northing (m)
BH501	331692	6248591
BH502	331699	6248594

3.2 Naming Convention

For fieldworks, the naming convention adopted for investigatory boreholes (BHs) was standardised in a sequential manner to provide unique identification.

- BH5xx – BH501, 502 and so on.

3.2.1 Fieldwork Activities

Fieldwork for the investigation was carried out on 20th, 21st and 23rd of September 2022, comprising of the following sequence of activities;

- A review of Dial Before You Dig (DBYD) and on-site service search;
- Drilling of two (2) boreholes (BH501 and BH502) at the proposed HLS lift pit area with a track mounted drill rig using solid flight augers with Tungsten Carbide (TC) bit and rock coring was carried out using NMLC coring techniques. These boreholes were drilled up to a depth of 14.79m below surface level (bsl);
- Collection of disturbed soil samples for laboratory testing; and
- Reinstatement of boreholes

All fieldworks, including logging of the subsurface profile, collection of soil samples, was undertaken by Geotechnical Engineers from Cardno. The locations of the completed geotechnical investigations are shown on the borehole location plan, attached to this report in **Appendix A – Site Plan.**

Subsurface conditions encountered are summarised in Section 4 and detailed in engineering borehole logs attached in **Appendix B** together with explanatory notes. Fieldwork was carried out in accordance with Australian Standard, AS1726-2017 '*Australian Standard - Geotechnical Investigations'*.

A breakdown of fieldwork activities is presented below:

3.2.1.1 Underground Service Search

A Dial Before You Dig (DBYD) underground service search and service clearance was conducted by the Astrea Pty Ltd.

3.2.1.2 Geotechnical Drilling

Investigatory drilling boreholes (BHs) were undertaken with the use of a tracked and Ute mounted rig operated by Geosense Engineering and Drilling Pty Ltd service. Boreholes were drilled vertically (90 degrees from the horizontal). Drilling through the soil and weathered rock was carried out using solid flight auger with Tungsten Carbide "TC" – bit. Deep boreholes were further advanced with NMLC coring until competent rock was reached, which ever came first. Standard penetration tests (SPT) were undertaken through the soil profile at 1.50 m intervals, proceeding from 1.5m below surface level (BSL). SPT refusal was considered where 30 blows generated less than 150mm penetration.

3.2.1.3 Standard Penetration Testing (SPT)

The SPT test involves raising and dropping a 63.5kg slide hammer 760mm to drive a thick-walled sample tube through the underlying layers. The number of blows required to penetrate the sample tube across 150mm increments is measured until the tube has penetrated 450mm into the subsurface, or the hammer is bouncing, causing refusal (Blow counts > 25). SPT tests were undertaken, to assist with the assessment of in-situ soil strength parameters. The tests were performed at 1.0m – 1.5m increments until refusal was achieved. SPT tests are presented in engineering logs provided in **Appendix B.**

3.2.2 Dynamic Cone Penetrometer (DCP) testing

DCP tests are carried out by driving a 16mm diameter steel rod with a 20mm diameter cone end into the ground using a standard 9kg hammer dropping 510mm. As the rod penetrates the soil, the number of blows required to penetrate each successive 100mm depth are recorded.

DCP tests were undertaken at the proposed delivery bund location, to assist with the assessment of in-situ soil strength. DCP tests are presented in separately in **Appendix B**.

3.3 Laboratory Testing

Samples of representative strata were recovered and returned to a NATA accredited laboratory. The following tests were carried out on selected samples:

- Two (2) samples for atterberg limits and particle size distribution testing to aid for material classification;
- Four (4) samples for Uniaxial Compressive Strength (UCS) testing to aid for rock strength;
- Four (4) samples to aggressivity and resistivity testing to steel and concrete; and
- Point load strength index tests were carried out every 1 m of recovered core where defect spacing provided enough core to carry out testing.

The following labs were used:

- Geotechnical Testing: STS Geotechnics Pty Ltd, Wetherill Park NSW
- Chemical Testing: Eurofins, Girraween NSW.

Laboratory test certificates are included in **Appendix C** for geotechnical testing and **Appendix D** for chemical testing. Geotechnical laboratory testing was carried out in accordance with Australian Standard AS1289 'Laboratory Testing for Engineering Purposes'.

4 PROPOSED DEVELOPMENT

The proposed development consisted of ancillary works to the RPA Hospital West Campus, comprising:

> Temporary helicopter landing site above existing multi storey carpark;

5 GROUND CONDITIONS ENCOUNTERED

5.1 Geotechnical Units

The geotechnical units along with the material descriptions of strata encountered during borehole investigation are summarised below in **Table 5-1**. For full descriptions of the sub-surface profiles encountered, reference can be made to the borehole logs presented in **Appendix B**.

Table 5-1 Geotechnical Units and Descriptions

Unit ID	Material Origin / Formation	Material Description
Unit P	Pavement	▪ Asphalt ▪ Concrete
Unit F	Fill	▪ Silty Sand, medium to coarse grained ▪ Silty CLAY: low to medium plasticity ▪ Stabilised Sandy Gravel ▪ Gravelly Sand, medium to coarse grained, grey, fine to medium, sub-angular to angular gravel ▪ Sand, medium to coarse grained ▪ Sandy Clay, medium to high plasticity, medium to coarse grained sand ▪ Sandy Gravel, medium to coarse grained, fine to medium grained sand
Unit R1	Residual	▪ Silty Clay, low to high plasticity ▪ Gravelly Sandy Silt, low plasticity, fine to coarse grained sand, fine, angular to sub-angular gravel ▪ Gravelly Clay, medium plasticity ▪ Clayey Sandy Gravel, fine to medium, sub-angular to angular, fine to medium grained, low plascitiy clay ▪ Sandy Clay, low to medium plasticity
Unit R2	Residual inferred as Extremely Weathered Bedrock	▪ Sity Clay, low to medium plascitiy, with ironstone and siltstone bands ▪ Gravelly Sandy Clay, medium plasticity, fine to medium grained sand, fine, sub-angular to angular siltstone and ironstone gravel ▪ Gravelly Clay, low plasticity ▪ Clayey Gravek, fine to medium gravel, low plasticity clay
Unit B	Bedrock	▪ Siltstone ▪ Interlaminated Siltstone and Sandstone

5.1.2 Summary of Subsurface Conditions

Table 5-2 summarises the geological units and the encountered depths in each borehole.

Table 5-2 Summary of Geotechnical Units - Encountered Depth m bsl

Borehole ID	Unit P	Unit F	Unit R1	Unit R2	Unit B	GW	TD
HLS Lift Pit							
BH501	0.0-0.07	0.20-0.70	0.70-4.00	4.00-6.20	6.20-TD	-	14.79
BH502	0.0-0.07	0.20-0.0	0.70-2.50	2.50-6.80	6.80-TD	-	14.62

Notes:
1. Bsl = below surface level
2. Unit P = Pavement
3. Unit F = Fill
4. Unit R1 = Residual
5. Unit R2 = Extremely Weathered Siltstone
6. Unit B = Bedrock
7. GW = Groundwater Seepage
8. TD = Target Depth

5.2 Groundwater

Groundwater was not encountered within BH501 & BH502; however groundwater monitoring wells were installed in BH502 after the completion of borehole drilling, details are provided in contamination report.

Where groundwater is encountered, It should be noted that groundwater levels may fluctuate depending on the time of year and following periods of wet weather. Seepage may also occur along the soil / rock interface during and after periods of wet weather.

The **Table 5-3** provides a summary of the groundwater levels encountered across the testing locations during the investigatory works.

Table 5-3 Summary of Groundwater level from monitoring wells

BH ID	Groundwater Level after well development (Date - m bsl)
BH502	29/09/2022 - 4.96

Notes:
1. BSL = Below Surface Level

6 LABORATORY TEST RESULTS

A summary of laboratory test results is presented in Tables **6-1** to **6-2**. The geotechnical lab results are attached in **Appendix C** and the chemical lab results are attached in **Appendix D**.

6.1 Soil Properties and classification

The results of material classification testing on selected samples are summarised below in **Table 6-1** below:

Table 6-1 Soil classification lab results summary

Hole ID	Depth (m BSL)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Gravel (%)	Sand (%)	Silt and Clay (%)
BH501	0.7-1.0	27.3	NT	NT	NT	NT	0.3	1.7	98
BH502	3.0	13.5	41	22	19	9.5	13.5	42.9	43.6

Notes:
1. NT = Not Tested

6.2 Chemical Properties

6.2.1 Soil Aggressivity Test Results

Results of soil aggressivity tests on selected samples obtained are summarised in **Table 6-2** below:

Table 6-2 Soil Aggressivity Test results summary

Hole ID	Depth (m BSL)	Chloride (mg/kg)	Conductivity (µS/cm)	pH	Resistivity (ohm.cm)	Sulphate (mg/kg)	Exposure Classification [a] (AS2159-2009)
BH501	3.0	<10	14	6.3	73000	<10	Non-aggressive to steel and concrete
BH502	10.21	<10	31	6.8	33000	<10	Non-aggressive to steel and concrete

Notes:
1. Based on AS 2159-2009 and groundwater condition mentioned above in Section 6.2.

6.3 Rock Testing

The point load test results are shown on the borehole logs attached in **Appendix B**. The summary of laboratory Uniaxial Compressive Strength (UCS) rock testing for the selected rock cores are provided in **Table 6-3** below:

Table 6-3 Summary of Rock UCS Test Results

Borehole ID	Depth (m BSL)	UCS (MPa)	Dry Density (t/m^3)	Moisture Content (%)
BH501	12.39	9.5	2.083	3.6
BH502	13.25	15.0	2.504	3.4

7 GEOTECHNICAL ASSESSMENT

7.1 Subsurface Conditions / Geology

The general ground conditions encountered on site have been discussed in **Section 5** of this report. In summary the ground condition encountered are relatively similar comprising asphaltic pavement overlying fill, overlying extremely weathered siltstone bedrock. From the investigation undertaken on site, the subsurface ground profile was generally consistent with the geology maps.

7.2 Earthworks

7.2.1 Site Preparation

The following sections provide advice on preparation, formation and unsuitable materials. The relevant earthworks standards referred to as a basis for design considerations and recommendations include:

- AS3798-2007 '*Guidelines on Earthworks for Commercial and Residential Developments'*.
- Safe Work Australia Excavation Work – Code of Practice

Prior to bulk earthworks, the site shall be cleared of any foreign matter or unsuitable material which includes but may not be limited to the following:

- Vegetation or organic matter including root balls of any larger trees onsite;
- Topsoil or soil significantly affected by roots or root fibres;
- Any scattered waste or dumped materials;
- Uncontrolled filling which may be subject to further assessment;
- Loose or low strength (soft to firm) soils or otherwise 'unsuitable' soils; or
- Expansive soils.

An erosion and sediment control plan should be implemented before commencing any earthworks for the proposed development.

7.2.2 Excavation Conditions

When considering excavation at any of the sites, the findings and recommendations presented in the Contamination Assessment report should also be considered.

Shallow / deep excavation will be required for lift pit foundation and it is recommended that construction contractors assess the engineering logs, core photographs and rock cores to make their own assessment of excavation plant and production rates. The recommendations presented below are preliminary only and based on the geotechnical information across the site.

Assessment of material excavatability can be based on the method published by Pettifer and Fookes (1994). The degree of excavatability of rock is based on its Point Load Index (Is50) and fracture spacing.

Excavatability categories range from easy to hard digging, through easy to hard ripping, to blasting.

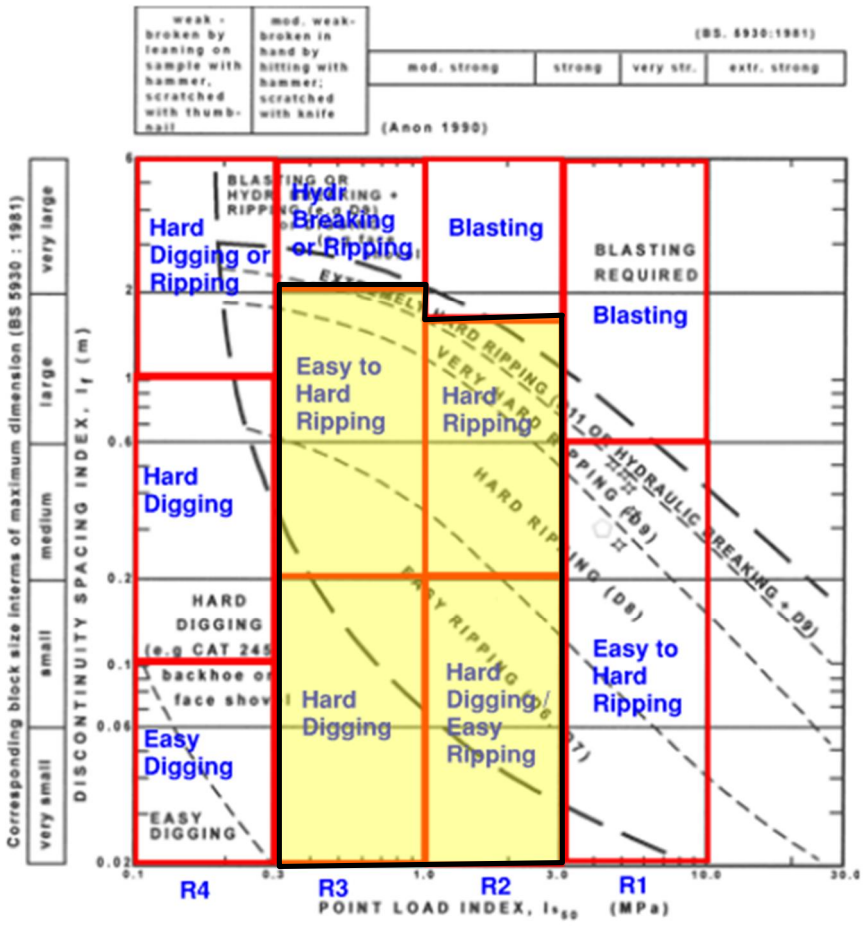

Figure 7-1 Zoning of excavatability based on Pettifer and Fookes (1994)

Examination of **Figure 7-1** shows that the excavatability zones are delineated according to rock strength categories (R4-low strength, R3-medium strength, R2-high strength, R1-very high strength), and further subdivided based on the defect spacing of the rock.

Our review of the borehole logs indicates that bedrock conditions encountered were generally moderately strong with defect spacing in the order of 5mm – 750mm. It is therefore expected that excavatability would classify as:

- hard digging to easy ripping conditions and;
- hard ripping in Class III to Class V Siltstone

7.3 Geotechnical Parameters

Geotechnical parameters relevant for the development have been developed based on available geotechnical information obtained to date for the project, published data and our experience of materials of similar nature and history on projects within Sydney region.

The design values derived are generally obtained from statistical analyses of project specific in-situ and laboratory test results. The values are representative of the properties of the material in its current condition. Where there are insufficient in-situ or laboratory tests, empirical correlations are used.

When project specific in-situ and laboratory tests, or empirical correlations are not applicable or not available, design values are then chosen with due consideration of relevant experience from past projects and the application of engineering judgement.

7.3.1 Soil Classification

No geotechnical parameters have been assigned to manmade fill layers due to potential variability. Relative density/consistency of natural granular/cohesive layers, if any, shall be assessed based on SPT N values.

Table 7-1 Material Strength Parameters

Material	g (kN/m^3)	C_u (kPa)	c' (kPa)	φ' (°)	E' (MPa)	n'	K_a	K_p
Fill	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CLAY (Stiff)	19	50	2	26	8	0.35	0.39	2.56
CLAY (Very Stiff)	20	100	5	28	15	0.35	0.36	2.77
CLAY (Hard)	21	200	10	28	30	0.3	0.36	2.77
GRAVEL (Dense - Very Dense)	20	-	0	36	60	0.3	0.26	3.85
Siltstone Class V	22	-	10	29	100	0.3	0.34	2.88
Siltstone Class IV	23	-	25	30	300	0.3	0.33	3.00
Siltstone Class III	23	-	100	32	600	0.2	-	-

Notes:
g: Unit Weight
c_u: Undrained Shear Strength
c': Drained Shear Strength
K_a: Active Earth Pressure
φ': Internal Friction Angle
E': Elastic Modulus
n': Poisson's ratio
K_p: Passive Earth Pressure
N/A = No geotechnical parameters have been assigned to fill layers due to potential variability.

7.3.2 Rock Classification

The classification of Siltstone bedrock (inferred as Shale) encountered on site is summarised in accordance with **Table 7-2** which are extracted from current Pells et al (2019) publication "Classification of Sandstones and Shales in the Sydney Region: A Forty Year Review".

Table 7-2 Rock Mass Classification System – Shale – Pells et al (2019)

Rock Mass Classification	Unconfined Compressive Strength q_u (MPa)	Defect Spacing	Allowable Seams
I	>16	>600	<2%
II	>7	>200	<4%
III	>2	>60	<8%
IV	>1	>20	<25%
V	>1	N/A	N/A

Considering the classification system, and UCS and point load testing, the rock classification for each borehole is summarised in the **Table 7-3** below:

Table 7-3 Classification of Rock at Borehole Locations

BH ID	Depth from BSL (m)	Thickness (m)	Rock Classification
BH501	6.50 – 8.40	1.90	Siltstone Class IV
BH501	8.40 – 14.79	6.39	Siltstone Class III
BH502	9.80 –10.06	0.26	Siltstone Class V

BH502	10.06 – 11.00	0.94	Siltstone Class IV
BH502	11.00 – 14.62	3.62	Siltstone Class III

Note:

The above classification considers rock substance strength, defect spacing, and allowable seams as required by Pells et al (2019). Thereby, a portion of rock mass not meeting an upper class is placed at the next lower class where all three factors are satisfied. A strata of rock is subjected to all three factors in general and combining thin layers of different class into a thick stratum using engineering judgement. The Designer shall review the borehole logs and core photographs to assess the potential impacts of thin layers combined in thicker layers. This is particularly true for end bearing piles which shall be checked not to be adversely impacted by weak/ highly fractured bands of rock below the designed pile toe level.

7.4 Foundation Options

Shallow / deep foundations would be suitable for lift pit, subject to loading conditions. Parameters for both shallow and deep footing options are provided below.

7.4.1 Shallow / Pad Footings

Due to the unknown loads and footing systems, no specified allowable bearing capacities can be determined at this time. Once specific loadings have been ascertained, Cardno can assist to optimise the footing size and depth to suit the loading on the founding material. Bearing capacity of footings in soil needs to be subjected to geotechnical checking considering footing size, depth, slope (ground surface and/or footing base) and loadings (i.e. bearing capacity is not a soil property but is dependent of footing size, depth, slope and loadings). A footing subjected to pull out forces will require further geotechnical assessment in addition to bearing capacity, overturning and sliding.

Conventional shallow footings designed in accordance with engineering principles and nominally embedded 0.5m into the design founding material, may be proportioned on the following ultimate end-bearing pressures, summarised in **Table 7-4** below:

Table 7-4 Shallow / Pad Footing Design Parameters

Founding Material	Area (m)	Ultimate Bearing Capacity (kPa)
CLAY – Stiff	1 x 1	300
CLAY – Very Stiff	1 x 1	500
CLAY – Hard	1 x 1	750

Note:

1. Ultimate bearing capacity tabulated above assuming eccentricity of 1/6 x footing width.
2. Horizontal ground is assumed
3. Consideration of Section 6.3 should be considered, prior to selection of founding level.
4. The settlement for shallow footings depends upon the loading conditions, footing size and foundation material, but it should be less than 1% of the footing width if proportioned on the basis of above parameters.
5. A minimum geotechnical strength reduction factor Øg of 0.4 can be applied for the allowable design values.

7.4.2 Deep Foundations

The proposed structures are recommended to be founded on piles that transfer the column loads to more suitable founding strata at depth below the sites. The type of pile will depend on the specific ground and groundwater conditions and relative cost. For the purposes of pile design, the parameters shown in **Table 7-5** may be used. However, if bored piles are adopted, the base of the piles must be inspected during construction to ensure that material of adequate capacity supports each pile.

Table 7-5 Pile Design Parameters (Based on Pells 2019)

Class	Serviceability End bearing (MPa)	Ultimate Shaft adhesion[1] (kPa)	Typical Efield (MPa)
Siltstone Class III	3.5	350	600
Siltstone Class IV	1	150	300
Siltstone Class V	0.7	50	100

Note:

1. Clean Sockets for roughness category R2 or better is required.
2. Horizontal ground is assumed
3. The settlement for shallow footings depends upon the loading conditions, footing size and foundation material, but it should be less than 1% of the footing width if proportioned on the basis of above parameters

Further Discussions for Pile Footings

- Where the design is dependent upon end bearing resistance, piles must extend at least 0.5m into the founding stratum to develop full design end bearing.
- The base of the piles must be inspected during construction to ensure that material of adequate capacity supports each pile.
- In accordance with the requirements of AS2159-2009, a geotechnical reduction factor is to be applied to the ultimate geotechnical strength to obtain the design geotechnical strength. We have determined that an average risk rating ARR=3.07 (corresponding to a moderate overall risk category) and a geotechnical reduction factor ϕg = 0.48 can be adopted for this project. This is based on the following assumptions:
  - Detailed level of construction control is required with professional geotechnical supervision, construction processes that are well established and relatively straightforward;
  - No performance monitoring of the supported structure during and after construction is proposed;
  - Table 7-6 below gives an option table for the proposed deep foundations that can be adopted across the subject site, discussion and comments being noted;

Table 7-6 Deep Foundation Options

Wall Type	Advantages	Disadvantages
Bored Piles	> Quiet / No Vibration > Greater lengths can be installed	> Requires the use of liners and possible slurry. > Requires additional plant (cranes, etc)
CFA Piles	> Low Noise / vibration > No need for casing due to sloughing/seepage > Faster productivity than bored piles	> A higher waste of concrete than traditional bored piles > Requires additional plant (Cranes, etc)

8 CONSTRUCTION INSPECTION

It is recommended that placement of all structural fill and footing excavations be inspected, tested, and certified where necessary, by a suitably qualified geotechnical engineer to ensure recommendations made in this report have been addressed. Should subsurface conditions other than those described in this report be encountered, Cardno should be consulted immediately, and appropriate modifications developed and implemented if necessary.

9 REFERENCES

[1] Design Guidance Note No. 030, Rev C, Issue date: 30 May 2018, by NSW Health Infrastructure

[2] Pells et al (2019) “Classification of Sandstone and Shales in the Sydney Region: A Forty Year Review”. Issue date: August 2020, by Pells et al.

[3[4] AS 1170.4 “Structural Design Actions, Part 4: Earthquake Actions in Australia”, 2007, by Australian Standard

[5] AS 1726-2017 “Geotechnical Site Investigation”, 2017, by Australian Standard

[6] AS 2159-2009 “Piling – Design and Installation”, 2009, by Australian Standard

[7] AS 2870-2011 “Residential Slabs and Footing”, 2011, by Australian Standard

[8] AS 3798-2007 “Guidelines on Earthworks for Commercial and Residential Developments”, 2007, by Australian Standard

10 CLOSURE

We appreciate the opportunity to work collaboratively with you on this project. Our team looks forward to bringing our high level of expertise to deliver successful outcomes in your future projects.

Your attention is drawn to the appended document titled “*Important Information about this Geotechnical Report”.* This document is intended to clarify to the reader what the realistic expectations of this report should be, and what is the correct use of the document. Misinterpretation of geotechnical information presents significant risk to projects: The document includes a discussion on general limitations of geotechnical services, which by nature, are based extensively on opinion and judgement.

The statements included in this document are not intended to be exculpatory clauses or to reduce the general responsibility accepted by Cardno, but rather to identify where Cardno and our Client’s responsibilities lie. The statements ensure that all parties that may rely on the report are aware of their respective responsibilities.

For further enquiries, please do not hesitate to contact Cardno on the information supplied.

11 LIMITATION

The geotechnical comments and recommendations are provided based on the existing geotechnical report. Prepared by DP. Cardno will not be held responsible if the data provided in DP’s report do not resemble with the current site conditions.

Yours sincerely,

Bikesh Deoju
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Enc: Appendix A – Site Plan
Appendix B – Borehole Logs with Explanatory Notes
Appendix C – Geotechnical Laboratory Test Results
Appendix D – Chemical Laboratory Test Results
Appendix E – Important Information

Appendix A – Site Plan

BH502

BH501

Rwa

Legend

Boreholes

Site

Sydney 1:100000 Geological Map

Rwa - Black to dark-grey shale and laminite

NSW GOVERNMENT Health Infrastructure

1:250 Scale at A3

0 5 10 15 20 m

Geotechnical and Contamination Investigation
HLS Carpark

Grose Street, Camperdown

Stantec

Map Produced by Stantec Australia Pty Ltd
Date: 2022-9-23| Project: 304100230
Coordinate System: GDA2020
Aerial imagery supplied by metromap (23 September 2022)

Appendix B – Borehole Logs with Explanatory Notes

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


PEAT, highly organic soil


TOPSOIL


FILL


FILL: Asphalt or Bituminous Seal


FILL: Ballast


FILL: Concrete


FILL: Roadbase


Sedimentary rock: fine, mostly clay (CLAYSTONE)


Sedimentary rock: fine, mostly silt (SILTSTONE)


Sedimentary rock: fine, silt and clay (MUDSTONE, SHALE, LAMINITE)


Sedimentary rock: medium (SANDSTONE, GREYWACKE)


Sedimentary rock: fine to coarse, angular (BRECCIA)


Sedimentary rock: coarse, rounded (CONGLOMERATE)


Sedimentary rock: Organic (COAL)


Sedimentary rock: Carbonate (LIMESTONE, DOLOMITE)


Sedimentary rock: Volcanic (TUFF, VOLCANIC BRECCIA, AGGLOMERATE)


Igneous rock: Felsic, fine (RHYOLITE)


Igneous rock: Felsic, coarse (GRANITE)


Igneous rock: Mafic, fine to medium (BASALT, DOLERITE)


Igneous rock: Mafic, coarse (GABBRO)


Metamorphic rock: Foliated, fine to medium (SLATE, PHYLLITE, SHIST)


Metamorphic rock: Foliated, coarse (GNEISS)


Metamorphic rock: Non-foliated (QUARTZITE, HORNFELS, MARBLE)

Cardno

BOREHOLE LOG SHEET

Client: Health Infrastructure
Project: RPA West Campus
Location: HLS Lift Pit

Hole No: BH501

Job No: 304100230 **Sheet:** 1 of 3

Position: E331693.701 N6248592.203 56 GDA2020 **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Geo205 **Mounting:** Track **Driller:** MT
Casing Diameter: **Contractor:** Geosense
Data Started: 20/9/22 **Date Completed:** 20/9/22 **Logged By:** BD **Checked By:** DD

Drilling			Water	Sampling & Testing	Depth (m)	Graphic Log	Classification	Material Description			
Method	Resistance	Casing		Sample or Field Test				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
HA								0.07m ASPHALT	M		PAVEMENT
								0.20m FILL: Silty SAND: medium to coarse grained, dark brown, trace fine sub-angular to angular gravel			FILL
								FILL: Silty CLAY: low to medium plasticity, brown, dark brown, orange mottled pale grey, trace rootlets (organic matter), trace fine sub-angular to angular gravel			
				D 0.70 - 1.00 m				0.70m Silty CLAY: medium plasticity, grey mottled orange, trace rootlets (organic matter)			RESIDUAL SOIL
					1			1.00m Same as above but colour change to grey and low to medium plasticity	M (≈PL)		
	E-F			SPT 1.50 - 1.95 m 5, 6, 10 N=16			Cl			St	
					2				M (≈PL) to M (<PL)		
								2.50m Gravelly Sandy SILT: low plasticity, grey, reddish brown, fine to coarse grained sand, fine grained, angular to sub-angular gravel, with low plasticity clay			
	F-H						ML			H	
				ES 3.00 m SPT 3.00 - 3.45 m 5, 10, 13 N=23	3			3.00m Silty CLAY: low plasticity, grey			
AD/T	E-F		Groundwater Not Observed				CL			VSt	
					4			4.00m Silty CLAY: low to medium plasticity, grey mottled reddish brown, trace fine to medium grained sand, trace fine angular to sub-angular, ironstone and siltstone gravel gravel			EXTREMELY WEATHERED
				SPT 4.50 - 4.80 m 7, 23 HB N=R				4.5-4.8: with reddish brown ironstone / siltstone bands	M (<PL)		
	F-H				5		CL-Cl			H	
				SPT 6.00 - 6.32 m 2, 10, 3/20mm HB N=R	6			6.20m SILTSTONE: grey, brown, highly weathered, very low strength			BEDROCK
	H							6.50m Continued as Cored Drill Hole			
					7						

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

CORE LOG SHEET

Client: Health Infrastructure
Project: RPA West Campus
Location: HLS Lift Pit

Hole No: BH501

Job No: 304100230 **Sheet:** 2 of 3

Position: E331693.701 N6248592.203 56 GDA2020	**Angle from Horizontal:** 90°	**Surface Elevation:**
Rig Type: Geo205	**Mounting:** Track	**Driller:** MT
Casing Diameter:	**Bit Type:** Diamond	**Bit Condition:** Good	**Contractor:** Geosense
Data Started: 20/9/22	**Date Completed:** 20/9/22	**Logged By:** BD	**Checked By:** DD

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
					1							
					2							
					3							
					4							
					5							
					6							
							6.50m START CORING AT 6.50m					
NMLC	5% Water LOSS	100	35		7		SILTSTONE, dark grey, indistinctly laminated with fine grained, light grey sandstone at 0- 5° with occassional iron staining	HW				6.55 m: BP, 0°, PR, S, CN 6.61 m: SM, 5 mm 6.62 - 6.72 m: JT, 80 - 90°, UN, RF, SN 6.75 m: JT, 60°, CU, C 6.80 m: DB 6.83 m: BP, 5°, PR, RF, SN 6.88 m: BP, 5°, ST, S, CT 6.96 m: SMGravely Clay, 10 mm 7.04 m: DB 7.08 - 7.13 m: JT, 80°, UN, S, CT 7.23 m: JT, 50°, PR, RF, C, 5 mm 7.26 m: BP, 5°, PR, S, CT 7.35 - 7.37 m: SMGravel and Clay mix 7.40 m: HB

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 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
- 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

CORE LOG SHEET

Client: Health Infrastructure
Project: RPA West Campus
Location: HLS Lift Pit

Hole No: BH501

Job No: 304100230 **Sheet:** 3 of 3

Position: E331693.701 N6248592.203 56 GDA2020 **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Geo205 **Mounting:** Track **Driller:** MT
Casing Diameter: **Bit Type:** Diamond **Bit Condition:** Good **Contractor:** Geosense
Data Started: 20/9/22 **Date Completed:** 20/9/22 **Logged By:** BD **Checked By:** DD

Coring: Method	Coring: Fluid	Coring: TCR (%)	Coring: RQD (%)	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Material Description: SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Material Description: Weathering	Material Description: Estimated Strength $Is_{(50)}$ MPa (● - Axial O - Diametral)	Defect Description: Average Natural Defect Spacing (mm)	Defect Description: Visual	Defect Description: Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
NMLC		100	35				SILTSTONE, dark grey, indistinctly laminated with fine grained, light grey sandstone at 0- 5° with occassional iron staining *(continued)*	HW				7.46 m: BP, 5°, PR, S, SN 7.61 m: HB 7.63 m: HB 7.75 m: BP, 0°, PR, S, CT 7.80 m: HB 7.86 m: BP, 0°, PR, S, CT 7.87 - 7.89 m: HB 7.93 m: BP, 0°, PR, S, SN 8.15 - 8.21 m: SM 8.23 - 8.25 m: SMGravel and Clay mix 8.29 m: BP, 0°, PR, S, CN 8.30 - 8.60 m: FZ 8.65 - 8.74 m: FZ 8.74 - 8.75 m: SM, 10 mm 8.84 m: BP, 0°, PR, S, CN 8.93 - 8.94 m: FZ 8.96 - 9.00 m: JT, 80°, PR, S, CN 9.00 - 9.04 m: JT, 50°, PR, S, CN 9.04 - 9.08 m: FZ 9.08 - 9.25 m: JT, 70°, PR, S, CN 9.25 m: BP, 0°, PR, S, CN 9.29 m: DB 9.39 m: BP, 0°, PR, S, CN 9.52 m: BP, 0°, UN, S, CN 9.62 m: DB 9.71 m: BP, 0°, PR, S, CN 9.82 m: BP, 0°, PR, S, CN 9.71 - 10.29 m: JT, 80 - 90°, PR, S, CN 10.20 m: BP, 0°, PR, S, CN 10.29 - 10.36 m: SMExtremely Weathered 10.36 - 10.50 m: JT, 80 - 90°, Pl-St, S, CN 10.50 - 10.60 m: FZ 10.61 m: BP, 0°, CU, S, CN 10.61 - 10.73 m: JT, 70°, PR, S, CN 10.76 m: DB 10.88 m: BP, 5°, PR, S, CN 10.91 - 10.99 m: JT, 80°, CU, S, CN 11.01 - 11.06 m: JT, 30°, CU, S, CN 11.06 - 11.18 m: JT, 40 - 90°, PR, S, CN 11.18 - 11.22 m: SMExtremely Weathered 11.23 m: JT, 50°, CU, S, CT 11.25 - 11.26 m: SM 11.38 m: HB 11.40 m: BP, 0 - 5°, PR, S, CN 11.42 m: HB 11.44 m: BP, 0 - 5°, PR, S, CN 11.47 m: BP, 0 - 5°, PR, S, CN 11.49 m: BP, 0 - 5°, PR, S, CN 11.49 - 11.57 m: JT, 70°, IR, S, CN 11.60 m: BP, 0 - 5°, PR, S, CN 11.60 - 11.70 m: JT, 80°, PR, S, CN 11.70 - 11.90 m: FZ 12.14 - 12.17 m: JT, 80°, UN, S, CN 12.17 m: BP, 5°, PR, S, CN 12.25 m: BP, 5°, PR, S, CN 12.38 - 12.40 m: JT, 30°, PR, S, CN 12.75 m: DB 12.90 m: DB 12.98 m: BP, 0 - 5°, CU, S, CN 13.04 m: BP, 0 - 5°, PR, S, CN 13.04 - 13.07 m: JT, 35°, PR, S, CN 13.12 m: BP, 0°, PR, S, CN 13.20 m: BP, 0°, PR, S, CN 13.25 m: BP, 0°, PR, S, CN 13.44 m: BP, 0 - 5°, CU, S, CN 13.88 m: BP, 0°, PR, S, CN 14.04 m: HB 14.19 m: BP, 0 - 5°, PR, S, CN 14.12 - 14.73 m: JT, 80°, PR, S, CN 14.60 m: BP, 0 - 5°, PR, S, CN
							8.3-8.6: highly fractured	MW				
	15% Water LOSS					8.60m 8.65m	CORE LOSS 0.05m (8.60-8.65)	MW				
		97	53		9		SILTSTONE, dark grey, with occassional fine grained, light grey sandstone laminated at 0-5°	MW to SW				
					10		10.24-10.36: highly fractured	HW to MW MW				
	5% Water LOSS	100	22		11		11.49-11.54: Siltstone, light brown,					
					12			F				
						12.46m						
	5% Water LOSS	100	83		13		SILTSTONE (60%), dark grey, with fine grained, light grey SANDSTONE (40%) interlaminated at 0-5°					
					14		14.08: Light grey sandstone band, highly weathered	HW F				
						14.79m						
					15		TERMINATED AT 14.79 m Target depth					

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 now Stantec / NSW Health Infrastructure	TITLE: **Borehole Core Photographs – BH501** **Geotechnical and Contamination Investigation – RPA West Campus – HLS Lift**			
	PROJECT NO: **304100230**	DRILLED DATE: **20/09/2022**	INCLINATION: **-90 degree**	CORED LENGTH: **BOX 1 OF 2** **6.50 m to 11.00 m – 4.50 m Length**
	DRILL RIG: **Comacchio GEO 205**	CONTRACTOR: **Cardno & Geosense**	LOGGED BY: **BD**	CHECKED BY: **DD**

Cardno now Stantec / NSW Health Infrastructure	TITLE: **Borehole Core Photographs – BH501** **Geotechnical and Contamination Investigation – RPA West Campus – HLS Lift**			
	PROJECT NO: **304100230**	DRILLED DATE: **20/09/2022**	INCLINATION: **-90 degree**	CORED LENGTH: **BOX 2 OF 2** **11.00 m to 14.79 m – 3.79 m Length**
	DRILL RIG: **Comacchio GEO 205**	CONTRACTOR: **Cardno & Geosense**	LOGGED BY: **BD**	CHECKED BY: **DD**

Cardno

BOREHOLE LOG SHEET

Client: Health Infrastructure
Project: RPA West Campus
Location: HLS Lift Pit

Hole No: BH502

Job No: 304100230 **Sheet:** 1 of 3

Position: E331700.964 N6248594.772 56 GDA2020 **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Geo205 **Mounting:** Track **Driller:** MT
Casing Diameter: **Contractor:** Geosense
Data Started: 21/9/22 **Date Completed:** 21/9/22 **Logged By:** BD **Checked By:** DD

Drilling			Water	Sampling & Testing	Depth (m)	Graphic Log	Classification	Material Description: 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
Method	Resistance	Casing		Sample or Field Test							
HA					0.07m			ASPHALT			PAVEMENT
					0.20m			FILL: Silty SAND: medium to coarse grained, dark brown, trace fine sub-angular to angular gravel			FILL
								FILL: Silty CLAY: low to medium plasticity, brown, dark brown, orange mottled pale grey, trace rootlets (organic matter), trace fine sub-angular to angular gravel			
					0.70m						RESIDUAL SOIL
	E-F				1		CI	Gravelly CLAY: medium plasticity, grey, reddish brown, fine to medium, sub-angular, siltstone and ironstone gravel	M (<PL)	H	
					1.30m						
	F			D 1.50 m SPT 1.50 - 1.95 m 5, 18, 25 N=43	2		GC	Clayey Sandy GRAVEL: fine to medium, sub-angular to angular, grey, reddish brown, fine to medium grained sand, low plasticity clay	D	VD	
					2.50m						
								Sandy CLAY: low plasticity, grey, reddish brown, trace fine to medium, sub-angular to angular, siltstone and ironstone gravel			EXTREMELY WEATHERED
				SPT 3.00 - 3.37 m 9, 20, 6/70mm HB N=R	3						
					4			3.8m: Same as above but colour changed to grey, reddish brown			
AD/T	F-H		Groundwater Not Observed		5		CL		M (<PL)	H	
					6			5.2m: Same as above but colour changed to light brown, reddish brown			
					6.80m						
					7			SILTSTONE: dark brown, dark grey, highly weathered, very low strength			BEDROCK

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: Health Infrastructure
Project: RPA West Campus
Location: HLS Lift Pit

Hole No: BH502

Job No: 304100230 **Sheet:** 2 of 3

Position: E331700.964 N6248594.772 56 GDA2020 **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Geo205 **Mounting:** Track **Driller:** MT
Casing Diameter: **Contractor:** Geosense
Data Started: 21/9/22 **Date Completed:** 21/9/22 **Logged By:** BD **Checked By:** DD

Drilling			Water	Sampling & Testing	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			Groundwater Not Observed		9			SILTSTONE: dark brown, dark grey, highly weathered, very low strength *(continued)*			BEDROCK
								9.80m Continued as Cored Drill Hole			
					10						
					11						
					12						
					13						
					14						
					15						

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

CORE LOG SHEET

Client: Health Infrastructure
Project: RPA West Campus
Location: HLS Lift Pit

Hole No: BH502

Job No: 304100230 **Sheet:** 3 of 3

Position: E331700.964 N6248594.772 56 GDA2020 **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Geo205 **Mounting:** Track **Driller:** MT
Casing Diameter: **Bit Type:** Diamond **Bit Condition:** Good **Contractor:** Geosense
Data Started: 21/9/22 **Date Completed:** 21/9/22 **Logged By:** BD **Checked By:** DD

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
					9							
							9.80m START CORING AT 9.80m					
NMLC	20% Water LOSS	98	71		10		9.91m SILTSTONE, dark grey, extremely weathered and very low strength 9.95m 10.04m CORE LOSS 0.04m (9.91-9.95) 10.06m SILTSTONE, dark grey CORE LOSS 0.02m (10.04-10.06)	XW HW HW				9.80 - 9.91 m: SM, EWM & Clay
					11		SILTSTONE, dark grey, traces of fine grained, sandstone, light grey laminated at 0-5° 10.5-10.55m: Siltstone, dark brown 11.12-11.20m: Siltstone, dark brown laminated at 0°	SW				10.13 m: BP, 0°, PR, S, CT 10.17 - 10.20 m: JT, 60°, PR, S, CN 10.20 m: SM, 5 mm 10.25 - 10.30 m: SM, EWM & Clay 10.30 - 10.40 m: JT, 70°, PR, S, CN 10.45 - 10.48 m: SM, EWM 10.56 m: BP, 0°, PR, S, CN 10.57 m: BP, 0 - 5°, PR, S, CN 10.64 m: HB 10.74 m: BP, 0°, PR, S, CN 10.81 - 10.87 m: BPx3, 0°, PR, S, CN 10.91 m: FZ, 5 mm 10.93 m: HB 10.95 m: HB 11.09 - 11.12 m: SM, Clay & Gravel 11.17 m: HB 11.25 m: JT, 40°, PR, S, CN 11.28 m: DB 11.65 m: JT, 40°, CU, S, CN 11.75 m: JT, 30°, CU, S, CN 11.89 m: JT, 60°, CU, S, CN
					12			F				12.20 m: JT, 65°, CU, S, CN
	5% Water LOSS	100	80		13		12.80m SILTSTONE (60%), dark grey, with fine grained, light grey SANDSTONE (40%) interlaminated at 0-5°					12.68 m: JT, 60°, CU, S, CN 12.78 m: HB 12.95 m: HB 13.18 m: BP, 5°, PR, S, CN 13.27 m: BP, 0°, PR, S, CN 13.49 m: BP, 0°, PR, S, CN 13.72 m: HB
					14		14.35-14.5m: interlamination at 10° 14.62m					14.24 m: JT, 30°, PR, S, CN 14.29 - 14.35 m: SZ, EWM & Clay 14.36 m: BP, 0°, PR, S, CN 14.48 m: JT, 20°, PR, S, CN 14.55 m: BP, 0°, IR, S, CN
					15		TERMINATED AT 14.62 m Target depth					

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 now Stantec / NSW Health Infrastructure	TITLE: **Borehole Core Photographs – BH502** **Geotechnical and Contamination Investigation – RPA West Campus – HLS Lift**			
	PROJECT NO: **304100230**	DRILLED DATE: **21/09/2022**	INCLINATION: **-90 degree**	CORED LENGTH: **BOX 1 OF 1** **9.80 m to 14.62 m – 4.82 m Length**
	DRILL RIG: **Comacchio GEO 205**	CONTRACTOR: **Cardno & Geosense**	LOGGED BY: **BD**	CHECKED BY: **DD**

Appendix C – Geotechnical Laboratory Test Results

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Moisture Content of Soil and Aggregate Samples

Project: RPA West Campus - Missenden Road, Camperdown — Project No.: 31980

Client: Cardno / Stantec Austrralia — Report No.: 22/3502

Address: Level 9, The Forum, 203 Pacific Highway St Leonards NSW 2065 Australia — Report Date: 6/10/2022

Test Method: AS1289.2.1.1 — Page: 1 of 1

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

STS / Sample No.	6947D-L/1	6947D-L/2	6947D-L/4			
Sample Location	BH 501	BH 502	BH 504			
Material Description	Silty Clay, grey brown trace of sand	Silty Sand, grey with gravel	Silty Sandy Gravel, grey			
Depth (mm)	0.7 - 1.0	1.5 - 1.95	1.0 - 1.5			
Sample Date	20-21/9/22	20-21/9/22	20-21/9/22			
Moisture Content (%)	**27.3**	**13.5**	**12.7**			

Remarks:

Approved Signatory.....

Technician: AS — David Ly - Senior Geotechnician

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

NATA Accredited for Compliance with ISO/IEC 17025 - Testing No. 2750

Atterberg Limits and Linear Shrinkage Report

Project: RPA West Campus - Missenden Road, Camperdown — Project No.: 31980

Client: Cardno / Stantec Austrralia — Report No.: 22/3503

Address: Level 9, The Forum, 203 Pacific Highway St Leonards NSW 2065 Australia — Report Date: 6/10/2022

Test Method: AS1289.3.1.2, 3.2.1, 3.4.1, 2.1.1 — Page: 1 of 1

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

STS / Sample No.	6947D-L/2	6947D-L/4				
Sample Location	BH 502	BH 504				
Material Description	Silty Sand, grey with gravel	Silty Sandy Gravel, grey				
Depth (m)	1.5 - 1.95	1.0 - 1.5				
Sample Date	20-21/9/22	20-21/9/22				
Sample History	Oven Dried	Oven Dried				
Method of Preparation	Dry Sieved	Dry Sieved				
Liquid Limit (%)	**41**	**38**				
Plastic Limit (%)	**22**	**19**				
Plasticity Index	**19**	**19**				
Linear Shrinkage (%)	**9.5**	**9.5**				
Mould Size (mm)	250	128				
Crumbing	N	N				
Curling	N	N				

Remarks:

Approved Signatory.....

Technician: DH

Lucky Ly - Senior Geotechnician

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

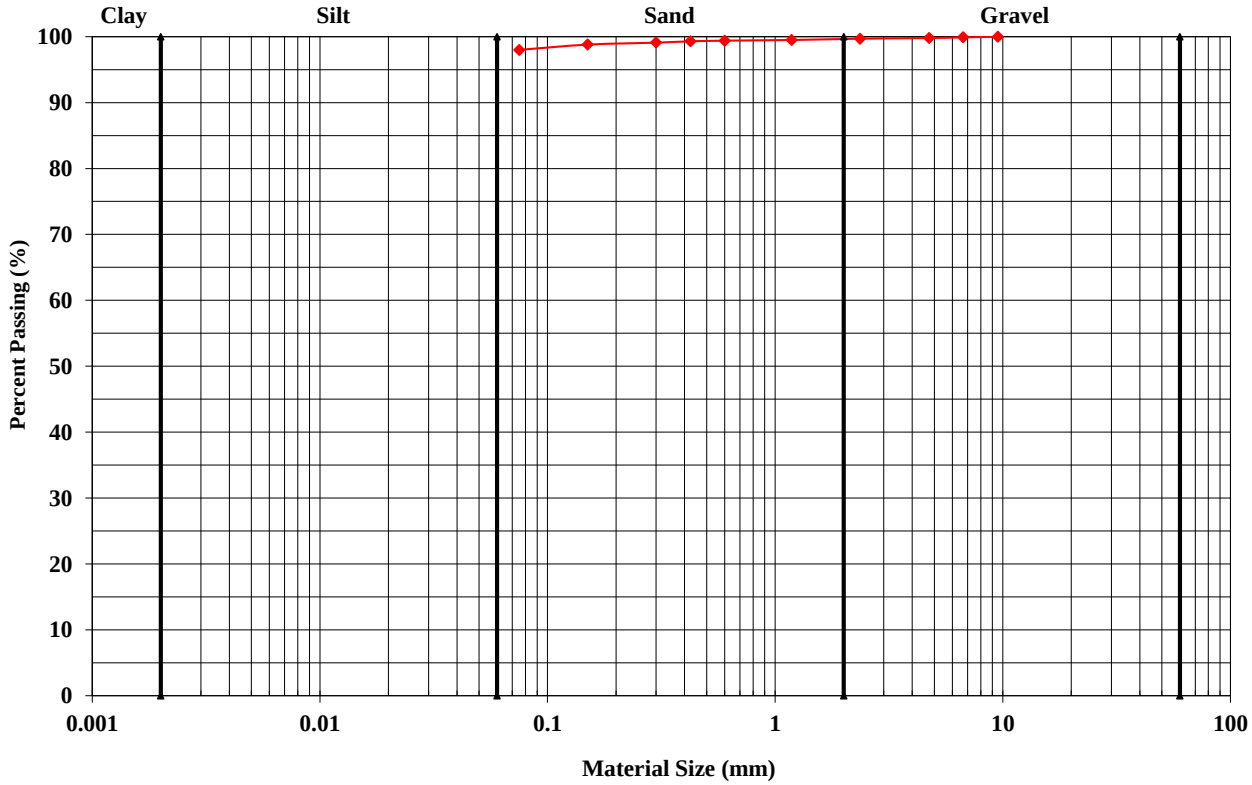
STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Particle Size Distribution

Project: RPA West Campus - Missenden Road, Camperdown
Client: Cardno / Stantec Australia
Address: Level 9, The Forum, 203 Pacific Highway St Leonards NSW 2065
Test Method: AS1289.3.6.1
Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)
Material Description: Silty Clay, grey brown trace of sand

STS / Sample No.: 6947D-L/1
Sample Location: BH501
Depth (m): 0.7 - 1.0
Date Sampled: 20-21/9/22

Project No.: 31980
Report No.: 22/3501
Report Date: 6/10/2022
Page: 1 of 3
Client Project No: 304100230



Sieve Size (mm)	Percent Passing (%)
9.5	100.0
6.7	99.9
4.75	99.8
2.36	99.7
1.18	99.5
0.60	99.4
0.425	99.3
0.30	99.1
0.15	98.8
0.075	98.0

Remarks:

Approved Signatory.....

Technician: AS/DH

David Ly - Senior Geotechnician

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

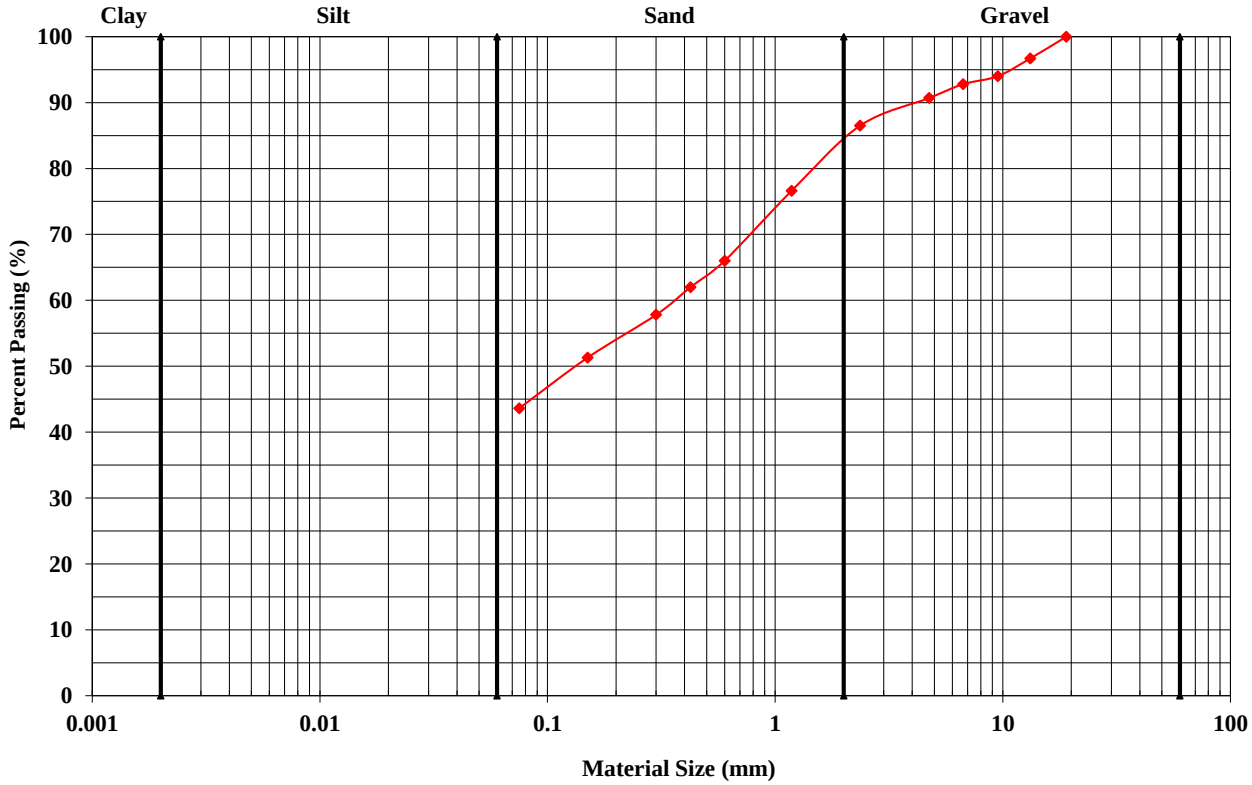
STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Particle Size Distribution

Project: RPA West Campus - Missenden Road, Camperdown
Client: Cardno / Stantec Australia
Address: Level 9, The Forum, 203 Pacific Highway St Leonards NSW 2065
Test Method: AS1289.3.6.1
Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)
Material Description: Silty Sand, grey with gravel

STS / Sample No.: 6947D-L/2
Sample Location: BH502
Depth (m): 1.5 - 1.95
Date Sampled: 20-21/9/22

Project No.: 31980
Report No.: 22/3501
Report Date: 6/10/2022
Page: 2 of 3
Client Project No: 304100230



Sieve Size (mm)	Percent Passing (%)
19.0	100.0
13.2	96.7
9.5	94.0
6.7	92.8
4.75	90.7
2.36	86.5
1.18	76.6
0.60	66.0
0.425	62.0
0.30	57.8
0.15	51.3
0.075	43.6

Remarks:

Approved Signatory.....

Technician: AS/DH

David Ly - Senior Geotechnician

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Uniaxial Compressive Strength of Rock Core

Project: RPA West Campus - Missenden Road, Camperdown — Project No.: 31980

Client: Cardno / Stantec Austrralia — Report No.: 22/3553

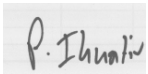
Address: Level 9, The Forum, 203 Pacific Highway St Leonards NSW 2065 Australia — Report Date: 07/10/22

Test Method: AS4133.4.2.2, .1.1 — Page: 1 of 2

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

Sample No.	6947D-L/5	6947D-L/6				
Location (BH)	BH501	BH502				
Depth (m)	12.39	13.25				
Sample Description	Shale	Shale				
Date Cored	21/09/2022	21/09/2022				
Date Tested	5/10/2022	5/10/2022				
Testing Machine	MAN1000	MAN1001				
Sample Diameter (mm)	51.7	51.9				
Sample Height (mm)	134.7	105.1				
L/D Ratio	2.6	2.0				
Sample Conditioning	Tested as Received	Tested as Received				
Test Duration (min:sec)	24:00	17:00				
Failure Description	Single Shear	Single Shear				
Uniaxial Compressive Strength (MPa)	**9.5**	**15**				
Moisture Content (%)	**3.6**	**3.4**				
Dry Density (t/m^3)	**2.083**	**2.504**				
Storage Conditions	Core wrapped	Core wrapped				
Other Comments						

Remarks:



Approved Signatory.....

Technician: LL — Philip Ihnativ - Senior Geotechnician

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Unconfined Compressive Strength of Rock Cores

Project: RPA West Campus - Missenden Road, Camperdown
Client: Cardno / Stantec
Address: Level 9, The Forum, 203 Pacific Highway St Leonards NSW 2065 Australia

Project No.: 31980
Report No.: 22/3553
Report Date: 7/10/2022

Appendix D – Chemical Laboratory Test Results

Stantec Australia Pty Ltd
Level 22, 570 Bourke Street
Melbourne
VIC 3000

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates.

Attention: **Bikesh Deoju**

Report **925953-S**
Project name GEOTECHNICAL INVESTIGATION - RPA WEST CAMPUS HLS LIFT
Project ID 304100230
Received Date Sep 23, 2022

Client Sample ID			**BH501**	**BH502**
Sample Matrix			**Soil**	**Soil**
Eurofins Sample No.			**S22-Se0051103**	**S22-Se0051104**
Date Sampled			**Sep 20, 2022**	**Sep 21, 2022**
Test/Reference	LOR	Unit		
Chloride	10	mg/kg	< 10	< 10
Conductivity (1:5 aqueous extract at 25 °C as rec.)	10	uS/cm	14	31
pH (1:5 Aqueous extract at 25 °C as rec.)	0.1	pH Units	6.3	6.8
Resistivity*	0.5	ohm.m	730	330
Sulphate (as SO4)	10	mg/kg	< 10	< 10
% Moisture	1	%	16	8.7

Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Chloride	Sydney	Sep 27, 2022	28 Days
- Method: LTM-INO-4270 Anions by Ion Chromatography			
Conductivity (1:5 aqueous extract at 25 °C as rec.)	Sydney	Sep 27, 2022	7 Days
- Method: LTM-INO-4030 Conductivity			
pH (1:5 Aqueous extract at 25 °C as rec.)	Sydney	Sep 27, 2022	7 Days
- Method: LTM-GEN-7090 pH by ISE			
Sulphate (as SO4)	Sydney	Sep 27, 2022	28 Days
- Method: In-house method LTM-INO-4270 Sulphate by Ion Chromatograph			
% Moisture	Sydney	Sep 23, 2022	14 Days
- Method: LTM-GEN-7080 Moisture			

eurofins

web: www.eurofins.com.au
email: EnviroSales@eurofins.com

Eurofins Environment Testing Australia Pty Ltd
ABN: 50 005 085 521

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Company Name: Stantec Australia Pty Ltd (NSW/ACT)
Address: Level 22, 570 Bourke Street
Melbourne
VIC 3000

Order No.:
Report #: 925953
Phone:
Fax:

Received: Sep 23, 2022 11:00 AM
Due: Sep 30, 2022
Priority: 5 Day
Contact Name: Bikesh Deoju

Project Name: GEOTECHNICAL INVESTIGATION - RPA WEST CAMPUS HLS LIFT
Project ID: 304100230

Eurofins Analytical Services Manager : Hannah Mawbey

Sample Detail						Aggressivity Soil Set	Moisture Set
Sydney Laboratory - NATA # 1261 Site # 18217						X	X
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	BH501	Sep 20, 2022		Soil	S22-Se0051103	X	X
2	BH502	Sep 21, 2022		Soil	S22-Se0051104	X	X
Test Counts						2	2

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

Units

mg/kg: milligrams per kilogram
mg/L: milligrams per litre
µg/L: micrograms per litre
ppm: parts per million
ppb: parts per billion
%: Percentage
org/100 mL: Organisms per 100 millilitres
NTU: Nephelometric Turbidity Units
MPN/100 mL: Most Probable Number of organisms per 100 millilitres

Terms

APHA	American Public Health Association
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
TBTO	Tributyltin oxide (*bis*-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment however free tributyltin was measured and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 5.4
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should be used as a guide only and may be different when site specific Sampling Analysis and Quality Plan (SAQP) have been implemented

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR: No Limit

Results between 10-20 times the LOR: RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.4 where no positive PFAS results have been reported have been reviewed and no data was affected.

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QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time.Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank									
Chloride			mg/kg	< 10			10	Pass	
Conductivity (1:5 aqueous extract at 25 °C as rec.)			uS/cm	< 10			10	Pass	
Sulphate (as SO4)			mg/kg	< 10			10	Pass	
LCS - % Recovery									
Chloride			%	109			70-130	Pass	
Conductivity (1:5 aqueous extract at 25 °C as rec.)			%	87			70-130	Pass	
Resistivity*			%	87			70-130	Pass	
Sulphate (as SO4)			%	98			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Chloride	S22-Se0045401	NCP	%	73			70-130	Pass	
Sulphate (as SO4)	S22-Se0045401	NCP	%	101			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Chloride	S22-Se0045400	NCP	mg/kg	< 10	< 10	<1	30%	Pass	
Conductivity (1:5 aqueous extract at 25 °C as rec.)	S22-Se0045404	NCP	uS/cm	19	20	3.1	30%	Pass	
pH (1:5 Aqueous extract at 25 °C as rec.)	S22-Se0045404	NCP	pH Units	7.2	7.1	<1	30%	Pass	
Resistivity*	S22-Se0045404	NCP	ohm.m	530	510	3.1	30%	Pass	
Sulphate (as SO4)	S22-Se0045400	NCP	mg/kg	< 10	< 10	<1	30%	Pass	
% Moisture	S22-Se0049914	NCP	%	10	10	1.9	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	No
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised by:

Hannah Mawbey	Analytical Services Manager
Ryan Phillips	Senior Analyst-Inorganic

Glenn Jackson
General Manager

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Alejandra Beltran
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Project	**304100230 - Additional**
Order Number	**304100230**
Samples	19

LABORATORY DETAILS

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SGS Reference	**SE237127A R0**
Date Received	27/9/2022
Date Reported	30/9/2022

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: 29/9/2022

PARAMETER	UOM	LOR	BH503_0.6-0.7 SOIL - 23/9/2022 SE237127A.002	BH504_0.4-0.6 SOIL - 23/9/2022 SE237127A.003
pH (1:2)	pH Units	-	**5.2**	**4.8**

Conductivity (1:2) in soil [AN106] Tested: 29/9/2022

PARAMETER	UOM	LOR	BH503_0.6-0.7 SOIL - 23/9/2022 SE237127A.002	BH504_0.4-0.6 SOIL - 23/9/2022 SE237127A.003
Conductivity (1:2) @25 C*	µS/cm	1	180	28
Resistivity (1:2)*	ohm cm	-	5500	35000

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography [AN245] Tested: 29/9/2022

PARAMETER	UOM	LOR	BH503_0.6-0.7 SOIL - 23/9/2022 SE237127A.002	BH504_0.4-0.6 SOIL - 23/9/2022 SE237127A.003
Chloride	mg/kg	0.25	**13**	**2.5**
Sulfate	mg/kg	0.5	**140**	**18**

METHOD	METHODOLOGY SUMMARY
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 of as received sample 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.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
***	Indicates that both * and ** apply.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Unless it is reported that sampling has been performed by SGS, the samples have been 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 and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

Appendix E – Important Information

Important Information about this Geotechnical Report

Scope of Work

The purpose of this report and any associated documentation is expressly stated in the document. This document does not form a complete assessment of the site, and no implicit determinations about Cardno's scope can be taken if not specifically referenced. Whilst this report is intended to reduce geotechnical risk, no level of detail or scope of work can entirely eliminate risk.

The nature of geotechnical data typically precludes auxiliary environmental assessment without undertaking specific methods in the investigation. Therefore, unless it is explicitly stated in the scope of work, this report does not provide any contamination or environmental assessment of the site or adjacent sites, nor can it be inferred or implied from any component of the document.

The scope of work, geotechnical information, and assessments made by Cardno may be summarised in the report; however, all aspects of the document, including associated data and limitations should be reviewed in its entirety.

Standard of care

Cardno have undertaken investigations, performed consulting services, and prepared this report based on the Client's specific requirements, data that was available or was collected, and previous experience.

Cardno's findings and assessment represent its reasonable judgment, diligence, skill, with sound professional standards, within the time and budget constraints of its commission. No warranty, expressed or implied, is made as to the professional advice included in this report.

Data sources

In preparing this document, or providing any consulting services during the commission, Cardno may have relied on information from third parties including, but not limited to; sub-consultants, published data, and the Client including its employees or representatives. This data may not be verified and Cardno assumes no responsibility for the adequacy, incompleteness, inaccuracies, or reliability of this information.

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Variability in conditions and limitations of data

Subsurface conditions are complex and can be highly variable; they cannot be accurately defined by discrete investigations. Geotechnical data is based on investigation locations which are explicitly representative of the specific sample or test points. Interpretation of conditions between such points cannot be assumed to represent actual subsurface information and there are unknowns or variations in ground conditions between test locations that cannot be inferred or predicted.

The precision and reliability of interpretive assessment between discrete points is dependent on the uniformity of the subsurface strata, as well as the frequency, detail, and method of sampling or testing.

Subsurface conditions are formed by various natural and anthropogenic processes and therefore are subject to change over time. This is particularly relevant with changes to the site ownership or usage, site boundary or layout, and design or planning modifications. Aspects of the site may also not be able to be determined due to physical or project related constraints and any information provided by Cardno cannot apply following modification to the site, regulations, standards, or the development itself.

It is important to appreciate that no level of detail in investigation, or diligence in assessment, can eliminate uncertainty related to subsurface conditions and thus, geotechnical risk. Cardno cannot and does not provide unqualified warranties nor does it assume any liability for site conditions not observed or accessible during the investigations.

Verification of opinions and recommendations

Geotechnical information, by nature, represents an opinion and is based extensively on judgment of both data and interpretive assessments or observation. This report and its associated documentation are provided explicitly based on Cardno's opinion of the site at the time of inspection, and cannot be extended beyond this.

Any recommendations or design are provided as preliminary until verified on site during project implementation or construction. Inspection and verification on site shall be conducted by a suitably qualified geotechnical consultant or engineer, and where subsurface conditions or interpretations differ from those provided in this document or otherwise anticipated, Cardno must be notified and be provided with an opportunity to review the recommendations.

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