Redfern Station Upgrade – New Southern Concourse

Appendix G - Geotechnical and Contamination Investigation Reports

Artist's impression of the proposed Redfern Station Upgrade - New Southern Concourse. Indicative only, subject to detailed design.

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Memorandum

To	**Marijan Harris**	From	**David Zhang**
Copy	**Brian Killeen**	Reference	**39525-TAP04**
Date	**2020-01-08**	Pages (including this page)	**15 +Appendices**
Subject	**Redfern Station Upgrade Geotechnical Investigation Report**		

1 Introduction

1.1 Project Background

Redfern Station is located approximately 1.3 km south of Central Station. The station has 12 platforms, two of which are underground (Platform 11 and 12). Redfern Station is served by a single concourse connecting all 12 platforms with frontage onto Lawson Street overbridge at the northern end of the station. There are three entrances to the Station; Lawson Street, Gibbons Street and an entrance at the southern end of Platform 10 which connects to a walkway to the Australian Technology Park (ATP).

Novo Rail is currently delivering the New Intercity Fleet (NIF) Project at Redfern Station. As part of this project, a pedestrian bridge is proposed to link from Platform 10 to Platform 1, which provides easy access for commuters between platforms. Figure 1 presents the indicative location of the proposed pedestrian bridge across Platform 1 - 10.

Novo Rail has engaged Aurecon to undertake intrusive investigation at Platform 10 and Platform 1. The purpose of the investigation is to understand the ground conditions to inform the pedestrian bridge foundation design and associated station upgrade works. This report presents the geotechnical investigation results, including results of fieldwork and laboratory testing, together with geotechnical comments and recommendations for pedestrian bridge design and associated works.

1.2 Objective of Investigation

The objective of this investigation is to provide the following information:

- Inferred subsurface conditions and ground model, including likely depth of soil and rock (and characteristics).
- Summary of geotechnical test results.
- Recommendations on foundation types and preliminary design parameters for pedestrian bridge.
- Discussion on station upgrade excavation conditions including preliminary recommendations parameters for support design.
- Preliminary comments on geotechnical issues and risks.

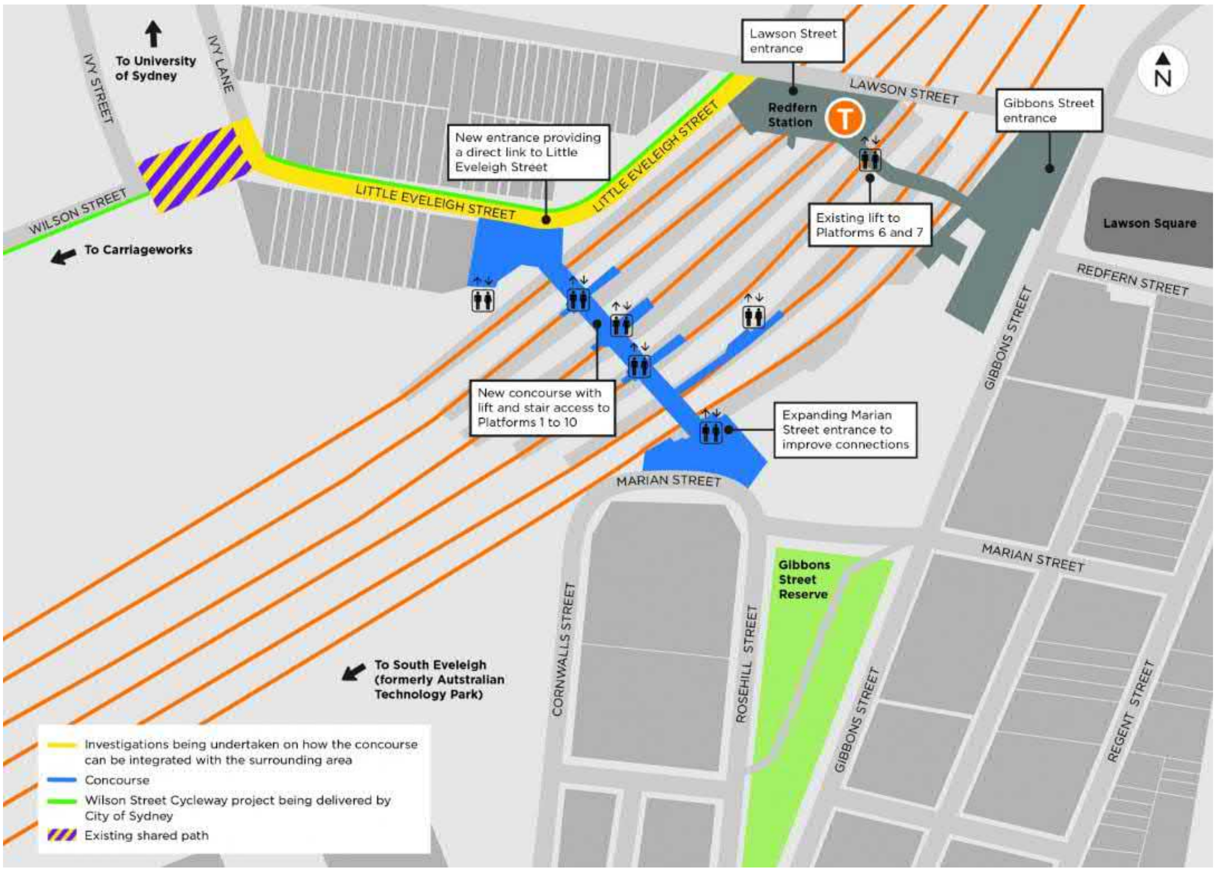

Figure 1: Proposed pedestrian bridge alignment at Redfern Station

2 Reference Documents

The following project documents have been referred to:

- Redfern Station Investigation Works, Geotechnical Investigation Report – by Jacobs (5 February 2018) (Document No. IA157700-RP-GI-0023 I 02)
- Redfern Station Investigation Works, Contamination Investigation Report – by Jacobs (5 February 2018) (Document No. IA157700-RP-GI-0025 I 02).

3 Scope of Work

The scope of work undertaken for this project included:

- Review of relevant Novo Rail safety procedures working within the Eveleigh Precinct
- Review of DBYD documents
- Clearance of test locations by a registered underground services locator
- Preparation of Occupational Health and Safety Plan
- Carry out intrusive geotechnical investigations
- Reinstatement of drilled holes with spoil and/or sand, and general clean up
- Logging of soils encountered in general accordance with AS1726-2017

- Collection, handling and transportation of representative material samples for laboratory testing
- Preparation of a geotechnical investigation report.

4 Site Settings

The following information documents were reviewed:

- Sydney 1: 100 000 Soil Landscape Series Sheet 9130
- Sydney 1: 100 0000 Geological Series 9130
- 1: 25 000 Acid Sulphate Soils (ASS) Risk Map Sheet 91 30S3.

4.1 Site Description

Platforms 1 through 10 are each provided with a single set of stairs and are connected by the northern concourse. Platforms 11 and 12 are located underground and are accessed via stairs and escalators from the Gibbons Street entrance at the south eastern end of the concourse. There is an entrance at the southern end of Platform 10 which connects with a walkway to the Australian Technology Park (ATP). There is also an entrance at southern end of Platforms 1 which connects with a walkway to Little Eveleigh Street.

4.2 Soil Landscapes

Reference to Sydney 1: 100, 000 Soil Landscape Series (Sheet 9130) indicates that soil along the project site is categorised as ‘disturbed terrain’; which suggests that the area has been modified for development. The landscape is characterised by gentle undulating rises (slopes <5%) on Wianamatta Group Shale and Hawkesbury Sandstone with local reliefs of up to 30 m. This area is further denoted as “developed terrain”.

The expected residual soils are either:

- Red and brown residual podzolic soils, shallow to moderately deep (up to 100 cm) located on crests, upper slopes and well drained area; or
- Yellow podzolic soils and soloths, deep (between 150 and 300 cm) located on lower slopes and in areas of poor drainage.

An extract from the soil landscape map is attached in Figure A4 of Appendix A of this report.

4.3 Site Geology

According to the available 1: 100 000 geological map (Sheet No. 9130), the expected geological units at the site are summarised below.

Table 1 Geology units

Unit	Description
(Rwa) Ashfield Shale	The site is expected to be underlain by Ashfield Shale unit which is a sequence of the Wianamatta Group. The Ashfield Shale sequence in the area typically comprises interbedded black to dark grey shales, laminates and fine to medium grained sandstones. These materials typically weather to form a residual profile of 1 to 3 metre of medium to high plasticity clays.

4.4 Acid Sulphate Soils

NSW Office of Environment and Heritage Acid Sulphate Soil mapping of the area suggests that no known occurrence of Acid Sulphate Soils has been identified within the Redfern area.

An extract from the acid sulphate soil map is given in Appendix A – Figure A5 of this report.

4.5 Existing Utilities

Review of DBYD (Dial before You Dig) have been carried out for the site area to obtain information on the services and utilities (under and above the ground) within the site area for the investigation fieldwork purposes. In addition, a site walkover and services search by a licenced Service Locator was undertaken within the investigation locations to assess and clear locations for intrusive investigations and to verify service locations identified during review of DBYD plans.

5 Method of Investigation

5.1 Borehole Investigation

The geotechnical investigation works were conducted on 14 March 2019, 4-5 April 2019,20 July 2019 and 7-8 December 2019 for BH02, BH03, BH04 and BH05 respectively. A summary of borehole information is provided in Table 2. The test location plan is shown on the site layout plan in Figure A2 of Appendix A.

Table 2 Summary of exploratory borehole locations

Hole ID	Termination	Termination Depth (m bgl)[1]	Coordinate[2]		Surface Level (m AHD)[3]
			Northing (m)	Easting (m)	
BH02	Target Depth	13.61	6248278	333393	29.4
BH03	Target Depth	16.25	6248326	333329	26.4
BH04	Target Depth	18.00	6248296	333386	26.4
BH05	Target Depth	18.72	6248333	333359	25.2

Notes: 1. m bgl = metres below ground level, 2. coordinate system MGA94 Zone 56, 3. m AHD = metres above Australian height datum

Drilling of BH02 and BH03 was completed using a multi-purpose CE 180 rig supplied and operated by BG Drilling Pty Ltd. BH04 and BH05 were completed using a XC Drill supplied and operated by Terratest Pty. Ltd. These small rigs were selected for their ability to access spatially constrained work spaces such as the BH02 location.

The holes were advanced with by solid auger drilling with a V-bit for drilling through soil. Standard penetration tests (to AS 1289.6.3.1) were performed at target depths as drilling progressed in soils for strength assessment and for obtaining samples for logging purposes. The disturbed soil samples collected from the Standard Penetration Testing (SPT) split spoon sampler were stored in labelled, sealed bags for laboratory testing purposes.

The holes were advanced with a NMLC core drilling techniques in rock strength materials. Rock core recovered from the drilling was packed in core trays, then logged and photographed.

Soil sampling was carried out at test locations, and subsequently delivered to a NATA accredited laboratory for testing.

Upon completion of the investigation at test locations, the holes were backfilled/reinstated with cement stabilised sand.

All site work was undertaken in accordance with the Safe Work Method Statement (SWMS) prepared by Aurecon. The fieldwork was supervised full time by an Aurecon Geotechnical Engineer in accordance with AS 1726 - 2017.

Test locations were captured on site using a hand-held GPS. The RLs indicated on logs have been estimated from the contour plan generated following detailed surface survey. The surface elevations are expected to be accurate to approximately ±0.5 m.

Fieldwork photos are provided in Appendix B.

A copy of borehole logs and explanatory notes are included in Appendix C.

5.2 Laboratory Testing

Selected soil/rock samples taken from the intrusive investigation were sent to a NATA accredited laboratory for testing. The samples include disturbed, SPT and rock core samples. A summary of the laboratory testing schedule is provided in Table 4.

The laboratory testing certificates are presented in Appendix C.

Table 3 Summary of laboratory testing

Testing Method	Method	Quantity				
		BH02	BH03	BH04	BH05	Total
Particle Size Distribution (PSD)	AS1289.3.6.1	4	1	2	-	7
Atterberg Limits	AS1289.3.1.2, AS 1289.3.3.1, AS 1289.3.2.1, AS1289.2.1.1	3	4	2	2	11
Moisture Content (MC)	AS1289.2.1.1	3	2	2	4	11
Durability Suites (pH, chloride, sulphates & resistivity)	APHA	1	-	-	2	3
Point Load Test	AS4133.4.1	14	32	51	11	108
Uniaxial Compressive Strength (UCS) Test	AS4133.4.2.2	1	7	1 (note 1)	2	11

Note: 1. Twelve samples from BH03 were scheduled for UCS testing, however, upon receiving the results, only one test specimen was within the standard length to diameter ratio range of 2.5-3, potentially due to handling breaks during transportation.

6 Laboratory Testing Results

Laboratory testing was conducted on samples obtained from boreholes. Samples were sent to a NATA accredited laboratory to confirm visual descriptions and materials classifications adopted by Aurecon's geotechnical engineer during site investigation work and derive engineering properties of each material unit based on standard test methods and published correlations to assist with the parameters development.

6.1 Soil Mechanical Testing

Small bulk disturbed samples were collected during the borehole investigation and were tested in the laboratory for the measurement of field moist content (FMC), Atterberg Limits, and Particle Size Distribution (PSD). The test results are summarised in Table 5. The laboratory test certificates are attached in Appendix C of this report.

Table 4 Summary of soil index test results

Borehole Number	Sample Depth (m)	Description (Classification)	FMC (%)	LL	PL	PI	LS	Grading		
								Clay/Silt (%)	Sand (%)	Gravel (%)
BH02	4.5	Silty CLAY	16.7	-	-	-	-	-	-	-
BH02	7	Silty CLAY	12.0	-	-	-	-	85	15	0
BH02	8-8.2	Silty CLAY (CH)	16.2	50	20	30	15.0	83	16	1
BH02	4.5	Silty CLAY	-	-	-	-	-	68	32	0
BH02	5	Silty CLAY (CI)	-	36	13	23	-	54	45	1
BH02	7	Silty CLAY (CH)	-	58	19	39	19.5	-	-	-
BH03	3	Silty CLAY (CH)	18.2	60	22	38	-	-	-	-
BH03	6	Silty CLAY (CI)	12.9	39	19	20	-	87	11	2
BH03	1.5	Silty CLAY(CH)	-	64	25	39	-	-	-	-
BH03	4.5	Silty CLAY (CH)	-	65	24	41	-	-	-	-
BH04	1.5	Silty CLAY (CI)	16.8	-	-	-	-	77	11	12
BH04	3	Silty CLAY (CH)	-	63	23	40	-	74	11	14
BH04	4.5	Silty CLAY (CH)	15.5	57	21	36	9.0	-	-	-
BH05	1.5-1.95	Sandy silty CLAY(CH)	-	54	22	32	-	-	-	-
BH05	3.0-3.45	Silty CLAY(CH)	-	59	20	39	-	-	-	-

Notes: FMC = Field Moisture Content, LL = Liquid Limit, PL = Plastic Limit, PI = Plastic Index, LS = Linear Shrinkage, Grading: Clay/Silt <0.075 mm, Sand 0.075 – 2.36 mm, Gravel > 2.36 mm.

6.2 Chemical Testing

Selected soil samples collected during the geotechnical intrusive investigation were tested in the laboratory for the measurement of pH, chlorides, sulphate, and resistivity to assess aggressivity for pile foundation design. The results are presented in Table 6.

Table 5 Summary of soil chemical test results

Borehole Number	Sample Depth (m)	Soil Conditions	pH	Chloride (mg/kg)	Sulphate (mg/kg)	Resistivity (ohm m)	Conductivity (µS/cm)
BH02	7	Clay (B)	5.0	68	83	560	90
BH05	1.5-1.95	Clay (B)	7.5	44.8	5.4	-	-
BH05	4.5-4.95	Clay (B)	6.3	11.9	7.8	-	-

The soils can be considered as 'non-aggressive' classification for steel and 'mild' for concrete piles buried below ground according to Table 6.5.2 and Table 6.4.2 of AS2159 – 2009.

The designer should review the results and make due allowance in their design for corrosion based on the recommended allowance set out in AS2159 or from local experiences. No sampling or testing for durability has been undertaken for groundwater as groundwater was not encountered during the investigation.

6.3 Rock Testing

Selected representative rock core recovered from boreholes were tested to determine Point Load Strength index (Is_{50}). The test results are summarised in Table 7. The laboratory test certificates are attached in Appendix D.

Table 6 Summary of rock test results

Borehole Number	Depth Range (m)	Corrected Point Load Strength, Is_{50}	
		Diametral (MPa)	Axial (MPa)
BH02	8.99-9.06	-	0.084
BH02	10.32-10.60	-	0.037
BH02	11.51-11.61	-	0.14
BH02	11.81-11.86	0.029	-
BH02	12.0-12.07	0.012	-
BH02	13.27-13.32	0.11	-
BH02	13.50-13.61	0.15	-
BH02	8.0	-	0.6
BH02	9.26	0.23	-
BH02	9.9	0.46	-
BH02	11.48	0.22	-
BH02	11.9	-	0.92
BH02	12.6	-	0.44
BH02	13.0	-	0.26
BH03	6.77-6.85	0.08	0.21
BH03	7.39-7.46	0.06	0.06
BH03	7.53-7.61	0.10	0.09
BH03	7.67-7.75	0.06	0.06
BH03	8.25-8.31	0.07	0.05
BH03	9-9.1	0.05	0.05
BH03	9.74-9.82	0.02	0.01
BH03	10.25-10.31	0.03	0.16
BH03	10.79-10.88	0.03	0.10
BH03	11.38-11.43	0.05	0.07
BH03	12.44-12.53	0.07	0.09
BH03	13.11-13.15	0.07	0.27
BH03	13.8-13.86	0.24	0.82
BH03	14.55-14.64	0.08	0.96
BH03	15.91-15.97	0.20	0.48

Borehole Number	Depth Range (m)	Corrected Point Load Strength, Is_{50}	
		Diametral (MPa)	Axial (MPa)
BH03	16.11-16.24	0.06	0.41
BH04	5.17-5.24	0.09	0.1
BH04	5.93-6	0.06	0.06
BH04	6.35-6.4	0.17	0.18
BH04	6.55-6.63	0.05	0.16
BH04	7.38-7.42	0.14	0.22
BH04	7.82-7.89	0.15	0.22
BH04	8.43-8.48	0.03	0.14
BH04	8.69-8.74	0.04	0.24
BH04	9.31-9.35	0.02	0.25
BH04	9.83-9.88	0.02	0.24
BH04	10.39-10.42	-	0.26
BH04	10.67-10.71	0.02	0.42
BH04	11.44-11.5	0.10	0.10
BH04	12.71-12.77	0.05	0.29
BH04	13.16-13.2	0.03	0.20
BH04	13.7-13.8	0.18	0.35
BH04	14.21-14.27	0.72	0.57
BH04	14.88-14.93	0.18	0.17
BH04	15.1-15.14	0.23	0.28
BH04	15.76-15.85	0.41	0.54
BH04	16.06-16.12	0.32	0.56
BH04	16.17-16.22	0.14	0.58
BH04	16.75-16.79	0.20	0.07
BH04	17.23-17.3	0.46	0.65
BH04	17.45-17.53	0.78	0.59
BH04	17.92-17.96	0.41	0.70
BH05	7.15-7.24	0.02	0.04
BH05	8.53-8.62	0.01	0.06
BH05	9.43-9.51	0.02	0.05
BH05	10.00-10.12	0.09	0.36
BH05	11.17-11.23	0.01	0.10
BH05	12.19-12.32	0.20	0.26
BH05	14.22-14.30	0.47	0.34
BH05	15.90-16.00	0.30	0.57
BH05	16.56-16.60	0.34	0.43
BH05	17.22-17.50	0.91	1.16
BH05	18.11-18.33	0.33	0.47

Borehole Number	Depth range (m)	Uniaxial Compressive Strength (MPa)
BH02	N/A	1.60
BH03	7.26-7.37	0.99
BH03	8.35-8.45	0.99
BH03	9.96-10.11	2.6
BH03	11.29-11.38	1.3
BH03	14.00-14.14	19
BH03	16.11-16.24	23
BH04	17.60-17.77	12
BH05	17.22-17.50	10
BH05	18.11-18.33	7.8

The results from point load tests and UCS tests were used to calibrate the field assessment of recovered rock core and generally confirmed the field assessment. This information has been used to inform the rock mass characterisation.

7 Geotechnical Design Profile

7.1 Subsurface Profile

Based on the geotechnical investigation results, a geotechnical model has been developed for the site to assess the foundation conditions and excavation conditions. A summary of descriptions of each geotechnical unit is presented in Table 8. The soil types and strength have been inferred based on SPT testing and field assessment for the soil units. The rock units are derived from point load / uniaxial compressive strength (UCS) test results and field assessment. The characterisation of geotechnical units has also been undertaken in accordance with AS2159 and relevant local experiences and references (Pells et al, 2019).

Table 7 Subsurface Profile

Unit	Origin	Material Description
1	Fill	Variable, gravelly/silty clay and gravelly sand, sub angular to angular, clay is medium to high plasticity
2	Residual Soils	Silty Clay, very stiff to hard, dry to moist, pale grey and red brown
3A	Shale (Class V)	Shale, interlaminated siltstone and sandstone, very low strength,
3B	Shale (Class IV)	Interlaminated siltstone and sandstone, low strength, moderately weathered, moderately fractured, grey and dark grey
3C	Shale (Class III)	Interlaminated siltstone and sandstone, medium to high strength, moderately to slightly weathered, dark grey and pale grey

7.2 Groundwater

No groundwater was observed during the investigation. It is noted that the boreholes were backfilled immediately following drilling and sampling, and no piezometer was installed for future groundwater monitoring. Introduction of water during core drilling may have obscured any observations.

8 Geotechnical Recommendations

8.1 Site preparation

The existing fill that covers investigation locations is variable in its condition and appears to be uncontrolled. So unless levelling works are required and this material removed, it is recommended that the fill be replaced with well compacted engineered fill. The existing fill is likely to present trafficability issues when wet.

Vegetated areas should be cleared and grubbed.

8.2 Earthworks

The existing site levels are expected to be largely retained except for minor levelling, resurfacing and regrading. No major bulk excavation is expected.

Groundwater was not encountered in both exploratory holes. However, if groundwater is encountered, adequate drainage measures (i.e. dewatering via pumping) must be provided to prevent ingress of water destabilising open excavations.

Excavation work should be conducted in accordance with Work Cover NSW Code of Practice for Excavation. Excavation depths greater than 1.5 m are considered 'high-risk' (this is particularly true given the variable filling and weak residual soils propensity to collapse) and will require safe work method statements and construction planning. Excavations should be stepped or battered at a safe angle or appropriately shored.

For temporary shoring design purposes, typical geotechnical parameters are provided in Table 9.

Table 8 Recommended lateral earth pressure coefficients for temporary shoring design

Material	Consistency/Strength	Unit Weight γ (kN/m^3)	Frictional Angle, ϕ' (°)	Poisson's ratio, ν	Coefficient of active earth pressure, K_a	Coefficient of passive earth pressure, K_p
Fill	Moderately to well compacted	17	26	0.3	0.4	2.6
Residual (Cohesionless)	Very loose to loose	16	26	0.3	0.4	2.6
Residual (Cohesive)	Soft to firm	16	22	0.3	0.45	2.2

Field personnel can use the guidelines in Table 10 to plan safe temporary cut batter slopes during excavation in dry conditions for slopes up to 3 m high. The cut material is not to be stockpiled any closer than 2 m from the crest of slopes. The recommendations are provided as a guide only and final adopted safe temporary batter angle will need to be assessed on site by a suitably qualified geotechnical engineer based on site conditions.

Table 9 Recommended temporary batter slopes

Material	Maximum Temporary batter slope (dry)
Soft soils	NA – shoring measures in place
Fill (moderately to well compacted) and very loose to loose soils	1V: 2H

Material	Maximum Temporary batter slope (dry)
Medium dense residual soil	1V: 2H
Stiff to very stiff residual soils	1V: 1.5H
Extremely to highly weathered Shale (Class V)	1V: 1.5H
Moderately to slightly weathered Sandstone/Shale (Class IV or better)	Vertical

8.3 Foundation Recommendation

Foundation conditions on site are variable. Shallow to moderately deep fill profiles are expected.

For the associated station enabling works, either shallow pad footings or piles may be adopted. The selection of the preferred foundation type is dependent on the lateral and vertical loads applied to the ground, the ground conditions present on site and the potential for clashes with existing infrastructure due to the foundation footprint.

There is no information available on foundation loads and foundation layouts at the time of preparing this report. However, it is anticipated that the following foundation systems may be feasible for canopy, OHWS or walkway type structures etc.

It is recommended that pile foundation design to follow AS2159 and AS5100.3 and relevant standards and using the geotechnical design parameters provided in Table 11. Note that the foundations capacity estimates are for ultimate values in accordance with AS2159-2009.

Table 10 Recommended geotechnical design parameters

Unit	Description	γ (kN/m^3)	c' (kPa)	ϕ' (°)	s_u (kPa)	υ	E' (MPa)	Bore Pile		Shallow Footing
								F_s (kPa)	F_b (kPa)	q_u (kPa)
Unit 1	Fill	17	2	26	-	0.3	20	-	-	-
Unit 2	Residual Soils	16	5	26	100	0.3	32	60	900	500
Unit 3A	Shale- Class V	22	30	28	300	0.3	50-400	50-100	3,000	700
Unit 3B	Shale- Class IV	23	50	30	-	0.3	100-500	150	3,000	-
Unit 3C	Shale- Class III	24	100	30	-	0.3	300-1,000	350	6,000	-

Note: γ: bulk unit weight; c': drained cohesion; ϕ': drained friction angle; S_u: undrained shear strength; E': soil/rock mass deformation modulus; υ: Poisson's ratio; F_s: ultimate shaft adhesion (smooth walls); F_b: ultimate end bearing capacity; q_u: ultimate bearing capacity of slab footing at min 0.5 m depth.

The above design parameters are subject to the assumptions outlined in Pells. et al. (2019): horizontal ground, no eccentric loading or horiziontal loading, etc.

8.3.1 Shallow Foundation

Where a shallow foundation is adopted as the preferred foundation it must be of regular shape and be of uniform thickness. A locally thickened slab may be suitable for some of the early enabling works.

An ultimate bearing capacity (q_u) should be used for design.

A geotechnical strength reduction factor (ϕ_g) of 0.4 may be adopted for shallow foundations in accordance to Table 5.3.3.3 (A) of AS5100.3: 2017.

It is recommended that pad, strip or raft foundations are not to be founded at shallow depth in any existing uncontrolled fill and very loose to loose and soft to firm residual soil, without ground improvement. If shallow foundations are considered, it is recommended that all poorly compacted, uncontrolled fill and/or weak residual soil are to be excavated and replaced with suitable engineered fill materials compacted to 98% MMDD to underside of the footing level.

8.3.2 Pile Foundation

Should a shallow foundation system not meet the required performance criteria for the proposed station upgrade structures, a piled foundation system will be required.

It is recommended that the pile foundation be designed in accordance with the requirements set out in AS2159, AS5100.3 and relevant Standards.

A geotechnical strength reduction factor (ϕ_g) of 0.4 may be adopted for piles designed in accordance with AS2159, assuming no pile load testing will be undertaken. We recommend that pile integrity testing is undertaken on each pile installed.

Lateral restraint from the soils in the top 0.5 m should be ignored in design due to the possible future excavation or disturbance.

For uplift calculation, it is conventional that a higher reduction factor is adopted. Although it is not specified in AS2159-2009, a reduction factor of ϕ_g=0.35 is recommended for uplift failure. In addition, with relation to uplift, the case of cone failure with an angle of 60^o should be considered in calculation of uplift resistance in cohesionless materials. For piles socketed into rock, the total uplift capacity should also consider an upper bound to uplift capacity based on a pull-out cone with an apex angle of 60^o.

The boring of each pile should be inspected by a geotechnical engineer to confirm the final pile length and to ensure that the base of excavation is clear of loose materials prior to concreting the shaft. If pile capacities rely on shaft adhesion, higher values of shaft friction may be achieved by roughening the side walls. Shaft adhesion in the fill and overburden soils should be ignored for design of rock end bearing and socketed piles.

8.3.3 Durability for Structures (Soil)

The soil testing results indicate a ‘mild’ classification for concrete and ‘non-aggressive’ classification for steel structures buried below ground in soil. The designers shall review the results and make allowance in the design for corrosion to meet the durability design requirements as set out in Section 6 of AS2159.

Groundwater was not encountered in the investigation works. However, if groundwater is encountered during the construction phase, it is recommended that groundwater testing should be undertaken for further durability assessment.

8.4 Subgrade Preparation

If exposed, it is recommended that existing fill and residual subgrade be moisture conditioned, compacted with at least eight passes of a 12-tonne minimum deadweight roller to achieve 98% SMDD and proof rolled. Any soft or heaving areas identified during proof-rolling should be excavated and replaced with a clean, well-graded material (preferably crushed or ripped sandstone) compacted to 98% SMDD and to within +/-2% OMC.

8.5 Construction Issues and Consideration

The construction of foundations in the soils at the site will require care to ensure that the exposed soils do not become disturbed by the construction activities or softened during construction. The contractor shall employ all labour supervision and plant necessary to ensure that the exposed soils are protected.

Care should be taken when base cleaning bored piles to remove all soft or loose materials. Where high groundwater level, soft or cohesionless soils are present, the use of drilling fluids and/or casing is recommended to maintain stability of the pile excavation.

Trenches or pits excavated to a minimum 2.0 m depth below existing ground surface are unlikely to encounter groundwater, although there is the potential for perched water tables to exist between the fill and cohesive residual soil interface after period of rainfall. Adequate drainage measures must be provided to prevent ingress of surface water runoff to open excavation trenches.

All excavation work must be undertaken in accordance with the Work Cover Excavation Code of Practice 2015 to ensure trench stability.

The potential impact of excavation work adjacent to existing underground services and structures must be assessed and approved by experienced geotechnical engineers and authorised engineers, respectively.

All backfill materials and compaction must be carried out in accordance with TfNSW TN 033: 2016 and ASA Standard T HR CI 12110 ST Earthworks and Formation 2015.

The ground stratification and materials encountered during installation of the foundation should be inspected and approved by an experienced geotechnical engineer to confirm the design assumptions and provided design parameters.

It is recommended that all factual geotechnical information be provided to the potential contractors to assist them in choosing the appropriate drill rig for the project.

8.6 Asset Management

As per specification T HR CI 12190 ST a stability risk assessment was undertaken for all existing structures within 6 m of the excavation relating to the proposed station development works. Based on site inspections and other observation, the proposed pile location showed no impact to neighbouring structures.

In saying so however, excavations greater than 1.5 m depth shall be supported by shoring mechanisms to provide safe access and provide added stability. These systems shall be of the type that can actively prop against the exposes soil and not rely on ground movements to engage the shoring system.

It is recommended that an experienced geotechnical engineer to be present during the excavation to assess the ground conditions encountered and assess stability of the excavation sides and base. If there is any risk of instability during the digging/drilling operation, the geotechnical engineer must direct the appropriate control measures such as immediate stop of works, backfill, and/or implementation of propping.

8.7 Earthquake Considerations

Structural design for earthquake loads should be carried out in accordance with the relevant codes as detailed in AS 1170.4 “Structural Design Actions Part 4: Earthquake Actions in Australia” or other specified Standards. The following lists the site sub-soil class and hazard factors based on AS 1170.4

- Based on soil conditions (up to 6.5 m soil over bedrock) – the sub-soil class is assessed as “Ce – shallow Soil Site”.
- Based on location – Hazard Factor (Z) of 0.08.

9 Limitations

Aurecon Australasia Pty Ltd has prepared this report for the use of our Client, Novorail. This report has not been prepared for use by parties other than the Client, and the Client’s respective consulting advisors.

The borehole logs represent subsurface conditions at the specific test locations only. Any interpretation undertaken must be based on experience and understanding of the geotechnical processes relevant to the site, bearing in mind the necessary limitations in frequency of drilling, testing and sampling due to cost and time constraints. Should conditions exposed at the site during construction vary significantly from those provided in this report based on the project specific factors cited in the introductory scope of the report, we request that Aurecon Australasia Pty Ltd be informed and have the opportunity to review any of the findings of this report.

This report has been written with the express intent of providing sufficient information for station upgrade design and operational methodology processes. Subsurface conditions relevant to the construction works should be assessed by contractors who can make their own interpretation of the factual data provide in the borehole logs and perform any additional tests as necessary for their own purposes.

The assessment and recommendations have been made to assist designers in developing concepts with regards to foundations conditions and general excavation support design. Once concepts have been confirmed, additional geotechnical advice will be required to confirm design assumptions made. This includes any recommendations on any testing that may be warranted to address potential geotechnical risks listed above and/or identify additional geotechnical risks for the project.

It is strongly recommended that any plans and specifications prepared by others and relating to the content of this report or amendments to the original plans and specifications be reviewed by Aurecon Australasia Pty Ltd to verify that the intent of our data is properly reflected in the design.

There are always some variations in subsurface conditions across a site that cannot be defined even by exhaustive investigation. Hence, it is unlikely that the measurements and values obtained from sampling and testing during the investigation will represent the extremes of conditions which exist within the site.

Further, subsurface conditions, including groundwater levels can change over time. This should be borne in mind, particularly if the report is used after a protracted delay or a period of protracted climatic conditions.

This report shall be updated when more investigation data is available during the project development.

10 References

- Standard Australia (2017), Australian Standard AS1726-2017 Geotechnical Site Investigation.

- Standard Australia (2002), Australian Standard AS4678-2002 Earth Retaining Structures.
- Standard Australia (2009), Australian Standard AS2159-2009 Pile Design and Installation.
- Standard Australia (2017), Australian Standard AS5100.3-2017 Bridge Design, Part 3: Foundation and Soil-Supporting Structures.
- Standard Australia (2007), Australian Standard AS1170.4-2007 Structural Design Actions, Part 4: Earthquake Actions in Australia.
- Pells, P.J.N., Douglas, D.J., Rodway, B., Thorne, C. & MaMahon, B, K. (1978), Design Loading for Foundations on Shale and Sandstone in Sydney Region, Australian Geomechanics Journal, Pages 31- 39.
- Pells, P.J.N., Mostyn, G., & Walker, B.F. (1998), Foundations on Sandstone and Shale in the Sydney Region, Australia Geomechanics Journal, Pages 17-29.
- Pells, P.J.N., Mostyn, G, Bertuzzi, R. & Wong, P.K. (2019), Classification of sandstones and shales in the Sydney region: A forty year review, Australian Geomechanics Journal, Pages 29 – 55.

11 Appendices

- Appendix A: Site Plan, Geology, Soil Landscapes and Acid Sulphate Soils Maps
- Appendix B: Site Photos
- Appendix C: Borehole Logs
- Appendix D: Laboratory Testing Certificates

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Appendix A – Site Plan, Geology, Soil Landscapes, Acid Sulphate Soils Maps

Figure A1: Regional Locality View

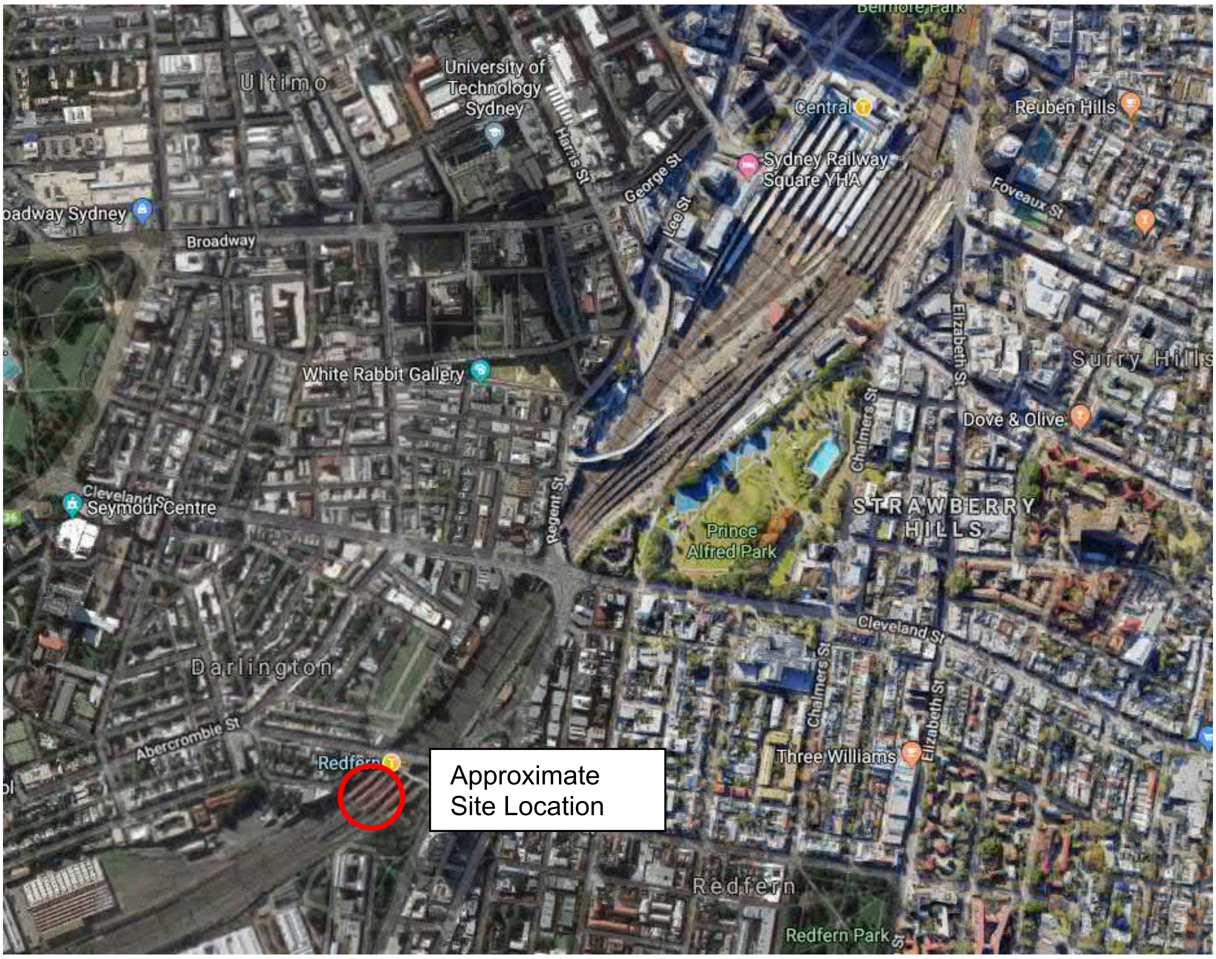


Figure A2: Site Location

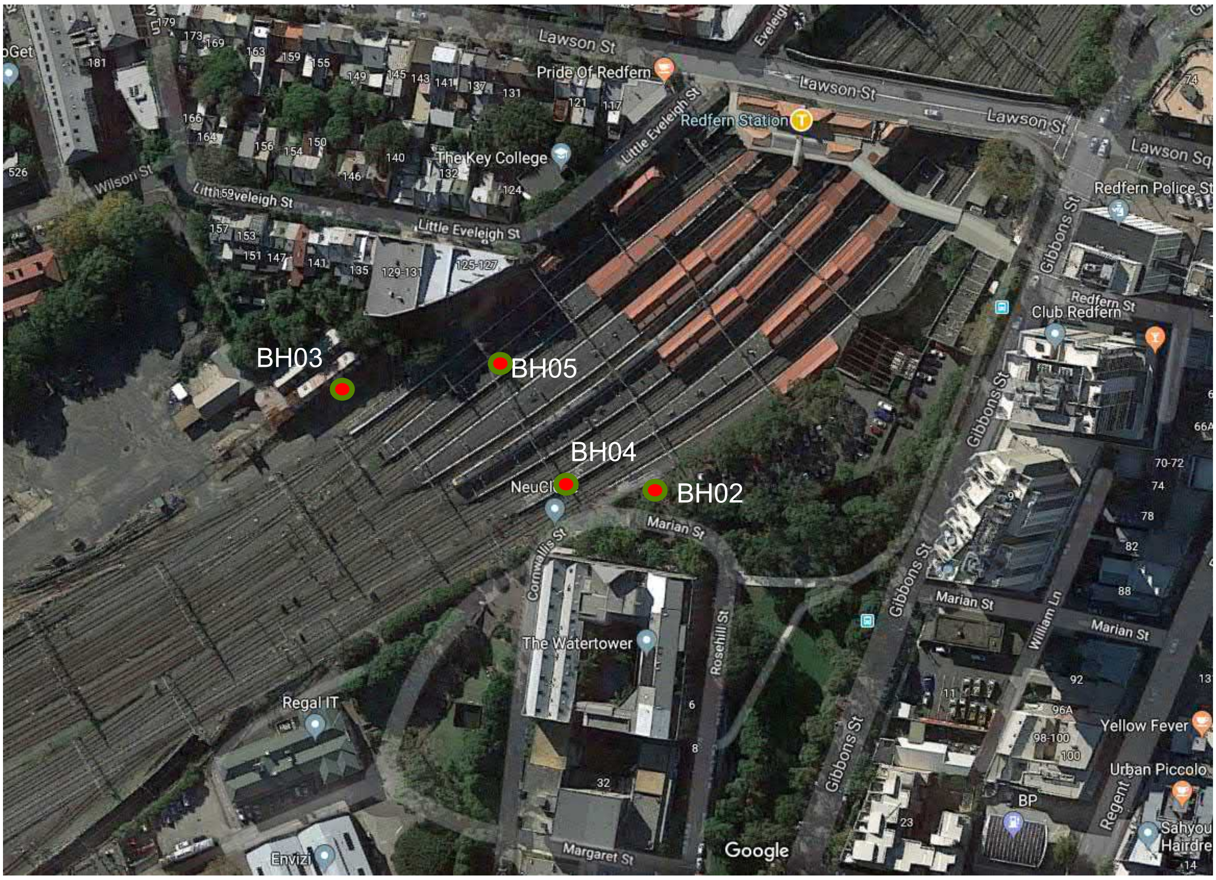


Figure A3: Geological Sheet Map Extract

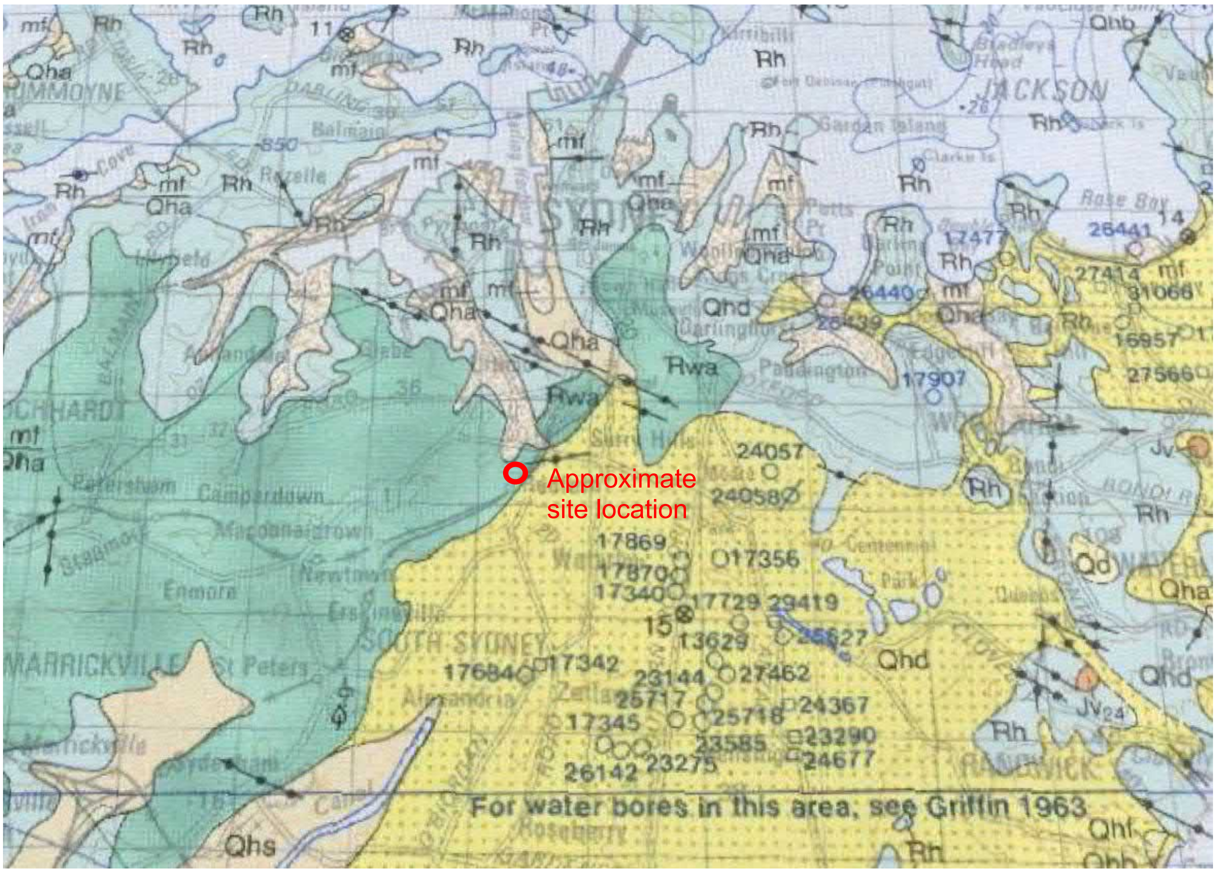


Figure A4: Soil Landscapes Map Extract

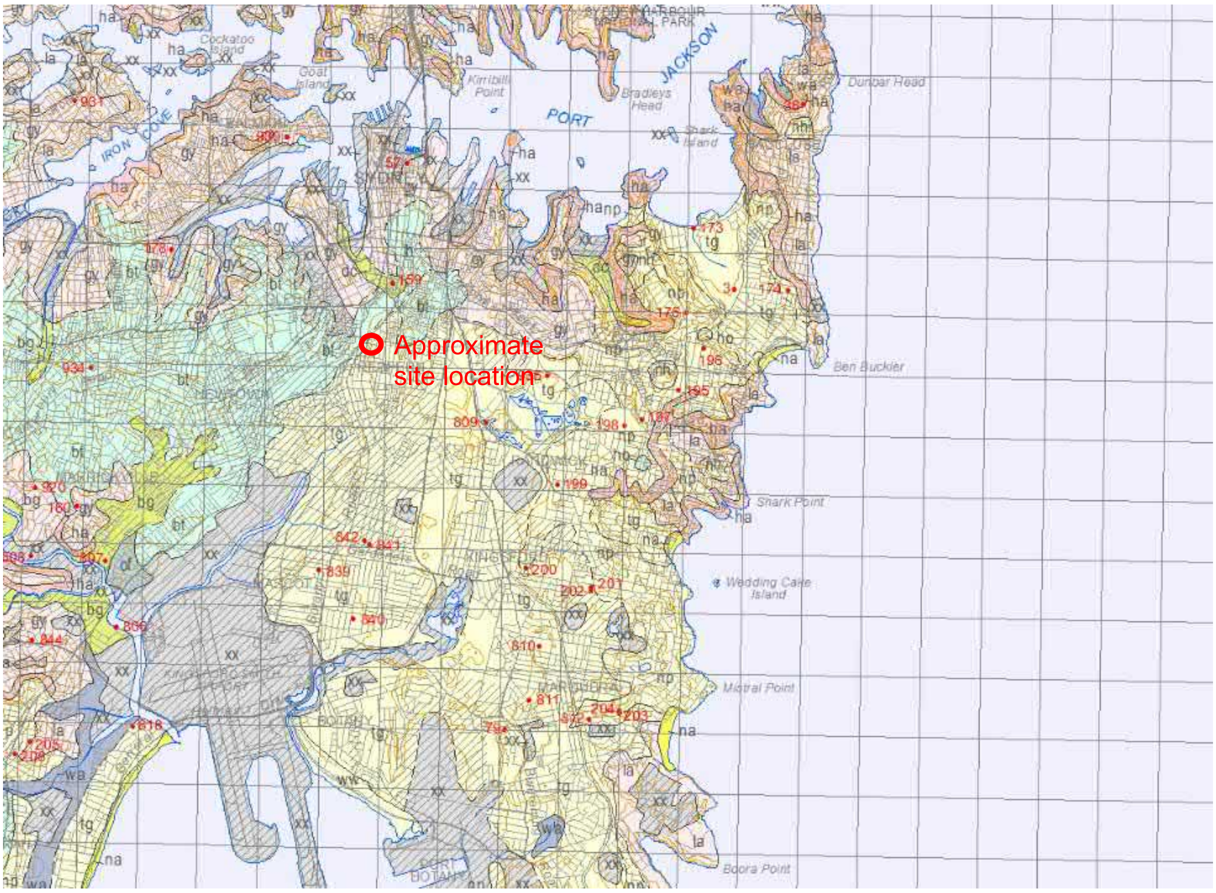
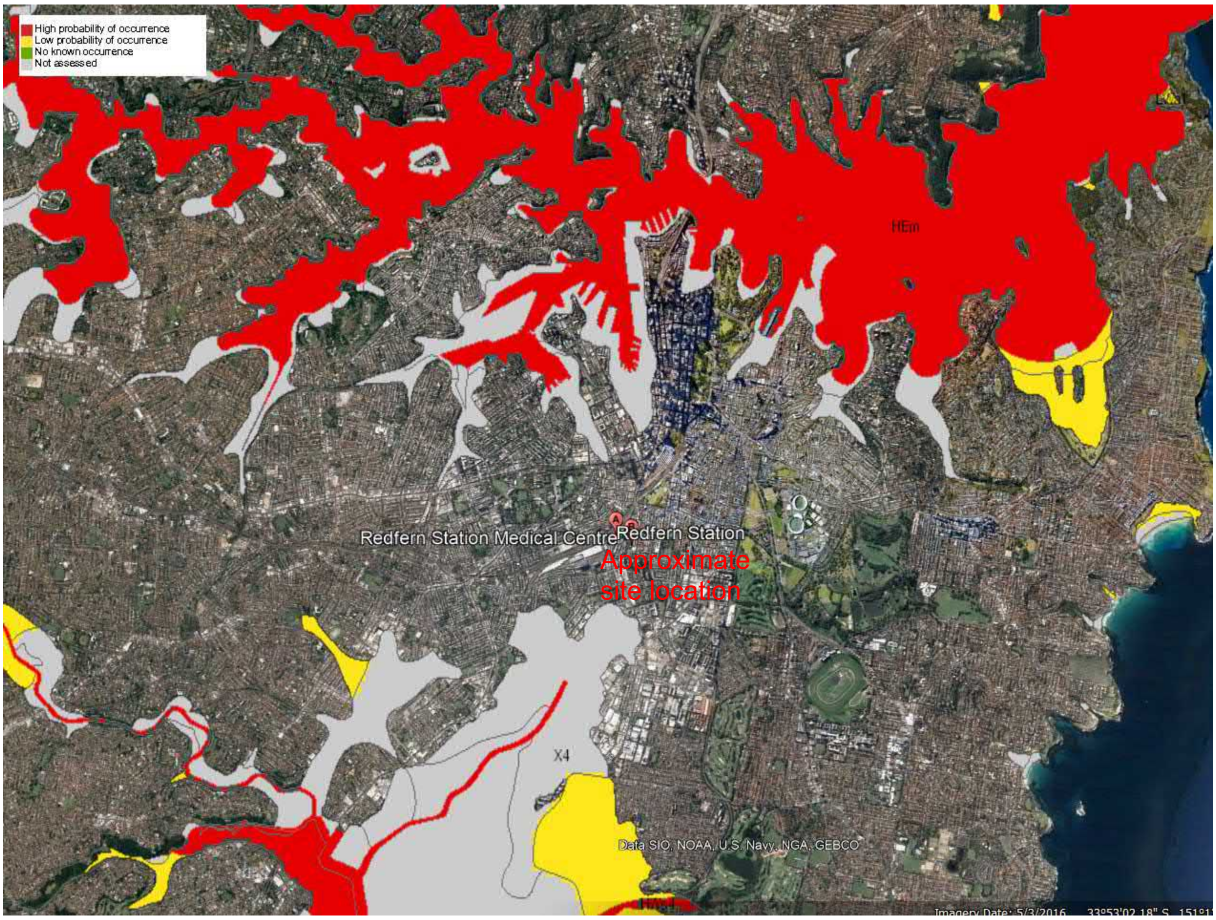


Figure A5: Acid Sulphate Soil Map Extract



Appendix B – Site Photos

Figure B1: Top of retaining wall above Platform 10 – BH02 location

Figure B2: Entrance to Little Eveleigh Street: BH03 location

Figure B3: Site location of BH04, after finishing

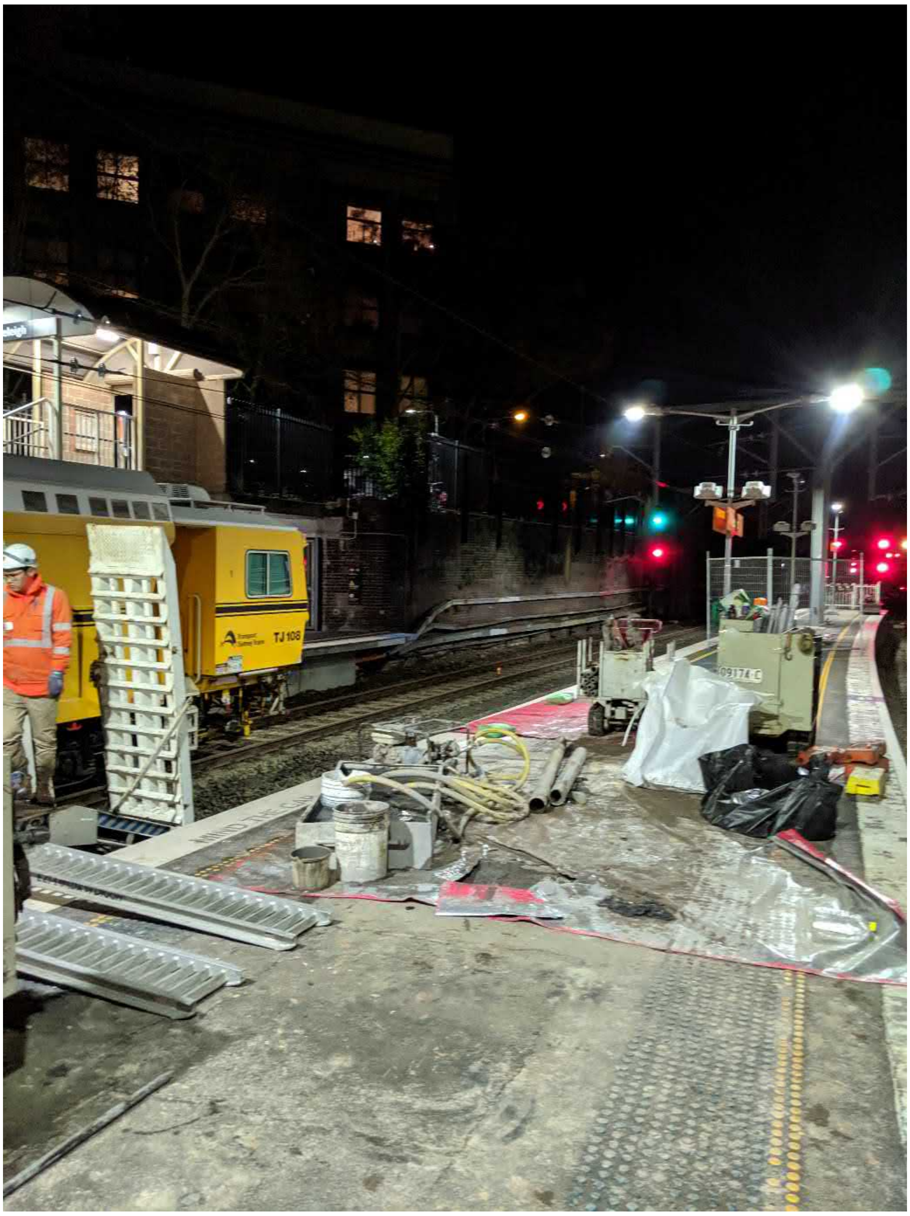
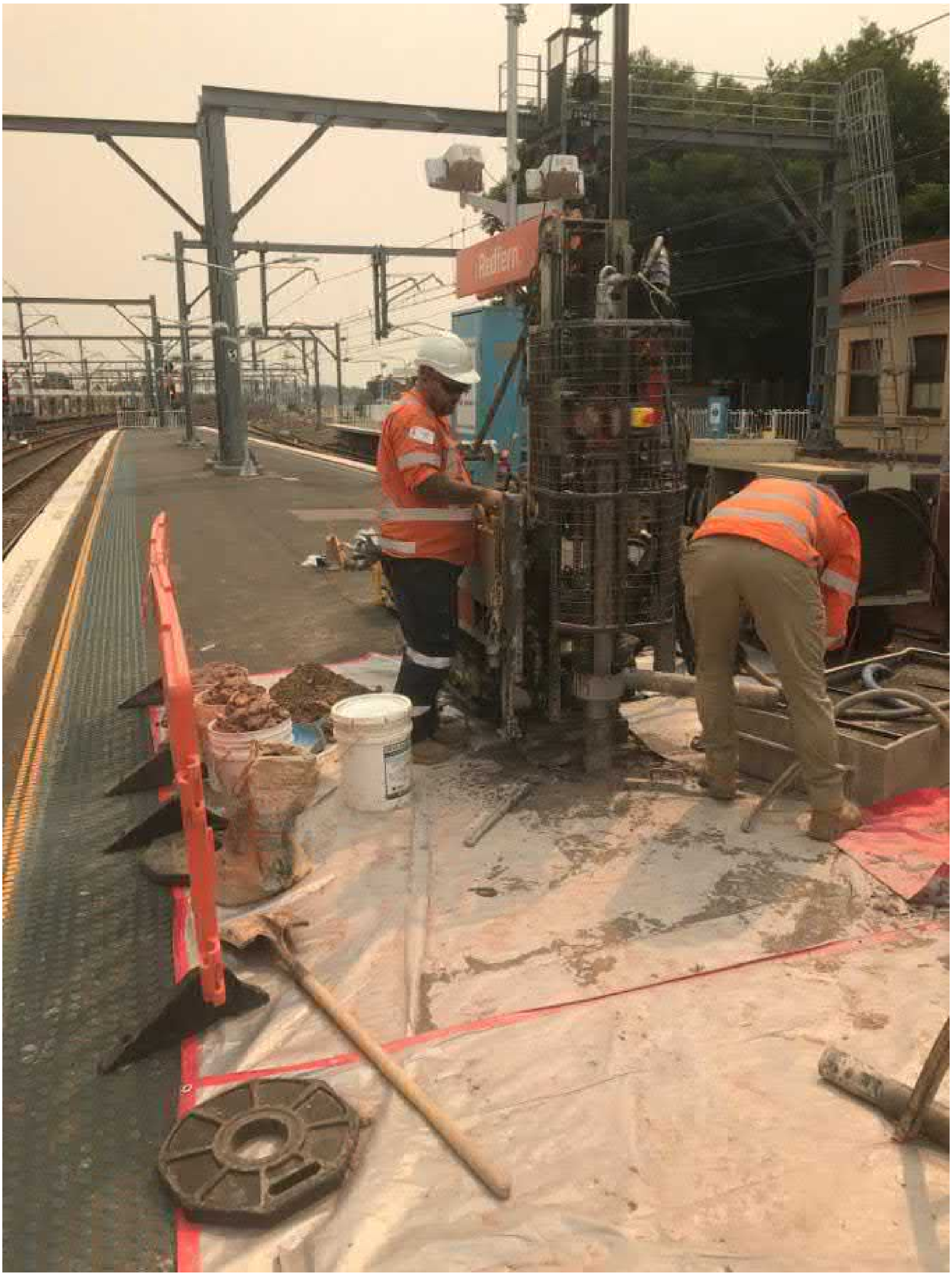


Figure B4: Site location of BH05



Appendix C – Borehole Logs

Borehole No: BH02

Engineering Log - Borehole

SHEET 1 OF 3

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrade	Logged By	DZ
Location	Redfern Station - platform 10 behind retaining wall	Checked By	HS

Started Drilling	3.14.19	Northing	6248278.00	Slope	90°	Equipment	Track
Completed Drilling	3.14.19	Easting	333393.00	Bearing	---	Ground Level	29.4 AHD

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
AD/T	Not Encountered	29.4	0.0			FILL: SAND: fine to medium grained, orange	M				FILL Fill appears poorly compacted
		26.4	3.0			FILL: SAND: fine to medium grained, orange, trace broken glass					Platform Level
		25.4	4.0			FILL: Clayey SAND: fine grained, brown, high plasticity clay				B	Fill appears moderately compacted
		24.4	5.0			FILL: Sandy CLAY: high plasticity, brown, fine grained sand				B	Fill appears well compacted
		22.4	7.0		CH	Silty CLAY: high plasticity, grey mottled red	<PL	F - St		B	RESIDUAL SOIL
						SILTSTONE: extremely weathered, very low strength, recovered as Silty CLAY, grey mottled orange, medium plasticity			SPT 23, 10, 0 N=10/10mm R		EXTREMELY WEATHERED ROCK
						Continued as Cored Drill Hole					

Remarks:

Borehole No: BH02

Engineering Log - Cored Borehole

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrade	Logged By	DZ
Location	Redfern Station - platform 10 behind retaining wall	Checked By	HS

Started Drilling	3.14.19	Northing	6248278.00	Slope	90°	Equipment	Track
Completed Drilling	3.14.19	Easting	333393.00	Bearing	---	Ground Level	29.4 AHD

DRILLING				ROCK MASS CHARACTERISTICS						DISCONTINUITIES		
Method	Water	RL (m)	Depth (m)	Graphic Log	Description of Rock (rock type: colour, grain size, structure, minor components)	Weathering	Strength Is_{50} (X - Axial, O - Diametral, □ - Lump; EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	IS_{50} (MPa) D L A	Defect Spacing (mm) 20 40 100 300 1000	Core Rec'y (%)	RQD (%)	Description of Defects (defect type, inclination, roughness, thickness, infilling)
		29										
			1									
		28										
			2									
		27										
			3									
		26										
			4									
		25										
			5									
		24										
			6									
		23										
			7									
		22			START CORING AT 7.76m							
			8		CORE LOSS 0.14m (7.76-7.90)					76	0	

Remarks:

Engineering Log - Cored Borehole

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrade	Logged By	DZ
Location	Redfern Station - platform 10 behind retaining wall	Checked By	HS

Started Drilling	3.14.19	Northing	6248278.00	Slope	90°	Equipment	Track
Completed Drilling	3.14.19	Easting	333393.00	Bearing	---	Ground Level	29.4 AHD

DRILLING | ROCK MASS CHARACTERISTICS | DISCONTINUITIES

Method: NMLC

Depth (m)	Description of Rock (rock type: colour, grain size, structure, minor components)	Weathering	Is_{50} (MPa)	Core Rec'y (%)	RQD (%)	Description of Defects (defect type, inclination, roughness, thickness, infilling)
	SHALE: grey, red brown, mottled orange brown, thinly laminated *(continued)*	DW / DW / XW	0.6, 0.084	76	0	8.02: Be, 5°, p, r, vn; 8.04: Be, 5°, p, r, vn; 8.12: Be, 5°, p, r, vn
9.11-9.20	CORE LOSS 0.09m (9.11-9.20)					
	SHALE: grey, thinly laminated, iron stained	DW	0.23	83	50	9.40: Jo, 20°, p, r, cg; 9.50: Jo, 30°, p, r, sn
9.62-9.82	CORE LOSS 0.20m (9.62-9.82)					
	SHALE: dark grey mottled with brown orange, thinly laminated, iron stained	DW	0.46, 0.037			10.07: Jo, 30°, p, r, vn; 10.23: Be, 0°, p, r, sn
10.50-10.61	CORE LOSS 0.11m (10.50-10.61)					
	SHALE: grey and brown, highly fractured	XW		100	0	
	SHALE: grey and brown, highly fractured					
	SHALE: dark grey and pale grey, distinctly laminated, some iron staining	DW	0.22, 0.14, 0.029, 0.92, 0.012	92	0	12.05-12.10: Cz, 0°, u, r, vn; 12.15: Be, 0-10°, p, r, cn
12.23-12.33	CORE LOSS 0.10m (12.23-12.33)					
	As above	SW	0.44			11.22-13.61: Be, 0-10°, p, r, cn, average spacing 40mm
	SHALE: dark grey, distinctly laminated, some iron staining along defects	SW	0.26, 0.11, 0.15	100	23	13.15-13.25: Cz, 0°, u, r, vn
13.61	Borehole BH02 Terminated at 13.61 m					

Remarks:

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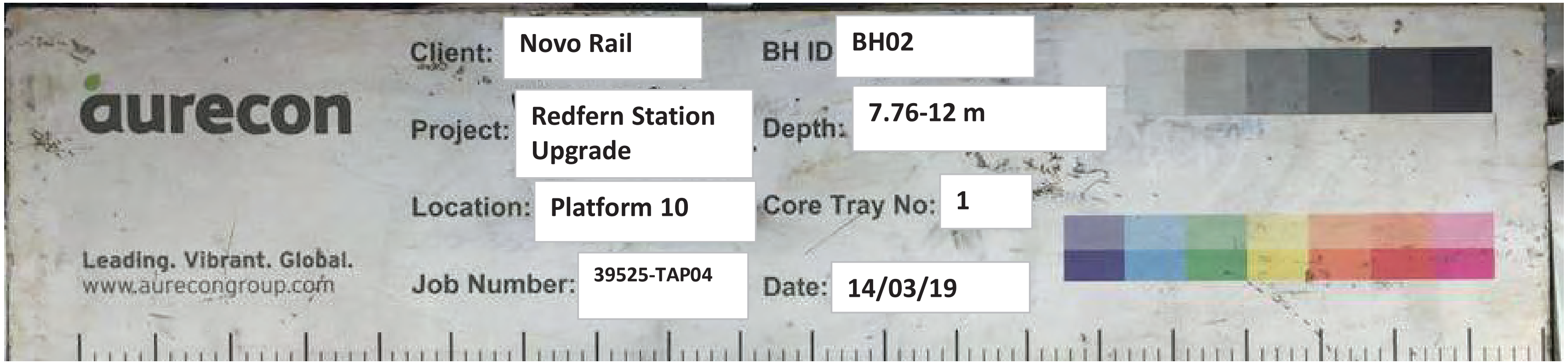
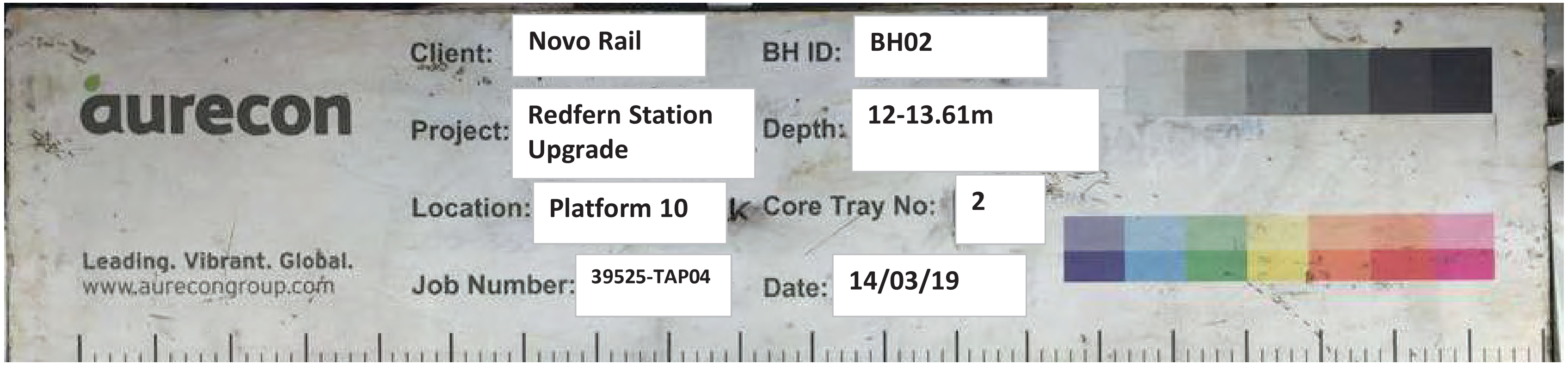
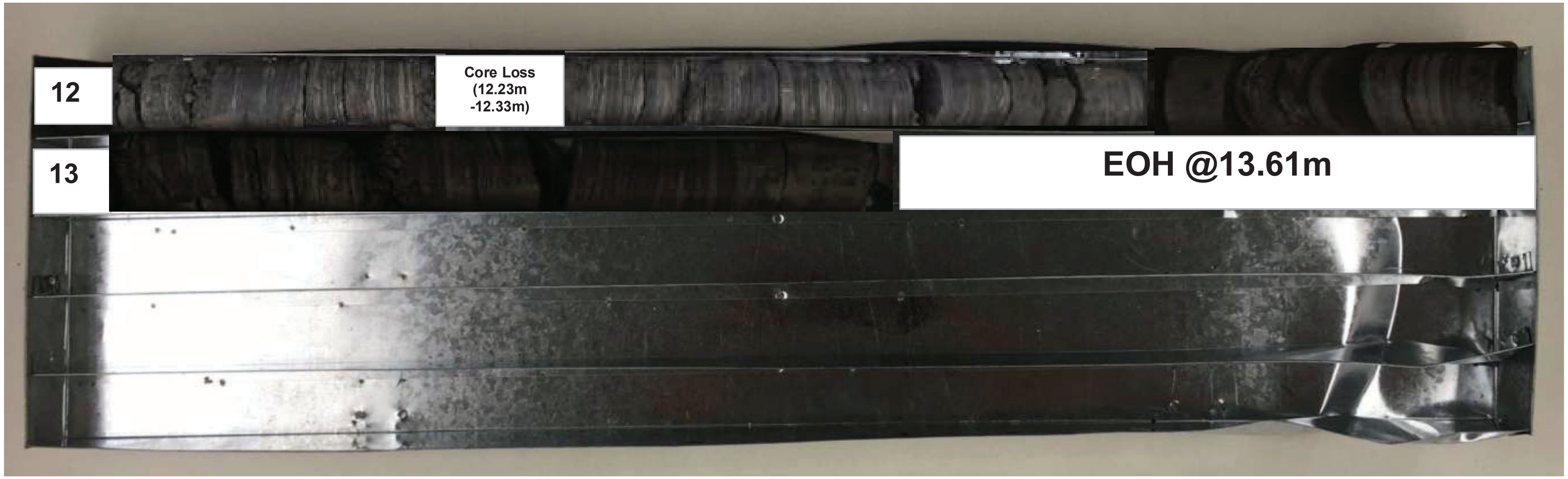


Client	Novo Rail	Core Photograph
Project	Redfern Station Upgrade	
Project No.	39525-TAP04	BH02 7.76-12m
Photo By:	DZ	





Client	Novo Rail	**Core Photograph**
Project	Redfern Station Upgrade	
Project No.	39525-TAP04	**BH02 12-13.61m**
Photo By:	DZ	

Engineering Log - Borehole

Borehole No: BH03

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrade	Logged By	DZ
Location	Redfern Station - platform 1	Checked By	HS

Started Drilling	4.4.19	Northing	6248326.00	Slope	90°	Equipment	Track
Completed Drilling	4.5.19	Easting	333329.00	Bearing	---	Ground Level	26.4 AHD

DRILLING				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
AD/T	Not Encountered	26–25	0–1.5			FILL: Silty CLAY: medium plasticity, Brown mottled grey, with sand, trace roots	<PL				FILL poorly compacted
			1.5–3.0		CH	Silty CLAY: high plasticity, red brown and pale grey, with fine to coarse grained subangular gravel	>PL	VSt	SPT 3, 4, 16 N=20	D	RESIDUAL SOIL
			3.0–4.5		CH	Silty CLAY: high plasticity, red brown, trace fine to coarse grained sand		St	SPT 6, 8, 6 N=14	D	
			4.5–6.35		CH	Silty CLAY: high plasticity, grey mottled red brown		H	SPT 2, 12, 24 N=36	D	
									SPT 8, 35 N>35	D	
		20–19	6.35–8			Continued as Cored Drill Hole					

Remarks:

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Engineering Log - Cored Borehole

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrade	Logged By	DZ
Location	Redfern Station - platform 1	Checked By	HS

Started Drilling	4.4.19	Northing	6248326.00	Slope	90°	Equipment	Track
Completed Drilling	4.5.19	Easting	333329.00	Bearing	---	Ground Level	26.4 AHD

DRILLING | ROCK MASS CHARACTERISTICS | DISCONTINUITIES

Method	Water	RL (m)	Depth (m)	Graphic Log	Description of Rock (rock type: colour, grain size, structure, minor components)	Weathering	Strength Is_{50} (X - Axial, O - Diametral, □ - Lump; EL, VL, L, M, H, VH, EH)	IS_{50} (MPa) D L A	Defect Spacing (mm)	Core Rec'y (%)	RQD (%)	Description of Defects (defect type, inclination, roughness, thickness, infilling)
		26 – 20	0 – 6.35		START CORING AT 6.35m							
NMLC		20 – 19	6.35 – 7.75		SHALE: pale grey, thinly laminated, highly fractured Becoming dark grey	DW		0.08, 0.21 0.06, 0.1, 0.09, 0.06		100	20	6.41-6.90: Be, 0-5°, p, s, vn, average spacing 60mm 7.13: Cs, Silty Clay, 10 mm 7.15: Jo, 75°, u, I, cg 7.35: Be, 0°, p, r, vn 7.45: Cs, Silty Clay, 7 mm
NMLC			7.75 – 8		SHALE: dark grey, thinly laminated	DW				72	0	

Remarks:

Engineering Log - Cored Borehole

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrade	Logged By	DZ
Location	Redfern Station - platform 1	Checked By	HS

Started Drilling	4.4.19	Northing	6248326.00	Slope	90°	Equipment	Track
Completed Drilling	4.5.19	Easting	333329.00	Bearing	---	Ground Level	26.4 AHD

DRILLING | ROCK MASS CHARACTERISTICS | DISCONTINUITIES

Columns: Method; Water; RL (m); Depth (m); Graphic Log; Description of Rock (rock type: colour, grain size, structure, minor components); Weathering; Strength Is_{50} (X - Axial, O - Diametral, □ - Lump; EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH); IS_{50} (MPa) D L A; Defect Spacing (mm) (20, 40, 100, 300, 1000); Core Rec'y (%); RQD (%); Description of Defects (defect type, inclination, roughness, thickness, infilling)

Method: NMLC

RL (m): 18, 17, 16, 15, 14, 13, 12, 11

Depth (m): 9, 10, 11, 12, 13, 14, 15, 16

Description of Rock	Weathering	IS_{50} (MPa) D	IS_{50} (MPa) A
SHALE: dark grey, thinly laminated *(continued)*	DW	0.07	0.05
CORE LOSS 0.33m (8.53-8.86)			
SHALE: pale brown, fragmented, infilled with clay	XW	0.05	
CORE LOSS 0.12m (9.24-9.36)			
SHALE: pale brown to dark grey, thinly laminated, fragmented	XW	0.02	0.01
SHALE: dark grey, thinly laminated	DW	0.03	0.16
		0.03	0.1
		0.05	0.07
CORE LOSS 0.17m (11.92-12.09)			
SHALE: dark grey, thinly laminated, fragmented	XW		
CORE LOSS 0.11m (12.25-12.36)			
SHALE: dark grey, distinctly laminated, fractured	SW	0.07	0.09
		0.07	0.27
		0.24	0.82
		0.08	0.96
SHALE: dark grey, distinctly laminated, fractured		0.2	

Core Rec'y (%)	RQD (%)
72	0
100	0
92	28
96	20
100	10

Description of Defects:

- 7.52-8.53: Be, 0-5°, p, r, vn, average spacing 60mm
- 8.08: Jo, 20°, p, r, vn
- 8.12-8.16: Cz, 0°, 40 mm
- 8.26: Jo, 40°, p, r, vn
- 10.10: Be, 0°, p, r, cn
- 10.14: Be, 0°, p, r, cn
- 10.20: Cs, 0°, Silty Clay, 4 mm
- 10.27: Jo, 60°, u, r, cn
- 10.32-10.80: Be, 0°, p, r, cn, average spacing 60mm
- 10.90: Jo, 50°, p, r, cn
- 11.10: Jo, 70-85°, u, s, cn
- 11.60: Jo, 20°, p, s, cn
- 11.73-11.76: Cz, u, 30 mm
- 12.20: Jo, 60°, p, s, cn
- 12.45-13.00: Be, 0-5°, p, s, cn, average spacing 70mm
- 12.96: Jo, 25°, p, s, cn
- 13.07-14.60: Be, 0-5°, p, s, cn, average spacing 40mm
- 14.22: Jo, 25°, p, s, cn
- 14.85: Jo, 30°, p, s, cn
- 15.02-16.25: Be, 0-5°, p, s, cn, average spacing 40mm

Remarks:

Engineering Log - Cored Borehole

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrade	Logged By	DZ
Location	Redfern Station - platform 1	Checked By	HS

Started Drilling	4.4.19	Northing	6248326.00	Slope	90°	Equipment	Track
Completed Drilling	4.5.19	Easting	333329.00	Bearing	---	Ground Level	26.4 AHD

DRILLING				ROCK MASS CHARACTERISTICS					DISCONTINUITIES		
Method	Water	RL (m)	Depth (m)	Graphic Log	Description of Rock (rock type: colour, grain size, structure, minor components)	Weathering	Strength Is_{50} (X - Axial, O - Diametral, □ - Lump; EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH)	IS_{50} (MPa) D L A	Defect Spacing (mm) 20 40 100 300 1000	Core Rec'y (%)	RQD (%)	Description of Defects (defect type, inclination, roughness, thickness, infilling)
					SHALE: dark grey, distinctly laminated, fractured *(continued)*	SW	O X	0.06 0.48 0.41		100	10	
		10			Borehole BH03 Terminated at 16.25 m							

RL (m): 10, 9, 8, 7, 6, 5, 4, 3
Depth (m): 17, 18, 19, 20, 21, 22, 23, 24

Remarks:

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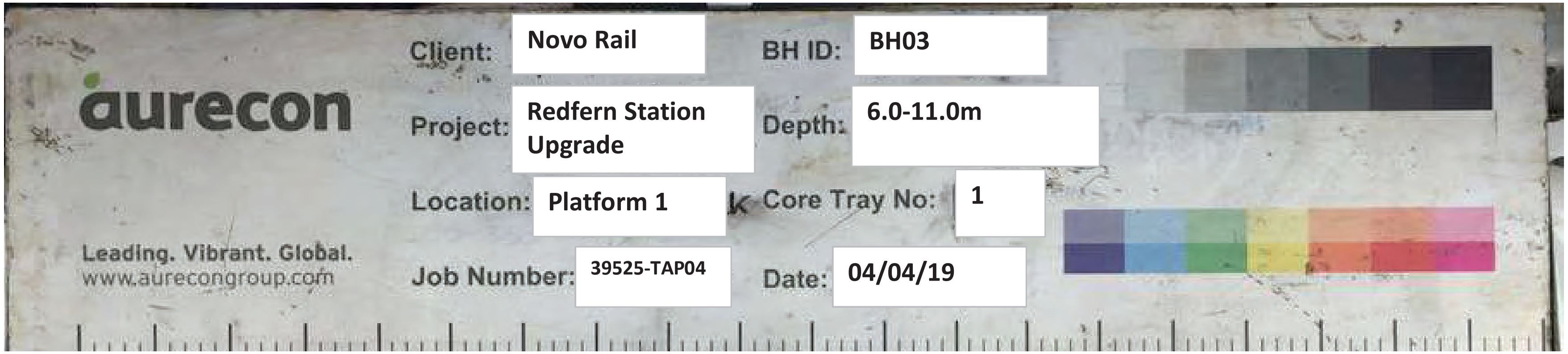
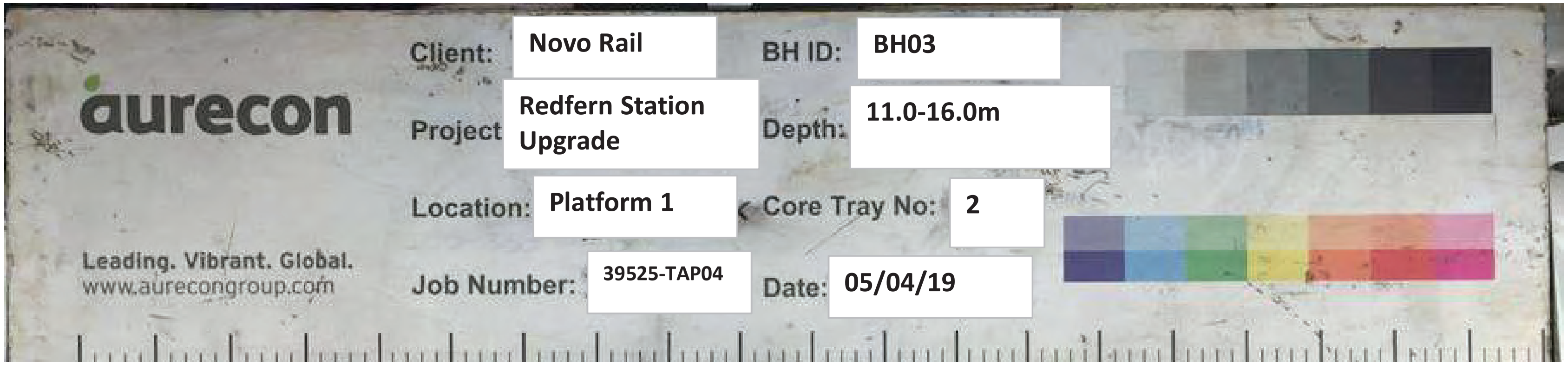


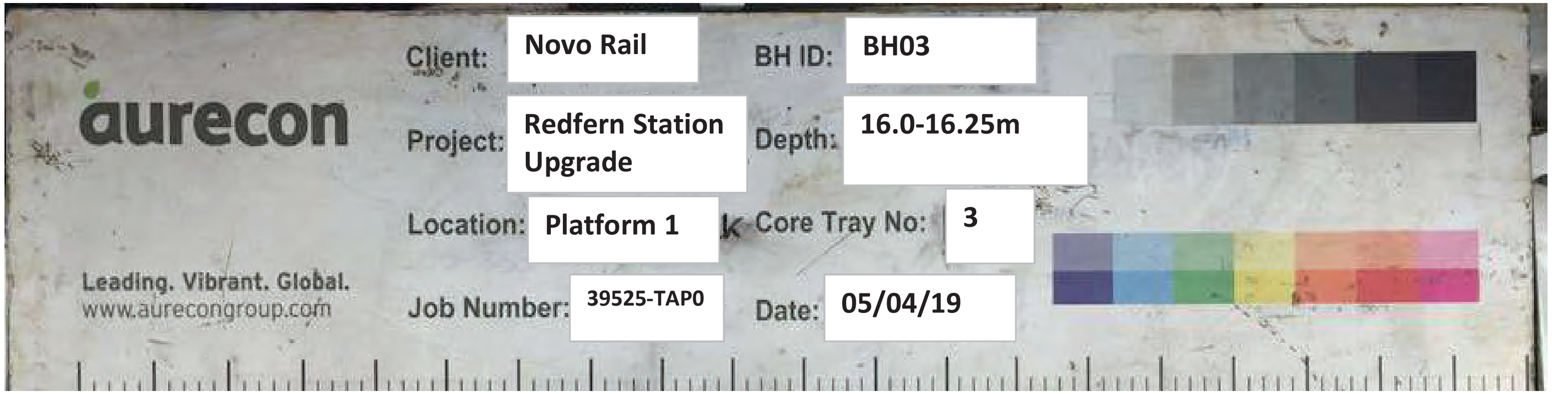
Client	Novo Rail	Core Photograph
Project	Redfern Station Upgrade	
Project No.	39525-TAP04	BH03 - 6.0-11.0 m
Photo By:	DZ	



Client	Novo Rail
Project	Redfern Station Upgrade
Project No.	39525-TAP04
Photo By:	DZ

Core Photograph

BH03 11.0-16.0



Client	Novo Rail	**Core Photograph**
Project	Redfern Station Upgrade	
Project No.	39525-TAP04	**BH03 16.0-16.25**
Photo By:	DZ	

Engineering Log - Borehole

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrades	Logged By	DZ/DR
Location	Redfern Station Platform	Checked By	HS

Started Drilling	20.7.19	Northing	6248296.00	Slope	90°	Equipment	XC Drill
Completed Drilling	20.7.19	Easting	333386.00	Bearing	---	Ground Level	26.4 AHD

DRILLING				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
HA	Not Encountered		0.0			ASPHALT					ROAD SURFACE
HA		26				FILL: Silty CLAY: medium plasticity, red yellow brown	<PL				FILL
AD/V		25	1.2		CH	Silty CLAY: high plasticity, grey mottled brown, trace fine to medium grained gravel, trace fine to coarse grained sand	~PL	H			RESIDUAL SOIL
			1.5						SPT 5, 8, 9 N=17	B	
		24	2								
		23	3						SPT 5, 11, 17 N=28	B	pp= 430 kPa
			4								

Remarks:

Engineering Log - Borehole

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrades	Logged By	DZ/DR
Location	Redfern Station Platform	Checked By	HS

Started Drilling	20.7.19	Northing	6248296.00	Slope	90°	Equipment	XC Drill
Completed Drilling	20.7.19	Easting	333386.00	Bearing	---	Ground Level	26.4 AHD

DRILLING				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
AD/V		22			CH	Silty CLAY: high plasticity, grey mottled brown, trace angular to subangular gravel	~PL	H			
						Continued as Cored Drill Hole			SPT 8/10mm HB N=Refusal	B	pp= 450 - 510 kPa
			5								
		21									
			6								
		20									
			7								
		19									
			8								

Remarks:

Borehole No: BH04

Engineering Log - Cored Borehole

SHEET 3 OF 6

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrades	Logged By	DZ/DR
Location	Redfern Station Platform 8/9	Checked By	HS

Started Drilling	20.7.19	Northing	6248296.00	Slope	90°	Equipment	XC Drill
Completed Drilling	20.7.19	Easting	333386.00	Bearing	---	Ground Level	26.4 AHD

DRILLING | ROCK MASS CHARACTERISTICS | DISCONTINUITIES

Method	Water	RL (m)	Depth (m)	Description of Rock (rock type: colour, grain size, structure, minor components)	Weathering	IS_{50} (MPa) D L A	Core Rec'y (%)	RQD (%)	Description of Defects (defect type, inclination, roughness, thickness, infilling)
		22		START CORING AT 4.51m					
NMLC	100% Water RETURN			INTERBEDDED SILTSTONE AND SANDSTONE: grey and pale grey, indistinct to distinct laminations at 0-10°, Heavily Iron stained, Sandstone is fine grained.	HW				
			5	GRAVELLY CLAY: medium to high plasticity, grey mottled orange red, gravel is angular, fine to coarse grained, trace of angular cobbles. Hard, ~PL. (Extremely Weathered Interbedded Siltstone and Sandstone).	EW		100	38	4.75-5.10: Ds
		21		INTERBEDDED SILTSTONE AND SANDSTONE: grey and pale grey, indistinct wavy lenticular laminations at 0°, Iron staining at defects. Sandstone is fine grained.	HW	0.09 / 0.1			5.15: Be, 0°, p, r, cg 5.40: Be, 0°, p, s, cn 5.52-5.57: Jo, 45°, p, s, vn
	100% Water RETURN	20	6	LAMINITE: dark grey and grey, distinct lenticular laminations at 0°	HW	0.06 0.17 / 0.18 0.05 / 0.16	100	58	5.70: Jo, 5°, p, s, vn 5.76: Be, 0°, p, r, cn 5.80-5.90: Is, 80°, u, r, ironstone, 3 mm 5.90: Be, 0-5°, u, r, sn 5.93: Db 6.00: Hb 6.09: Jo, 0-5°, p, s, sn 6.13: Be, 0°, p, s, sn 6.25: Hb 6.26: Hb 6.28: Hb 6.52: Db 6.60: Jo, 5°, p, s, vn
			7	LAMINITE: dark grey and grey to orange, distinct laminations at 0°, Sandstone is iron stained.	HW				6.71: Cs, 0°, Silty Clay, 5 mm 6.79: Jo, 5°, p, r, vn 6.87: Be, 0°, p, r, vn 6.95: Cs, gravelly clay, 3 mm 7.00: Hb 7.04: Hb 7.12: Hb
	100% Water RETURN	19	8	LAMINITE: dark grey and grey, distinct lenticular laminations at 0°	MW	0.14 / 0.22 0.15 / 0.22	100	50	7.14: Be, 0-5°, p, s, sn 7.16: Be, 0-5°, p, s, sn 7.19: Be, 0-5°, p, s, sn 7.27: Db 7.31: Cs, Silty Clay, 2 mm 7.35: Db 7.49: Db 7.54: Db 7.59: Db 7.71: Db 7.77: Db 7.80: Db 7.81: Db 7.89: Db 7.95: Hb

Strength Is_{50}: X - Axial, O - Diametral, □ - Lump; EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH

Defect Spacing (mm): 20, 40, 100, 300, 1000

Remarks: Defects are typically Bedding partings, 0-5°, planar smooth/rough, clean @ 20-200mm spacings (at laminations).

Rock Unit is Ashfield Shale.

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Engineering Log - Cored Borehole

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrades	Logged By	DZ/DR
Location	Redfern Station Platform 8/9	Checked By	HS

Started Drilling	20.7.19	Northing	6248296.00	Slope	90°	Equipment	XC Drill
Completed Drilling	20.7.19	Easting	333386.00	Bearing	---	Ground Level	26.4 AHD

DRILLING | ROCK MASS CHARACTERISTICS | DISCONTINUITIES

Method: NMLC

Water: 100% Water RETURN; 100% Water RETURN

Description of Rock (rock type: colour, grain size, structure, minor components):

- LAMINITE: dark grey and grey, distinct lenticular laminations at 0° *(continued)*
- Laminations dipping at 30°, fault zone
- Laminations at 45°

Weathering: EW - HW; HW; EW

RL (m): 18, 17, 16, 15

Depth (m): 9, 10, 11, 12

IS50 (MPa) D	IS50 (MPa) A	Core Rec'y (%)	RQD (%)
0.03	0.14		
0.04	0.24		
0.02	0.25		
0.02	0.24		
	0.26		
0.02	0.42		
0.1			

Core Rec'y (%)	RQD (%)
100	50
100	80
100	85
100	40

Description of Defects (defect type, inclination, roughness, thickness, infilling):

- 8.00-8.43: Fragmented Zone
- 8.43: Be, 0°, p, s, cn
- 8.51: Db
- 8.53: Cs, 0°, High Plasticity CLAY, 10 mm
- 8.57: Db
- 8.69: Hb
- 8.81: Be, 0°, p, s, cn
- 8.93: Hb
- 9.00: Hb
- 9.14: Be, 0°, p, s, cn
- 9.19: Db
- 9.27: Db
- 9.53: Be, 0°, p, High Plasticity CLAY cg
- 9.61: Be, 0°, p, gravelly clay cg
- 9.90: Jo, 10°, p, r, cn
- 9.98: Hb
- 10.00: Hb
- 10.03: Hb
- 10.05: Hb
- 10.10: Hb
- 10.12: Hb
- 10.19: Be, 0°, p, High Plasticity CLAY cg
- 10.24: Be, 0°, p, s, cn
- 10.30: Cs, 0°, p, High Plasticity CLAY, 6 mm
- 10.36: Be, 0°, p, r, cn
- 10.42: Be, 0°, p, r, cn
- 10.47: Be, 0°, p, r, cn
- 10.71: Be, 0°, p, r, cn
- 10.74: Db
- 11.00: Hb
- 11.18: Be, 0°, p, r, cn
- 11.20: Be, 0°, p, r, cn
- 11.42: Cs, 0°, Low Plasticity CLAY, 12 mm
- 11.50: Db
- 11.60: Be, 20°, p, s, vn
- 11.75: Db
- 11.82: Be, 45°, u, r

Remarks: Defects are typically Bedding partings, 0-5°, planar smooth/rough, clean @ 20-200mm spacings (at laminations).

Rock Unit is Ashfield Shale.

Engineering Log - Cored Borehole

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrades	Logged By	DZ/DR
Location	Redfern Station Platform 8/9	Checked By	HS

Started Drilling	20.7.19	Northing	6248296.00	Slope	90°	Equipment	XC Drill
Completed Drilling	20.7.19	Easting	333386.00	Bearing	---	Ground Level	26.4 AHD

DRILLING | ROCK MASS CHARACTERISTICS | DISCONTINUITIES

Method: NMLC

Water: 100% Water RETURN

Depth (m)	RL (m)	Description of Rock (rock type: colour, grain size, structure, minor components)	Weathering
12 (start of sheet)	14.4	LAMINITE: dark grey and grey, distinct lenticular laminations at 0° *(continued)*	EW, HW
13	13.4	SHALE: dark grey to black, indistinct laminations at 0°	HW, EW, MW - SW

Strength Is_{50}: X - Axial; O - Diametral; □ - Lump (EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH)

IS_{50} (MPa) D	A
0.05	0.29
0.03	0.2
0.18	0.35
0.72	0.57
0.18	0.17
0.23	0.28
0.41	0.54

Defect Spacing (mm): 20, 40, 100, 300, 1000

Core Rec'y (%)	RQD (%)
100	40
100	45
100	65

Description of Defects (defect type, inclination, roughness, thickness, infilling)

- 11.83-12.37: Jo, 85-90°, p, s, cn
- 11.85-12.38: Fragmented Zone
- 12.38: Be, 0°, p, s, vn
- 12.46: Cs, 0°, p, Low Plasticity CLAY, 10 mm
- 12.49: Be, 0°, p, s, vn
- 12.77-12.84: Jo, 60°, p, s, cn
- 12.88: Jo, 35°, p, s, cn
- 12.95: Jo, 35°, p, s, High Plasticity CLAY cg
- 13.00: Hb
- 13.09-13.14: Fragmented Zone
- 13.20: Db
- 13.23: Db
- 13.25: Db
- 13.27: Db
- 13.37: Cs, 20°, p, gravelly clay, 5 mm
- 13.37-13.42: Jo, 45°, p, s
- 13.45-13.75: Fragmented Zone
- 13.86: Be, 0-5°, p, s, cn
- 14.00: Db
- 14.06: Db
- 14.12: Db
- 14.17: Db
- 14.20: Be, 0-5°, p, s, vn
- 14.26: Cs, 0°, gravelly clay, 3 mm
- 14.28: Db
- 14.30: Cs, 0°, gravelly clay, 3 mm
- 14.41: Be, 0°, p, s, cg
- 14.46: Cs, 0°, gravelly clay, 5 mm
- 14.53: Cs, 0°, High Plasticity CLAY, 3 mm
- 14.55: Db
- 14.57: Cs, 0°, High Plasticity CLAY, 10 mm
- 14.63: Cs, 0°, Low Plasticity CLAY, 3 mm
- 14.65: Cs, 0°, Low Plasticity CLAY, 3 mm
- 14.76-14.86: Db, due to over-coring
- 14.93: Be, 0°, p, s, cn
- 15.00: Db
- 15.10: Be, 0°, p, s, cn
- 15.22: Cs, gravelly clay, 4 mm
- 15.26: Jo, 30°, p, s, cn
- 15.33: Be, 0°, p, s, cn
- 15.34: Jo, 30°, p, s, cn
- 15.43: Be, 0°, p, s, cn
- 15.47: Cs, 0°, gravelly clay, 6 mm
- 15.51: Db
- 15.53: Cs, 0°, 7 mm
- 15.65-15.76: Fragmented Zone
- 15.86: Db
- 15.83-15.90: Jo, 55°, p, s, cn
- 15.95: Db

Remarks: Defects are typically Bedding partings, 0-5°, planar smooth/rough, clean @ 20-200mm spacings (at laminations).

Rock Unit is Ashfield Shale.

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Borehole No: BH04

Engineering Log - Cored Borehole

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrades	Logged By	DZ/DR
Location	Redfern Station Platform 8/9	Checked By	HS

Started Drilling	20.7.19	Northing	6248296.00	Slope	90°	Equipment	XC Drill
Completed Drilling	20.7.19	Easting	333386.00	Bearing	---	Ground Level	26.4 AHD

DRILLING | ROCK MASS CHARACTERISTICS | DISCONTINUITIES

Method	Water	RL (m)	Depth (m)	Description of Rock (rock type: colour, grain size, structure, minor components)	Weathering	IS50 (MPa) D L A	Core Rec'y (%)	RQD (%)	Description of Defects (defect type, inclination, roughness, thickness, infilling)
NMLC	100% Water RETURN	10		SHALE: dark grey to black, indistinct laminations at 0° *(continued)*	MW - SW	0.32 / 0.56; 0.14 / 0.58	100	65	16.00: Hb 16.12-16.16: Jo, 45°, p, s, cn 16.25-16.40: Db, due to over-coring
	100% Water RETURN			CORE LOSS 0.16m (16.40-16.56)					
		9	17	As above Laminations at 30°, fault zone Laminations at 0° Laminations at 20°	MW - SW; SW	0.2 / 0.07; 0.46 / 0.65; 0.78 / 0.59; 0.41 / 0.7	90	35	16.56-16.87: Fragmented Zone 16.95-17.21: Fragmented Zone 17.24: Jo, 30°, p, s, cn 17.36: Jo, 30°, p, s, cn 17.47: Be, 0-5°, p, s, cn 17.60: Db 17.79: Be, 20°, p, r, cn 17.85-17.90: Jo, 45°, p, s, cn 17.94: Be, 20°, p, s, cn
		8	18	Borehole BH04 Terminated at 18.00 m Target depth					
		7	19						
			20						

Strength Is_{50}: X - Axial; O - Diametral; □ - Lump. EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH

Defect Spacing (mm): 20, 40, 100, 300, 1000

Remarks: Defects are typically Bedding partings, 0-5°, planar smooth/rough, clean @ 20-200mm spacings (at laminations).

Rock Unit is Ashfield Shale.

Client	Novo Rail	
Project	Redfern Station Upgrade	
Project No.	39525- TAP05	
Photo By:	DZ	

Core Photograph

BH04 (4.51-9m)

Client	Novo Rail	Core Photograph
Project	Redfern Station Upgrade	
Project No.	39525- TAP05	BH04 (9-14m)
Photo By:	DZ	

Client	Novo Rail	**Core Photograph**
Project	Redfern Station Upgrade	**BH04 (14-18m)**
Project No.	39525- TAP05	
Photo By:	DZ	

Borehole No: BH05

Engineering Log - Borehole

SHEET 1 OF 4

Client	Novo Rail	Project No.	39525
Project	Redfern Station Upgrades	Logged By	DZ/JP
Location	Redfern Station Platform 2/3	Checked By	RS

Started Drilling	12.7.19	Northing	6248333.00	Slope	90°	Equipment	XC Drill
Completed Drilling	12.7.19	Easting	333359.00	Bearing	---	Ground Level	26.4 AHD

DRILLING				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
AST	Not Encountered	26.4	0.0			FILL: Sandy CLAY: low to medium plasticity, brown, fine to coarse sand, trace medium to coarse gravel	<PL				FILL: Poorly Compacted
			1.5			FILL: Silty CLAY: high plasticity, brown, trace fine to coarse gravel, trace fine to coarse sand			SPT 2, 2, 3 N=5	D	
			3.0			Silty CLAY: high plasticity, red-brown		VSt	SPT 4, 9, 8 N=17	D	RESIDUAL SOIL
			4.5						SPT 5, 10, 8 N=18	D	
			6.0						SPT 10, 9/90mm N>9	D	
			6.2			Continued as Cored Drill Hole					

Remarks:

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BW>mW> NW8BH05

Engineering Log - Cored Borehole

SHEET 1 Ol h

Ce>ny	NW7WRaie	GrW2j y NWo	V° 515
GrW2j y	R>pf>rn SyayiWn UvFrap>u	LWFF>p Bb	Dq6JG
LWyayiWn	R>pf>rn SyayiWn GeayfW3 16V	Cm>j) >p Bb	RS

Syary>p DrieinF	21o o2°	NWymirF	91h/ VVVo00	SeWV>	° 0k	E, xiv3 >ny	z C Driee
CW8 ve>y>p DrieinF	21o o2°	EauyinF	VVVV5° o00	B>arinF	…	g rWtnp L>7>e	19oh AHD

DRILLINg | ROCK MASS CHARACTERISTICS | DISCONTINUITIES

M>yWp	P ay>r	RL s3 (	D>vyms3 (	g ravmj LWF	D>uj rivyiWn Wf RWj) srWj) yby>8j WeWtrcFrain ui' >c uyrxj yxr>c3 inWr j W8 vWn>nyu(	P >ay>rinF	Syr>nFym Iu50	IS50 sMGa(	D>f>j y Svaj inF s3 3 (	CW> R>j % sQ(	RXD sQ(	D>uj rivyiWn Wf D>f>j yu sp>f>j yyby>cinj einayiWnc rWtFm>uucymj) n>uuc infieinF(
		19										
			2									
		15										
			1									
		1h										
			V									
		1V										
			h									
		11										
			5									
		12										
			9		START CORINg AT 9o103							
NMLC		10			LAMINITE8Dar) Fr>b uiejuyWn> anp vae> Fr>bcfin> Frain>p uanpuyWn>c piuyinj yb ea3 inay>p ay0.5 p>Fr>>u					200	25	9o5V8B>c0kcvcrcj F; 9o5/ 8B>c0kcvcrcj F; 9o / 8B>c0kcvcrcj F; 9o/ V8B>c0kcvcrcj F
			:			DP yW EP	X	0o01 0o0h				: o298B>c0kcvcrcj F
		2°								200	V0	: oVh8B>c0kcvcrcj F; : oh18B>c0kcvcrcj F; : o508Cuc5kc20 3 3; : o55.: o9h8Duc0kc/ 5 3 3; : o9V8B>c0kcvcrcj F
			/			EP						

Strength Is50 scale: EL, VL, L, M, H, VH, EH; D L A. Defect spacing scale: 10, h0, 200, V00, 2000.

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Engineering Log - Cored Borehole

Ce>ny	NWWRaie	GrWEj yNWo	V°515
GrWEj y	R>pf>rn SyayiWn UvFrap>u	LWFF>p Bb	Dq6JG
LWayiWn	R>pf>rn SyayiWn GeayfW3 16V	Cm>j)>p Bb	RS

Syary>p DrieinF	21o o2°	NWymınF	91h/ VVVo00	SeW>	°0k	E, xiv3 >ny	zC Drie
CW ve>y>p DrieinF	21o o2°	EauyinF	VVVV5° o00	B>arinF	…	g rWnp L>7>e	19oh AHD

DRILLINg | ROCK MASS CHARACTERISTICS | DISCONTINUITIES

M>ymWb | P ay>r | RL s3 (| D>vyms3 (| g ravmj LWF | D>uj rivyiWn Wf RWj) srWj) ybv>8j WWrcFrain ui' >c uyrxj yxr>c3 inWj W vWn>nyu(| P >ay>rinF | Syr>nFym Iu$_{50}$ X. A-iae O Dia3 >yae □ Lx3 v | IS$_{50}$ sMGa(D L A | D>f>j y Svaj inF s3 3 (| CW> R>j % sQ(| RXD sQ(| D>uj rivyiWn Wf D>f>j yu sp>f>j yybv>cinj einayiWnc rWFm>uucymij) n>uuc infieinF(

NMLC

RL: 2/ … 2: … 20 … 29 … 22 … 25 … 21 … 2h … 2V … 2V … 2h … 21 … 25 … 22 … 29

LAMINITE8Dar) Fr>b uieuyWn> anp vae Fr>bcfin> Frain>p uanpuyWn>c piuyinj yb ea3 inay>p ay0.5 p>Fr>>u *(continued)*

DP yW EP — 0o02 / 0o09

DP — 0o01 / 0o05 — 0o0° / 0oV9 — 0o2

CORE LOSS 0oV23 s22o h.21o25(

LAMINITE8Dar) Fr>b uieuyWn> anp vae Fr>bcfin> Frain>p uanpuyWn>c piuyinj yb ea3 inay>p ay0 p>Fr>>u

SP yW DP — 0o1 / 0o19

CORE LOSS 0oV03 s2Vo10.2Vo50(

SILTSTONE8Dar) Fr>bcpiuyinj yb ea3 inay>p ay0 yW5 p>Fr>>ucwiym fin> Frain>p uanpuyWn> ea3 inayiWnu s10Q(

SP yW DP — 0oh: / 0oVh

EP

SP yW DP — 0oV

CW> R>j: 200 / 0 / 0 — RXD: V0 / V0 / 5

- / o00./ o98C' c0.5kc90 3 3
- / o2V./ o258C' c0.5kc15 3 3
- / o108B>c0kcvcrcj F
- / o18B>c0.5kcvcrc7n
- / o198B>c0kcvcrcj F
- / oV18B>c0kcvcrcj F
- / oV1./ oV98JWc/ 0kcvcrcj Fch5 3 3
- / oV98B>c0kcvcrcj F
- / oV/ ./ oh58C' c0.5kc95 3 3
- / o50./ o558C' c0.5kc50 3 3
- / o9V./ o958Duc0kc10 3 3
- / o 28Duc0kc25 3 3
- / o 1./ o 58Duc0kcV0 3 3
- °o2: .°o108D' c0kcV0 3 3
- °ohV8B>c0kcvcrcj n
- °oh98B>c0kcvcrcj n
- °o508B>c0kcvcrcj n
- °o50.°o528JWc/ 0kcvcrcj n
- °o91.°o9h8Cuc0kc15 3 3
- °o9°8B>c0kcvcrcj n
- °o 08B>c0kcvcrcj n
- °o 28B>c0kcvcrcj n
- 20o10.20o 58B>c0.5kcvcrc7nc s503 3 a7>raF> uvaj inF(
- 20o 5.20o V8C' c0kc/ 0 3 3
- 20o 5.22o008C' c0kc50 3 3
- 22o01.22o058C' c0kcV0 3 3
- 22o0/ 8B>c0.5kcvcrcj n
- 22o218B>c0.5kcvcrcj n
- 22o2h.22o2: 8C' c0kcV0 3 3
- 22o10.22oh08B>c0.5kcvcrc7nc sh03 3 a7>raF> uvaj inF(
- 22oh18Cuc0kc20 3 3
- 22oh/ .22o5V8JWc/ 0kcvcrc7n
- 22o5V8Cuc0kc20 3 3
- 22o5/ 8Cuc0kc20 3 3
- 22o95.22o9/ 8Duc0kcV0 3 3
- 22o 5.22o 08C' c0kc50 3 3
- 21oV18B>c0kcvcrcj F
- 21oV: 8Duc0kcxcj F
- 21oh: 8Smcj Fc50 3 3
- 21o508B>c0kcvcrcj n
- 21o5°8B>c0kcvcrcj n
- 21o h.21o 28Duc0kc: 0 3 3
- 2Vo20.2Vo298C' c0kc95 3 3
- 2Vo50.2Vo558C' c0.15kcxcrcj Fc 50 3 3
- 2Vo55.2ho108B>c0.5kcvcrcj Fc sh03 3 a7>raF> uvaj inF(
- 2ho10.2ho158Dd
- 2ho°8B>c0kcvcrcj F
- 2hoV8B>c0kcvcrcj F
- 2hoV98Cuc0kc5 3 3
- 2ho28B>c0kcvcrcj F
- 2hoh: .2ho908Duc0.h5kc2V0 3 3
- 2ho55.2ho908JWch5kcvcej F
- 2ho99.2ho 58Duc0.V0kc°0 3 3
- 2ho 18B>c0kcvcrcj F
- 2ho 1.2ho°8Duc0kc: 0 3 3
- 2ho 0.2ho 18Duc0kc10 3 3
- 25o058B>c0kcvcrcj F
- 25o0/ 8Cuc0kc20 3 3
- 25o2h8Cuc0kc20 3 3
- 25oV18B>c0kcvcrcj F
- 25oV9.25oh18JWc°0kcxcrcj Fc 90 3 3
- 25oh9.25o5h8JWc°0kcxcrcj Fc 90 3 3

R>3 ar) u8

AURECON SYD LIB 05. COGY.BACKUGg LB LWF CP CORED BOREHOLE LOg RSUgg GJ <<DrawinFl ie44 0/ 6/26/010 29:2: 20o0o0o2o0: D>7>eW>p db DayF>e

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Engineering Log - Cored Borehole

Cei>ny	NW7WRaie	GrWZej yNWo	V° 515
GrWZej y	R>pf>rn SyayiWn UvFrap>u	LWFF>p Bb	Dq6JG
LWjayiWn	R>pf>rn SyayiWn Geayf W3 16V	Cm>j) >p Bb	RS

Syary>p DrieinF	21o o2°	NWryminF	91h/ VVVo00	SeW>	° 0k	E, xiv3 >ny	z C Driee
CW3 ve>y>p DrieinF	21o o2°	EauyinF	VVVV5° o00	B>arinF	…	g rWXnp L>7>e	19oh AHD

DRILLINg				ROCK MASS CHARACTERISTICS							DISCONTINUITIES		
M>yWo	P ay>r	RL s3 (	D>vyms3 (	g ravmij LWF	D>uj rivyiWn Wf RWj) srWj) yb v>8j WeWrcFrain ui' >c uyrxj yxr>c3 inWrj W3 vWn>nyu(	P >ay>rinF	Syr>nFym Iu50 (X. A-iae; Dia3 >yae; Lx3 v) EL VL L M H VH EH	IS50 sMGa(D L A	D>f>j y Svaj inF s3 3 (10 h0 200 V00 2000	CW> R>j % sQ(	RXD sQ(	D>uj rivyiWn Wf D>f>j yu sp>f>j yyb v>cinj einayiWnc rWxFmn>uucymij) n>uuc infieinF(
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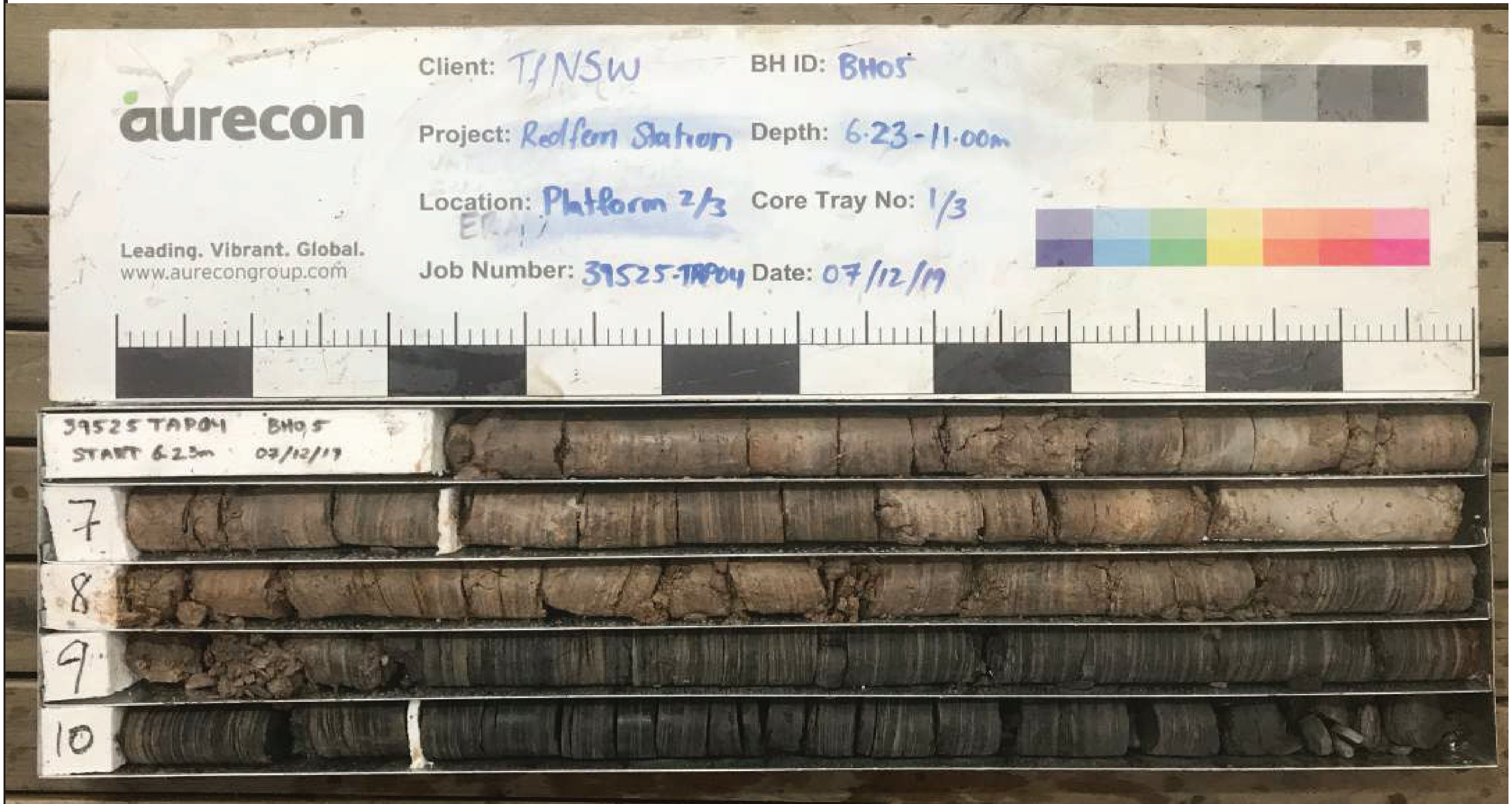
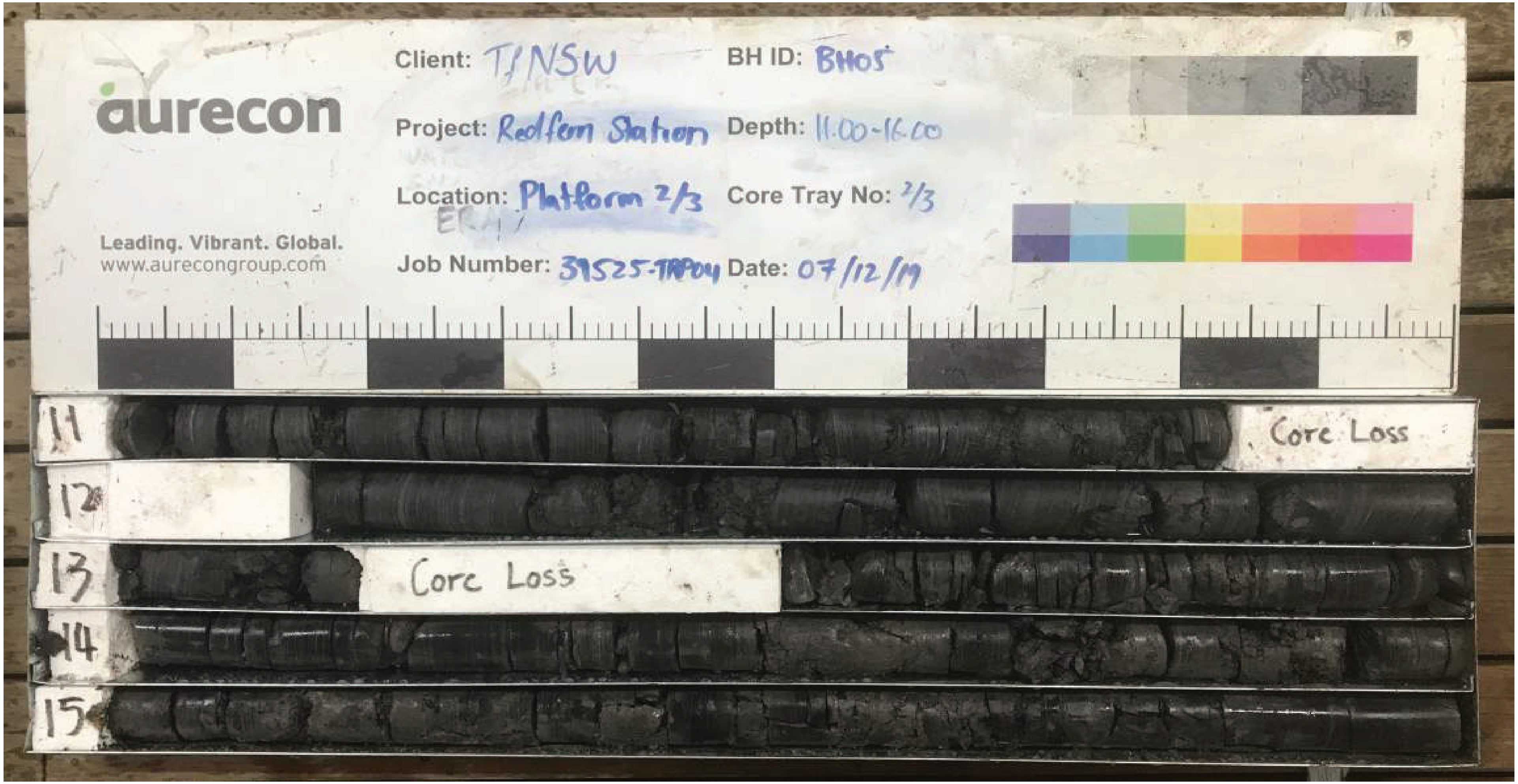
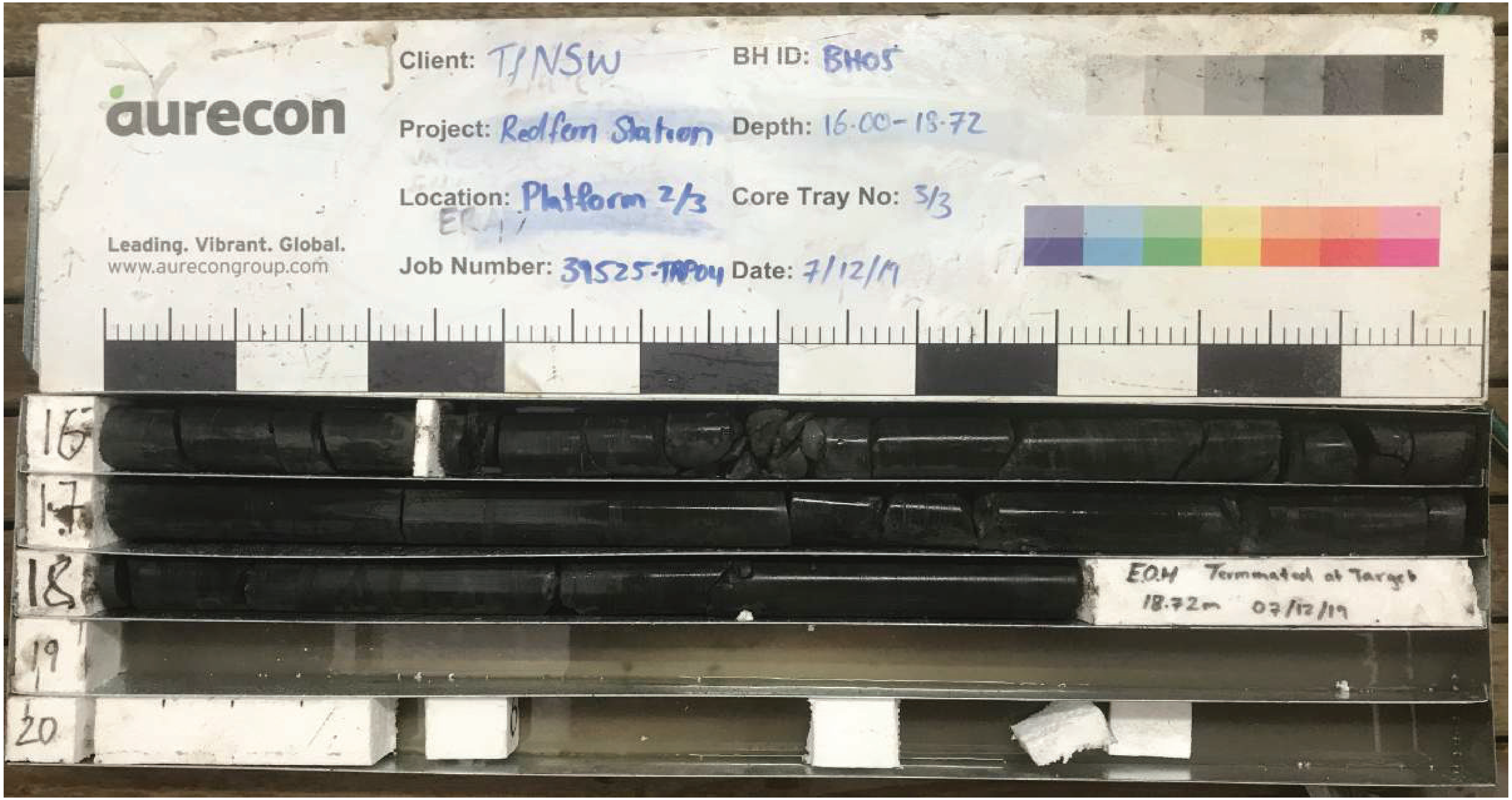


Client	Novo Rail	**Core Photograph**
Project	Redferen Station Upgrade	
Project No.	39525- TAP05	**BH05 (6.23-11m)**
Photo By:	DZ	



Client	Novo Rail	**Core Photograph**
Project	Redferen Station Upgrade	**BH05 (11-16m)**
Project No.	39525- TAP05	
Photo By:	DZ	



aurecon	Client	Novo Rail	Core Photograph
	Project	Redferen Station Upgrade	BH05 (16-18.72m)
	Project No.	39525- TAP05	
	Photo By:	DZ	

Appendix D – Laboratory Testing Certificates

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 2/4 Kellogg Road,
Glendenning NSW 2761

Laboratory: Glendenning Laboratory
Phone: 02 4577 3555
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

MOISTURE CONTENT REPORT

Client:	Novo rail	Report Number:	12385/R/154832-3
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/74655
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019 Page 1 of 1

Test Procedures:	AS1289.2.1.1

Sample Number	12385/S/606186	12385/S/606188	12385/S/606189	
ID / Client ID	-	-	-	
Lot Number	-	-	-	
Date / Time Sampled	15/03/2019	15/03/2019	15/03/2019	
Sampling Method	Tested As Received	Tested As Received	Tested As Received	
Date Tested	21/03/2019	21/03/2019	21/03/2019	
Material Source	Unknown	Unknown	Unknown	
Material Type	-	-	-	
Borehole	BH02	BH02	BH02	
Depth	4.5m	7m	8-8.2m	
Moisture Content (%)	**16.7**	**12.0**	**16.2**	

Sample Number				
ID / Client ID				
Lot Number				
Date / Time Sampled				
Sampling Method				
Date Tested				
Material Source				
Material Type				
Borehole				
Depth (m)				
Moisture Content (%)				

Remarks	Re-Issued Report Replaces Report No 12385/R/154832-2 (reason: in-correct borehole number supplied.).

NATA

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Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 12385

Pat Deasy

Approved Signatory: Patrick Deasy
Form ID: W20Rep Rev 1

Construction Sciences

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ABN: 74 128 806 735

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Unit 2/4 Kellogg Road,
Glendenning NSW 2761

Laboratory: Glendenning Laboratory
Phone: 02 4577 3555
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

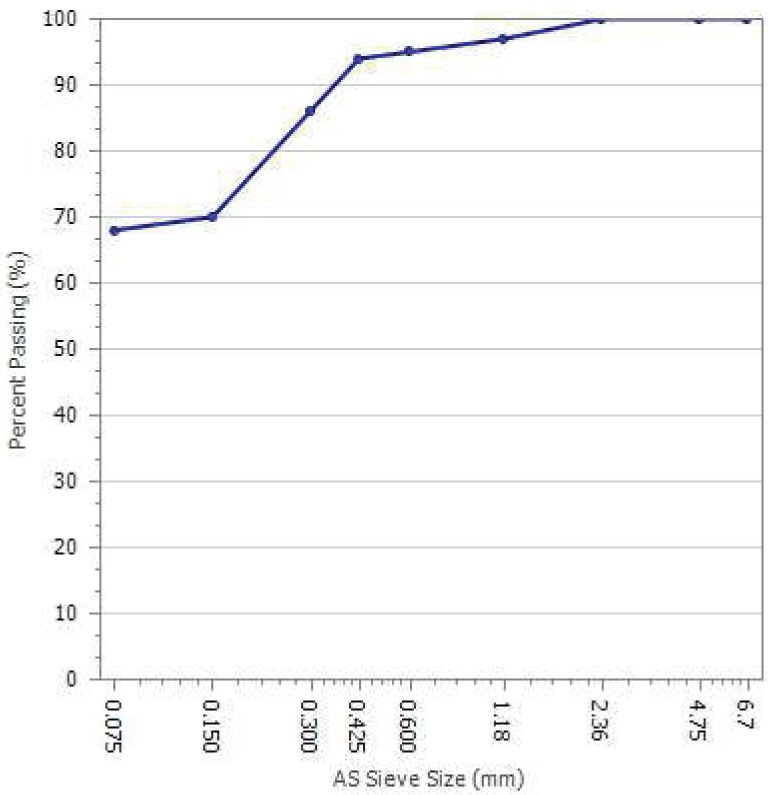
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Novo rail	Report Number:	12385/R/154838-2
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/74655
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019 Page 1 of 4

Test Procedures:	AS1289.3.6.1		
Sample Number	12385/S/606186	Sample Location	
Sampling Method	Tested As Received	Borehole	BH02
Date Sampled	15/03/2019	Depth (m)	4.5m
Sampled By	Client Sampled		
Date Tested	21/03/2019		
Material Source	Unknown	Material Type	-

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
6.7		**100**	
4.75		**100**	
2.36		**100**	
1.18		**97**	
0.600		**95**	
0.425		**94**	
0.300		**86**	
0.150		**70**	
0.075		**68**	

PARTICLE SIZE DISTRIBUTION GRAPH



Remarks: Re-Issued Report Replaces Report No 12385/R/154838-1 (reason: In-correct borehole number supplied.).

NATA

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Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Patrick Deasy
Form ID: W9Rep Rev 2

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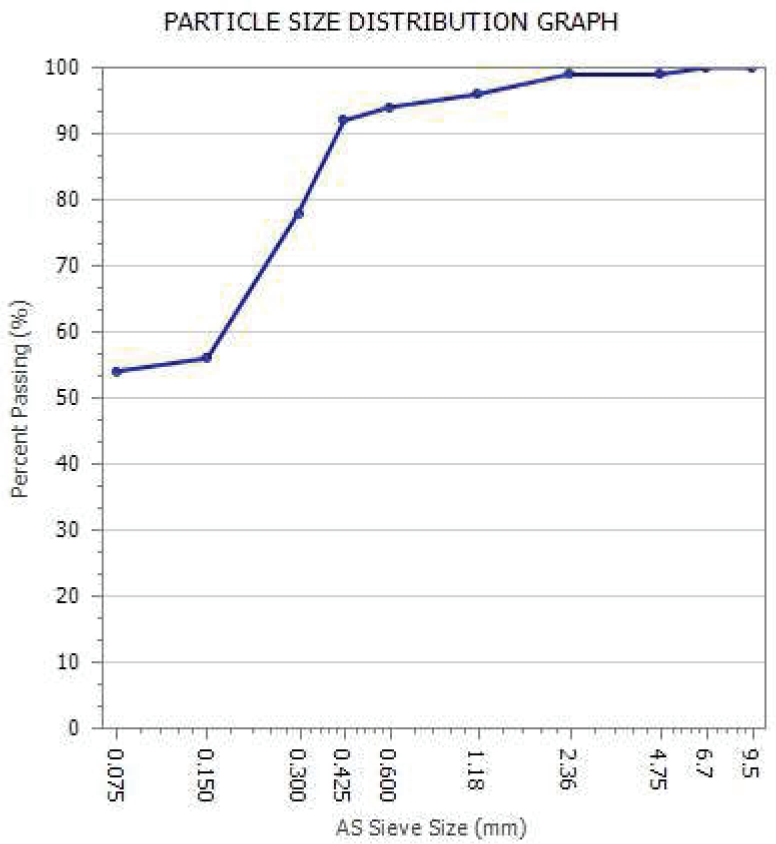
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

PARTICLE SIZE DISTRIBUTION REPORT

Client:	Novo rail	Report Number:	12385/R/154838-2
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/74655
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019 Page 2 of 4

Test Procedures:	AS1289.3.6.1			
Sample Number	12385/S/606187	Sample Location		
Sampling Method	Tested As Received	Borehole		BH02
Date Sampled	15/03/2019	Depth	(m)	5m
Sampled By	Client Sampled			
Date Tested	21/03/2019			
Material Source	Unknown	Material Type	-	

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
9.5		**100**	
6.7		**100**	
4.75		**99**	
2.36		**99**	
1.18		**96**	
0.600		**94**	
0.425		**92**	
0.300		**78**	
0.150		**56**	
0.075		**54**	



Remarks	Re-Issued Report Replaces Report No 12385/R/154838-1 (reason: In-correct borehole number supplied.).

NATA

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Form ID: W9Rep Rev 2

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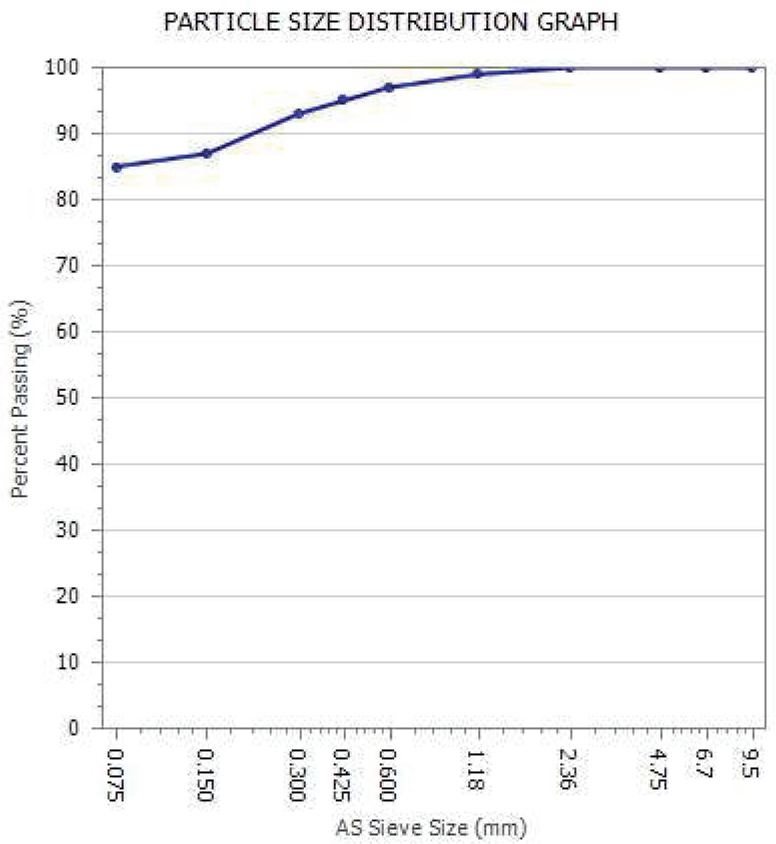
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

PARTICLE SIZE DISTRIBUTION REPORT

Client:	Novo rail	Report Number:	12385/R/154838-2
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/74655
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019 Page 3 of 4

Test Procedures:	AS1289.3.6.1			
Sample Number	12385/S/606188	Sample Location		
Sampling Method	Tested As Received	Borehole		BH02
Date Sampled	15/03/2019	Depth	(m)	7m
Sampled By	Client Sampled			
Date Tested	21/03/2019			
Material Source	Unknown	Material Type	-	

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
9.5		**100**	
6.7		**100**	
4.75		**100**	
2.36		**100**	
1.18		**99**	
0.600		**97**	
0.425		**95**	
0.300		**93**	
0.150		**87**	
0.075		**85**	



Remarks	Re-Issued Report Replaces Report No 12385/R/154838-1 (reason: In-correct borehole number supplied.).

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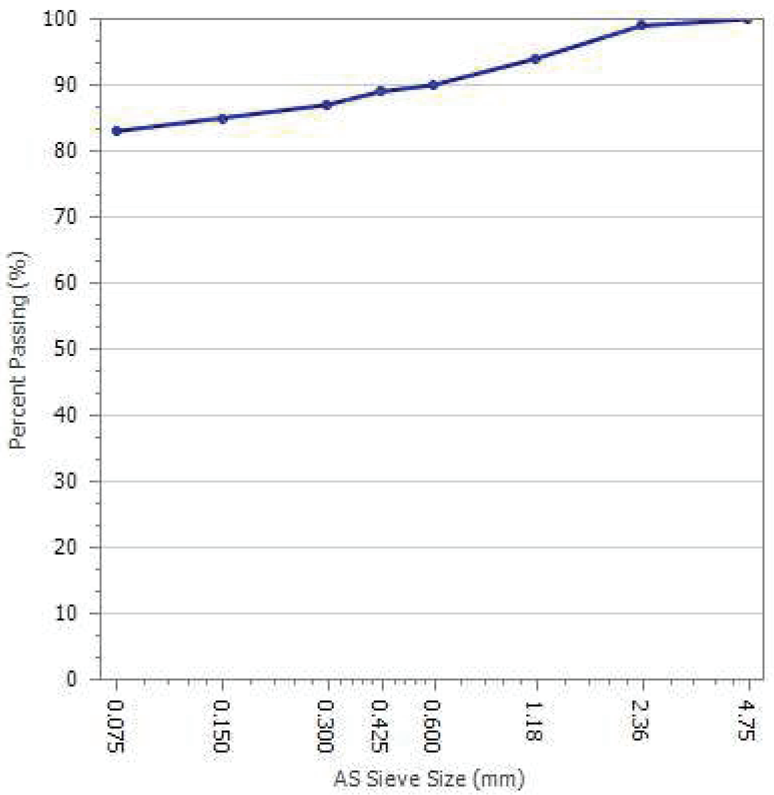
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Novo rail	Report Number:	12385/R/154838-2
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/74655
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019 Page 4 of 4

Test Procedures:	AS1289.3.6.1			
Sample Number	12385/S/606189	Sample Location		
Sampling Method	Tested As Received	Borehole		BH02
Date Sampled	15/03/2019	Depth	(m)	8-8.2m
Sampled By	Client Sampled			
Date Tested	21/03/2019			
Material Source	Unknown	Material Type	-	

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
4.75		**100**	
2.36		**99**	
1.18		**94**	
0.600		**90**	
0.425		**89**	
0.300		**87**	
0.150		**85**	
0.075		**83**	

PARTICLE SIZE DISTRIBUTION GRAPH



Remarks	Re-Issued Report Replaces Report No 12385/R/154838-1 (reason: In-correct borehole number supplied.).

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ATTERBERG LIMITS REPORT

Client:	Novo rail	Report Number:	12385/R/154840-2
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/74655
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019 Page 1 of 3

Test Procedures: AS1289.3.1.2, AS 1289.3.3.1, AS1289.3.2.1, AS1289.2.1.1

Sample Number	12385/S/606187	Sample Location	
Sampling Method	Tested As Received	Borehole	BH02
Date Sampled	15/03/2019	Depth (m)	5m
Sampled By	Client Sampled		
Date Tested	26/03/2019		
Att. Drying Method	Oven Dried	Material Source	Unknown
Atterberg Preparation	Dry Sieved	Material Type	-
Material Description	Silty Sandy CLAY		

Atterberg Limits Results

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		**36**	
Plastic Limit (%)		**13**	
Plasticity Index (%)		**23**	
Linear Shrinkage (%)			
Linear Shrinkage Defects:			

Remarks: Re-Issued Report Replaces Report No 12385/R/154840-1 (reason: In-correct borehole number supplied.).

NATA

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Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Patrick Deasy
Form ID: W11bRep Rev 1

Construction Sciences

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Email: Sydney@constructionsciences.net

ATTERBERG LIMITS REPORT

Client:	Novo rail	Report Number:	12385/R/154840-2
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/74655
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019

Test Procedures:	AS1289.3.1.2, AS 1289.3.3.1, AS1289.3.2.1, AS1289.3.4.1, AS1289.2.1.1		
Sample Number	12385/S/606188	Sample Location	
Sampling Method	Tested As Received	Borehole	BH02
Date Sampled	15/03/2019	Depth (m)	7m
Sampled By	Client Sampled		
Date Tested	26/03/2019		
Att. Drying Method	Oven Dried	Material Source	Unknown
Atterberg Preparation	Dry Sieved	Material Type	-
Material Description	Sility CLAY		

Atterberg Limits Results

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		**58**	
Plastic Limit (%)		**19**	
Plasticity Index (%)		**39**	
Linear Shrinkage (%)		**19.5**	
Linear Shrinkage Mould Length / Defects:	Mould Length: 250.3mm / N/A		

Remarks	Re-Issued Report Replaces Report No 12385/R/154840-1 (reason: In-correct borehole number supplied.).

NATA

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Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Patrick Deasy
Form ID: W11bRep Rev 1

Construction Sciences

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ATTERBERG LIMITS REPORT

Client:	Novo rail	Report Number:	12385/R/154840-2
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/74655
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019 Page 3 of 3

Test Procedures:	AS1289.3.1.2, AS 1289.3.3.1, AS1289.3.2.1, AS1289.3.4.1, AS1289.2.1.1		
Sample Number	12385/S/606189	Sample Location	
Sampling Method	Tested As Received	Borehole	BH02
Date Sampled	15/03/2019	Depth (m)	8-8.2m
Sampled By	Client Sampled		
Date Tested	26/03/2019		
Att. Drying Method	Oven Dried	Material Source	Unknown
Atterberg Preparation	Dry Sieved	Material Type	-
Material Description	Silty CLAY		

Atterberg Limits Results

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		**50**	
Plastic Limit (%)		**20**	
Plasticity Index (%)		**30**	
Linear Shrinkage (%)		**15.0**	
Linear Shrinkage Mould Length / Defects:	Mould Length: 125.4mm / N/A		

Remarks	Re-Issued Report Replaces Report No 12385/R/154840-1 (reason: In-correct borehole number supplied.).

NATA

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Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Patrick Deasy
Form ID: W11bRep Rev 1

Construction Sciences

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POINT LOAD STRENGTH INDEX REPORT

Client:	Novo rail	Report Number:	12385/R/163272-2
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/78773
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019 Page 1 of 2

Test Procedures:	AS4133.4.1

Sample Number	12385/S/640802	12385/S/640803	12385/S/640804	12385/S/640805
ID / Client ID	-	-	-	-
Lot Number	-	-	-	-
Date / Time Tested	15/03/2019	15/03/2019	15/03/2019	15/03/2019
Material Source	Not Supplied	Not Supplied	Not Supplied	Not Supplied
Material Type	-	-	-	-
Sampling Method				
Borehole Number	BH01	BH01	BH01	BH01
Section Tested (m)	8.0	9.26	9.9	11.48
Borehole	BH02	BH02	BH02	BH02
Depth (m)	8.0	9.26	9.9	11.48
Manner of Testing	Axial	Diametral	Diametral	Diametral
Failure Mode	Single Shear	Single Shear	Single Shear	Single Shear
Storage History	n/a	n/a	n/a	n/a
Moisture Condition	Dry/Moist	Dry/Moist	Dry/Moist	Dry/Moist
Lithology	n/a	n/a	n/a	n/a
Weakness Plane (Orientation)	n/a	n/a	n/a	n/a
Weakness Plane (Nature)	n/a	n/a	n/a	n/a
Uncorrected Point Load Strength (MPa) - Is	**0.61**	**0.24**	**0.47**	**0.22**
Point Load Strength Index (MPa) - Is(50)	**0.6**	**0.23**	**0.46**	**0.22**
Specimen Remarks	n/a	n/a	n/a	n/a

Remarks	Re-Issued Report Replaces Report No 12385/R/163272-1 (reason: Borehole number added).

NATA

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Patrick Deasy
Form ID: W50Rep Rev 1

Construction Sciences

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Glendenning NSW 2761

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Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

POINT LOAD STRENGTH INDEX REPORT

Client:	Novo rail	Report Number:	12385/R/163272-2
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/78773
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019 Page 2 of 2

Test Procedures:	AS4133.4.1

Sample Number	12385/S/640806	12385/S/640807	12385/S/640808	
ID / Client ID	-	-	-	
Lot Number	-	-	-	
Date / Time Tested	15/03/2019	15/03/2019	15/03/2019	
Material Source	Not Supplied	Not Supplied	Not Supplied	
Material Type	-	-	-	
Sampling Method				
Borehole Number	BH01	BH01	BH01	
Section Tested (m)	11.9	12.6	13.0	
Borehole	BH02	BH02	BH02	
Depth (m)	11.9	12.6	13.0	
Manner of Testing	Axial	Axial	Axial	
Failure Mode	Single Shear	Axial Splitting	Single Shear	
Storage History	n/a	n/a	n/a	
Moisture Condition	Dry/Moist	Dry	Dry/Moist	
Lithology	n/a	n/a	n/a	
Weakness Plane (Orientation)	n/a	n/a	n/a	
Weakness Plane (Nature)	n/a	n/a	n/a	
Uncorrected Point Load Strength (MPa) - Is	**0.98**	**0.44**	**0.26**	
Point Load Strength Index (MPa) - Is(50)	**0.92**	**0.44**	**0.26**	
Specimen Remarks	n/a	n/a	n/a	

Remarks	Re-Issued Report Replaces Report No 12385/R/163272-1 (reason: Borehole number added).

NATA

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Accreditation Number: 1986
Corporate Site Number: 12385

Pat Deasy

Approved Signatory: Patrick Deasy
Form ID: W50Rep Rev 1

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 2/4 Kellogg Road,
Glendenning NSW 2761

Laboratory: Glendenning Laboratory
Phone: 02 4577 3555
Fax: 02 4577 9055
Email: Sydney@constructionsciences.net

POINT LOAD STRENGTH INDEX REPORT

Client:	Novo rail	Report Number:	12385/R/154820-2
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/74655
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019 Page 1 of 2

Test Procedures:	AS4133.4.1

Sample Number	12385/S/606190	12385/S/606192	12385/S/606193	12385/S/606194
ID / Client ID	-	-	-	-
Lot Number	-	-	-	-
Date / Time Tested	15/03/2019	15/03/2019	15/03/2019	15/03/2019
Material Source	Unknown	Unknown	Unknown	Unknown
Material Type	-	-	-	-
Sampling Method	Tested As Received	Tested As Received	Tested As Received	Tested As Received
Borehole Number	BH01	BH01	BH01	BH01
Section Tested (m)	8.99-9.06	10.32-10.60	11.57-11.61	11.81-11.86
Borehole	BH02	BH02	BH02	BH02
Depth (m)	8.99-9.06m	9.65-9.72m	11.57-11.61m	11.81-11.86m
Manner of Testing	Axial	Axial	Axial	Diametral
Failure Mode	Single Shear	Single Shear	Single Shear	Single Shear
Storage History	n/a	n/a	n/a	n/a
Moisture Condition	Dry/Moist	Dry/Moist	Dry/Moist	Dry/Moist
Lithology	n/a	n/a	n/a	n/a
Weakness Plane (Orientation)	n/a	n/a	n/a	n/a
Weakness Plane (Nature)	n/a	n/a	n/a	n/a
Uncorrected Point Load Strength (MPa) - Is	**0.082**	**0.035**	**0.15**	**0.029**
Point Load Strength Index (MPa) - Is(50)	**0.084**	**0.037**	**0.14**	**0.029**
Specimen Remarks	n/a	n/a	n/a	n/a

Remarks	Re-Issued Report Replaces Report No 12385/R/154820-1 (reason: In-correct borehole nuber supplied.).

NATA

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Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 12385

Pat Deasy

Approved Signatory: Patrick Deasy
Form ID: W50Rep Rev 1

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POINT LOAD STRENGTH INDEX REPORT

Client:	Novo rail	Report Number:	12385/R/154820-2
Client Address:	136 Railway Parade, Everleigh,	Project Number:	12385/P/1203
Project:	Redfern Station Upgrade	Lot Number:	
Location:	Sydney	Internal Test Request:	12385/T/74655
Supplied To:	n/a	Client Reference/s:	39525-06037
Area Description:		Report Date / Page:	24/05/2019 Page 2 of 2

Test Procedures:	AS4133.4.1

Sample Number	12385/S/606195	12385/S/606197	12385/S/606198	
ID / Client ID	-	-	-	
Lot Number	-	-	-	
Date / Time Tested	15/03/2019	15/03/2019	15/03/2019	
Material Source	Unknown	Unknown	Unknown	
Material Type	-	-	-	
Sampling Method	Tested As Received	Tested As Received	Tested As Received	
Borehole Number	BH01	BH01	BH01	
Section Tested (m)	12.0-12.07	13.27-13.32	13.50-13.61	
Borehole	BH02	BH02	BH02	
Depth (m)	12-12.07m	13.27-13.32m	13.5-16.61	
Manner of Testing	Diametral	Diametral	Diametral	
Failure Mode	Single Shear	Single Shear	Single Shear	
Storage History	n/a	n/a	n/a	
Moisture Condition	Dry/Moist	Dry/Moist	Dry/Moist	
Lithology	n/a	n/a	n/a	
Weakness Plane (Orientation)	n/a	n/a	n/a	
Weakness Plane (Nature)	n/a	n/a	n/a	
Uncorrected Point Load Strength (MPa) - Is	**0.012**	**0.12**	**0.15**	
Point Load Strength Index (MPa) - Is(50)	**0.012**	**0.11**	**0.15**	
Specimen Remarks	n/a	n/a	n/a	

Remarks	Re-Issued Report Replaces Report No 12385/R/154820-1 (reason: In-correct borehole nuber supplied.).

NATA

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Accreditation Number: 1986
Corporate Site Number: 12385

Approved Signatory: Patrick Deasy
Form ID: W50Rep Rev 1

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

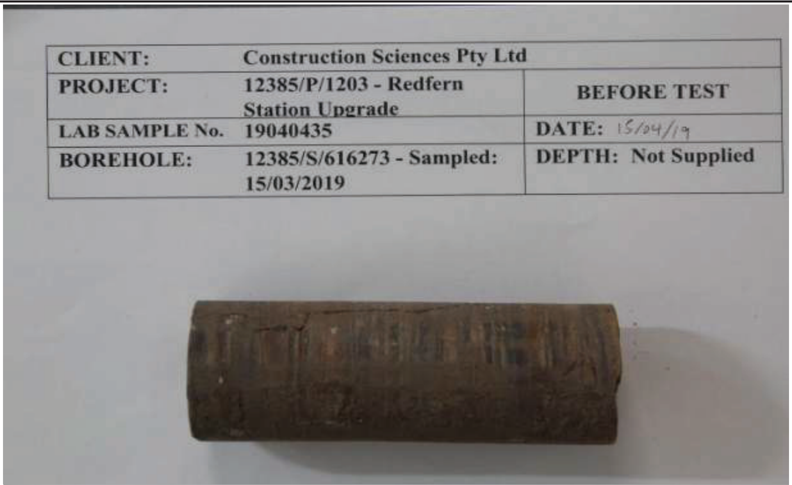
Test Method: AS 4133.4.2.2 & AS 4133.1.1.1

Client	Construction Sciences Pty Ltd	**Report No.**	19040435-UCS
		This replaces previous report dated 16/4/19	
Address	Unit 2/4 Kellogg Road Glendenning NSW 2761	**Test Date**	15/04/2019
		Report Date	24/05/2019
Project	12385/P/1203 - Redfern Station Upgrade		
Client ID	12385/S/616273 - BH2	**Depth (m)**	Not Supplied
Description	-		
Sample Type	Single Individual Rock Core Specimen		

TEST DETAILS

Average Sample Diameter (mm)	51.5	Moisture Content (%)	7.2
Sample Height (mm)	140.9	Wet Density (t/m^3)	2.23
Duration of Test (min)	18:57	Dry Density (t/m^3)	2.08
Rate of Displacement (mm/min)	0.10	Bedding (°)	15
Mode of Failure	Shear and Defect	Test Apparatus	50 kN Load Cell in Compression Machine
Rupture Angle (°)	80		
UCS (MPa)	**1.60**		

Before and After Photo's



NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client

Photo's not to scale

Accredited for compliance with ISO/IEC 17025 - Testing.
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Authorised Signatory
N. Maddison

NATA
ACCREDITED FOR TECHNICAL COMPETENCE
Laboratory No. 9926

eurofins | mgt

Certificate of Analysis

Construction Sciences Pty Ltd
2/4 Kellogg Rd
Glendenning
NSW 2761

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025 – Testing
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Attention:	**Patrick Deasy**
Report	**646854-S**
Project name	REDFERN STATION UPGRADE
Project ID	12385/P/1203
Received Date	Mar 22, 2019

Client Sample ID			**12385/S/606188**
Sample Matrix			**Soil**
Eurofins | mgt Sample No.			**S19-Ma30996**
Date Sampled			**Mar 15, 2019**
Test/Reference	LOR	Unit	
Chloride	10	mg/kg	68
Conductivity (1:5 aqueous extract at 25°C as rec.)	5	uS/cm	90
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	5.0
Resistivity*	0.5	ohm.m	560
Sulphate (as SO4)	10	mg/kg	83
% Moisture	1	%	11

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

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	Mar 25, 2019	28 Day
- Method: E045 /E047 Chloride			
Conductivity (1:5 aqueous extract at 25°C as rec.)	Sydney	Mar 25, 2019	7 Day
- Method: LTM-INO-4030 Conductivity			
pH (1:5 Aqueous extract at 25°C as rec.)	Sydney	Mar 25, 2019	7 Day
- Method: LTM-GEN-7090 pH in soil by ISE			
Sulphate (as SO4)	Sydney	Mar 25, 2019	28 Day
- Method: E045 Anions by Ion Chromatography			
% Moisture	Sydney	Mar 22, 2019	14 Day
- Method: LTM-GEN-7080 Moisture			

Company Name: Construction Sciences Pty Ltd
Address: 2/4 Kellogg Rd
Glendenning
NSW 2761

Project Name: REDFERN STATION UPGRADE
Project ID: 12385/P/1203

Order No.:
Report #: 646854
Phone: 02 9854 1700
Fax:

Received: Mar 22, 2019 12:40 PM
Due: Mar 29, 2019
Priority: 5 Day
Contact Name: Patrick Deasy

Eurofins | mgt Analytical Services Manager : Nibha Vaidya

Sample Detail						Aggressivity Soil Set	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271							
Sydney Laboratory - NATA Site # 18217						X	X
Brisbane Laboratory - NATA Site # 20794							
Perth Laboratory - NATA Site # 23736							
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	12385/S/606188	Mar 15, 2019		Soil	S19-Ma30996	X	X
Test Counts						1	1

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, April 2011 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. 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.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

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

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - 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.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.2 2018
CP	Client Parent - QC was performed on samples pertaining to this report
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.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

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%

Surrogate Recoveries: Recoveries must lie between 50-150%-Phenols & PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.2 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

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. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. 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.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank									
Chloride			mg/kg	< 10			10	Pass	
Sulphate (as SO4)			mg/kg	< 10			10	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Chloride	S19-Ma30996	CP	%	110			70-130	Pass	
Sulphate (as SO4)	S19-Ma30996	CP	%	108			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	S19-Ma30996	CP	mg/kg	68	68	<1	30%	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	S19-Ma30996	CP	uS/cm	90	94	5.0	30%	Pass	
pH (1:5 Aqueous extract at 25°C as rec.)	S19-Ma30996	CP	pH Units	5.0	5.0	pass	30%	Pass	
Resistivity*	S19-Ma30996	CP	ohm.m	560	530	5.0	30%	Pass	
Sulphate (as SO4)	S19-Ma30996	CP	mg/kg	83	88	6.0	30%	Pass	
% Moisture	N19-Ma26340	NCP	%	7.4	7.8	5.0	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

Nibha Vaidya	Analytical Services Manager
Gabriele Cordero	Senior Analyst-Inorganic (NSW)

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.

MOISTURE CONTENT TEST REPORT

Client:	Novo Rail	**Job No:**	S19163
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Report No:**	S47309-MC
Project:	Redfern Station Upgrade (39525-06037)		

Test Procedure:

- ☑ AS 1289 2.1.1 Soil moisture content tests - Determination of the moisture content of a soil - Oven drying method (Standard method).
- ☐ AS4133 1.1.1 Rock moisture content tests - Determination of the moisture content of rock - Oven drying method (standard method)
- ☐ RMS T120 Moisture content of road construction materials (Standard method)
- ☐ RMS T262 Determination of moisture content of aggregates (Standard method)

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample No.	Source	Sample Description	Moisture Content %
S47309	BH03 3-m	Silty CLAY	**18.2**
S47311	BH03 6-m	Silty CLAY trace of Sand and Gravel	**12.9**

Notes:

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

15/04/2019

Date:

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

SOIL CLASSIFICATION REPORT

Client	Novo Rail	**Source**	BH03 1.5-m
Address	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description**	Silty CLAY
Project	Redfern Station Upgrade (39525-06037)	**Report No**	S47308-PI
Job No	S19163	**Lab No**	S47308

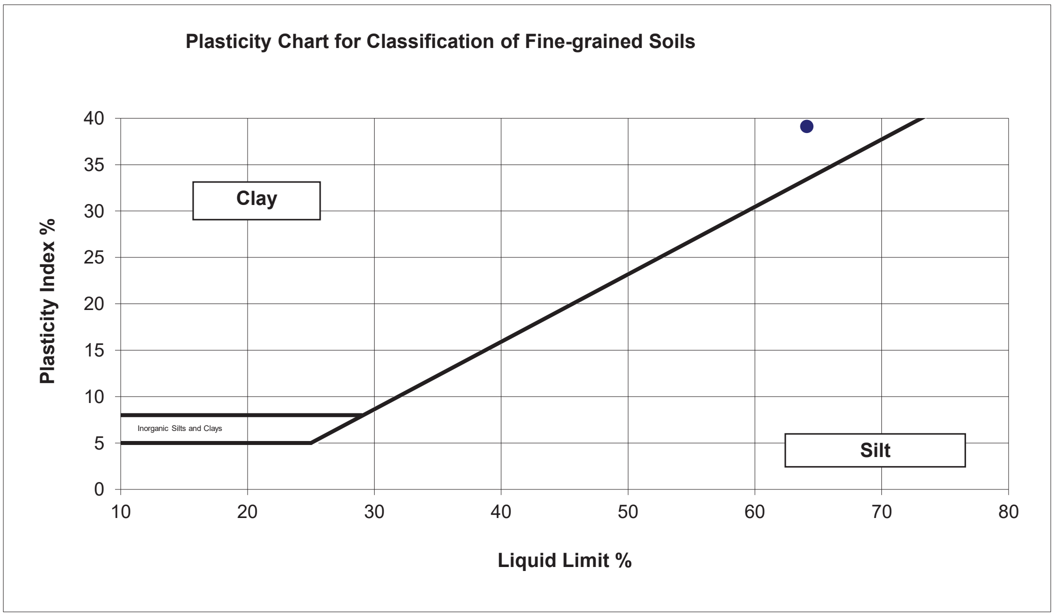
Test Procedure:

- ☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☐ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	64	**Linear Shrinkage (%)**	-
Plastic Limit (%)	25	**Plasticity Index**	39



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: N/A

Notes	

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15/04/2019

Date:

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

SOIL CLASSIFICATION REPORT

Client	Novo Rail	**Source**	BH03 3-m
Address	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description**	Silty CLAY
Project	Redfern Station Upgrade (39525-06037)	**Report No**	S47309-PI
Job No	S19163	**Lab No**	S47309

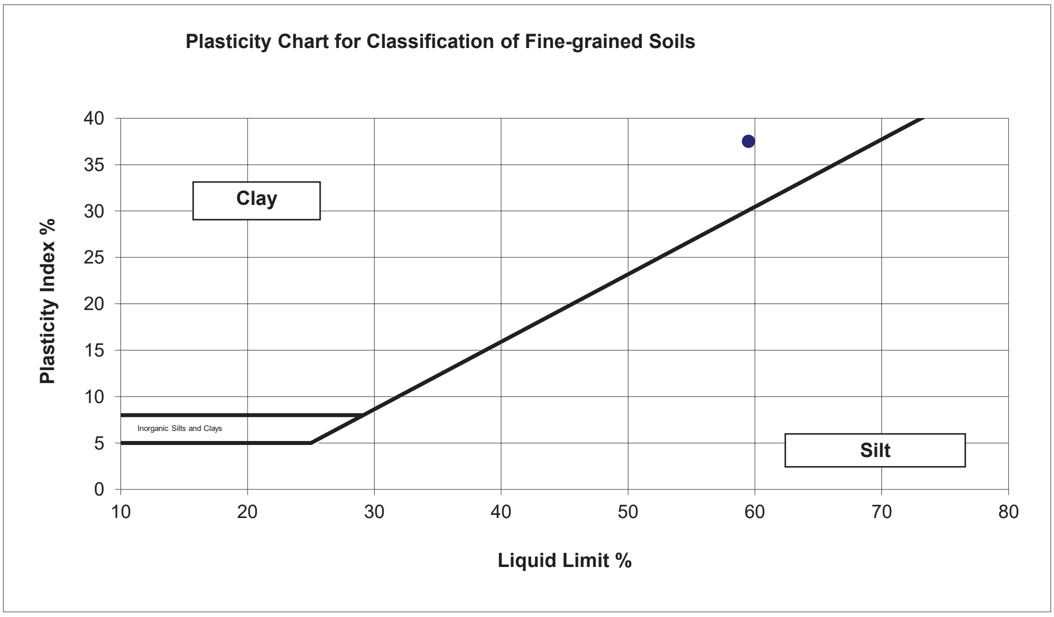
Test Procedure:

- ☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☐ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	60	**Linear Shrinkage (%)**	-
Plastic Limit (%)	22	**Plasticity Index**	38



Soil Preparation Method: Dry Sieved
Soil History: Air Dried
Soil Condition: N/A

Notes	

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Authorised Signatory:

Chris Lloyd

15/04/2019

Date:

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

SOIL CLASSIFICATION REPORT

Client	Novo Rail	**Source**	BH03 4.5-m
Address	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description**	Silty CLAY
Project	Redfern Station Upgrade (39525-06037)	**Report No**	S47310-PI
Job No	S19163	**Lab No**	S47310

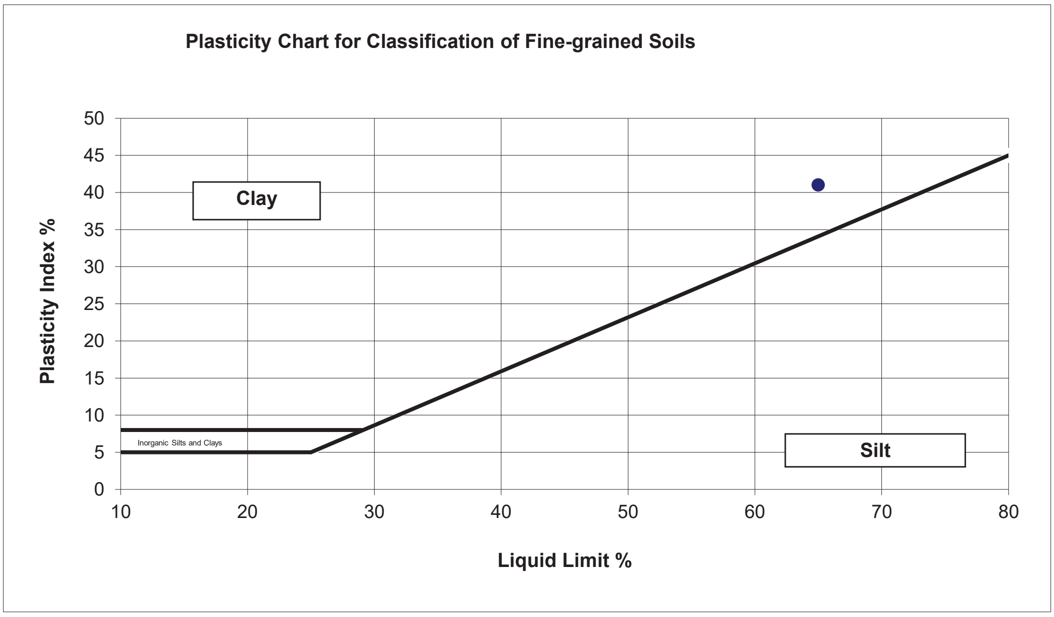
Test Procedure:

- ☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☐ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	65	**Linear Shrinkage (%)**	-
Plastic Limit (%)	24	**Plasticity Index**	41



Soil Preparation Method: Dry Sieved
Soil History: Air Dried
Soil Condition: N/A

Notes

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

15/04/2019
Date:

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

SOIL CLASSIFICATION REPORT

Client	Novo Rail	**Source**	BH03 6-m
Address	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description**	Silty CLAY trace of Sand and Gravel
Project	Redfern Station Upgrade (39525-06037)	**Report No**	S47311-PI
Job No	S19163	**Lab No**	S47311

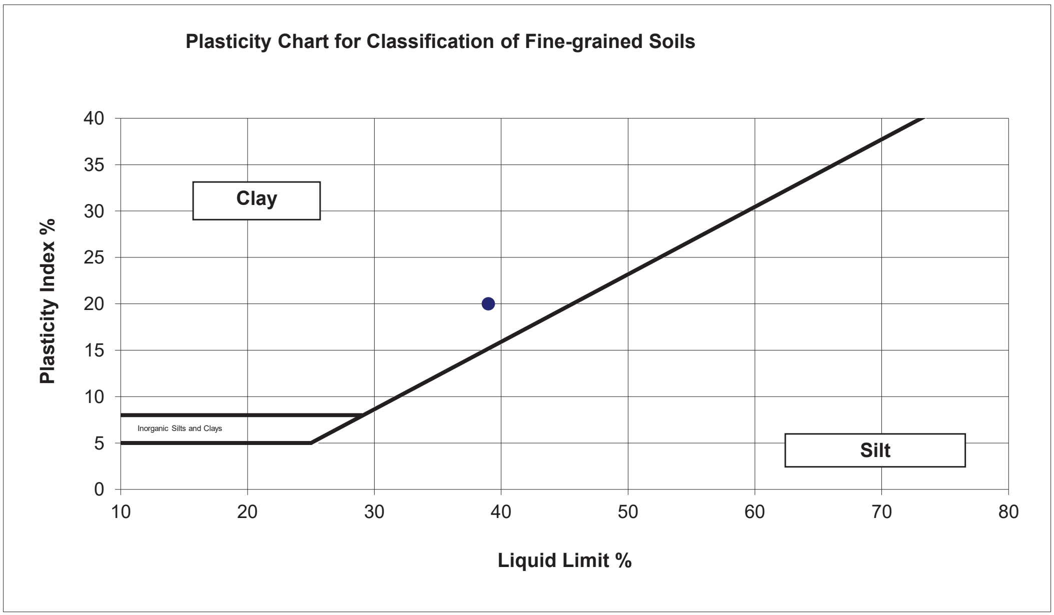
Test Procedure:

- ☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☐ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	39	**Linear Shrinkage (%)**	-
Plastic Limit (%)	19	**Plasticity Index**	20



Soil Preparation Method: Dry Sieved
Soil History: Air Dried
Soil Condition: N/A

Notes	

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Authorised Signatory:

Chris Lloyd

15/04/2019

Date:

Macquarie Geotechnical
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Alexandria NSW 2015

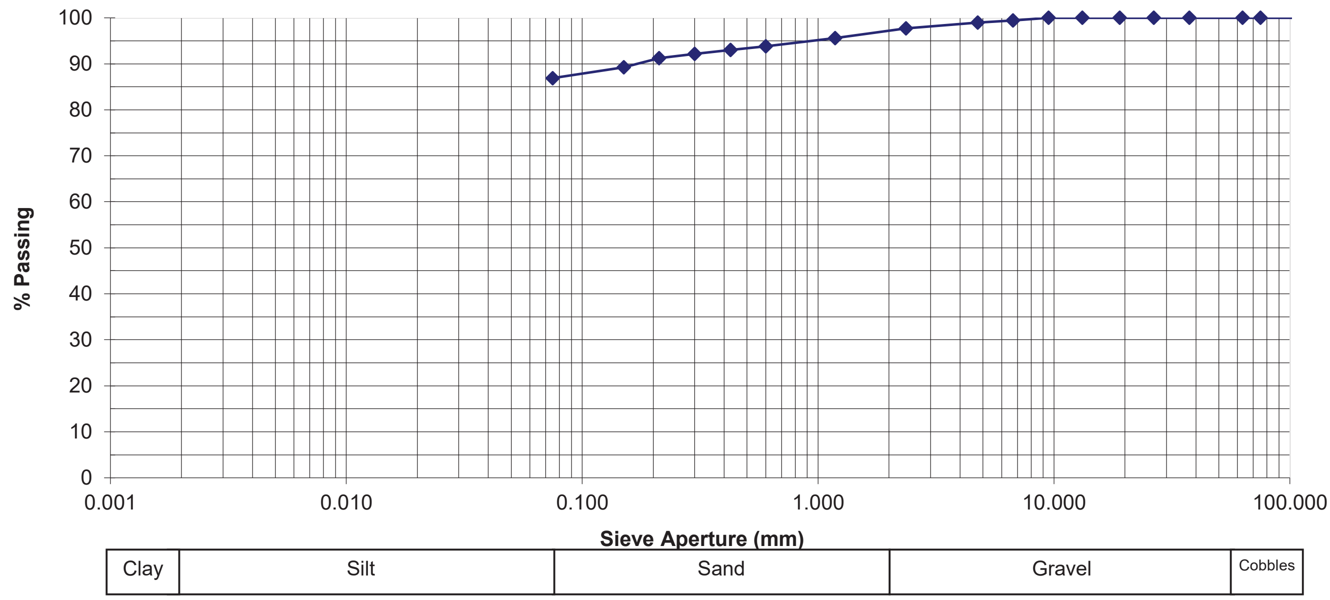
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Novo Rail	**Source:**	BH03 6-m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Silty CLAY trace of Sand and Gravel
Project:	Redfern Station Upgrade (39525-06037)	**Report No.:**	S47311-PSD
Job No.:	S19163	**Lab No.:**	S47311

Test Procedure: ☑ AS1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling: Sampled by Client | Date Sampled: Unknown

Preparation: Prepared in accordance with the test method



Sieve Apperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
200	100		4.75	99	
75	100		2.36	98	
63	100		1.18	96	
37.5	100		0.600	94	
26.5	100		0.425	93	
19	100		0.300	92	
13.2	100		0.212	91	
9.5	100		0.150	89	
6.7	99		0.075	87	

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MACQUARIE GEOTECH

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POINT LOAD STRENGTH INDEX REPORT

Client:	Novo Rail	**Moisture Content Condition:**	As received
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Storage History:**	Core boxes
Project:	Redfern Station Upgrade (39525-06037)	**Report No:**	S47312-PL
Job No:	S19163	**Date Tested:**	15/04/2019

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S47312	BH03 6.77-6.85m	Shale	Diametral	-	47.0	0.18	0.08	0.08	1
			Axial	51.2	13.0	0.23	0.27	0.21	1
S47313	BH03 7.39-7.46m	Shale	Diametral	-	45.0	0.13	0.06	0.06	1
			Axial	49.9	32.0	0.12	0.06	0.06	1
S47314	BH03 7.53-7.61m	Shale	Diametral	-	46.0	0.09	0.04	0.04	2
			Axial	50.3	29.0	0.18	0.10	0.09	1
S47315	BH03 7.67-7.75m	Shale	Diametral	-	47.0	0.13	0.06	0.06	1
			Axial	50.9	35.0	0.15	0.06	0.06	1
S47316	BH03 8.25-8.31m	Shale	Diametral	-	47.0	0.17	0.07	0.07	1
			Axial	51.1	27.0	0.10	0.06	0.05	1
S47317	BH03 9-9.1m	Shale	Diametral	-	40.0	0.09	0.06	0.05	1
			Axial	43.6	28.0	0.08	0.05	0.05	1
S47318	BH03 9.74-9.82m	Shale	Diametral	-	47.0	0.04	0.02	0.02	1
			Axial	53.3	36.0	0.03	0.01	0.01	1
S47319	BH03 10.25-10.31m	Shale	Diametral	-	48.0	0.06	0.03	0.03	1
			Axial	51.5	22.0	0.26	0.18	0.16	1
S47320	BH03 10.79-10.88m	Shale	Diametral	-	48.0	0.08	0.03	0.03	1
			Axial	50.6	27.0	0.20	0.11	0.10	1
S47321	BH03 11.38-11.43m	Shale	Diametral	-	44.0	0.10	0.05	0.05	1
			Axial	47.9	22.0	0.11	0.08	0.07	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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POINT LOAD STRENGTH INDEX REPORT

Client:	Novo Rail	**Moisture Content Condition:**	As received
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Storage History:**	Core boxes
Project:	Redfern Station Upgrade (39525-06037)	**Report No:**	S47322-PL
Job No:	S19163	**Date Tested:**	15/04/2019

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S47323	BH03 12.44-12.53m	Shale	Diametral	-	45.0	0.15	0.07	0.07	1
			Axial	49.4	25.0	0.17	0.10	0.09	1
S47324	BH03 13.11-13.15m	Shale	Diametral	-	48.0	0.17	0.07	0.07	1
			Axial	51.2	28.0	0.53	0.29	0.27	1
S47325	BH03 13.8-13.86m	Shale	Diametral	-	48.0	0.56	0.24	0.24	1
			Axial	51.4	31.0	1.75	0.86	0.82	1
S47326	BH03 14.55-14.64m	Shale	Diametral	-	48.0	0.19	0.08	0.08	2
			Axial	51.5	24.0	1.68	1.07	0.96	1
S47327	BH03 15.91-15.97m	Shale	Diametral	-	48.0	0.46	0.20	0.20	1
			Axial	51.5	34.0	1.09	0.49	0.48	1
S47328	BH03 16.11-16.24m	Shale	Diametral	-	49.0	0.16	0.06	0.06	1
			Axial	51.6	30.0	0.86	0.44	0.41	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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MACQUARIE GEOTECH

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH03 7.26-7.37m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-06037)	**Report No.:**	S47313-UCS
Job No.:	S19163	**Lab No.:**	S47313
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 0.99 MPa

Date Tested:	13/04/2019		Moisture Content:	12.0	%
Specimen Height:	96.3	mm	Duration of Test:	604	seconds
Average Specimen Diameter:	50.6	mm	Rate of Displacement:	< 0.1	mm/min
Failure Type:	Tensile dominated				
Other Pertinent Observations:					
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.				

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH03 8.35-8.45m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-06037)	**Report No.:**	S47316-UCS
Job No.:	S19163	**Lab No.:**	S47316
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 0.99 MPa

Date Tested:	13/04/2019		Moisture Content:	12.6	%
Specimen Height:	82.7	mm	Duration of Test:	604	seconds
Average Specimen Diameter:	50.8	mm	Rate of Displacement:	< 0.1	mm/min
Failure Type:	Tensile dominated				
Other Pertinent Observations:					
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.				

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH03 9.96-10.11m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-06037)	**Report No.:**	S47320-UCS
Job No.:	S19163	**Lab No.:**	S47320
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 2.6 MPa

Date Tested:	13/04/2019		Moisture Content:	10.3	%
Specimen Height:	105.3	mm	Duration of Test:	621	seconds
Average Specimen Diameter:	50.8	mm	Rate of Displacement:	< 0.1	mm/min
Failure Type:	Single shear plane				
Other Pertinent Observations:					
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.				

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH03 11.29-11.38m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-06037)	**Report No.:**	S47322-UCS
Job No.:	S19163	**Lab No.:**	S47322
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 1.3 MPa

Date Tested:	13/04/2019		Moisture Content:	13.2	%
Specimen Height:	78.2	mm	Duration of Test:	609	seconds
Average Specimen Diameter:	48.3	mm	Rate of Displacement:	< 0.1	mm/min
Failure Type:	Tensile dominated				
Other Pertinent Observations:					
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.				

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH03 14.00-14.14m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-06037)	**Report No.:**	S47326-UCS
Job No.:	S19163	**Lab No.:**	S47326
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 19 MPa

Date Tested:	13/04/2019		Moisture Content:	5.5	%
Specimen Height:	99.8	mm	Duration of Test:	679	seconds
Average Specimen Diameter:	51.6	mm	Rate of Displacement:	< 0.1	mm/min
Failure Type:	Tensile dominated				
Other Pertinent Observations:					
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.				

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH03 16.11-16.24m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-06037)	**Report No.:**	S47328-UCS
Job No.:	S19163	**Lab No.:**	S47328
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 23 MPa

Date Tested:	13/04/2019	Moisture Content:	3.5 %
Specimen Height:	131.6 mm	Duration of Test:	714 seconds
Average Specimen Diameter:	51.6 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type:	Mixed mode		
Other Pertinent Observations:			

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MACQUARIE GEOTECH

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MOISTURE CONTENT TEST REPORT

Client:	Novo Rail	**Job No:**	S19163
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Report No:**	S51183-MC
Project:	Redfern Station Upgrade (39525-TAP04-06037)		

Test Procedure:

- [x] AS 1289 2.1.1 Soil moisture content tests - Determination of the moisture content of a soil - Oven drying method (Standard method).
- [ ] AS4133 1.1.1 Rock moisture content tests - Determination of the moisture content of rock - Oven drying method (standard method)
- [ ] RMS T120 Moisture content of road construction materials (Standard method)
- [ ] RMS T262 Determination of moisture content of aggregates (Standard method)

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample No.	Source	Sample Description	Moisture Content %
S51183	BH04 1.5-1.95m	Clayey SILT, trace Gravel, trace Sand	**16.8**
S51185	BH04 4.5-m	Silty CLAY	**15.5**

Notes:

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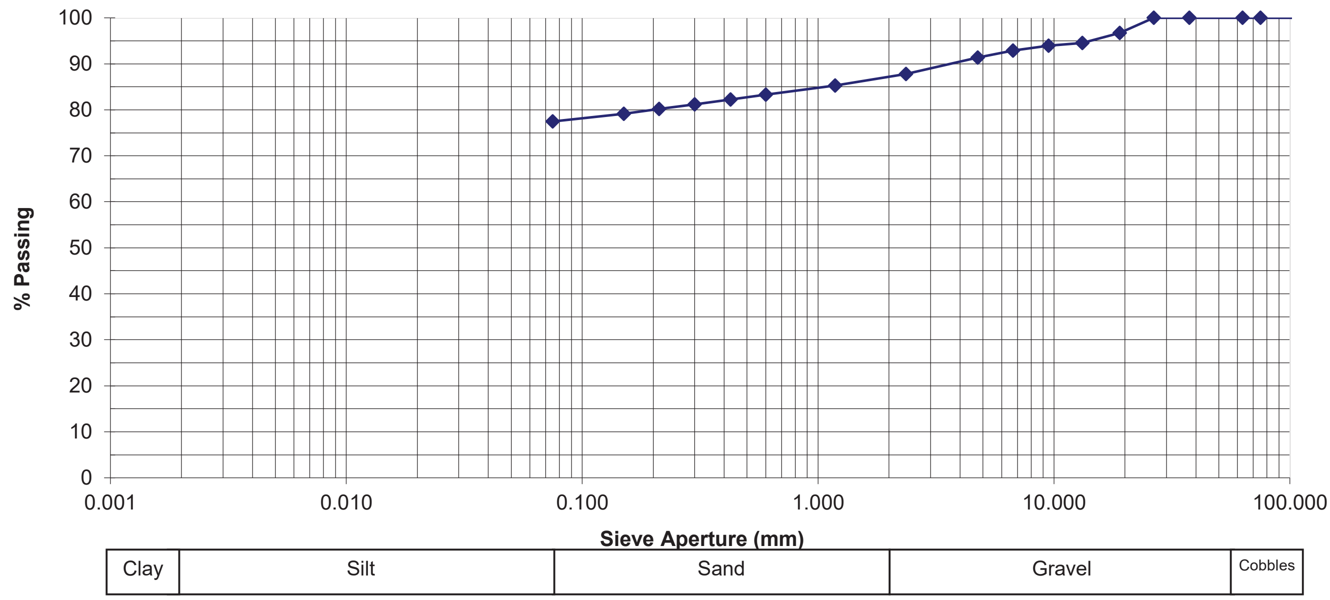
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Novo Rail	**Source:**	BH04 1.5-1.95m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Clayey SILT, trace Gravel, trace Sand
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51183-PSD
Job No.:	S19163	**Lab No.:**	S51183

Test Procedure: ☑ AS1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling: Sampled by Client | Date Sampled: Unknown

Preparation: Prepared in accordance with the test method



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200	100		4.75	91	
75	100		2.36	88	
63	100		1.18	85	
37.5	100		0.600	83	
26.5	100		0.425	82	
19	97		0.300	81	
13.2	95		0.212	80	
9.5	94		0.150	79	
6.7	93		0.075	77	

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MACQUARIE GEOTECH

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SOIL CLASSIFICATION REPORT

Client	Novo Rail	**Source**	BH04 3-3.45m
Address	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description**	Silty CLAY, trace Gravel, trace Sand
Project	Redfern Station Upgrade (39525-TAP04-06037)	**Report No**	S51184-PI
Job No	S19163	**Lab No**	S51184

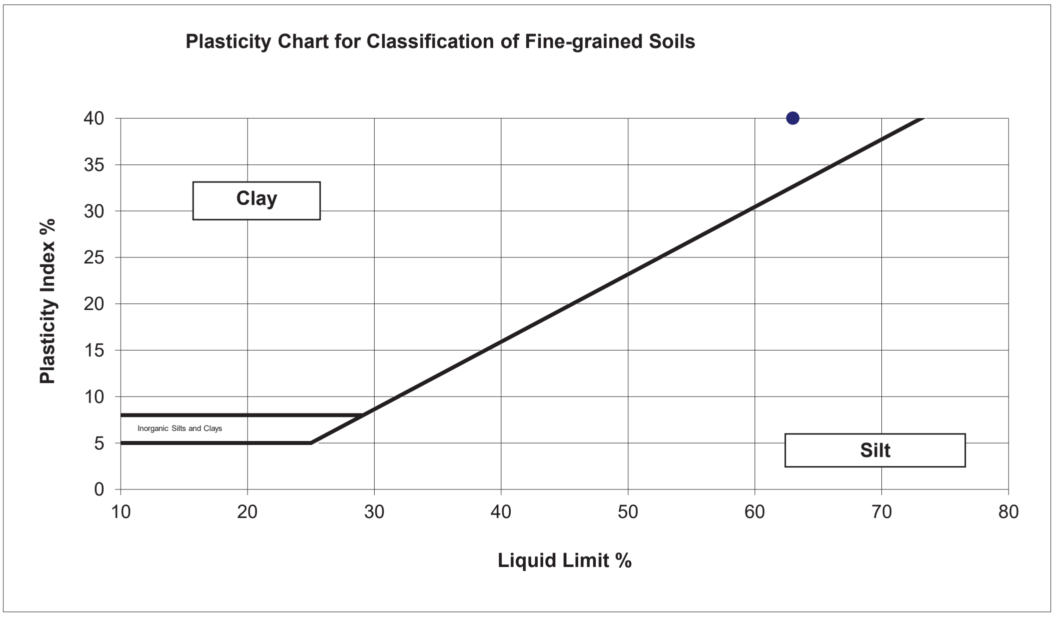
Test Procedure:

- ☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☐ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	63	**Linear Shrinkage (%)**	-
Plastic Limit (%)	23	**Plasticity Index**	40



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition:

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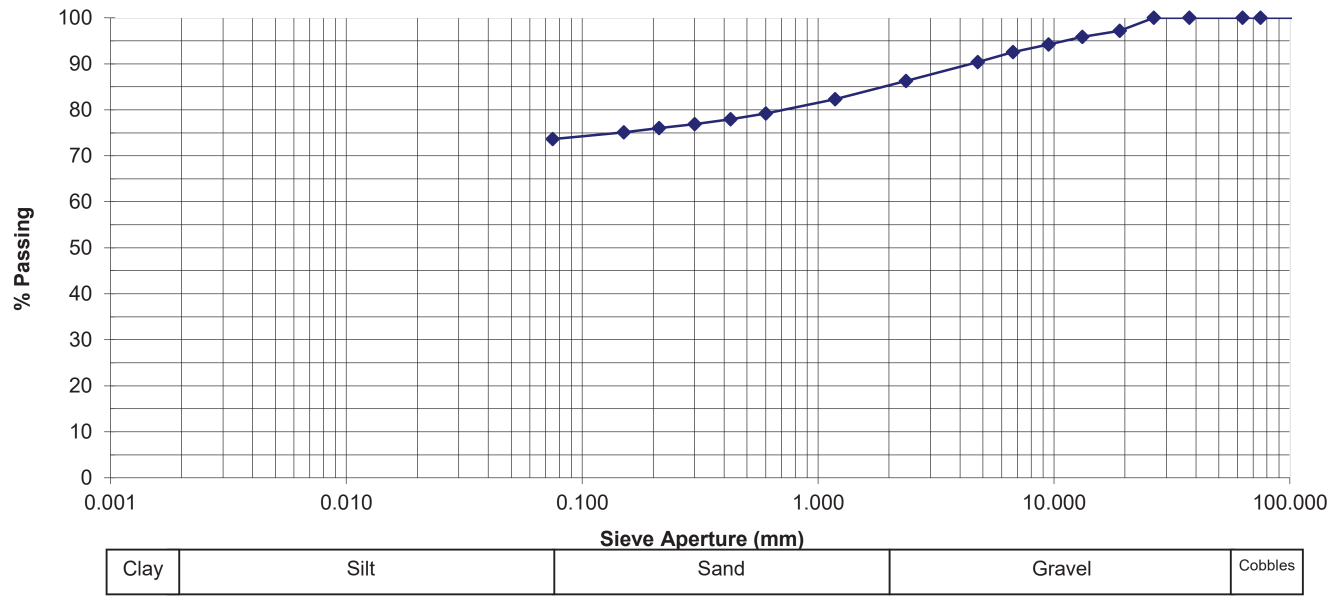
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Novo Rail	**Source:**	BH04 3-3.45m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Silty CLAY, trace Gravel, trace Sand
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51184-PSD
Job No.:	S19163	**Lab No.:**	S51184

Test Procedure: ☑ AS1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling: Sampled by Client | Date Sampled: Unknown

Preparation: Prepared in accordance with the test method



Sieve Apperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
200	100		4.75	90	
75	100		2.36	86	
63	100		1.18	82	
37.5	100		0.600	79	
26.5	100		0.425	78	
19	97		0.300	77	
13.2	96		0.212	76	
9.5	94		0.150	75	
6.7	93		0.075	74	

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SOIL CLASSIFICATION REPORT

Client	Novo Rail	**Source**	BH04 4.5-m
Address	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description**	Silty CLAY
Project	Redfern Station Upgrade (39525-TAP04-06037)	**Report No**	S51185-PI
Job No	S19163	**Lab No**	S51185

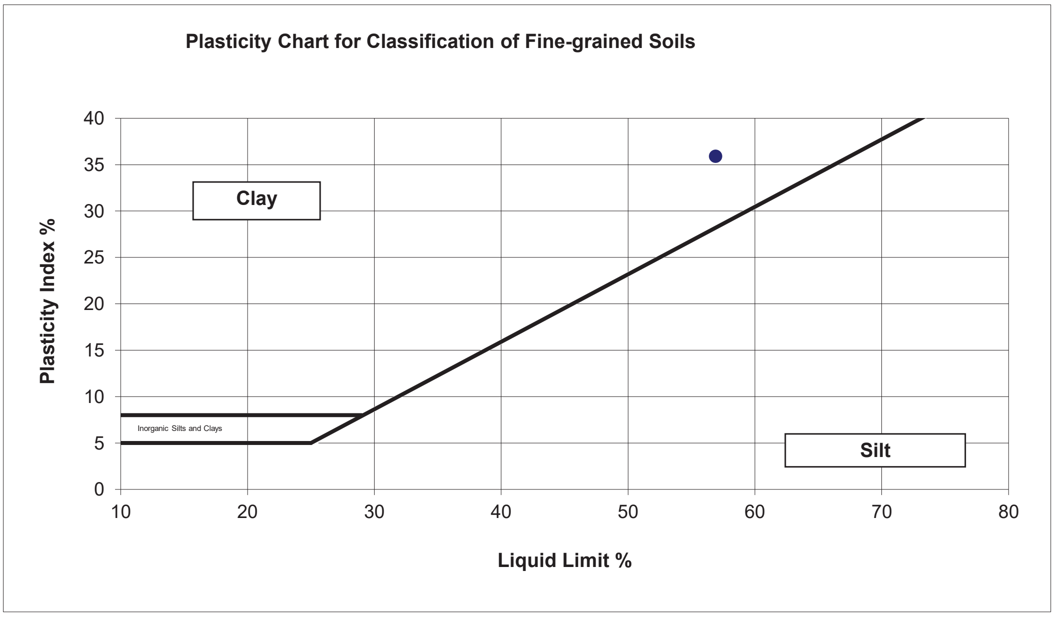
Test Procedure:

- ☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	57	**Linear Shrinkage (%)**	9.0
Plastic Limit (%)	21	**Plasticity Index**	36



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

Notes

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Chris Lloyd

Date: 8/08/2019

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

POINT LOAD STRENGTH INDEX REPORT

Client:	Novo Rail	**Moisture Content Condition:**	As received
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Storage History:**	Core boxes
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No:**	S51186-PL
Job No:	S19163	**Date Tested:**	6/08/2019

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S51186	BH04 5.17-5.24m	Shale	Diametral	-	47.0	0.21	0.10	0.09	1
			Axial	51.4	31.0	0.21	0.10	0.10	1
S51187	BH04 5.93-6.00m	Shale	Diametral	-	45.0	0.12	0.06	0.06	1
			Axial	50.5	19.0	0.08	0.07	0.06	1
S51188	BH04 6.35-6.40m	Shale	Diametral	-	48.0	0.39	0.17	0.17	1
			Axial	51.2	31.0	0.39	0.19	0.18	1
S51189	BH04 6.55-6.63m	Shale	Diametral	-	49.0	0.12	0.05	0.05	1
			Axial	51.4	16.0	0.21	0.20	0.16	1
S51190	BH04 7.38-7.42m	Shale	Diametral	-	48.0	0.34	0.15	0.14	1
			Axial	51.5	20.0	0.34	0.26	0.22	1
S51191	BH04 7.82-7.89m	Shale	Diametral	-	48.0	0.36	0.16	0.15	1
			Axial	51.5	24.0	0.39	0.25	0.22	1
S51192	BH04 8.43-8.48m	Shale	Diametral	-	49.0	0.07	0.03	0.03	1
			Axial	51.4	18.0	0.20	0.17	0.14	1
S51193	BH04 8.69-8.74m	Shale	Diametral	-	48.0	0.09	0.04	0.04	1
			Axial	51.6	16.0	0.31	0.29	0.24	1
S51194	BH04 9.31-9.35m	Shale	Diametral	-	49.0	0.06	0.02	0.02	1
			Axial	51.9	11.0	0.24	0.33	0.25	1
S51195	BH04 9.83-9.88m	Shale	Diametral	-	49.0	0.06	0.02	0.02	1
			Axial	51.7	13.0	0.26	0.30	0.24	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 6.41-6.47m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51188-UCS
Job No.:	S19163	**Lab No.:**	S51188
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 1.9 MPa

Date Tested:	8/08/2019	Moisture Content:	9.5 %
Specimen Height:	59.2 mm	Duration of Test:	615 seconds
Average Specimen Diameter:	51.3 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type:	Mixed mode		
Other Pertinent Observations:			
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.		

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 7.89-7.95m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51190-UCS
Job No.:	S19163	**Lab No.:**	S51190
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 0.47 MPa

Date Tested:	8/08/2019	Moisture Content:	8.2 %
Specimen Height:	54.8 mm	Duration of Test:	615 seconds
Average Specimen Diameter:	128.5 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type:	Mixed mode		
Other Pertinent Observations:			
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.		

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 8.63-8.69m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51193-UCS
Job No.:	S19163	**Lab No.:**	S51193
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 2.8 MPa

Date Tested:	8/08/2019		Moisture Content:	8.6	%
Specimen Height:	58.3	mm	Duration of Test:	602	seconds
Average Specimen Diameter:	51.0	mm	Rate of Displacement:	< 0.1	mm/min
Failure Type:	Mixed mode				
Other Pertinent Observations:					
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.				

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 9.78-9.83m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51194-UCS
Job No.:	S19163	**Lab No.:**	S51194
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 4.7 MPa

Date Tested:	8/08/2019		Moisture Content:	10.3	%
Specimen Height:	45.3	mm	Duration of Test:	615	seconds
Average Specimen Diameter:	51.6	mm	Rate of Displacement:	< 0.1	mm/min
Failure Type:	Mixed mode				
Other Pertinent Observations:					
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.				

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POINT LOAD STRENGTH INDEX REPORT

Client:	Novo Rail	**Moisture Content Condition:**	As received
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Storage History:**	Core boxes
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No:**	S51196-PL
Job No:	S19163	**Date Tested:**	6/08/2019

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S51196	BH04 10.39-10.42m	Shale	Diametral						
			Axial	51.6	20.0	0.40	0.30	0.26	1
S51197	BH04 10.67-10.71m	Shale	Diametral	-	50.0	0.06	0.02	0.02	1
			Axial	51.6	12.0	0.43	0.55	0.42	1
S51198	BH04 11.44-11.50m	Shale	Diametral	-	50.0	0.25	0.10	0.10	1
			Axial	51.6	21.0	0.15	0.11	0.10	1
S51199	BH04 12.71-12.77m	Shale	Diametral	-	49.0	0.13	0.05	0.05	1
			Axial	51.8	16.0	0.37	0.35	0.29	1
S51200	BH04 13.16-13.20m	Shale	Diametral	-	50.0	0.07	0.03	0.03	1
			Axial	51.8	16.0	0.26	0.25	0.20	1
S51201	BH04 13.70-13.80m	Shale	Diametral	-	49.0	0.43	0.18	0.18	1
			Axial	51.7	31.0	0.75	0.37	0.35	1
S51202	BH04 14.21-14.27m	Shale	Diametral	-	46.0	1.59	0.75	0.72	1
			Axial	51.7	28.0	1.13	0.61	0.57	1
S51203	BH04 14.88-14.93m	Shale	Diametral	-	48.0	0.43	0.19	0.18	1
			Axial	51.9	24.0	0.30	0.19	0.17	1
S51204	BH04 15.10-15.14m	Shale	Diametral	-	49.0	0.55	0.23	0.23	1
			Axial	51.7	20.0	0.43	0.33	0.28	1
S51205	BH04 15.76-15.85m	Shale	Diametral	-	49.0	0.99	0.41	0.41	1
			Axial	51.7	21.0	0.86	0.62	0.54	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 10.94-11.00m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51197-UCS
Job No.:	S19163	**Lab No.:**	S51197
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 3.8 MPa

Date Tested:	8/08/2019			Moisture Content:		10.0	%
Specimen Height:		41.5	mm	Duration of Test:		694	seconds
Average Specimen Diameter:		51.6	mm	Rate of Displacement:		< 0.1	mm/min
Failure Type:	Mixed mode						
Other Pertinent Observations:							
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.						

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 12.82-12.89m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51199-UCS
Job No.:	S19163	**Lab No.:**	S51199
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 6.9 MPa

Date Tested:	8/08/2019		Moisture Content:	7.7	%
Specimen Height:	42.3	mm	Duration of Test:	610	seconds
Average Specimen Diameter:	51.6	mm	Rate of Displacement:	< 0.1	mm/min
Failure Type:	Tensile dominated				
Other Pertinent Observations:					
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.				

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 13.26-13.32m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51200-UCS
Job No.:	S19163	**Lab No.:**	S51200
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 1.0 MPa

Date Tested:	8/08/2019	Moisture Content:	11.1 %
Specimen Height:	51.8 mm	Duration of Test:	600 seconds
Average Specimen Diameter:	51.4 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type:	Mixed mode		
Other Pertinent Observations:			
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.		

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 14.93-15.00m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51203-UCS
Job No.:	S19163	**Lab No.:**	S51203
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 0.71 MPa

Date Tested:	8/08/2019			Moisture Content:		11.2	%
Specimen Height:		53.2	mm	Duration of Test:		620	seconds
Average Specimen Diameter:		51.8	mm	Rate of Displacement:		< 0.1	mm/min
Failure Type:	Other - see photo						
Other Pertinent Observations:							
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.						

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Uniaxial Compressive Strength			
Client:	Novo Rail	**Sample Source:**	BH04 15.14-15.23m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51204-UCS
Job No.:	S19163	**Lab No.:**	S51204
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 5.7 MPa

Date Tested:	8/08/2019	Moisture Content:	8.2 %
Specimen Height:	81.1 mm	Duration of Test:	615 seconds
Average Specimen Diameter:	51.8 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type:	Mixed mode		
Other Pertinent Observations:			
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.		

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POINT LOAD STRENGTH INDEX REPORT

Client:	Novo Rail	**Moisture Content Condition:**	As received
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Storage History:**	Core boxes
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No:**	S51206-PL
Job No:	S19163	**Date Tested:**	6/08/2019

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S51206	BH04 16.06-16.12m	Shale	Diametral	-	49.0	0.78	0.32	0.32	1
			Axial	51.8	29.0	1.14	0.60	0.56	1
S51207	BH04 16.17-16.22m	Shale	Diametral	-	50.0	0.36	0.14	0.14	1
			Axial	51.8	20.0	0.88	0.67	0.58	1
S51208	BH04 16.75-16.79m	Shale	Diametral	-	48.0	0.47	0.20	0.20	1
			Axial	51.9	25.0	0.13	0.08	0.07	1
S51209	BH04 17.23-17.30m	Shale	Diametral	-	49.0	1.12	0.47	0.46	1
			Axial	51.7	31.0	1.38	0.68	0.65	1
S51210	BH04 17.45-17.53m	Shale	Diametral	-	48.0	1.82	0.79	0.78	1
			Axial	51.7	34.0	1.35	0.60	0.59	1
S51211	BH04 17.92-17.96m	Shale	Diametral	-	49.0	0.99	0.41	0.41	1
			Axial	51.6	15.0	0.85	0.86	0.70	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 16.87-16.95m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51208-UCS
Job No.:	S19163	**Lab No.:**	S51208
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 11 MPa

Date Tested:	8/08/2019		Moisture Content:	7.9	%
Specimen Height:	56.7	mm	Duration of Test:	646	seconds
Average Specimen Diameter:	51.8	mm	Rate of Displacement:	< 0.1	mm/min
Failure Type:	Tensile dominated				
Other Pertinent Observations:					
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.				

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 17.34-17.44m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51209-UCS
Job No.:	S19163	**Lab No.:**	S51209
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 8.3 MPa

Date Tested:	5/08/2019		Moisture Content:	7.8	%
Specimen Height:	104.8	mm	Duration of Test:	610	seconds
Average Specimen Diameter:	51.8	mm	Rate of Displacement:	< 0.1	mm/min
Failure Type:	Mixed mode				
Other Pertinent Observations:					
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.				

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Alexandria NSW 2015

Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 17.60-17.77m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51210-UCS
Job No.:	S19163	**Lab No.:**	S51210
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 12 MPa

Date Tested:	5/08/2019	Moisture Content:	8.0 %
Specimen Height:	145.9 mm	Duration of Test:	644 seconds
Average Specimen Diameter:	50.2 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type:	Mixed mode		
Other Pertinent Observations:			

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Date: 9/08/2019

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Uniaxial Compressive Strength

Client:	Novo Rail	**Sample Source:**	BH04 17.79-17.87m
Address:	136 Railway Parade, Eveleigh, NSW, 2015	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525-TAP04-06037)	**Report No.:**	S51211-UCS
Job No.:	S19163	**Lab No.:**	S51211
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	Unknown
Storage History:	Core Box	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 11 MPa

Date Tested:	8/08/2019	Moisture Content:	6.1 %
Specimen Height:	50.0 mm	Duration of Test:	681 seconds
Average Specimen Diameter:	51.7 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type:	Mixed mode		
Other Pertinent Observations:			
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.		

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SOIL CHEMICAL PROPERTIES REPORT

Client	Aurecon	**Source**	BH05 1.5-1.95m
Address	Level 5, 116 Military Rd, Neutral Bay, Sydney NSW 2089	**Sample Description**	Gravelly CLAY
Project	Redfern Station Upgrade (39525 - TAP04)	**Report No.**	B59995-SCP
Job No	S19604	**Lab No.**	B59995 (S56875)

Test Procedure:

☐	AS1289 4.2.1	Soil Chemical Tests - Determination of a sulfate content of a natural soil and the sulfate content of the groundwater - Normal Method
☐	AS1289 4.3.1	Soil Chemical Tests - Determination of the pH value of a soil - Electrometric method
☐	AS 1289 4.4.1	Soil Chemical Tests - Determination of the electrical resistivity of a soil - Method for sands and granular material
☐	AS 1012.20	Chloride and sulphate
☐	RMS T123	pH value of a soil (electrometric method)
☐	RMS T185	Resistivity of sands and granular road construction materials
☐	RMS T200	Chloride content of roadbase
☐	RMS T1010	Quantitative determination of chlorides in soil
☐	RMS T1011	Quantitative determination of sulphates in soil
☐	BS1377(1990 pt.3)	Water soluble sulphate content
☑	APHA 4500 H+B	pH
☑	APHA 4500 SO4 2-B	Sulphate
☑	APHA 4500 Cl-B	Chloride
☐	APHA 2510 & 2520-B	Electrical Conductivity
☐	TAI B117	Sulphides Present (This service Not Covered by NATA Accreditation)

Sampling:	Sampled by Client	**Date Sampled:**	7/12/2019
Preparation:	Prepared in accordance with the test method		

Sulphides Present	-
Sulphur Peroxide (% w/w)	-
Sulphate content (ppm)	5.4
Sulphate content (% w/w)	-
Chloride ion content (ppm)	44.8
Chloride ion content (% w/w)	-
pH	7.5
Electrical Conductivity (uS/cm)	-
Mean Resistivity Ω.m	-
(Resisitivity) Density ratio (R_D)	-
(Resisitivity) Density index (I_D)	-

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Authorised Signatory:

Brad Morris

Date: 18/12/2019

Macquarie Geotechnical
3 Watt Drive
Bathurst NSW 2795

SOIL CHEMICAL PROPERTIES REPORT

Client	Aurecon	**Source**	BH05 4.5-4.95m
Address	Level 5, 116 Military Rd, Neutral Bay, Sydney NSW 2089	**Sample Description**	CLAY with gravel
Project	Redfern Station Upgrade (39525 - TAP04)	**Report No.**	B59996-SCP
Job No	S19604	**Lab No.**	B59996 (S56877)

Test Procedure:

☐	AS1289 4.2.1	Soil Chemical Tests - Determination of a sulfate content of a natural soil and the sulfate content of the groundwater - Normal Method
☐	AS1289 4.3.1	Soil Chemical Tests - Determination of the pH value of a soil - Electrometric method
☐	AS 1289 4.4.1	Soil Chemical Tests - Determination of the electrical resistivity of a soil - Method for sands and granular material
☐	AS 1012.20	Chloride and sulphate
☐	RMS T123	pH value of a soil (electrometric method)
☐	RMS T185	Resistivity of sands and granular road construction materials
☐	RMS T200	Chloride content of roadbase
☐	RMS T1010	Quantitative determination of chlorides in soil
☐	RMS T1011	Quantitative determination of sulphates in soil
☐	BS1377(1990 pt.3)	Water soluble sulphate content
☑	APHA 4500 H+B	pH
☑	APHA 4500 SO4 2-B	Sulphate
☑	APHA 4500 Cl-B	Chloride
☐	APHA 2510 & 2520-B	Electrical Conductivity
☐	TAI B117	Sulphides Present (This service Not Covered by NATA Accreditation)

Sampling:	Sampled by Client	**Date Sampled:**	7/12/2019
Preparation:	Prepared in accordance with the test method		

Sulphides Present	-
Sulphur Peroxide (% w/w)	-
Sulphate content (ppm)	7.8
Sulphate content (% w/w)	-
Chloride ion content (ppm)	11.9
Chloride ion content (% w/w)	-
pH	6.3
Electrical Conductivity (uS/cm)	-
Mean Resistivity Ω.m	-
(Resisitivity) Density ratio (R_D)	-
(Resisitivity) Density index (I_D)	-

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Authorised Signatory:

Brad Morris

18/12/2019

Date:

Macquarie Geotechnical
3 Watt Drive
Bathurst NSW 2795

MOISTURE CONTENT TEST REPORT

Client:	Aurecon	**Job No:**	S19604
Address:	Level 5, 116 Military Rd, Neutral Bay, Sydney NSW 2089	**Report No:**	S56875-MC
Project:	Redfern Station Upgrade (39525 - TAP04)		

Test Procedure:

- ☑ AS 1289 2.1.1 Soil moisture content tests - Determination of the moisture content of a soil - Oven drying method (Standard method).
- ☐ AS4133 1.1.1 Rock moisture content tests - Determination of the moisture content of rock - Oven drying method (standard method)
- ☐ RMS T120 Moisture content of road construction materials (Standard method)
- ☐ RMS T262 Determination of moisture content of aggregates (Standard method)

Sampling: Sampled by Client | **Date Sampled:** 7/12/2019

Preparation: Prepared in accordance with the test method

Sample No.	Source	Sample Description	Moisture Content %
S56875	BH05 1.5-1.95m	Sandy Silty CLAY, with Gravel	**21.1**
S56876	BH05 3.0-3.45m	Silty CLAY	**17.6**
S56877	BH05 4.5-4.95m	Silty CLAY	**16.4**
S56878	BH05 6.0-6.1m	Silty CLAY	**12.2**

Notes:

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SOIL CLASSIFICATION REPORT

Client	Aurecon	**Source**	BH05 1.5-1.95m
Address	Level 5, 116 Military Rd, Neutral Bay, Sydney NSW 2089	**Sample Description**	Sandy Silty CLAY, with Gravel
Project	Redfern Station Upgrade (39525 - TAP04)	**Report No**	S56875-PI
Job No	S19604	**Lab No**	S56875

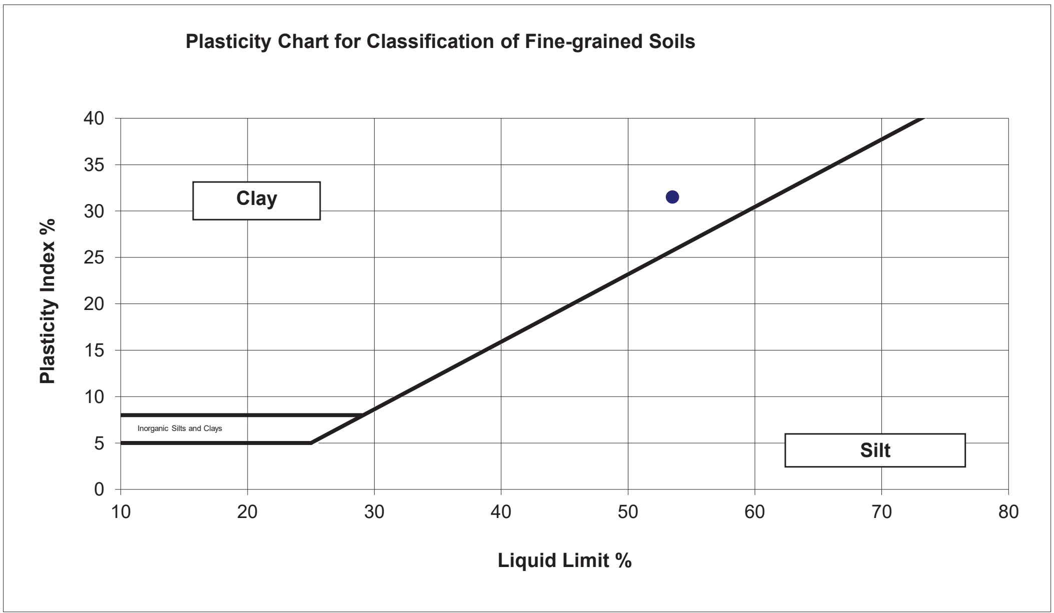
Test Procedure:

- ☑ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client **Date Sampled:** 7/12/2019

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	54	**Linear Shrinkage (%)**	-
Plastic Limit (%)	22	**Plasticity Index**	32



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: N/A

Notes

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Date: 19/12/2019

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SOIL CLASSIFICATION REPORT

Client	Aurecon	**Source**	BH05 3.0-3.45m
Address	Level 5, 116 Military Rd, Neutral Bay, Sydney NSW 2089	**Sample Description**	Silty CLAY
Project	Redfern Station Upgrade (39525 - TAP04)	**Report No**	S56876-PI
Job No	S19604	**Lab No**	S56876

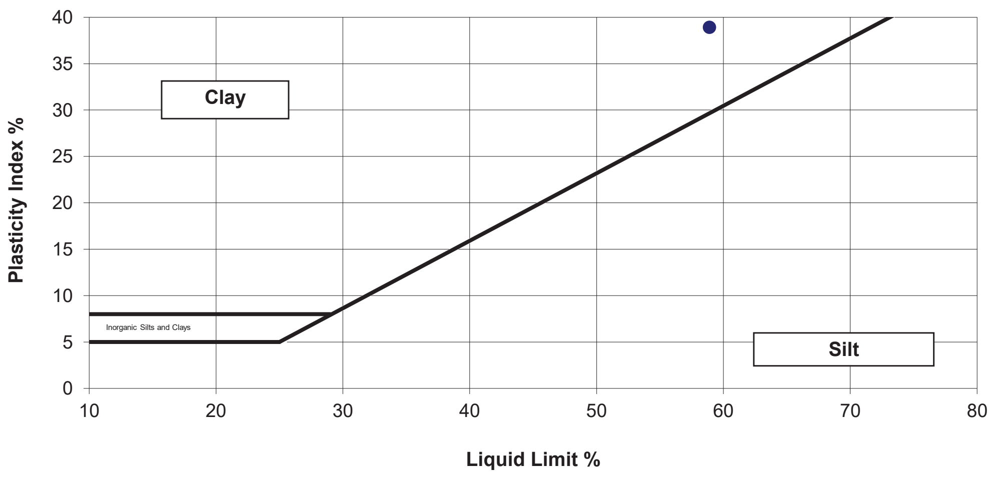
Test Procedure:

- ☑ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling:	Sampled by Client	**Date Sampled:**	7/12/2019
Preparation:	Prepared in accordance with the test method		

Liquid Limit (%)	59	**Linear Shrinkage (%)**	-
Plastic Limit (%)	20	**Plasticity Index**	39

Plasticity Chart for Classification of Fine-grained Soils



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: N/A

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POINT LOAD STRENGTH INDEX REPORT

Client:	Aurecon	**Moisture Content Condition:**	As received
Address:	Level 5, 116 Military Rd, Neutral Bay, Sydney NSW 2089	**Storage History:**	Core boxes
Project:	Redfern Station Upgrade (39525 - TAP04)	**Report No:**	S56879-PL
Job No:	S19604	**Date Tested:**	13/12/2019

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** 7/12/2019

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S56879	BH05 7.15-7.24m	Shale	Diametral	-	48.0	0.04	0.02	0.02	1
			Axial	50.5	34.0	0.08	0.04	0.04	1
S56880	BH05 8.53-8.62m	Shale	Diametral	-	47.0	0.02	0.01	0.01	3
			Axial	51.0	30.0	0.13	0.07	0.06	1
S56881	BH05 9.43-9.51m	Shale	Diametral	-	48.0	0.05	0.02	0.02	1
			Axial	51.4	38.0	0.13	0.05	0.05	1
S56882	BH05 10.00-10.12m	Shale	Diametral	-	48.0	0.22	0.10	0.09	1
			Axial	51.5	36.0	0.87	0.37	0.36	1
S56883	BH05 11.17-11.23m	Shale	Diametral	-	46.0	0.03	0.01	0.01	3
			Axial	51.2	29.0	0.20	0.11	0.10	1
S56884	BH05 12.19-12.32m	Shale	Diametral	-	48.0	0.47	0.20	0.20	1
			Axial	51.3	35.0	0.60	0.26	0.26	1
S56885	BH05 14.22-14.30m	Shale	Diametral	-	47.0	1.06	0.48	0.47	1
			Axial	51.9	41.0	0.91	0.34	0.34	1
S56886	BH05 15.90-16.0m	Shale	Diametral	-	49.0	0.73	0.30	0.30	1
			Axial	51.1	33.0	1.27	0.59	0.57	4
S56887	BH05 16.56-16.60m	Shale	Diametral	-	49.0	0.83	0.35	0.34	1
			Axial	51.5	39.0	1.10	0.43	0.43	3

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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POINT LOAD STRENGTH INDEX REPORT

Client:	Aurecon	**Moisture Content Condition:**	As received
Address:	Level 5, 116 Military Rd, Neutral Bay, Sydney NSW 2089	**Storage History:**	Core boxes
Project:	Redfern Station Upgrade (39525 - TAP04)	**Report No:**	S56888-PL
Job No:	S19604	**Date Tested:**	13/12/2019

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** 7/12/2019

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S56888	BH05 17.22-17.50m	Shale	Diametral	-	49.0	2.20	0.92	0.91	1
			Axial	51.5	25.0	2.10	1.28	1.16	1
S56889	BH05 18.11 - 18.33m	Shale	Diametral	-	48.0	0.77	0.33	0.33	2
			Axial	51.7	17.0	0.63	0.56	0.47	3

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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7/01/2020

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Uniaxial Compressive Strength

Client:	Aurecon	**Sample Source:**	BH05 17.22-17.50m
Address:	Level 5, 116 Military Rd, Neutral Bay, Sydney NSW 2089	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525 - TAP04)	**Report No.:**	S56888-UCS
Job No.:	S19604	**Lab No.:**	S56888
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	7/12/2019
Storage History:	Sealed	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 10 MPa

Date Tested:	18/12/2019		Moisture Content:	4.2	%
Specimen Height:	146.7	mm	Duration of Test:	618	seconds
Average Specimen Diameter:	51.5	mm	Rate of Displacement:	< 0.1	mm/min
Failure Type:	Tensile dominated				
Other Pertinent Observations:					

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Uniaxial Compressive Strength

Client:	Aurecon	**Sample Source:**	BH05 18.11-18.33m
Address:	Level 5, 116 Military Rd, Neutral Bay, Sydney NSW 2089	**Sample Description:**	Shale
Project:	Redfern Station Upgrade (39525 - TAP04)	**Report No.:**	S56889-UCS
Job No.:	S19604	**Lab No.:**	S56889
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	**Sample Curing:**	-
Sampling Method:	Sampled by Client	**Date Sampled:**	7/12/2019
Storage History:	Sealed	**Storage Environment:**	Sealed at as received moisture condition

Uniaxial Compressive Strength 7.8 MPa

Date Tested:	18/12/2019	Moisture Content:	4.2 %
Specimen Height:	147.2 mm	Duration of Test:	605 seconds
Average Specimen Diameter:	51.7 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type:	Tensile dominated		
Other Pertinent Observations:			

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Date: 19/12/2019

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Alexandria NSW 2015

Redfern Station Investigation Works

Transport for NSW

Contamination Investigation Report

IA157700-RP-CI-0025 | 02

5 February 2018

TfNSW Project Number - 150031

Redfern Station Investigation Works

Project No:	IA157700
Document Title:	Contamination Investigation Report
Document No.:	IA157700-RP-CI-0025
Revision:	02
Date:	5 February 2018
Client Name:	Transport for NSW
Client No:	150031
Project Manager:	Josh Cowley
Author:	Michael Grasso and Michael Stacey
File Name:	J:\IE\Projects\04_Eastern\IA157700\21 Deliverables\Contamination Investigation report\IA157700-RP-CI-0025_Rev02_Contamination Investigation Report FINAL.docx

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Document history and status

Revision	Date	Description	By	Review	Approved
01	22/12/17	Draft – Contamination Investigation Report	M Grasso	M Stacey	J Cowley
02	05/02/18	Final – Contamination Investigation Report	M Grasso	M Stacey	J Cowley

Contents

<u>Tables</u>

1. Introduction

Jacobs has been commissioned by Transport for NSW (TfNSW) to undertake a combined land survey, geotechnical investigation and contamination study to inform future development plans for Redfern Station and the surrounding precinct (referred to herein after as the site).

This report details the results of the preliminary contamination investigation.

The contamination scope of work consisted of six (6) boreholes and contamination sampling at locations nominated by TfNSW. The investigation works were completed between the 7 and 28 November, including works during two planned weekend rail track shutdowns (WE20 – 11/12 November 2017 and WE21 – 18/19 November 2017).

This report presents the results of the preliminary contamination investigation including the results of the fieldwork and laboratory testing, together with conclusions and recommendations.

2. Objectives

The objectives of the preliminary contamination investigation were to:

- Assess and describe the nature and extent of contamination (if present) at the site in context of a commercial/industrial land use (considered to be the most appropriate land use setting based on the current railway setting).
- Determine the waste classification of soils in accordance with the NSW EPA (2014) *Waste Classification Guidelines – Part 1: Classifying Waste*.
- Provide recommendations for the management of contamination risk (if present) at the site.

3. Scope of works

The scope of works undertaken for the contamination investigation was as follows:

- Prepare a Safe Work Method Statement (SWMS) that identified the foreseeable risks and provided strategies for removing and/or managing the risks.
- Undertake a Dial Before You Dig (DBYD) search and service locating for underground services by a qualified service locator prior to commencement of field works.
- Excavation of six boreholes as part of the geotechnical investigation at locations nominated by TfNSW, logging and sampling of recovered materials.
- Analysis of soil/fill samples for contaminants of concern.
- Preparation of a contamination investigation report detailing observations made during the fieldwork program and the results of the laboratory analysis.

4. Site setting

4.1 Site description

Redfern Station is located approximately 1.3 km south of Central Station. The station has 12 platforms, two of which are underground (Platforms 11 and 12). Redfern Station is served by a single concourse connecting all 12 platforms with frontage onto the Lawson Street overbridge at the northern end of the station. There are three entrances to the Station; Lawson Street, Gibbons Street and an entrance at the southern end of Platform 10 which connects with the walkway to Australian Technology Park (ATP).

Platforms 1 through 10 are each provided with a single set of stairs and are connected by the concourse. Platforms 11 and 12 are located underground and are accessed via stairs and escalators from the Gibbons Street entrance end of the concourse. Select photographs are provided on plates 1 to 4.

Plate 1: Redfern Station, looking south-west from Platform 10

Plate 2: Redfern Station, looking north-east from Platform 4

Plate 3: Illawarra Relief compound area, looking south-west

Plate 4: Rock outcropping within the Illawarra Relief compound area

4.2 Geology and soils

The following information documents were available at the time of preparing this report:

- Sydney 1:100 000 Soil Landscape Series Sheet 9130
- Sydney 1:100 000 Geological Series Sheet 9130
- 1:25,000 Acid Sulfate Soils (ASS) Risk Map Sheet 91 30S3

4.2.1 Soil landscapes and site geology

An understanding of the soils and geology expected for the area surrounding the station site has been based on the available 1:100 000 soil landscape and geological maps. The expected soil and geological units at the station site is summarised in Table 4.1.

Table 4.1 – Geological units

Unit	Description
Soil landscape	
(bt) Blacktown	The landscape is characterised by gentle undulating rises (slopes <5%) on Wianamatta Group shales and Hawkesbury Sandstone with local reliefs of up 30 m. This area is further denoted as "developed terrain". The expected residual soils are either: • Red and brown residual podzolic soils, shallow to moderately deep (up to 100cm) located on crests, upper slopes and well drained areas; or • Yellow podzolic soils and soloths, deep (between 150 to 300 cm) located on lower slopes and in areas of poor drainage.
Geology	
(Rwa) Ashfield Shale	The site is expected to be underlain by Ashfield Shale unit which is a sequence of the Wianamatta Group. The Ashfield Shale sequence in the area typically comprises interbedded black to dark grey shales, laminites and fine to medium grained sandstones. These materials typically weather to form a residual profile of 1 to 3 metres of medium to high plasticity clays.

The presence of the above geological units was confirmed from the observations made during this investigation with approximately 1.5 m thick layer of fill overlying 3.5 m of residual clay profile then shale/laminite bedrock.

4.2.2 Acid sulphate soils

Office of Environment and Heritage Acid Sulfate Soil (ASS) mapping of the area suggests that no known occurrence of ASS has been noted within the Redfern area.

4.3 Previous reports

The following documents were sourced during the preparation of this assessment. Copies of relevant information are included in **Appendix B** and investigation locations have been plotted onto the site plan in **Appendix A**, based on available records and have not been verified.

- ***(Jacobs May 2017)*** – Station Upgrade Project – Redfern Station SP3, Geotechnical Investigation Memorandum.
  - Four boreholes (BH1 to BH4) on the concourse area located at the corner of Gibbons and Lawson Street were progressed to depths of up to 5.0 m below ground level. The logs indicated fill up to 2.4 m underlain by residual and then extremely weathered shale.
- ***(GeoEnviro Consultancy Pty April 2015)*** - Proposed Railway Platform Nos 6 and 7 Upgrade, Redfern Station, Geotechnical Investigation Report
  - Nine boreholes (BH1 to BH9) were drilled along the platform and were progressed to depths ranging from 0.3 to 3.3 m below existing platform level. The logs indicated fill up to 1.6 m underlain by residual and then extremely weathered shale at approximately 2.5 to 3 m depth below platform level.
  - One (1) test pit was excavated on the south west side of the existing station building in order to assess the existing footing conditions underlying foundation material. The test pit was excavated to a depth of 1.0m below existing platform level.
- ***(Novo Rail Alliance January 2015)*** – Transport Access Program – Redfern Station Easy Access Upgrade, Geotechnical Interpretive Report.
  - A single exploratory hole was advanced using push tube and rotary auger techniques to a depth of 12m below ground level. The ground conditions comprised poorly compacted granular fill (up to 0.5 m bgl) over residual soil (0.5 to 2.3 m bgl) becoming weathered shale from 2.3 m grading to low strength shale from 4.2 m. No coring was undertaken in this borehole, with the borehole terminated at 12 m.
- ***(RailCorp February 2010/2011)*** – Formation Investigation and platform stability during track upgrading – Redfern, Platform 6.
  - Eight test pits (8573-TP1 to 8573-TP8) were excavated within the 'four-foot' of the Down Local to depths between 0.68 and 1.0 m below track level. Generally, the test pits indicated Ballast overlying a capping layer up to 1.0 m depth. In some locations, this was underlain by residual soil or weathered shale bedrock.
  - Three boreholes (8573-BH1 to 8573-BH3) were drilled through platform 6 to depths between 3.0 to 3.4m. The borehole indicated fill up to 2.0 m overlying residual soils and weathered shale bedrock at the base of the borehole (approximately 3 m).
- ***(J&K January 2009)*** – Proposed Track Reconditioning – Redfern Station Platform Four, Geotechnical Investigation Report (proposed Redfern Station Platform 4 track reconditioning works between track kilometrages 0.950 km and 1.405 km)
  - During the initial field investigations in 2007, nine test pits (TL1 to TL9) were excavated at 50 m centres within the 'four-foot' using a 3.5 tonne excavator. The test pits were excavated to depths between 0.5 m and 1.35 m and dynamic cone penetration (DCP) tests were carried out within the test pit to depths extending between 1.2m and 2.0 m.
  - RailCorp then excavated six additional test pits in 2008 (8376-1 to 8376-6) in close proximity to the test pits excavated by J&K. The test pits were excavated to depths between 0.7 m and 1.1 m.
  - Generally, the test pits from both investigations encountered granular railway ballast overlying fill or natural clayey soils, then in a number of test pits, weathered shale bedrock.

5. Fieldwork

5.1 General

The preliminary contamination investigation (undertaken as part of the geotechnical investigation) was undertaken between 7 November and 28 November 2017, part of which was undertaken during planned weekend shutdowns of the rail line (WE20 and WE21) under the full time supervision of a Jacobs' geotechnical engineer. The investigation comprised the drilling of six (6) boreholes, undertaking in-situ SPTs (Standard Penetration Tests) and sampling for laboratory testing purposes. The surveyed positions of Jacobs' field investigation locations are as shown on the site plan included in **Appendix A**.

The field investigation comprised six boreholes (Boreholes BH1 to BH6) drilled to depths of 8.50 m to 10.40 m below existing ground level. Borehole BH1 was drilled in Eveleigh Carriage Works Yard behind platform one. Boreholes BH2, BH3 and BH4 were drilled in the country ends of Platforms 3, 4 and 9 respectively. Borehole BH5 was drilled in the Illawarra Relief Site Compound Excavation and Borehole BH6 was drilled in the Illawarra Relief Site Compound South Entry Forecourt.

Boreholes BH1, BH2, BH3 and BH4 were drilled using the XC rig, BH5 was drilled using the Commachio 205 and BH6 was drilled using the Hanjin DB8, all of which were track mounted rigs. The borehole locations are provided on the site plan in **Appendix A**. Boreholes were drilled using a tungsten carbide drill bit (TC) and then cored following SPT refusal or judgment made by the geotechnical engineer. All boreholes were extended by NMLC core drilling techniques to the levels provided in Table 5.1 below.

SPTs were carried out during borehole drilling at regular intervals within the soil and weathered rock horizons to recover representative samples.

Materials encountered in each borehole were logged by the Jacobs geotechnical engineer in accordance with Australian Standards AS1726-2017. Borehole logs are presented in **Appendix B**. The investigated borehole locations were surveyed by a surveyor from Jacobs. A summary of the borehole survey information, including elevation and termination depths are provided in Table 5.1.

Table 5.1 – Summary of borehole locations and termination depth

Borehole No.	Termination Depth (m BGL)[1]	Easting (m)[2]	Northing (m)[2]	Surface Elevation (m AHD)[3]
BH1	9.15	333321.80	6248324.58	25.90
BH2	8.50	333351.56	6248322.83	26.37
BH3	9.00	333359.66	6248314.17	26.48
BH4	10.00	333412.36	6248312.39	26.34
BH5	10.40	333481.43	6248345.75	24.03
BH6	9.90	333452.63	6248279.52	25.14

Notes:
1. m BGL = metres below ground level
2. Coordinate system MGA94 Zone 56 H
3. m AHD = metres above Australian height datum

5.2 Depth intervals of sampling

Soils samples for contamination testing were collected from the surface of the borehole locations (0.0 metre) and at 0.5 metre intervals until contact with natural soils and/or bedrock or at other discrete locations where there was evidence of potential contamination (e.g. odorous and/or discoloured materials, presence of erroneous wastes).

5.3 Method of sample collection

All soil samples were collected as grab samples from the surface of the borehole locations and from a decontaminated SPT sampler at depth. Samples were transferred to sample containers by Jacobs field staff by hand using disposable nitrile gloves. New nitrile gloves were used for the collection of each sample.

Care was taken to ensure that representative samples were obtained from the depth required and that the integrity was maintained, which is particularly important when dealing with potentially volatile components.

5.4 Sample containers, method of sample storage and handling

All soil samples were placed in jars provided by the primary laboratory Envirolab Services (Envirolab). All sample jars were fitted with Teflon lined lids. The jars were completely filled with soil, labelled with the date, unique sampling point identification and sampler information.

The soil jars once filled with sample and sealed, were immediately placed in an esky/cool box in which a cooling medium had been added to keep the samples below a temperature of approximately 4ºC. At the end of the sampling program the samples in the cool box were transported to the laboratory. Custody seals were placed on the esky / cool box for delivery to the laboratory.

5.5 Decontamination procedures

The SPT sampler was decontaminated between sample locations by washing the sampler with a solution of phosphate free, laboratory grade detergent (Decon 90) and potable water and rinsing with potable water. All samples were collected using new, disposable nitrile gloves.

The physical attributes of samples such as soil/fill characteristics, obvious signs of contamination such as discolouration and/or odour were noted on a log.

All samples were transported to the laboratory under Chain-of-Custody (CoC) procedures and maintained in an ice-filled cool box. The CoC detailed the following information:

- Site identification
- The sampler
- Nature of the sample
- Collection time and date
- Analyses to be performed
- Sample preservation method.

5.6 Sample logging

Experienced Jacobs field staff completed soil logs during the borehole drilling exercise. The logs recorded the following data:

- Sample number and depth
- Soil classification, colour, consistency or density, moisture content and obvious indications of contamination
- Depth of excavation
- Excavation refusal
- Method of excavation
- The depth of first encountered free water.

5.7 Laboratory analysis

Soil samples were selected for analysis based generally on providing vertical and lateral coverage and on visual observations. A summary of the laboratory testing undertaken is detailed in Table 5.2.

Table 5.2 – Contamination laboratory testing

Laboratory Testing	Quantity
Heavy metals (As, Cd, Cr, Cu, Pb, Ni, Hg, Zn), hydrocarbon compounds (TRH, BTEX, PAH), pesticides (OCP), polychlorinated biphenyls (PCB) and asbestos (presence/absence).	11
Heavy metals, TRH, BTEX, PAH	1
Heavy metals, pH, cation exchange capacity (CEC) and % clay	2
Leachable (TCLP) nickel and benzo(a)pyrene	1
TCLP lead and mercury	1

5.8 Analytical parameters and methods

Jacobs commissioned Envirolab as the primary laboratory. Envirolab laboratories are National Association of Testing Authorities (NATA) accredited for the testing undertaken.

Where appropriate, the soil samples were analysed in accordance with NEPC N*ational Environment Protection (Assessment of Site Contamination) Measure 1999*, as amended 2013 (NEPC, 2013) guidelines using methods based on US Environment Protection Agency (US EPA) and American Public Health Association (APHA) approved analytical methods.

6. Quality control plan

Field and laboratory QA/QC requirements compliant with NEPC (2013) requirements (where applicable) were undertaken as part of the fieldwork program as outlined below.

6.1 Field QA/QC programme

Field QA/QC for this project consisted of the collection of a blind replicate sample.

6.1.1 Environmental samples

Environmental samples or field samples were the representative soil samples collected for analysis to determine aspects of their chemical composition.

6.1.2 Blind replicate samples

A blind replicate sample was provided by the collection of two environmental samples from the same location. These samples were preserved, stored, transported, prepared and analysed in an identical manner. As a minimum, the results of analyses on the blind replicate sample pair were assessed by calculating the Relative Percentage Differences (RPDs) between the results. The RPD was calculated as the difference between the results divided by their mean value and expressed as a percentage. If the RPD exceeded the value adopted for any analytes, additional investigation would be required, or justification provided for not conducting additional investigation.

Blind replicate samples were generally collected at a rate of one duplicate for every 20 environmental samples in accordance with AS 4482.1-2005 Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds.

6.2 Laboratory QA/QC programme

The reliability of test results from the analytical laboratories was monitored according to the QA/QC procedures used by the NATA accredited laboratory. The QA/QC programme employed by Envirolab (the primary laboratory) specified holding times, extraction dates, method descriptions, CoC requirements, analysis, laboratory levels of reporting (LORs) and acceptance criteria for the results. Laboratory QA/QC requirements undertaken by Envirolab are based on NEPC 2013 requirements and are outlined below.

6.2.1 Laboratory duplicate samples

Laboratory duplicates provided data on analytical precision for each batch of samples.

Laboratory duplicates were performed at a rate of one duplicate for batches of 8-10 samples with an additional duplicate for each subsequent ten samples.

6.2.2 Laboratory control samples

Laboratory control samples consisted of a clean matrix (de-ionised water or clean sand) spiked with a known concentration of the analyte being measured. These samples monitored method recovery in clean samples and were used (where required) to evaluate matrix interference by comparison with matrix spikes.

6.2.3 Surrogates

For organic analyses, a surrogate was added at the extraction stage in order to verify method effectiveness. The surrogate was then analysed with the batch of samples and percentage recovery calculated.

6.2.4 Matrix spike

Matrix spikes consisted of samples spiked with a known concentration of the analyte being measured, in order to identify properties of the matrix that may hinder method effectiveness. Samples were spiked with concentrations equivalent to 5 to 10 times the LOR and percentage recovery calculated.

6.2.5 Method blanks

Method blanks (de-ionised water or clean sand) were carried through all stages of sample preparation and analysis at a rate of approximately 10%. Analyte concentrations in blanks should be less than the stated LOR. Reagent blanks were run if the method blank exceeded the LOR. The purpose of method blanks was to detect laboratory contamination.

6.3 Data acceptance criteria

The QA/QC was assessed against the Data Acceptance Criteria (DAC) provided in Table 6.1.

Table 6.1 – QA/QC compliance assessment

QA/QC Sample Type	Method of Assessment	Acceptable Range
Field QA/QC		
Blind Replicates Samples	The assessment of blind replicate samples is undertaken by calculating the Relative Percent Difference (RPD) of the replicate concentration compared with the original sample concentration. The RPD is defined as: $$\text{RPD} = 100 \times \frac{\lvert X1 - X2 \rvert}{\text{Average}}$$ Where: X1 and X2 are the concentration of the original and replicate/triplicate samples.	The acceptable range depends upon the levels detected: • 0 – 100% RPD (When the average concentration is < 5 times the LOR) • 0 – 75% RPD (When the average concentration is 5 to 10 times the LOR) • 0 – 50% RPD (When the average concentration is > 10 times the LOR)
Laboratory QA/QC		
Laboratory Duplicates	Assessment as per Blind Replicates and Split Samples.	The acceptable range depends upon the levels detected: • 0 – 100% RPD (When the average concentration is < 4 times the LOR) • 0 – 50% RPD (When the average concentration is 4 to 10 times the LOR) • 0 – 30% RPD (When the average concentration is > 10 times the LOR)
Surrogates Matrix Spikes Laboratory Control Samples	Assessment is undertaken by determining the percent recovery of the known spike or addition to the sample. $$\%\ \text{Recovery} = 100 \times \frac{C - A}{B}$$ Where: A = Concentration of analyte determined in the original sample; B = Added Concentration; C = Calculated Concentration.	• 70% - 130% (General Analytes) • 50% - 130% (Phenols) • 60% - 130% (OP Pesticides)
Method Blanks	Each blank is analysed as per the original samples.	Analytical Result < LOR
Note: LOR = Laboratory Level of Reporting (LOR) or the minimum detection limit for a particular analyte.		

7. Quality assurance / quality control

For the purpose of assessing the quality of data presented in this report, Jacobs collected and analysed various Quality Control (QC) samples (blind duplicate and blind triplicate sample), while the laboratory completed their own internal QC. The current section of this report is focused on the presentation of the results of these QC samples, adherence to Quality Assurance (QA) systems and discussion of deviations, if any from the DAC.

7.1 Field quality assurance

Field QA/QC for this project consisted of the collection of blind replicate and triplicate samples.

7.2 Field quality control

The following QC samples were collected for laboratory analysis:

- Blind Replicate: DUPB (duplicate of soil sample BH5/0.0-0.1).

One blind replicate sample was analysed to assess the quality control during the field sampling program. This equates to 9% blind replicate analysis. This blind replicate analysis exceeds and therefore conforms to the AS 4482.1 – 2005 requirement of 5%.

The RPDs for all analytes for the soil blind replicate pairs conformed to the DAC with the exception of copper and lead concentrations. It is inherently difficult to obtain representative duplicate samples from heterogeneous fill material which cannot be homogenised to retain volatiles. The exceedances of the RPD for selected heavy metals in these samples are unlikely to affect the usability of the data set. RPD results for soil are presented in Table A.

7.3 Laboratory quality assurance

All analysis was undertaken by a NATA accredited laboratory using NATA accredited analytical methods.

7.4 Laboratory quality control

Where undertaken, laboratory QC data is presented in full in the laboratory certificates in Appendix C.

7.4.1 Laboratory duplicates

RPDs for all laboratory duplicates for soil samples conformed to the DAC with the exception of RPDs reported for PAH and lead in Envirolab laboratory batch 180999.

The Envirolab laboratory report stated that the RPD for PAHs was acceptable due to the homogenous nature of the sample.

A triplicate result for heavy metals was undertaken for laboratory sample 180999-5. For the purposes of assessing contamination, Jacobs will utilise the highest heavy metal concentration from both samples.

The exceedance for laboratory duplicates is unlikely to affect the usability of the data set.

7.4.2 Laboratory control samples

Recoveries for all laboratory control samples for soil and water conformed to the DAC.

7.4.3 Surrogates

Recoveries for all laboratory surrogate samples for soil conformed to the DAC.

7.4.4 Matrix spikes

Recoveries for all matrix spike control samples for soil and water conformed to the DAC.

7.4.5 Method blanks

All method blanks for soil and water reported analyte concentrations below the laboratory LOR and therefore conformed to the DAC.

7.4.6 Sample holding times

All soil and water samples were extracted and analysed within the specified holding times.

7.4.7 Sample condition

All samples were received by the analytical laboratories in correctly preserved and chilled containers with no reported breakages. The individual sample receipts are presented with the laboratory reports in Appendix C.

7.5 QA/QC assessment

It is concluded that the laboratory data are of acceptable quality and are considered useable in making conclusions and recommendations regarding the condition of the respective sites.

8. Site assessment criteria

To address potential health impacts at the site, Jacobs compared the analytical testing results against a set of health and ecological based soil investigation levels to be referred to as Site Assessment Criteria (SAC) appropriate for the current land use (i.e. commercial/industrial guidelines, given the current land use / railway setting). That is, the SAC have been set at levels that provide confidence that contaminant concentrations below the SAC will not adversely affect human health or environmental receptors.

The SAC developed for the investigation was derived (where applicable) from the following guidelines.

- NEPC (2013) - Schedule B1 Guideline on Investigation levels for Soil and Groundwater.
- The Dutch (2000) groundwater intervention levels for Total Petroleum Hydrocarbons fractions.

8.1 Aesthetics

Aesthetics on sites relates to the presence of observable odours, discoloration and erroneous wastes materials in soil which could possibly indicate contamination. Such olfactory evidence can point to how receptors can be impacted by vapours on and migrating from the site. Odour threshold for organic substances can be exceeded in off-site settings (through groundwater transmission of hydrocarbons) and whilst may not represent a direct health risk, could possibly prompt civil action. Aesthetics were continually assessed during the investigation and reported (where present) on the field logs.

8.2 Ecological investigation levels

EILs were generated using the NEPC (2013) – Volume 2 – Table 1B (1-7). For the site, it has been assessed that the EILs will apply to contaminants within the top 2 metres of soil at the surface / ground level which corresponds to the root zone and habitation zone of many species. Additionally, typical background concentrations were required to be calculated in order to derive selected EILs. To generate the EILs for the investigation, Jacobs have used the methodology as described in Appendix D and summarised below.

EILs were generated for heavy metals, DDT and naphthalene. Samples BH4/1.5 and BH2SPT/3.0 were assumed to be representative of the 'background conditions' due to the samples being taken from natural soils/rock and that the soil at this location was unlikely to be impacted by anthropogenic sources. The EILs were calculated (where appropriate) using the NEPC (2013) equation:

EIL = ABC1 + ACL2

EIL calculation are presented as **Appendix D**. A summary of the adopted EILs is presented as Table 8.1.

Table 8.1 - Ecological investigation levels (expressed as mg/kg).

Compounds	Ecological Investigation Level
Arsenic	160 [1]
Cadmium	3 [2]
Chromium	665 [3]
Copper	140 [3]
Lead	1,808 [3]
Mercury	1 [2]
Nickel	55 [3]

[1] ABC is ambient background concentration (the soil concentration in a specified locality that is the sum of the naturally occurring background level and the contaminant levels that have been introduced from diffuse or non-point sources by general anthropogenic activity).
[2] ACL is added contaminant limit (the added concentration (above the ABC) of a contaminant above which further appropriate investigation and valuation of the impact on ecological values is required).

Compounds	Ecological Investigation Level
Zinc	218 [3]
DDT	640 [1]
Naphthalene	370 [1]

[1] Generic EILs for aged arsenic/DDT/Naphthalene from Table 1B(5) in NEPC (2013).

[2] EILs from NEPC1999 (no EILs specified for contaminants in NEPC 2013).

[3] EILs derived from NEPC (2013) equation ABC+ACL.

8.3 Ecological screening levels

Ecological Screening Levels (ESLs) are focused on petroleum hydrocarbon and total recoverable hydrocarbon (TRH) compounds and are compared against actual site conditions (sub-surface materials and depth) to assess the potential risk to terrestrial ecosystems. For the purposes of calculating the ESLs, the generic soil type (i.e. three broad classes of sands, silts or clays) and land use need to be defined.

Based on site observations and for the purposes of this investigation, Jacobs considered a clay soil to be most representative of soil texture at the site. As such, Jacobs has adopted ESLs for fine grained soil type.

Table 8.2 summarises the adopted ESL criteria for soils (based on the current commercial/industrial land use of the site and soil type observed during the investigation).

Table 8.2 - ESLs for petroleum based fractions (expressed as mg/kg).

Compounds / Fraction	Ecological Screening Levels [1]
F1 (C6 – C10)	215
F2 (>C10 – C16)	170
F3 (>C16 – C34)	2500
F4 (>C34 – C40)	6600
Benzene	95
Toluene	135
Ethylbenzene	185
Xylenes	95
Benzo(a)pyrene	0.7

[1] Table 1B(6) ESLs for TPH fractions F1 – F4, BTEX and Benzo(a)pyrene in fine grained soils (commercial and industrial) - NEPC (2013).

8.4 Health investigation levels

To address potential health impacts at the site, Jacobs compared the soil analytical testing results against a set of health based Soil Investigation Levels (SILs) appropriate for commercial/industrial land use in context of the current land use (railway setting) of the site and have taken into consideration the potential for contamination in soil to impact upon groundwater and generate vapours which could impact upon on human receptors. The health based SILs have been derived from the NEPC (2013) guidelines. The adopted SILs are summarised in Table 8.3.

HILs have been developed for a broad range of metals and organic substances. The HILs are applicable for assessing human health risk via all relevant pathways of exposure. The HILs are generic to all soil types and apply generally to a depth of three m below the surface for residential use. The guidance does not specify a depth range for commercial/industrial use. As a conservative measure, Jacobs have adopted a soil depth of 3m below the surface to assess contamination risk.

HSLs have been developed for selected petroleum compounds and fractions and are applicable to assessing human health risk via the inhalation and direct contact pathways. The HSLs depend on specific soil physio-chemical properties, land use scenarios, and the characteristics of building structures. They apply to different soil types, and depths below surface to >4 metres. Further details on their use are provided in Friebel and Nadebaum (2011a, 2011b & 2011c).

The HSLs defined within the NEPC (2013) relate only to the volatile fractions of the petroleum hydrocarbons range i.e. BTEX, naphthalene and TRH C6 – C10, TRH C10 – C16.

Jacobs has adopted the lower value from the following criteria as a conservative measure:

- NEPC (2013) Health Investigation Level recommended from exposure setting 'D' which includes premises such as shops, offices, factories and industrial sites (i.e. sites with minimal exposure opportunities).
- Friebel, E & Nadebaum, P (September 2011) Technical Report No.10, Health screening levels for petroleum hydrocarbons in soil and groundwater. Part 1: Technical development document - HSL-D Commercial / Industrial Criteria and Intrusive Maintenance Worker (Table A4).

NEPC (2013) provides health based screening levels for different forms of asbestos contamination in soil. To apply these screening levels, significant investigations, excavation and sample volumes are required to assess the volume of asbestos relative to soil. Jacobs have adopted a high-level criterion to assess the presence / absence of asbestos in soil samples and to determine whether additional investigations are required to assess the risk to site users. The high level criterion adopted by Jacobs is no asbestos in any form present in soil samples or observed on surface soils and in excavated materials.

The adopted SIL are detailed in Table 8.3.

Table 8.3 - Soil investigation levels (expressed mg/kg)

Compounds / Fraction	Soil Investigation Levels
Heavy Metals	
Arsenic (total)	3,000 [1]
Cadmium	900 [1]
Chromium (VI)	3,600 [1]
Copper	240,000 [1]
Lead	1,500 [1]
Mercury (inorganic)	730[1]
Nickel	6,000 [1]
Zinc	400,000 [1]
Polychlorinated Biphenyls (PCBs)	
PCBs	7 [1]
Polycyclic Aromatic Hydrocarbons (PAHs)	
Naphthalene	NL [2]
BaP TEQ	40 [1]
Total PAH	4,000 [1]
Total Recoverable Hydrocarbons (TRH) [3]	
C_6-C_{10}	26,000
>C_{10}-C_{16}	20,000

Compounds / Fraction	Soil Investigation Levels			
>C_{16}-C_{34}	27,000			
>C_{34}-C_{40}	38,000			
Organochlorine Pesticides (OCP) [1]				
DDT+DDE+DDD	3,600			
Aldrin and dieldrin	45			
Chlordane	530			
Endosulfan	2,000			
Endrin	100			
Heptachlor	50			
HCB	80			
Methoxychlor	2,500			
Mirex	100			
Toxaphene	160			
F1, F2 and BTEX (based on CLAY soil type) [#]				
Depth (m)	0 – <1	1 – <2	2 – <4	>4
F1 (C_6-C_{10} minus sum of BTEX concentrations)	310 [2]	480 [2]	26000 [2]	26000 [3]
F2 (>C_{10}-C_{16} minus naphthalene)	20,000 [3]	20,000 [3]	20,000 [3]	20,000 [3]
Benzene	4 [2]	6 [2]	9 [2]	20 [2]
Toluene	99,000 [3]	99,000 [3]	99,000 [3]	99,000 [3]
Ethylbenzene	27,000 [3]	27,000 [3]	27,000 [3]	27,000 [3]
Xylenes	81,000 [3]	81,000 [3]	81,000 [3]	81,000 [3]
Naphthalene	11,000 [3]	11,000 [3]	11,000 [3]	11,000 [3]
Asbestos				
All forms of asbestos	No asbestos in any form present in soil samples or observed on surface soils and in excavated materials			

[1] NEPC (2013) Table 1 A(1) Health investigations levels for soil contaminants – Commercial / Industrial D.

[2] NEPC (2013) Table 1 A(3) Soil HSLs for vapour intrusion – commercial/industrial, 0 to <1, 1 - <2, 2 - <4, >4 m CLAY.

[3] HSL-D Commercial / Industrial Criteria Soil Vapour and Direct Contact detailed within Table A4, Friebel, E & Nadebaum, P 2011, Soil Health screening levels for direct contact, Technical Report 10.

[4] NEPC (2013) Table 1A(3) Soil HSLs for Vapour Intrusion (mg/kg) HSL D Commercial / Industrial.

NL – NL indicates the HSL is not limiting (see Footnote 5, Table 1A(3)).

TEQ – Toxic Equivalent.

Soil Vapour as the primary Exposure Pathway to impact potential receptors.

8.5 Management limits

Within NEPC (2013), management limits are applied to petroleum hydrocarbons, which are considered in addition to the SAC (HILs, EILs, ESLs etc). These Management limits reflect the nature and properties of petroleum hydrocarbons and their potential effects such as:

- formation of observable light non-aqueous phase liquids (LNAPL)
- fire and explosive hazards

- effects on buried infrastructure e.g. penetration of, or damage to, in-ground services by hydrocarbons.

The application of the management limits will require site specific factors to be considered in more detail. These factors include, but are not limited to, depth of building basements and services (where applicable) and depth to groundwater in order to determine the maximum depth to which the limits should apply. When the management limits are exceeded, further site-specific assessment and management may enable any identified risk to be addressed.

The presence of site TRH contamination at the levels of the management limits does not imply that there is no need for administrative notification or controls in accordance with jurisdiction requirements. Adopted management limits for petroleum hydrocarbons for fine grained soils are detailed in Table 8.4.

Table 8.4 - Management limits for TPH fractions F1–F4 in soil (adapted from NEPC 2013 Schedule B1)

TRH Fraction	Soil Texture	Management Limits1 (mg/kg dry soil) – Commercial/Industrial
F1[2] C_6- C_{10}	Coarse	800
F2[2] $>C_{10}$-C_{16}	Coarse	1,000
F3 $>C_{16}$-C_{34}	Coarse	5,000
F4 $>C_{34}$-C_{40}	Coarse	10,000

[1] Management limits are applied after consideration of relevant ESLs and HSLs.

[2] Separate management limits for BTEX and naphthalene are not available hence these should not be subtracted from the relevant fractions to obtain F1 and F2.

8.6 Waste classification

Waste classification is defined in Schedule 1 of the Protection of the Environment Operations Act 1997 (“POEO Act”), and in the NSW EPA (2014) Waste Classification Guidelines (the waste guidelines)

To assist in the appropriate classification of waste, Tables 1 and 2 in Part 1 of the waste guidelines provides a list of chemical contaminants that are used in the classification of waste. These guidelines provide a framework whereby waste materials can be classified for appropriate offsite disposal at suitably licenced facilities.

The waste guidelines contain a two-stage process for the chemical classification of waste. The first stage involves the comparison of total or Specific Contaminant Concentrations (SCC) with Contaminant Threshold (CT) values (Table 1). The second stage of waste characterisation involves the determination of leachable contaminant concentrations using the TCLP. In this stage, both SCC and leachable concentrations are used to classify waste. The final waste classification is determined jointly by SCC and leachable concentrations. It should be noted that in the instance that either SCC or leachable concentration criteria for one contaminant are exceeded, then the higher waste category should be adopted.

9. Results

9.1 Site stratigraphy

A summary of the sub-surface material sampled in the boreholes (BH1 – BH6) and the respective laboratory analysis is provided in Table 9.1.

Table 9.1 – Summary of sub-surface materials and laboratory analysis

Sample ID	Depth (mBGL)	Material Description	Samples Tested
BH1	0.0-0.1	FILL: Gravelly CLAY: Brown, medium plasticity, gravel is fine to coarse, subangular to angular, with a trace of root fibres	Heavy metals, TRH, BTEX, PAH, OCP, PCB and asbestos. TCLP nickel and benzo(a)pyrene.
BH1	0.3-0.4	FILL: Silty SAND: Brown, fine to medium grained, with a trace of clay and gravel.	Heavy metals, TRH, BTEX, PAH, OCP, PCB and asbestos. TCLP lead and mercury.
BH2	0.8-0.9	FILL: Clayey SAND: Brown, fine to medium grained with some medium to coarse, subangular to subrounded gravel.	Heavy metals, TRH, BTEX, PAH, OCP, PCB and asbestos.
BH2	1.0-1.1	FILL: Clayey SAND: Brown, fine to medium grained with some medium to coarse, subangular to subrounded gravel.	Heavy metals, TRH, BTEX, PAH, OCP, PCB and asbestos.
BH3	0.6-0.7	FILL: Silty CLAY: Orange-brown and red-brown, high plasticity with trace of sand and fine subangular gravel. At 0.6m, buried pavement, approximately 100mm thick, including asphalt over bricks.	Heavy metals, TRH, BTEX, PAH, OCP, PCB and asbestos.
BH3	1.1-1.2	FILL: Silty CLAY: Orange-brown and red-brown, high plasticity with trace of sand and fine subangular gravel.	Heavy metals, TRH, BTEX, PAH, OCP, PCB and asbestos.
BH4	0.4	FILL: Gravelly CLAY: Brown, medium plasticity, gravel is fine to coarse, subangular to angular.	Heavy metals, TRH, BTEX, PAH, OCP, PCB and asbestos.
BH4	1.5	Silty CLAY: Grey and red-brown, high plasticity with ironstone gravel	Heavy metals, TRH, BTEX, PAH, OCP, PCB and asbestos. pH, CEC and % clay.
BH5	0.0-0.1	FILL: Sandy Gravelly CLAY: Brown and red-brown, low to medium plasticity, gravel is fine to medium.	Heavy metals, TRH, BTEX, PAH, OCP, PCB and asbestos.
BH5	0.5-0.95	FILL: Sandy Gravelly CLAY: Brown and red-brown, low to medium plasticity, gravel is fine to medium. From 0.5m, coal layer (100mm). FILL: Silty Sandy CLAY: Brown and red-brown, medium to high plasticity, sand is fine to coarse grained, with a trace of siltstone lenses.	Heavy metals, TRH, BTEX, PAH, OCP, PCB and asbestos.
DUPB (duplicate of BH5/0.0-0.1)	0.0-0.1	FILL: Sandy Gravelly CLAY: Brown and red-brown, low to medium plasticity, gravel is fine to medium	Heavy metals, TRH, BTEX, PAH.
BH6	0.6	FILL: Sandy Clayey GRAVEL: Dark grey and brown, fine to coarse, subanagular to subrounded. At 0.4m, some broken bricks. At 0.6m, some shale cobbles and boulders up to 300mm.	Heavy metals, TRH, BTEX, PAH, OCP, PCB and asbestos.
BH2SPT/3.0	3.0	Silty CLAY: Grey mottled red-brown, high plasticity with trace of ironstone gravel.	Heavy metals. pH, CEC and %clay.

9.2 Aesthetics

Fill was identified overlying natural materials at all borehole locations. Plastic debris and bricks were observed in boreholes BH1 and BH6 respectively. Buried asphalt pavements were identified in BH2 and BH3. No potential asbestos containing materials, odorous or discoloured materials were identified in the material recovered from the boreholes.

9.3 Soil analytical results

Soil analytical results from samples collected from boreholes BH1 – BH6 in comparison to the SAC are discussed below. Analytical results are provided in Table B. Laboratory certificates of analysis are presented in **Appendix C**.

9.3.1 Heavy metals

Concentrations of heavy metals in all samples analysed were below the SAC with the following exceptions:

- Copper concentrations in BH1/0.3-0.4 (510 mg/kg) exceed the ecological investigation level of 140 mg/kg
- Zinc concentrations in BH4/1.5 (220 mg/kg), BH1/0.0-0.1 (240 mg/kg) and BH1/0.3-0.4 (880 mg/kg) exceed the ecological investigation level of 140 mg/kg.

9.3.2 BTEX

Concentrations of BTEX compounds in all samples analysed were below the LOR and below the SAC.

9.3.3 TRH

Concentrations of TRH in all samples analysed were below the SAC.

9.3.4 PAH

Concentrations of all PAH compounds in all samples analysed were below the SAC with the following exception:

- Benzo(a)pyrene in BH1/0.0-0.1 (0.87 mg/kg) marginally exceed the ecological screening level of 0.7 mg/kg.

9.3.5 OCP

Concentrations of all OCP compounds in all samples were below the LOR and below the SAC.

9.3.6 PCB

Concentrations of all PCB compounds in all samples analysed were below the SAC.

9.3.7 Asbestos

No asbestos or respirable fibres were identified in any of the analysed soil samples.

9.4 Waste classification

Soil analytical results with respect to waste classification are presented below. Laboratory certificates of analysis are presented in Appendix C.

- Total concentrations of benzo(a)pyrene and nickel in sample BH1/0.0-0.1 were detected above the CT1 Thresholds for maximum values of specific contaminant concentration (SCC) for classification without TCLP (Table 1:CT1 and CT2 values for classifying waste by chemical assessment without the TCLP test).
- Total concentrations of lead and mercury in sample BH1/0.3-0.4 were detected above the CT1 Thresholds for maximum values of specific contaminant concentration (SCC) for classification without TCLP (Table 1:CT1 and CT2 values for classifying waste by chemical assessment without the TCLP test).
- Subsequent TCLP analysis of BH1/0.0-0.1 and BH1/0.3-0.4 for the respective analytes exceeding the CT1 thresholds returned concentrations below the TCLP1 and SCC1 Thresholds for maximum values for leachable concentration and specific contaminant concentration when used together (Table 2: Leachable concentration (TCLP) and specific contaminant concentration (SCC) values for classifying waste by chemical assessment).
- All other samples reported analyte concentrations which would classify the sampled material as general solid waste.

Based on field observations and the results of the laboratory analysis, the material to the limit of the investigation would be classified as General Solid Waste (non-putrescible) in accordance with the waste guidelines (NSW EPA, 2014).

10. Conclusions and recommendations

10.1 Contamination

The results of the contamination investigation (to the limit of the investigation) did not identify significant contamination which would constrain a development consistent with the current use of the site (i.e. railway setting – commercial/industrial land use).

Selected heavy metals and benzo(a)pyrene were detected in a number of samples at concentrations exceeding ecological assessment criteria. The exceedances of these ecological assessment criteria in a small number of samples are unlikely to pose a risk to future development as the areas investigated are already highly modified (contain filling) and is unlikely to represent a sensitive terrestrial ecosystem.

10.2 Waste Classification

Based on field observations and the results of the laboratory analysis, the material to the limit of the investigation would be classified as General Solid Waste (non-putrescible) in accordance with the waste guidelines (NSW EPA, 2014).

10.3 Recommendations

At the time of preparing this report, the strategic concepts for the Redfern Station and precinct upgrade were in development and were not known. It is recommended that once concepts have been developed, additional contamination advice be sought or the report updated to confirm assumptions made including any recommendations on further testing that may be warranted.

The contamination investigation was preliminary in nature. With fill identified in all borehole locations and the current and historical use of the site as a railway, there is the potential for other areas of contamination to be present across the site which were not assessed as part of this investigation. Once concepts are developed, it is likely that additional contamination investigations and waste classifications will be required in areas which have not been subjected to investigations.

11. Limitations

The sole purpose of this report is to present the interpretive results from the contamination investigation carried out by Jacobs for Transport for NSW ('the Client') in connection with the Redfern Station Investigation Works. This report was produced in general accordance with and is limited to the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

All reports and conclusions that deal with sub-surface conditions are based on interpretation and judgement and as a result have uncertainty attached to them. You should be aware that this report contains interpretations and conclusions which are uncertain, due to the nature of the investigations. No study can investigate every risk, and even a rigorous assessment and/or sampling programme may not detect all problem areas within a site.

This report is based on assumptions that the site conditions as revealed through sampling are indicative of conditions throughout the site. The findings are the result of standard assessment techniques used in accordance with normal practices and standards, and (to the best of Jacobs' knowledge) they represent a reasonable interpretation of the current conditions on the site.

Sampling techniques, by definition, cannot determine the conditions between the sample points and so this report cannot be taken to be a full representation of the sub-surface conditions. This report only provides an indication of the likely sub surface conditions.

Conditions encountered when site work commences may be different from those inferred in this report, for the reasons explained in this limitation statement. If site conditions encountered during site works are different from those encountered during Jacobs' site investigation, Jacobs reserves the right to revise any of the findings, observations and conclusions expressed in this report.

The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report.

In preparing this report, Jacobs has relied upon, and presumed accurate, information provided by the Client and from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, the Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Tables

Table A: QAQC - Soil

Compounds	Units	LOR	BH5/0.0-0.1 Primary	DUPB Blind	RPD
TRH C6 - C9	mg/kg	25	<25	<25	0%
TRH C6 - C10	mg/kg	25	<25	<25	0%
vTPH C6 - C10 lessBTEX (F1)	mg/kg	25	<25	<25	0%
Benzene	mg/kg	0.2	<0.2	<0.2	0%
Toluene	mg/kg	0.5	<0.5	<0.5	0%
Ethylbenzene	mg/kg	1	<1	<1	0%
m+p-xylene	mg/kg	2	<2	<2	0%
o-Xylene	mg/kg	1	<1	<1	0%
naphthalene	mg/kg	1	<1	<1	0%
Total +ve Xylenes	mg/kg	1	<1	<1	0%
TRH C10 - C14	mg/kg	50	<50	<50	0%
TRH C15 - C28	mg/kg	100	<100	<100	0%
TRH C29 - C36	mg/kg	100	<100	<100	0%
TRH >C10-C16	mg/kg	50	<50	<50	0%
TRH >C10 - C16less Naphthalene (F2)	mg/kg	50	<50	<50	0%
TRH >C16-C34	mg/kg	100	<100	<100	0%
TRH >C34-C40	mg/kg	100	<100	<100	0%
Total +ve TRH (>C10-C40)	mg/kg	50	<50	<50	0%
Naphthalene	mg/kg	0.1	<0.1	<0.1	0%
Acenaphthylene	mg/kg	0.1	0.1	0.2	67%
Acenaphthene	mg/kg	0.1	<0.1	<0.1	0%
Fluorene	mg/kg	0.1	0.1	0.2	67%
Phenanthrene	mg/kg	0.1	0.9	1.4	43%
Anthracene	mg/kg	0.1	0.4	0.7	55%
Fluoranthene	mg/kg	0.1	1.3	1.8	32%
Pyrene	mg/kg	0.1	1.3	1.8	32%
Benzo(a)anthracene	mg/kg	0.1	0.8	0.9	12%
Chrysene	mg/kg	0.1	0.6	0.8	29%
Benzo(b,j+k)fluoranthene	mg/kg	0.2	1	1	0%
Benzo(a)pyrene	mg/kg	0.05	0.61	0.69	12%
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	0.3	0.3	0%
Dibenzo(a,h)anthracene	mg/kg	0.1	<0.1	<0.1	0%
Benzo(g,h,i)perylene	mg/kg	0.1	0.3	0.4	29%
Total +vePAH's	mg/kg	0.05	7.7	10	26%
Benzo(a)pyrene TEQ calc (zero)	mg/kg	0.5	0.8	0.9	12%
Benzo(a)pyrene TEQ calc(half)	mg/kg	0.5	0.8	0.9	12%
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	0.5	0.8	0.9	12%
HCB	mg/kg	0.1	<0.1	-	0%
alpha-BHC	mg/kg	0.1	<0.1	-	0%
gamma-BHC	mg/kg	0.1	<0.1	-	0%
beta-BHC	mg/kg	0.1	<0.1	-	0%
Heptachlor	mg/kg	0.1	<0.1	-	0%
delta-BHC	mg/kg	0.1	<0.1	-	0%
Aldrin	mg/kg	0.1	<0.1	-	0%
Heptachlor Epoxide	mg/kg	0.1	<0.1	-	0%
gamma-Chlordane	mg/kg	0.1	<0.1	-	0%
alpha-chlordane	mg/kg	0.1	<0.1	-	0%
Endosulfan I	mg/kg	0.1	<0.1	-	0%
pp-DDE	mg/kg	0.1	<0.1	-	0%
Dieldrin	mg/kg	0.1	<0.1	-	0%
Endrin	mg/kg	0.1	<0.1	-	0%
pp-DDD	mg/kg	0.1	<0.1	-	0%
Endosulfan II	mg/kg	0.1	<0.1	-	0%
pp-DDT	mg/kg	0.1	<0.1	-	0%
Endrin Aldehyde	mg/kg	0.1	<0.1	-	0%
Endosulfan Sulphate	mg/kg	0.1	<0.1	-	0%
Methoxychlor	mg/kg	0.1	<0.1	-	0%
Total +ve DDT+DDD+DDE	mg/kg	0.1	<0.1	-	0%
Aroclor 1016	mg/kg	0.1	<0.1	-	0%
Aroclor 1221	mg/kg	0.1	<0.1	-	0%
Aroclor 1232	mg/kg	0.1	<0.1	-	0%
Aroclor 1242	mg/kg	0.1	<0.1	-	0%
Aroclor 1248	mg/kg	0.1	<0.1	-	0%
Aroclor 1254	mg/kg	0.1	<0.1	-	0%
Aroclor 1260	mg/kg	0.1	<0.1	-	0%
Total +ve PCBs (1016-1260)	mg/kg	0.1	<0.1	-	0%
Arsenic	mg/kg	4	8	5	46%
Cadmium	mg/kg	0.4	<0.4	<0.4	0%
Chromium	mg/kg	1	6	8	29%
Copper	mg/kg	1	30	51	**52%**
Lead	mg/kg	1	32	84	**90%**
Mercury	mg/kg	0.1	<0.1	<0.1	0%
Nickel	mg/kg	1	3	4	29%
Zinc	mg/kg	1	92	150	48%
Acceptable RPD Ranges	0-100%RPD (When the average concentration is <5 times the LOR) 0-75%RPD (When the average concentration is 5 to 10 times the LOR) 0-50%RPD (When the average concentration is >10 times the LOR)				

Table B: Soil Analytical Results

Compounds	Units	LOR	Site Assessment Criteria (SAC) EIL	ESL	HIL	ML	BH4 - 0.4	BH4 - 1.5	BH6 - 0.6	BH1/0.0-0.1	BH1/0.3-0.4	BH2/0.8-0.9	BH2/1.0-1.1	BH3/0.6-0.7	BH3/1.1-1.2	BH2STP/3.0	BH5/0.0-0.1	BH5/0.5-0.95	DUPB	BH5 -Triplicate
TRH C6 - C9	mg/kg	25					<25	<25	<25	<25	<25	<25	<25	<25	<25		<25	<25	<25	
TRH C6 - C10	mg/kg	25			26,000		<25	<25	<25	<25	<25	<25	<25	<25	<25		<25	<25	<25	
vTPH C6 - C10 lessBTEX (F1)	mg/kg	25		215	310	800	<25	<25	<25	<25	<25	<25	<25	<25	<25		<25	<25	<25	
Benzene	mg/kg	0.2		95	4		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2		<0.2	<0.2	<0.2	
Toluene	mg/kg	0.5		135	99,000		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	
Ethylbenzene	mg/kg	1		185	27,000		<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	
m+p-xylene	mg/kg	2					<2	<2	<2	<2	<2	<2	<2	<2	<2		<2	<2	<2	
o-Xylene	mg/kg	1					<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	
naphthalene	mg/kg	1					<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	
Total +ve Xylenes	mg/kg	1		95	81,000		<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	
TRH C10 - C14	mg/kg	50					<50	<50	<50	<50	<50	<50	<50	<50	<50		<50	<50	<50	
TRH C15 - C28	mg/kg	100					<100	<100	<100	150	<100	<100	<100	<100	<100		<100	<100	<100	
TRH C29 - C36	mg/kg	100					<100	160	<100	240	<100	<100	<100	<100	<100		<100	<100	<100	
TRH >C10-C16	mg/kg	50			20,000		<50	<50	<50	<50	<50	<50	<50	<50	<50		<50	<50	<50	
TRH >C10 - C16less Naphthalene (F2)	mg/kg	50			800	1,000	<50	<50	<50	<50	<50	<50	<50	<50	<50		<50	<50	<50	
TRH >C16-C34	mg/kg	100			27,000	5,000	<100	130	<100	290	<100	<100	<100	<100	<100		<100	<100	<100	
TRH >C34-C40	mg/kg	100			38,000	10,000	<100	100	<100	180	<100	<100	<100	<100	<100		<100	<100	<100	
Total +ve TRH (>C10-C40)	mg/kg	50					<50	240	<50	470	<50	<50	<50	<50	<50		<50	<50	<50	
Naphthalene	mg/kg	0.1	370		4.3		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	
Acenaphthylene	mg/kg	0.1					<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	0.2	
Acenaphthene	mg/kg	0.1					<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	
Fluorene	mg/kg	0.1					<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	0.2	
Phenanthrene	mg/kg	0.1					<0.1	<0.1	<0.1	0.8	0.4	0.4	0.1	<0.1	<0.1		0.9	<0.1	1.4	
Anthracene	mg/kg	0.1					<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1		0.4	<0.1	0.7	
Fluoranthene	mg/kg	0.1					<0.1	<0.1	<0.1	2	0.9	0.4	0.2	<0.1	<0.1		1.3	0.1	1.8	
Pyrene	mg/kg	0.1					<0.1	<0.1	<0.1	1.8	1	0.3	0.1	<0.1	<0.1		1.3	0.1	1.8	
Benzo(a)anthracene	mg/kg	0.1					<0.1	<0.1	<0.1	1	0.5	0.1	<0.1	<0.1	<0.1		0.8	<0.1	0.9	
Chrysene	mg/kg	0.1					<0.1	<0.1	<0.1	0.9	0.5	0.1	<0.1	<0.1	<0.1		0.6	<0.1	0.8	
Benzo(b,j+k)fluoranthene	mg/kg	0.2					<0.2	<0.2	<0.2	2	0.8	<0.2	<0.2	<0.2	<0.2		1	<0.2	1	
Benzo(a)pyrene	mg/kg	0.05		0.7			<0.05	<0.05	<0.05	0.87	0.4	0.1	<0.05	<0.05	<0.05		0.61	<0.05	0.69	
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1					<0.1	<0.1	<0.1	0.4	0.2	<0.1	<0.1	<0.1	<0.1		0.3	<0.1	0.3	
Dibenzo(a,h)anthracene	mg/kg	0.1					<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	
Benzo(g,h,i)perylene	mg/kg	0.1					<0.1	<0.1	<0.1	0.4	0.3	<0.1	<0.1	<0.1	<0.1		0.3	<0.1	0.4	
Total +vePAH's	mg/kg	0.05			4,000		<0.05	<0.05	<0.05	10	5	1.4	0.4	<0.05	<0.05		7.7	0.3	10	
Benzo(a)pyrene TEQ calc (zero)	mg/kg	0.5			40		<0.5	<0.5	<0.5	1.3	0.6	<0.5	<0.5	<0.5	<0.5		0.8	<0.5	0.9	
Benzo(a)pyrene TEQ calc(half)	mg/kg	0.5			40		<0.5	<0.5	<0.5	1.3	0.6	<0.5	<0.5	<0.5	<0.5		0.8	<0.5	0.9	
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	0.5			40		<0.5	<0.5	<0.5	1.3	0.6	<0.5	<0.5	<0.5	<0.5		0.8	<0.5	0.9	
HCB	mg/kg	0.1			80		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
alpha-BHC	mg/kg	0.1					<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
gamma-BHC	mg/kg	0.1					<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
beta-BHC	mg/kg	0.1					<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Heptachlor	mg/kg	0.1			50		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
delta-BHC	mg/kg	0.1					<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Aldrin	mg/kg	0.1			45		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Heptachlor Epoxide	mg/kg	0.1			50		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
gamma-Chlordane	mg/kg	0.1			530		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
alpha-chlordane	mg/kg	0.1			530		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Endosulfan I	mg/kg	0.1			2,000		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
pp-DDE	mg/kg	0.1					<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Dieldrin	mg/kg	0.1			45		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Endrin	mg/kg	0.1			100		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
pp-DDD	mg/kg	0.1					<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Endosulfan II	mg/kg	0.1			2,000		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
pp-DDT	mg/kg	0.1	640				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Endrin Aldehyde	mg/kg	0.1			100		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Endosulfan Sulphate	mg/kg	0.1			2,000		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Methoxychlor	mg/kg	0.1			2,500		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Total +ve DDT+DDD+DDE	mg/kg	0.1			3,600		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Aroclor 1016	mg/kg	0.1					<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Aroclor 1221	mg/kg	0.1					<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Aroclor 1232	mg/kg	0.1					<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Aroclor 1242	mg/kg	0.1					<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Aroclor 1248	mg/kg	0.1					<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Aroclor 1254	mg/kg	0.1					<0.1	<0.1	<0.1	<0.2	0.3	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Aroclor 1260	mg/kg	0.1					<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Total +ve PCBs (1016-1260)	mg/kg	0.1			7		<0.1	<0.1	<0.1	<0.2	0.3	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		
Arsenic	mg/kg	4	160		3,000		8	<4	6	16	25	<4	<4	5	10	<4	8	16	5	6
Cadmium	mg/kg	0.4	3		900		<0.4	<0.4	<0.4	0.5	2	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	1	<0.4	<0.4
Chromium	mg/kg	1	665		3,600		8	5	7	12	12	3	9	33	45	13	6	23	8	8
Copper	mg/kg	1	140		240,000		14	<1	35	140	510	2	14	<1	2	<1	30	42	51	47
Lead	mg/kg	1	1808		1,500		31	8	21	300	840	19	18	11	18	11	32	48	84	75
Mercury	mg/kg	0.1	1		730		0.2	<0.1	<0.1	1.2	5.9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	1	55		6,000		1	<1	9	48	18	<1	2	2	1	<1	3	6	4	7
Zinc	mg/kg	1	218		400,000		13	220	37	240	880	7	12	2	3	8	92	91	150	150
Asbestos																				
Asbestos					No asbestos		ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND		
Respirable Fibres					No respirable fibres		ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND		

Legend colour	Meaning
Green	Concentration exceeds EIL only
Orange	Concentration exceeds ESL only
Red	Concentration exceeds HIL and EIL / ESL (where applicable)
Blue	Concentration exceeds ML only

Appendix A. Site investigation plan and cross sections

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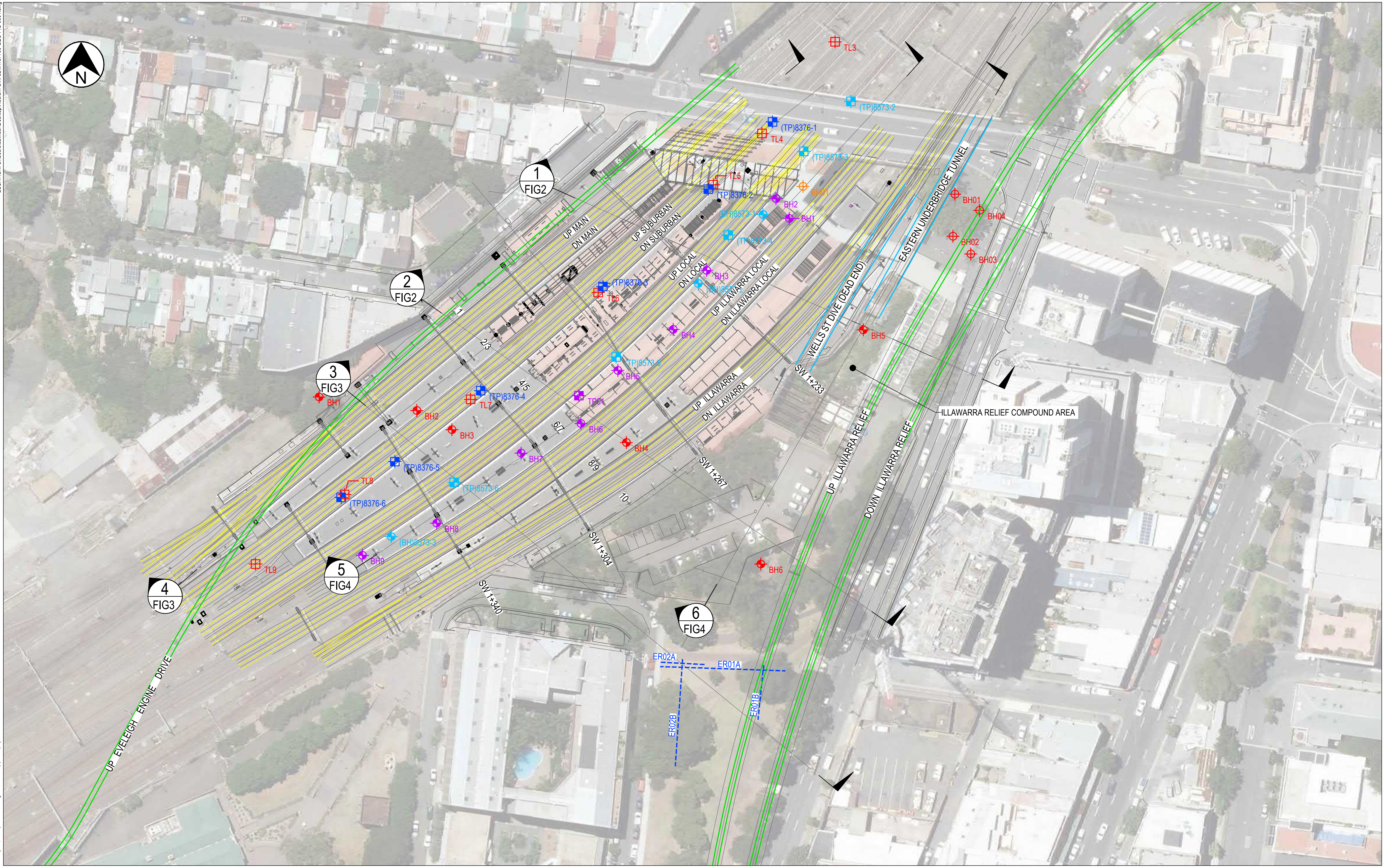

JACOBS

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

CURRENT INVESTIGATION
- Borehole (JACOBS Nov 2017)
- Electrical Resistivity Test

PREVIOUS STUDIES
- Borehole (JACOBS May 2017)
- Borehole (NovoRail 2014)
- Borehole (GeoEnviro 2015)
- Borehole (Railcorp 2010)
- Test Pit (Railcorp 2010)
- Test Pit (Railcorp 2008)
- Test Pit (J&K 2007)

SCALES ON A3 SIZE DRAWING
SCALE 1:1000 — 10 0 10 20 — AT A3

REDFERN STATION INVESTIGATION WORKS
GEOTECHNICAL INVESTIGATION
SITE PLAN
IA157700-0000-CI-SKT-001
Figure 1

DATE: 5/02/2018 10:20:43 AM NAME: DAWIDOWICZ, ROBERT
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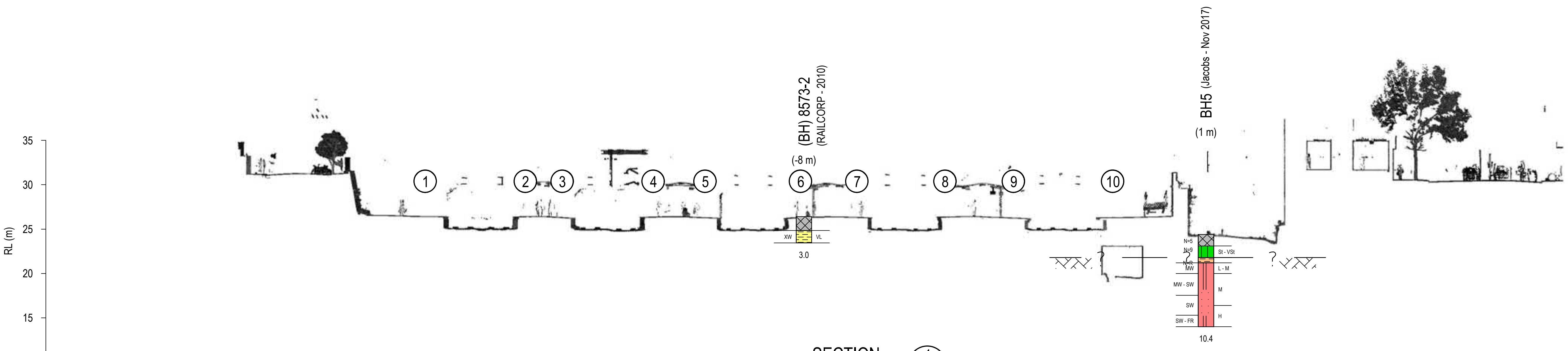
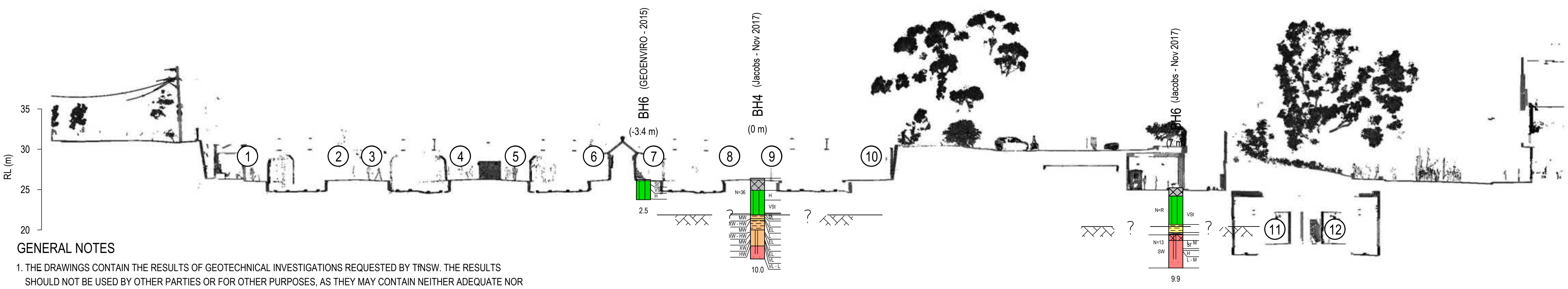


SECTION 1
1:500
FIG1



SECTION 2
1:500
FIG1

GENERAL NOTES

1. THE DRAWINGS CONTAIN THE RESULTS OF GEOTECHNICAL INVESTIGATIONS REQUESTED BY TfNSW. THE RESULTS SHOULD NOT BE USED BY OTHER PARTIES OR FOR OTHER PURPOSES, AS THEY MAY CONTAIN NEITHER ADEQUATE NOR APPROPRIATE INFORMATION.
2. SURFACE LEVELS FOR SECTIONS HAVE BEEN PREPARED FROM 2017 POINT CLOUD / STATIC SCANNER DATA BY JACOBS.
3. SUBSURFACE CONDITIONS HAVE BEEN ASSUMED BY INTERPRETATION AND/OR EXTRAPOLATION FROM DISCRETE AND WIDELY SPACED EXPLORATORY HOLES. AS SUCH THE CONDITIONS SHOWN ARE AN INTERPRETATION OF THE GROUND CONDITIONS AND MUST BE CONSIDERED AS A GUIDE ONLY.
4. LOCAL VARIATIONS OR ANOMALIES IN GROUND CONDITIONS CAN OCCUR IN THE NATURAL ENVIRONMENT, PARTICULARLY BETWEEN DISCRETE EXPLORATORY HOLE LOCATIONS.
5. ALL DRAWINGS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GEOTECHNICAL REPORT.

LEGEND

1	PLATFORM No
?	INFERRED ROCK LEVEL

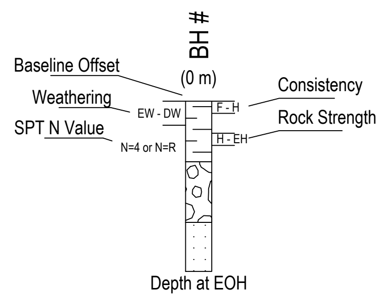
MATERIAL GRAPHIC

- FILL
- CH - High Plasticity CLAY
- CORE LOSS
- INTERBEDDED SILTSTONE & SANDSTONE
- SHALE
- GC - Clayey GRAVEL
- Asphaltic Concrete

GEOLOGY UNIT

- FILL (UNIT 1)
- RESIDUAL (UNIT 2)
- Class V (UNIT 3A)
- Class IV (UNIT 3B)
- Class III (UNIT 3C)

POST LEGEND



SOIL CONSISTENCY

VS	VERY SOFT	(su <12 kPa)
S	SOFT	(su 12 to 25 kPa)
F	FIRM	(su 25 to 50 kPa)
St	STIFF	(su 50 to 100 kPa)
VSt	VERY STIFF	(su 100 to 200 kPa)
H	HARD	(su >200 kPa)

ROCK WEATHERING

XW	EXTREMELY WEATHERED
HW	HIGHLY WEATHERED
MW	MODERATELY WEATHERED
SW	SLIGHTLY WEATHERED
FR	FRESH

ROCK STRENGTH

EL	EXTREMELY LOW STRENGTH
VL	VERY LOW STRENGTH
L	LOW STRENGTH
M	MEDIUM STRENGTH
H	HIGH STRENGTH
VH	VERY HIGH STRENGTH
EH	EXTREMELY HIGH STRENGTH

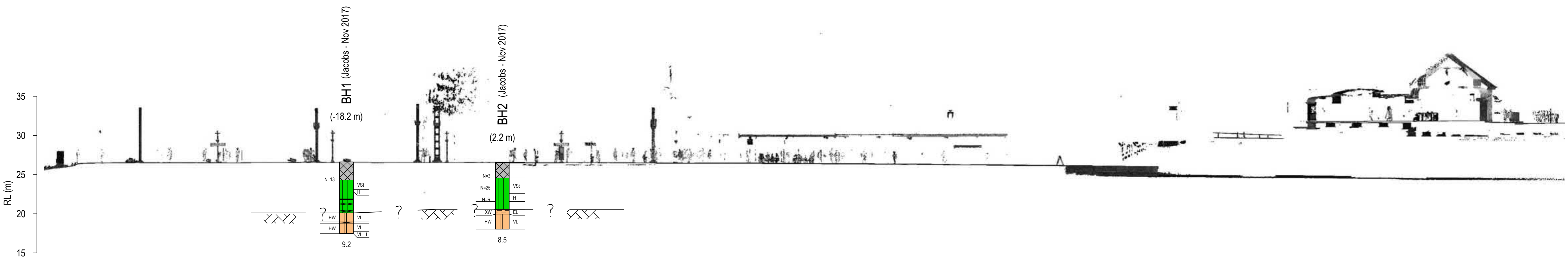
JACOBS

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

SCALES ON A3 SIZE DRAWING
SCALE 1:500 — 5 0 5 10 — AT A3

REDFERN STATION INVESTIGATION WORKS
GEOTECHNICAL INVESTIGATION
SECTIONS
IA157700-0000-CI-SKT-002
Figure 2

SECTION 3
1:500
FIG1



SECTION 4
1:500
FIG1

LEGEND

1 PLATFORM No

? INFERRED ROCK LEVEL

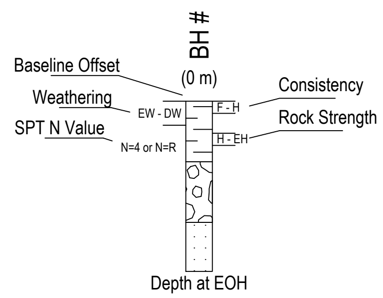
MATERIAL GRAPHIC

- FILL
- CH - High Plasticity CLAY
- CORE LOSS
- INTERBEDDED SILTSTONE & SANDSTONE
- SHALE
- GC - Clayey GRAVEL
- Asphaltic Concrete

GEOLOGY UNIT

- FILL (UNIT 1)
- RESIDUAL (UNIT 2)
- Class V (UNIT 3A)
- Class IV (UNIT 3B)
- Class III (UNIT 3C)

POST LEGEND



SOIL CONSISTENCY

VS	VERY SOFT	(su <12 kPa)
S	SOFT	(su 12 to 25 kPa)
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VL	VERY LOW STRENGTH
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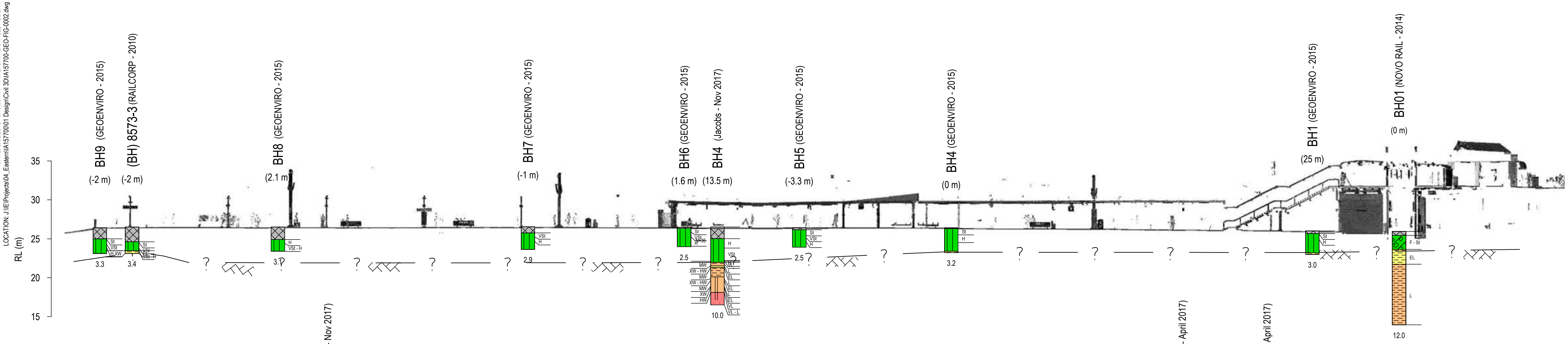
M	MEDIUM STRENGTH
H	HIGH STRENGTH
VH	VERY HIGH STRENGTH
EH	EXTREMELY HIGH STRENGTH

JACOBS

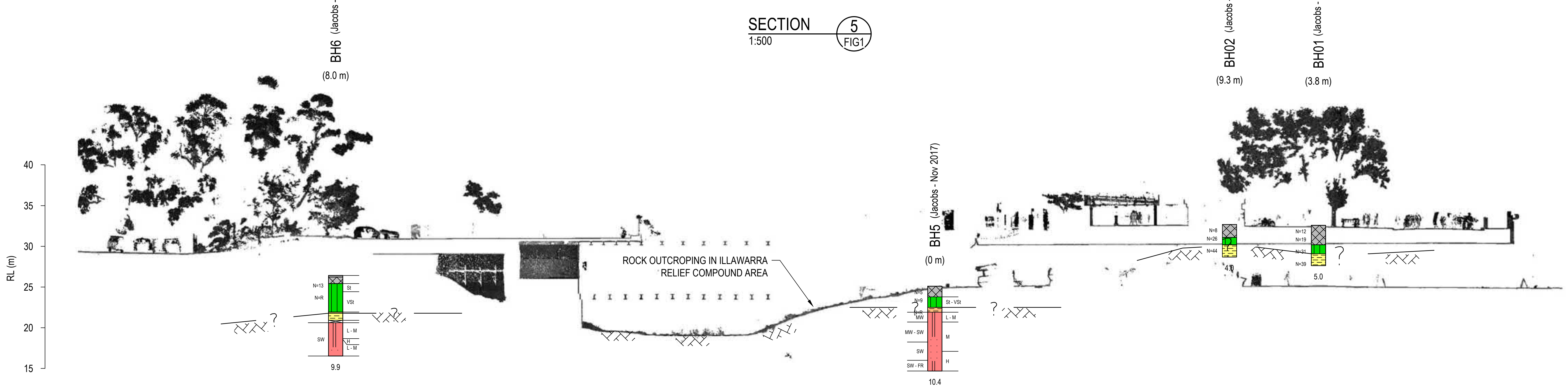
SCALES ON A3 SIZE DRAWING
SCALE 1:500 5 0 5 10 AT A3

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

REDFERN STATION INVESTIGATION WORKS
GEOTECHNICAL INVESTIGATION
SECTIONS
IA157700-0000-CI-SKT-002
Figure 3



SECTION 5
1:500
FIG1



SECTION 6
1:500
FIG1

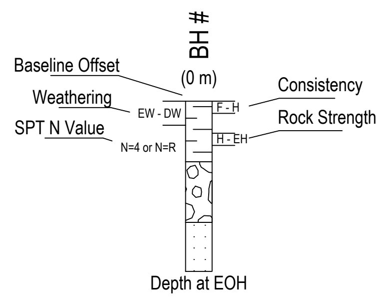
MATERIAL GRAPHIC

- FILL
- CH - High Plasticity CLAY
- CORE LOSS
- INTERBEDDED SILTSTONE & SANDSTONE
- SHALE
- GC - Clayey GRAVEL
- Asphaltic Concrete
- ? INFERRED ROCK LEVEL

GEOLOGY UNIT

- FILL (UNIT 1)
- RESIDUAL (UNIT 2)
- Class V (UNIT 3A)
- Class IV (UNIT 3B)
- Class III (UNIT 3C)

POST LEGEND



SOIL CONSISTENCY

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S	SOFT	(su 12 to 25 kPa)
F	FIRM	(su 25 to 50 kPa)
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ROCK WEATHERING

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HW	HIGHLY WEATHERED
MW	MODERATELY WEATHERED
SW	SLIGHTLY WEATHERED
FR	FRESH

ROCK STRENGTH

EL	EXTREMELY LOW STRENGTH
VL	VERY LOW STRENGTH
L	LOW STRENGTH
M	MEDIUM STRENGTH
H	HIGH STRENGTH
VH	VERY HIGH STRENGTH
EH	EXTREMELY HIGH STRENGTH

JACOBS

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

SCALES ON A3 SIZE DRAWING
SCALE 1:500 — 5 0 5 10 — AT A3

REDFERN STATION INVESTIGATION WORKS
GEOTECHNICAL INVESTIGATION
SECTIONS
IA157700-0000-CI-SKT-002
Figure 4

Appendix B. Borehole logs

JACOBS

Soil Description

MATERIAL DESCRIPTION

Soil description is based on an assessment of disturbed samples, as recovered from boreholes and excavation, and from undisturbed materials as seen in excavation and exposures or in undisturbed samples.

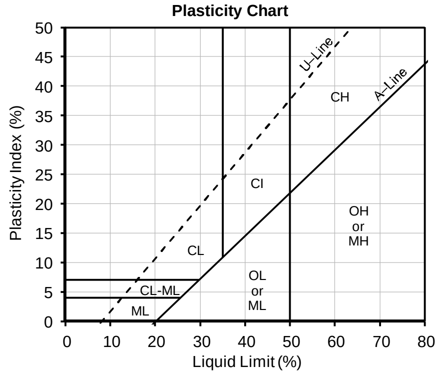
CLASSIFICATION

Soils are described in general accordance with AS1726-1993 and the Unified Soil Classification (USC) as shown below.

Field Identification procedures (Excluding particles larger than 63 mm and basing fractions on estimated mass)				Code	Typical Names	Describing Soils	Use grain size curve in identifying the fractions as given under field identification	Laboratory Classification Criteria		
COARSE GRAINED SOILS More than 50% of material less than 63 mm is larger than 0.075 mm	GRAVELS More than 50% of coarse fraction is larger than 2.36 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name, symbol, indicate approximate % of sand and gravel, maximum size, angularity, surface condition, and strength of coarse grains: colour, amount plasticity of fine component. For undisturbed soils add information on moisture content, degree of compactness, stratification, cementation, and odour. Give local and other pertinent descriptive information. Example: SILTY SAND (SM), fine to coarse, light grey, about 20% strong angular gravel particles – 10mm max. size, rounded and sub-angular sand, about 12% non-plastic fines, moist, dense alluvial sand.		Determine percentages of gravel and sand from grain size curve. Depending on percentage smaller than 0.075 mm size coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP. More than 12% GM, GC, SM, SC. 5% to 12% Borderline cases requiring use of dual symbols	Greater than 4 $C_u = \frac{D_{60}}{D_{10}}$	Between 1 & 3 $C_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$
			Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels				Not meeting all gradation requirements for GW.	
		GRAVELS WITH FINE (Appreciable fines)	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	GM	Silty gravels, gravel-sand-silt mixtures				Atterberg limits below 'A' line or PI less than 4	Above 'A' line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			'Dirty' materials with excess of plastic fines, medium to high dry strength	GC	Clayey gravels, gravel-sand-clay mixtures				Atterberg limits above 'A' line with PI greater than 7	
	SANDS More than 50% of coarse fraction is smaller than 2.36 mm	CLEAN SANDS (little or no fines)	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	SW	Well graded sands, gravelly sands, little or no fines				Greater than 6 $C_u = \frac{D_{60}}{D_{10}}$	Between 1 & 3 $C_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$
			Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands				Not meeting all gradation requirements for SW	
		SANDS WITH FINES (Appreciable fines)	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	SM	Silty sands, sand-silt mixtures				Atterberg limits below 'A' line or PI less than 4	Above 'A' line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			'Dirty' materials with excess of plastic fines, medium to high dry strength	SC	Clayey sands, sand-clay mixtures				Atterberg limits above 'A' line with PI greater than 7	

FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm	IDENTIFICATION PROCEEDURES ON FRACTIONS < 0.075 mm						
		DRY STRENGTH	DILATANCY	TOUGHNESS	Code	Typical Names	Describing Soils
	SILTS AND CLAYS Liquid limit <50	None to low	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with low plasticity. Silts of low to medium Liquid Limit	Give typical name, symbol, and indicate degree and character of plasticity, colour, amount and size of coarse grains. For undisturbed soils add information on moisture content, consistency, structure, stratification, and odour. Give local or geologic name and other pertinent descriptive information. Example: CLAYEY SILT (ML), brown, low plasticity, trace sand, firm, dry, numerous vertical root holes.
		Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays	
		Low to medium	Slow	Low	OL*	Organic silts and organic silt-clays of low to medium plasticity	
	SILTS AND CLAYS Liquid limit >50	Low to medium	Slow to none	Low to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, silts of high Liquid Limit	
		High to very high	None	High	CH	Inorganic clays of high plasticity	
		Medium to high	None to very slow	Low to medium	OH*	Organic clays of high plasticity	
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture				Pt*	Peat and other highly organic soils	

Plasticity Chart



Laboratory:

MC	Moisture Content	MDD	Maximum Dry Density
LL	Liquid Limit	OMC	Optimum Moisture Content
PL	Plastic Limit	PSD	Particle Size Distribution
PI	Plasticity Index	UU	Undrained Unconsolidated
LS	Linear Shrinkage	CU	Consolidated Undrained
ρ_p	Particle Density	CD	Consolidated Drained
ρ_b	Bulk Density	$I_{s(50)}$	Point Load Index
ρ_d	Dry Density	UCS	Uniaxial Compressive Strength

Boundary classifications – Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.

* effervesces with H_2O_2

DESCRIPTION OF A SOIL

i. Colour
ii. Plasticity or particle characteristics of soil
iii. Secondary components name
iv. Estimated proportion
v. Secondary component plasticity or particle characteristics
vi. Other minor soil components
vii. Structure of soil, geological origin
viii. Consistency / density
ix. Moisture condition

Term		Grain Size	Shape and Texture	Field Guide
CLAY		< 2 µm	Shiny	Not visible under 10x
SILT		7 – 75 µm	Dull	Visible under 10x
SAND	Fine	0.075 – 0.2 mm	Angular / sub - angular / sub - rounded / rounded	Visible by eye
	Medium	0.2 – 0.6 mm		Visible at < 1 mm
	Course	0.6 – 2.36 mm		Visible at < 3 mm
GRAVEL	Fine	2.36 – 6 mm		Visible at < 5 mm
	Medium	6 – 20 mm		Road Gravel
	Course	20 – 63 mm		Rail ballast
COBBLES		63 – 200 mm		Beaching
BOULDERS		> 200 mm		

COLOUR

The colour of a soil should be described using simple terns, such as black, white, grey, red, brown, orange, yellow green or blue. These may be modified as necessary by 'pale', 'dark' or 'mottled'. Borderline colours may be described as a combination of these colours (e.g. orange brown). Where a soil consists of a primary colour with a secondary mottling it should be described as (primary colour) mottled (first colour) and (secondary colour). Where a soil consists of two colours presented in roughly equal proportions the colour description should be mottled (first colour) and (secondary).

PARTICLE CHARACTERISTICS – COARSE GRAINED SOILS

Term	Description
Well Graded	Having good representation of all particle sizes
Poorly graded	With one or more intermediate size poorly represented
Gap graded	With one or more intermediate sizes absent
Uniform	Essentially of one size

ANGULARITY – COARSE GRAINED SOILS

Rounded   Sub-rounded   Sub-angular   Angular

PLASTICITY

Liquid limit (%)	Description
≤ 35	Low plasticity
>35 to ≤ 50	Medium plasticity
> 50	High plasticity

DESCRIPTIVE TERMS FOR SECONDARY AND MINOR COMPONENTS

Coarse Grained Soils		Fine grained soils	
% Fines	Modifier	% Coarse	Modifier
≤ 5	Omit or use 'trace'	≤ 15	Omit, or use 'trace'
>5 to ≤12	Describe as 'with clay/ silt' as applicable	>15 to ≤ 30	Describe as 'with sand/ gravel' as applicable
> 12	Prefix soil type as 'clayey/silt' as applicable	> 30	Prefix soil type as 'sandy/ gravelly' as applicable

CONSISTENCY TERMS – COHESIVE SOILS

Term	Undrained shear strength	SPT (N) Blow Count	Field Guide to consistency
Very Soft (VS)	<12	0 – 2	Easily penetrated several centimetres by fist, exudes between fingers when squeezed in fist
Soft (S)	12 – 25	2 – 4	Easily penetrated several centimetres by thumb, easily moulded by light finger pressure
Firm (F)	25 – 50	4 – 8	Can be penetrated several centimetres by thumb with moderate effort, and moulded between the fingers by strong pressure
Stiff (St)	50 – 100	8 – 15	Readily indented by thumb but penetrated only with difficultly. Cannot be moulded by fingers
Very Stiff (VSt)	100 – 200	15 –30	Readily intended by thumb nail, still very tough
Hard (H)	>200	>30	Indented with difficulty by thumb nail, brittle

CONSISTENCY TERMS – NON COHESIVE SOILS

Term	Density Index (%)	SPT (N) Blow Count	Field Guide to Density
Very Loose (VL)	< 15	0 – 4	Ravels
Loose (L)	15 – 35	4 – 10	Shovels easily
Medium Dense (MD)	35 – 65	10 – 30	Shovelling very difficult
Dense (D)	65 – 85	30 – 50	Pick required
Very Dense (VD)	> 85	50 -100	Pick difficult

MOISTURE

Term (Symbol)	Description
Dry / <Wp (D)	Hard and friable or powdery, moisture content well below plastic limit
Moist / Wp (M)	Soil feels cool, darkened in colour, can be moulded, near plastic limit
Wet / >Wp (W)	Soil feels cool, dark, usually weakened, free water, moisture content well above plastic limit

STRUCTURE

Term	Description
Zoning	Soils may consist of separate zones different in colour, grain size or other properties. The thickness, orientation and any distinguishing features of the zone should be described i.e. gradational or distinct boundaries. The patterns of these zones may be described using layer (zone is continuous), lens (a discontinuous layer of different material, with lenticular shape) or pocket (irregular inclusion of different materials).
Defects	The dimensions, orientation and spacing of the defects should be given. The surface of the defects should be described in terms of texture (rough, polished) and coating. Defects may be re-cemented and may be stronger than the parent soils. Defects may include fissures, cracks, roots, roots and tube holes, infill tubes, in-filled seams, dykes.
Cementing	Soils or defects within soils may be cemented together by various agencies. The nature of the cementing agent should be identified if possible, strength, reaction to acid and the like. Weakly cemented – If the cementing agent allows the particle aggregation to be easily fractured by hand when the soil is saturated. Strongly cemented – If the cementing agent prevents fracturing by hand of the particle when the soil is saturated (use strength classification as per rock)

ADDITIONAL OBSERVATIONS

Geological origin

Term	Description
Weathered in place soils	Extremely weathered soil - Structure and fabric of parent rock visible
	Residual soil - Structure and fabric of parent rock not visible
Transported soils	Aeolian soil - Deposited by wind
	Alluvial soil - Deposited by streams and rivers
	Colluvial soil -Deposited on slopes (transported down slope)
	Lacustrine soil - Deposited by lakes
	Marine soil - Deposited in ocean, bays, beaches and estuaries
Fill materials	Soil Fill - Describe soil type, UCS symbol and add 'FILL'
	Rock Fill - Rock type, degree of weathering, and word 'FILL'
	Domestic Fill - Percent soil or rock, whether pretrucible or not
	Industrial Fill - Percent soil, whether contaminated, particle size & type of waste product, i.e. – brick, concrete, metal

Any scour should be noted.

ORGANIC OR ARTIFICIAL MATERIALS

Preferred Terms	Secondary Description
Organic matter	Fibrous peat, charcoal, wood fragments, roots (greater than 2 mm diameter), root fibres (less than 2 mm diameter)
Waste fill	Domestic refuse, oil, bitumen, brickbats, concrete rubble, fibrous plaster, wood pieces, wood shavings, saw dust, iron filings, drums, steel bars, steel scrap, bottles, broken glass, leather.

Rock Description

ROCK TYPE

Composition of the rock material i.e. colour, grain size, structure, texture, fabric, mineral composition, hardness alteration, cementation etc. as applicable. Condition of the material i.e. estimated strength, weathering and moisture condition. Rock mass properties i.e. structure of rock, defects – type, orientation spacing, roughness, waviness and continuity and weathering (of the rock mass).

GRAIN SIZE

Particle size scales depends on rock type. For sedimentary rocks, the following descriptors can be used:

- Sand terms for sandstone
- Gravel terms for conglomerates and breccias
- No description of grainsize is required for claystone, siltstone, shale and mudstone etc.

For metamorphic and igneous rocks, record the typical grain size in millimetres

COLOUR

The colour of a rock should be described using simple terms, such as black, white, grey, red, brown, orange, yellow, green or blue. These may be modified as necessary by 'pale', 'dark' or 'mottled'. Borderline colours may be described as a combination of these colours (e.g. grey green).

STRUCTURE

Terms typically used to describe the structure of a rock mass where possible include:

- Sedimentary rocks – bedded, laminated
- Metamorphic – foliated, banded, cleaved
- Igneous rocks – massive, flow banded.

The spacing or thickness of these structural features should be given as described in the table below:

Thickness	Bedding Term
< 6 mm	Very thinly laminated
6 – 20 mm	Thinly laminated
20 – 60 mm	Laminated
60 – 200 mm	Thinly Bedded
0.2 – 0.6 m	Medium bedding
0.6 – 2 m	Thickly bedded
> 2 m	Very thickly bedded

TEXTURE

Type	Definition
Massive	Effectively Homogeneous and isotropic. Bulky or equidimensional and elongated or tabular grains uniformly distributed.
Distinct	Bedded, foliated, cleaved – effectively homogeneous with planar anisotropy. Elongated or tabular grains or pores in a layered arrangement. The arrangement of grains, referred to as the rock fabric, may show a preferred orientation.

STRENGTH

Term	Code	$I_{s(50)}$ (MPa)	Field Guide to Strength
Extremely Low	EL	≤ 0.30	Easily remoulded by hand to a material with soil properties.
Very Low	VL	> 0.03 to ≤0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 3 cm thick can be broken by finger pressure.
Low	L	> 0.1 to ≤ 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blow of the pick point; has dull sound under hammer. A piece of core 150 mm long 50 mm in diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	> 0.3 to ≤ 1.0	Readily scored with a knife; a piece of core 150 mm long by 50 mm in diameter can be broken by hand with difficulty.
High	H	> 1 to ≤ 3	A piece of core 150 mm long by 50 mm in diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	VH	> 3 to ≤ 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High	EH	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

1. These terms refer to the strength of the rock material and not to the strength of the rock mass which may be considered weaker due to the effect of rock defects.
2. The field guide visual assessment of rock strength may be used for preliminary assessment or when point load testing is not available.
3. Anisotropy of rock material samples may affect the field assessment of strength

WEATHERING CLASSIFICATION

Degree of weathering		Definition
Residual soil (RS)		Soil developed from weathering of rock in-situ. The mass structure and substance fabric are no longer evident.
Extremely weathered rock (XW)		Rock is weathered to such an extent that it has soil properties. It disintegrates or can be remoulded in water. It shows a rock fabric but is described as a soil.
Highly weathered rock (HW)	Distinctly weathered (DW)*	Secondary minerals often weathered to clay. Staining of most grain boundaries and some disintegration due to weakening of grain bonds. Often significant loss of strength. However cementing of joints can occasionally lead to strengthening.
Moderately weathered rock (MW)		Staining and pitting of most secondary minerals and other grain boundaries. The loss of strength depends on the weathering and extent of secondary minerals in the rock matrix. The rock substance may be highly discoloured, usually by iron staining.
Slightly weathered rock (SW)		Secondary minerals are stained but not pitted, slight staining at some grain boundaries. Little or no change of strength indicated by amount of colour change.
Fresh rock (F)		Rock shows no sign of decomposition or staining. Relatively strong.

*Distinctly Weathered indicates a distinct change in colour, hardness and/or friability and not distinguishable into HW or MW

DESCRIPTION OF A DISCONTINUITY

- Depth
- Dip
- Infill material
- Aperture observation
- Planarity
- Small scale roughness
- Aperture measurement (mm)
- Remark
- Roughness Class

INFILL MATERIAL

Code	Description
CA	Calcite
CH	Clay
CG	Clayey gravel
GM/ GP/ GW	Gravel
Fe	Iron oxide
Fe Clay	Iron oxide clay
Qz	Quartz
X	Carbonaceous

APERTURE OBSERVATION

Term	Code	Description
Clean	CN	No visible coating or infill
Stain	Sn	No visible coating or infill but surfaces are discoloured by mineral staining
Veneer <1 mm	VR	A visible coating or soil or mineral substance but usually unable to be measured. If discontinuous over the plane, patchy veneer.
Coating >1 mm to <10mm	CT	A visible coating or infilling of soil or mineral substance. Describe composition and thickness.
Filling (Filled) >10 m	Filled	A visible filling of soil or mineral substance. Describe composition and thickness.

PLANARITY

Code	Description
CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped

SMALL SCALE ROUGHNESS

Code	Description
POL	Polished
RF	Rough
S	Smooth
SL	Slickensided
VR	Very rough

ROUGHNESS CLASS

Code	Description
I	Rough or irregular, stepped
II	Smooth, stepped
III	Slickensided, stepped
IV	Rough or irregular, undulating
IX	Slickensided, planar
V	Smooth, undulating
VI	Slickensided, undulating
VII	Rough or irregular, planar

TYPE OF DISCONTINUITY

Term	Code	Description	
Bedding	BP	Generally no micro fractures	Arrangement in layers, of mineral grains of similar sizes or composition, and/or arrangement of elongated to tabular minerals near parallel to one another, and/ or to the layers.
Foliation	FL	Discontinuous micro fractures may be present, near parallel to the layering	
Cleavage	CL		
Schistosity	SH		
Contact	CO	A contact is the surface along which one rock touches another.	
Joint	JT	A discontinuity or crack, planar, curved, irregular, across which the rock usually has little tensile strength. The joint may be open (filled with air or water) or filled by soil substance or by rock substance or rock substance which acts as a cement, joint surface may be rough, smooth or slickensided	
Shear seam/ zone	SS/ SZ	Zone, with roughly parallel planar boundaries of rock material intersected by closely spaced (generally <50 mm) joints and/ or microscopic fractures (cleavage) planes. The joints are at small angles to the zone boundaries. They are usually slightly curved and divide the mass into blocks of lenticular or wedge space.	
Crushed seam/ zone	CS/ CZ	Zone with roughly parallel planar boundaries, composed of disoriented, usually angular fragments of the host rock substance. The fragments may be of clay, silt, sand or gravel size, or mixtures of any of these. Some minerals maybe altered or decomposed but this is not necessarily so.	
Decomposed seam / zone	DS/ DZ	Seam or zone of any shape, but commonly with roughly parallel boundaries in which the rock material is discoloured and usually weakened. The boundaries with fresh rock are usually gradational. Geological structures in the fresh rock are usually preserved in the decomposed rock.	
Infill seam/ zone	IS	Seam or zone of any shape, but commonly with roughly parallel boundaries composed of soil substance. The infill is caused by migration of soil and into open joints. May show layering roughly parallel to the zone boundaries. Geological structures in the adjacent rock do not continue into the infill substance.	
Vein	VN	vein is a distinct sheet like body of crystallized minerals within a rock	
Dyke	DK	Dykes are sheet-like bodies of igneous rock that cut across sedimentary bedding or foliations in rocks. They may be single or multiple in nature.	
Sill	SI	A sill is an intrusion of magma that spreads underground between the layers of another kind of rock	
Void	VO	A completely empty space.	

Refer to Table A10 in AS1726-1993

Drilling

DRILLING / EXCAVATION METHOD

Code	Description
AD/V	Auger drilling V-bit
AD/T	Auger drilling with TC-bit
AT	Air track
B	Bulldozer
BD	Backhoe bucket
BH	Washbore drag pit
CA	Casing advancer
E	Excavator
EH	Excavator with hammer
HA	Hand auger
NMLC	NMLC core barrel
HMLC	HMLC core barrel
NQ3	Wire line NQ core barrel
HQ3	Wire line HQ core barrel
PQ3	Wire line PQ core barrel
PT	Push tube
RR	Rock roller
WB	Washbore
X	Existing excavation
N	Natural exposure

WATER/ DRILLING FLUID

Symbol	Description
	Water loss: partial
	Water loss: complete
	Water inflow
	Water outflow
	Water level: drilling
	Water level: standing

DRILLING PENETRATION

Ease of penetration in non-core drilling

Code	Description
VE	Very easy
E	Easy
F	Firm
H	Hard
VH	Very hard

SAMPLES AND FIELD TEST

Code	Description
B	Bulk disturbed sample
BLK	Block sample
DS	Small disturbed sample
ES	Soil sample for environmental testing
EW	Water sample for environmental testing
LB	Large bulk disturbed sample
P	Piston sample
SPT	Standard Penetration Test
VS	Vane shear test
HP	Hand penetrometer test
U	Undisturbed push in sample

BACKFILL / WELL DETAIL

Symbol	Description
	Cement seal
	Grout backfill
	Blank pipe
	Slotted pipe
	Filter pack: sand filter
	Bentonite seal
	Backfill – excavated material

NON-CORE DRILL HOLE - GEOLOGICAL LOG

JACOBS

HOLE NO : BH1
FILE / JOB NO : IA157700
SHEET : 1 OF 3

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333321.8, N: 6248324.6 (MGA94 Zone 56) SURFACE ELEVATION : 25.90 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : BM

DATE STARTED : 20/11/2017 DATE COMPLETED : 20/11/2017 DATE LOGGED : 20/11/2017 LOGGED BY : MG CHECKED BY :

DRILLING

Depth (m)	Progress: Drilling & Casing	Water	Drilling Penetration	Ground Water Levels	Samples & Field Tests
0.00–1.50	NDD		E (0.00–1.80)	Not Observed	ES 0.10m; 0.30m ES 0.40m; 0.60m ES 0.70m; 1.00m ES 1.10m
1.50–3.80	CASING; AD/T		F (1.80–2.00); E (2.00–2.70); F (2.70–3.50); H (3.50–3.80)		2.00m SPT 6,6,7 N=13 2.45m; 3.50m D 3.70m

MATERIAL

Depth (m)	Graphic Log	Classification Symbol	Material Description (Soil Type, Colour, Plasticity or Particle Characteristic; Secondary and Minor Components)	Moisture Condition	Consistency / Relative Density	Structure & Other Observations
0.00–0.10m	Fill		FILL: Gravelly CLAY: Brown, medium plasticity, gravel is fine to coarse, subangular to angular, with a trace of root fibres.	M		FILL
0.10–0.50m	Fill		FILL: Silty SAND: Brown, fine to medium grained, with a trace of clay and gravel.	M		0.30: Plastic bottle and plastic debris recovered.
0.50–2.30m	Fill		FILL: Gravelly CLAY: Orange-brown, high plasticity, gravel is fine to coarse, subangular to subrounded. From 0.9m, reducing in gravel amount. From 1.5m, colour change to red-brown.	M		2.00: Sandstone gravel recovered in SPT.
2.30–3.80m	Clay	CH	Silty CLAY: Red-brown and pale grey, high plasticity.	D	VSt; H (from 3.50)	RESIDUAL SOIL 2.70: Increased drilling resistance.
3.80m			Continued as Cored Drill Hole			3.80: TC-bit refusal at 3.8m.

DEPTH (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH1
FILE / JOB NO : IA157700
SHEET : 2 OF 3

POSITION : E: 333321.8, N: 6248324.6 (MGA94 Zone 56) SURFACE ELEVATION : 25.90 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : BM

DATE STARTED : 20/11/2017 DATE COMPLETED : 20/11/2017 DATE LOGGED : 20/11/2017 LOGGED BY : MG CHECKED BY :

CASING DIAMETER : HQ BARREL (Length) : BIT : BIT CONDITION :

Drilling & Casing	Water	Core Loss (Run %) / Drill Depth	Samples & Field Tests	Depth (m)	Description (Rock type: Colour, Grain size, Structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable))	Weathering	Estimated Strength Is(50) (● Axial, ○ Diametral)	Additional Data (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0–3.80	3.80m START CORING AT 3.80m			
NMLC	0% LOSS	0% LOSS; 4.65		3.80–4.70	Silty CLAY: Pale grey with some red-brown ironstone gravel, high plasticity, dry, hard, gravel is medium to coarse, subangular to angular.			
NMLC	5% LOSS	24% LOSS		4.70–4.81	CORE LOSS 0.11m (4.70-4.81)			
NMLC	5% LOSS			4.81–5.24	Silty CLAY: Pale grey with some red-brown ironstone gravel, high plasticity, dry, hard, gravel is medium to coarse, subangular to angular.			
NMLC	5% LOSS			5.24–5.49	CORE LOSS 0.25m (5.24-5.49)			
NMLC	5% LOSS	6.15		5.49–6.15	Silty CLAY: Pale grey with some red-brown ironstone laminae, high plasticity, dry, hard.			
NMLC	5% LOSS	17% LOSS		6.15–6.40	CORE LOSS 0.25m (6.15-6.40)			
NMLC	5% LOSS			6.40–6.50	Silty CLAY: Pale grey with some red-brown ironstone laminae, high plasticity, dry, hard.			
NMLC	5% LOSS	7.65	Is(50) a=0.05 d=0.12 MPa	6.50–7.65	INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Grey and pale grey, sandstone is fine grained, distinctly laminated at 0-5°, some iron staining along defects. From 6.80m, becoming dark grey and pale grey. From 7.29 to 7.46m, clay seam, grey and pale grey.	HW		ALL DEFECTS ARE SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5°) 6.6 6.65 to 6.74: VN, Cu, 80-90°, Fe. 6.74 to 6.83: Highly fractured. 6.91 to 6.97: Clay SM, 60mm. 7.06 to 7.10: FZ, 40mm. 7.13 7.23 7.29 to 7.46: Clay SM, 170mm. 7.48 7.57
NMLC	5% LOSS	11% LOSS		7.65–7.81	CORE LOSS 0.16m (7.65-7.81)			
NMLC	5% LOSS		Is(50) a=0.01 d=0.07 MPa	7.81–8.0		HW		7.81 7.83

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS

CORED DRILL HOLE LOG

HOLE NO : BH1
FILE / JOB NO : IA157700
SHEET : 3 OF 3

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333321.8, N: 6248324.6 (MGA94 Zone 56) SURFACE ELEVATION : 25.90 (AHD) ANGLE FROM HORIZONTAL : 90°
RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : BM
DATE STARTED : 20/11/2017 DATE COMPLETED : 20/11/2017 DATE LOGGED : 20/11/2017 LOGGED BY : MG CHECKED BY :
CASING DIAMETER : HQ BARREL (Length) : BIT : BIT CONDITION :

DRILLING & CASING	WATER	CORE LOSS (RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	NATURAL FRACTURE (mm) (20 40 100 300 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	5% LOSS	11% LOSS		8.0		INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Grey and pale grey, sandstone is fine grained, distinctly laminated at 0-5°. *(continued)*	HW				7.88 7.95: Sandstone SM. 8.06 8.14 8.24 8.27 8.31 8.38 8.41 8.5 8.53 8.62 8.64 8.69 8.75
			Is(50) a=0.03 d=0.09 MPa								
		9.15	Is(50) a=0.04 d=0.08 MPa	9.0	9.15m	From 8.90m, becoming grey-brown, increasing strength.					
						Hole Terminated at 9.15 m Target depth					8.78 8.82 8.91: Fe. 8.97: Fe. 9.11 9.13
				10.0							
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

PointID : BH1 Depth Range: 3.80 - 9.15 m

JACOBS	CLIENT Transport for NSW			
	PROJECT Redfern Station Investigation			
	DRAWN MG	DRAWING CHECK MF	REVIEWED	APPROVED
	DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE Core Photo - BH1		
SCALE Not To Scale	DRAWING No 1/1	REV

NON-CORE DRILL HOLE - GEOLOGICAL LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH2
FILE / JOB NO : IA157700
SHEET : 1 OF 3

POSITION : E: 333351.6, N: 6248322.8 (MGA94 Zone 56) SURFACE ELEVATION : 26.37 (AHD) ANGLE FROM HORIZONTAL : 90°
RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : PB
DATE STARTED : 18/11/2017 DATE COMPLETED : 18/11/2017 DATE LOGGED : 18/11/2017 LOGGED BY : MG CHECKED BY :

DRILLING & CASING	WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
NDD (0.0–1.1)		E	Not Observed		0.00–0.05m		Asphaltic CONCRETE.			FILL
					0.05–0.45m		FILL: Gravelly SAND: Brown, fine to coarse grained, gravel is fine to coarse, subangular to angular.	D		
				0.80m ES 0.90m; 1.00m ES 1.10m	0.45–1.50m		FILL: Clayey SAND: Brown, fine to medium grained with some medium to coarse, subangular to subrounded gravel. At 1.0m, with some red-brown and grey clay.	M		0.40: Buried Asphalt pavement, 50mm thick.
AD/T, CASING (1.1–5.0)				1.50m SPT 4,1,2 N=3. 1.95m	1.50–2.00m		FILL: Gravelly CLAY: Brown, low plasticity, gravel is fine to coarse, subangular to angular.	D		
		E (to 3.5), F (3.5–5.0)		3.00m SPT 5,10,15 N=25. 3.45m; 4.50m SPT 11,16,5/20mm HB, N=R. 4.82m	2.00–5.00m	CH	Silty CLAY: Grey mottled red-brown, high plasticity with trace of ironstone gravel.	D	VSt (2.0–4.0), H (4.0–5.0)	RESIDUAL SOIL
					5.00m		Continued as Cored Drill Hole			

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS

CORED DRILL HOLE LOG

HOLE NO : BH2
FILE / JOB NO : IA157700
SHEET : 2 OF 3

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333351.6, N: 6248322.8 (MGA94 Zone 56) SURFACE ELEVATION : 26.37 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : PB

DATE STARTED : 18/11/2017 DATE COMPLETED : 18/11/2017 DATE LOGGED : 18/11/2017 LOGGED BY : MG CHECKED BY :

CASING DIAMETER : HQ BARREL (Length) : 1.50 m BIT : BIT CONDITION :

DRILLING: PROGRESS (DRILLING & CASING; WATER); (CORE LOSS RUN %) DRILL DEPTH; SAMPLES & FIELD TESTS; DEPTH (m)

MATERIAL: GRAPHIC LOG; DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable); Weathering; ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)

FRACTURES: NATURAL FRACTURE (mm) (20, 40, 100, 300, 1000); VISUAL; ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other

Drilling & Casing	Water	Core Loss / Drill Depth	Samples & Field Tests	Depth (m)	Description	Weathering	Additional Data
				0.0 – 5.00			
NMLC	0% LOSS	0% LOSS		5.00m	START CORING AT 5.00m		
					Silty CLAY: Pale grey, with some red-brown ironstone gravel, high plasticity, dry, hard.		
		5.50 / 0% LOSS			From 5.5m, ironstone gravel is absent.		
				6.00m	SHALE: Grey, red-brown laminated.	XW	ALL DEFECTS ARE SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5°). 6.10: Clay SM 50mm. 6.15 6.30: Clay SM 50mm. 6.36 6.40
				6.60m	INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Grey and pale grey, sandstone is fine grained, distinctly laminated at 0-5°, some iron staining along defects.	HW	6.44: JT, 90 degrees, Cu, Infilled. 6.48 6.57 to 6.6: Clay SM 30mm. 6.67: Fe. 6.73: Fe.
		7.00 / 0% LOSS	Is(50) d=0.05 a=0.05 MPa	7.0			6.89: Fe, JT, 70 to 90 degrees, St, Infilled. 7.10 7.14 7.15 7.17: Clay SM. 7.21: Clay SM. 7.25 7.28
			Is(50) d=0.01 a=0.1 MPa	8.0	From 7.59 to 7.68, pale grey clay seam.		7.35: Clay, SM. 7.37

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH2
FILE / JOB NO : IA157700
SHEET : 3 OF 3

POSITION : E: 333351.6, N: 6248322.8 (MGA94 Zone 56) SURFACE ELEVATION : 26.37 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : PB

DATE STARTED : 18/11/2017 DATE COMPLETED : 18/11/2017 DATE LOGGED : 18/11/2017 LOGGED BY : MG CHECKED BY :

CASING DIAMETER : HQ BARREL (Length) : 1.50 m BIT : BIT CONDITION :

DRILLING & CASING	WATER	CORE LOSS (CORE RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	NATURAL FRACTURE (mm) (20 40 100 300 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	0% LOSS	0% LOSS		8.0		INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Grey and pale grey, sandstone is fine grained, distinctly laminated at 0-5°, some iron staining along defects. *(continued)*	HW				7.38 7.42, Clay SM 10mm. 7.47 7.52 7.55 7.59-7.63: Clay SM 40mm. 7.68 7.71 7.74 7.82 7.93 7.98 to 8.06: Fz. 8.06 8.10: Clay SM 40mm. 8.17 to 8.22: Clay SM 50mm. 8.22 8.27: Fe. 8.28: Fe. 8.33: Fe. 8.35 8.40: Fe.
		8.50	Is(50) d=0.04 a=0.09 MPa		8.50m	Hole Terminated at 8.50 m Target depth					
				9.0							
				10.0							
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

PointID : BH2 Depth Range: 5.00 - 8.50 m

JACOBS	CLIENT: Transport for NSW			
	PROJECT: Redfern Station Investigation			
	DRAWN: MG	DRAWING CHECK: MF	REVIEWED	APPROVED
	DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE: Core Photo - BH2		
SCALE: Not To Scale	DRAWING No: 1/1	REV

NON-CORE DRILL HOLE - GEOLOGICAL LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH3
FILE / JOB NO : IA157700
SHEET : 1 OF 3

POSITION : E: 333359.7, N: 6248314.2 (MGA94 Zone 56) | SURFACE ELEVATION : 26.48 (AHD) | ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC | MOUNTING : Track | CONTRACTOR : Terratest | DRILLER : PF

DATE STARTED : 19/11/2017 | DATE COMPLETED : 19/11/2017 | DATE LOGGED : 19/11/2017 | LOGGED BY : MG | CHECKED BY :

Drilling & Casing	Water	Drilling Penetration	Ground Water Levels	Samples & Field Tests	Depth (m)	Classification Symbol	Material Description (Soil Type, Colour, Plasticity or Particle Characteristic, Secondary and Minor Components)	Moisture Condition	Consistency / Relative Density	Structure & Other Observations
NDD				0.05m ES 0.15m; 0.30m ES 0.40m; 0.60m ES 0.70m	0.0–0.05		0.05m Asphaltic CONCRETE.			FILL
					0.05–0.40		FILL: Gravelly SAND: Brown and grey, fine to coarse grained sand gravel is fine to coarse, subangular to angular.	D		
				1.10m ES 1.20m	0.40–1.50		0.40m FILL: Silty CLAY: Orange-brown and red-brown, high plasticity with trace of sand and fine subangular gravel. At 0.6m, buried pavement, approximately 100mm thick, including asphalt over bricks.	M		0.80: Terracotta pipe at 0.8m depth, hole moved 0.5m.
AD/T, CASING		E	Not Observed	1.50m SPT 3,7,9 N=16. 1.95m; 3.00m SPT 9,16,10/50mm HB, N=R. 3.35m	1.50–4.80	CH	1.50m Silty CLAY: Red-brown and pale-grey, high plasticity with a trace of ironstone gravel.	M (to 2.5m); D	VSt (to 2.5m); H	RESIDUAL SOIL
					4.80		4.80m Continued as Cored Drill Hole			

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

HOLE NO : BH3
FILE / JOB NO : IA157700
SHEET : 2 OF 3

CLIENT : Transport for NSW
PROJECT : Redfern Station Investigation Works
LOCATION : Redfern, NSW

POSITION : E: 333359.7, N: 6248314.2 (MGA94 Zone 56) SURFACE ELEVATION : 26.48 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : PF

DATE STARTED : 19/11/2017 DATE COMPLETED : 19/11/2017 DATE LOGGED : 19/11/2017 LOGGED BY : MG CHECKED BY :

CASING DIAMETER : HQ BARREL (Length) : 1.50 m BIT : BIT CONDITION :

Drilling & Casing	Water	Core Loss (Core Run %) / Drill Depth	Samples & Field Tests	Depth (m)	Description (Rock type: Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable))	Weathering	Estimated Strength Is(50) (● Axial, ○ Diametral)	Natural Fracture (mm)	Additional Data (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0–4.80					
NMLC	0% LOSS	0% LOSS (4.80–6.20)		4.80m	START CORING AT 4.80m				ALL DEFECTS ARE SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5 degrees).
				4.80–6.35	Silty CLAY: Pale grey with a trace of red-brown staining, high plasticity, dry, hard.				
	0% LOSS	6.20; 0% LOSS (6.20–7.55)		6.35–6.80	Silty CLAY: Grey-brown, with red-brown ironstone laminae, high plasticity, dry, hard.				
				6.80–7.55	SHALE: Dark grey and pale grey, thinly laminated to laminated.	XW			6.8 to 7.15: Highly fractured, with iron staining in defects.
			Is(50) d=0 a=0.01 MPa				●		7.15; 7.25; 7.32; 7.45; 7.5
	0% LOSS	7.55; 0% LOSS		7.55–8.00	SHALE: Pale grey with iron staining. From 7.70m, colour is brown.				7.55 to 8.00: Clay SM.

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS 3.01.2 LIB.GLB Log IS AU CORED BOREHOLE 2 IA157700.GPJ <<DrawingFile>> 18/12/2017 09:33 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: Jacobs 3.01.2 2017-03-09 Prj: Jacobs 3.00.0 2016-07-17

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH3
FILE / JOB NO : IA157700
SHEET : 3 OF 3

POSITION : E: 333359.7, N: 6248314.2 (MGA94 Zone 56) SURFACE ELEVATION : 26.48 (AHD) ANGLE FROM HORIZONTAL : 90°
RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : PF
DATE STARTED : 19/11/2017 DATE COMPLETED : 19/11/2017 DATE LOGGED : 19/11/2017 LOGGED BY : MG CHECKED BY :
CASING DIAMETER : HQ BARREL (Length) : 1.50 m BIT : BIT CONDITION :

DRILLING & CASING	WATER	CORE LOSS (CORE RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL, VL, L, M, H, VH, EH; 0.03, 0.1, 0.3, 1, 3, 10)	NATURAL FRACTURE (mm) (20, 40, 100, 300, 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	0% LOSS	0% LOSS		8.0		SHALE: Dark grey and brown, thinly laminated to laminated.	HW				8.15 to 8.25: Clay SM. 8.25 to 8.30: Clay SM, orange brown. 8.3 to 8.54: Highly fractured. 8.64 8.84
		9.00	Is(50) d=0 a=0.04 MPa	9.0	9.00m			●			
						Hole Terminated at 9.00 m Target depth					
				10.0							
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

PointID : BH3 Depth Range: 4.80 - 9.00 m

JACOBS	CLIENT Transport for NSW			
	PROJECT Redfern Station Investigation			
	DRAWN MG	DRAWING CHECK MF	REVIEWED	APPROVED
	DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE Core Photo - BH3		
SCALE Not To Scale	DRAWING No 1/1	REV

NON-CORE DRILL HOLE - GEOLOGICAL LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH4
FILE / JOB NO : IA157700
SHEET : 1 OF 3

POSITION : E: 333412.4, N: 6248312.4 (MGA94 Zone 56) | SURFACE ELEVATION : 26.34 (AHD) | ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC | MOUNTING : Track | CONTRACTOR : Terratest | DRILLER : BM/PF

DATE STARTED : 11/11/2017 | DATE COMPLETED : 12/11/2017 | DATE LOGGED : 11/11/2017 | LOGGED BY : MG | CHECKED BY : MF

Drilling & Casing	Drilling Penetration	Ground Water Levels	Samples & Field Tests	Depth (m)	Classification Symbol	Material Description	Moisture Condition	Consistency / Relative Density	Structure & Other Observations
AD/T	E	Not Observed		0.0–0.20m		Asphaltic CONCRETE			FILL
NDD			0.40m ES 0.50m	0.20–0.50m		FILL: Gravelly CLAY: Brown, medium plasticity, gravel is fine to coarse, subangular to angular.	D		
			0.80m ES 0.90m	0.50–1.50m		FILL: Silty CLAY: Grey mottled red-brown, medium to high plasticity.			1.00: Possibly Residual Soil. 1.30: Platform height is 1.3m above rail ballast.
AD/T, CASING	E		1.50m SPT 8,11,25 N=36 1.95m	1.50m	CH	Silty CLAY: Grey and red-brown, high plasticity with ironstone gravel	D	H	RESIDUAL SOIL 1.80: SPT hammer bouncing from 1.8m
			2.50m D 2.70m						
	F		2.70m SPT 2,5,17 N=22 3.15m					VSt	2.70: Nearing TC-bit refusal on ironstone cobble
			3.30m D 3.50m						3.50: SPT unable to be performed due to hole cave-in
	H			4.40m		From 4.30m, becoming grey to dark grey		H	4.30: TC-bit refusal
						Continued as Cored Drill Hole			

Depth scale: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW	PROJECT : Redfern Station Investigation Works
LOCATION : Redfern, NSW	
HOLE NO : BH4	FILE / JOB NO : IA157700
SHEET : 2 OF 3	

POSITION : E: 333412.4, N: 6248312.4 (MGA94 Zone 56) SURFACE ELEVATION : 26.34 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : BM/PF

DATE STARTED : 11/11/2017 DATE COMPLETED : 12/11/2017 DATE LOGGED : 11/11/2017 LOGGED BY : MG CHECKED BY : MF

CASING DIAMETER : HQ BARREL (Length) : 0.80 m BIT : BIT CONDITION :

DRILLING

DRILLING & CASING	WATER	PROGRESS (CORE LOSS / RUN %)	DRILL DEPTH	SAMPLES & FIELD TESTS
NMLC	0% LOSS	0% LOSS	5.20	Is(50) d=0.1 a=0.07 MPa
NMLC	0% LOSS	0% LOSS	6.00	Is(50) d=0.13 a=0.06 MPa
NMLC	10% LOSS	0% LOSS	6.80	
NMLC	10% LOSS	0% LOSS	7.60	Is(50) d=0 a=0.08 MPa
NMLC	10% LOSS	0% LOSS		Is(50) d=0 a=0.11 MPa

MATERIAL

DESCRIPTION: ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)

Estimated strength $Is(50)$: ● - Axial, ○ - Diametral (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)

Natural fracture (mm): 20, 40, 100, 300, 1000

DEPTH (m)	DESCRIPTION	Weathering
4.40m	START CORING AT 4.40m	
4.40–4.55m	Silty CLAY: Grey, high plasticity, dry, very stiff.	
4.55–5.00m	SHALE: Dark grey, thinly laminated.	MW
5.00–5.20m	SHALE: Brown and grey, thinly laminated.	XW - HW
5.20–6.40m	SHALE: Dark grey, laminated with iron staining in defects.	MW
6.40m–	INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Dark grey and grey sandstone is fine grained, distinctly laminated at 0-5°.	MW; XW - HW (6.80); MW; XW (7.60); HW

FRACTURES

ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other

ALL DEFECTS ARE SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5°)

- 4.40 to 4.55: Clay SM, 150mm
- 4.70: JT, 90°, Pl, R
- 4.77
- 5.00
- 5.04: Clay SM, 30mm
- 5.07 to 5.12: FZ.
- 5.13: Clay SM, 20mm
- 5.17: Clay SM, 60mm
- 5.36: JT, 80°, Pl, Sr
- 5.40: Fe
- 5.54: JT, 70-80°, Pl, Sr
- 5.65
- 5.80 to 6.00: JT, 60-80°, Cu, R, Fe
- 5.90
- 6.13: Clay infill
- 6.17: JT, 20-30°, Pl, R, Fe
- 6.23
- 6.40: JT, 70°, Pl, R, Fe
- 6.45: Clay SM, 20mm
- 6.49: Fe
- 6.65 to 6.80: FZ.
- 6.82
- 6.86
- 6.89
- 6.95 to 7.09: Highly fractured.
- 7.38: Clay SM, 10mm
- 7.42: Clay SM, 40mm
- 7.52
- 7.55
- 7.60 to 7.72: Clay SM.
- 7.83: Clay infill
- 7.87: Clay infill

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

HOLE NO : BH4
FILE / JOB NO : IA157700
SHEET : 3 OF 3

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333412.4, N: 6248312.4 (MGA94 Zone 56) | SURFACE ELEVATION : 26.34 (AHD) | ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC | MOUNTING : Track | CONTRACTOR : Terratest | DRILLER : BM/PF

DATE STARTED : 11/11/2017 | DATE COMPLETED : 12/11/2017 | DATE LOGGED : 11/11/2017 | LOGGED BY : MG | CHECKED BY : MF

CASING DIAMETER : HQ | BARREL (Length) : 0.80 m | BIT : | BIT CONDITION :

DRILLING: PROGRESS – DRILLING & CASING	WATER	CORE LOSS (RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	MATERIAL: DESCRIPTION – ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	FRACTURES: ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	10% LOSS	0% LOSS; 8.40		8.0	INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Dark grey and grey sandstone is fine grained, distinctly laminated at 0-5°. *(continued)*	HW	7.92; 7.96; 8.07; 8.14: JT, 70°, Pl, Sr, Fe; 8.27: Clay infill; 8.34: Clay SM, 10mm
	10% LOSS	0% LOSS; 9.20	Is(50) d=0.11 a=0.19 MPa	9.0			8.54: Clay infill; 8.57; 8.64: Clay SM, 15mm; 8.76; 8.82: Clay SM, 20mm; 8.88: Clay SM, 10mm; 8.93: Clay SM, 10mm; 8.98; 9.08: Clay SM, 30mm; 9.17: JT, 80-90°, Pl, R
	10% LOSS	0% LOSS; 10.00	Is(50) d=0.2 a=0.05 MPa		10.00m		9.25: Clay SM, 10mm; 9.29; 9.34: Clay SM, 20mm; 9.43: Clay SM, 10mm; 9.49: Clay SM, 10mm; 9.54; 9.75: Clay SM, 10mm; 9.77: Clay SM, 10mm; 9.88: Clay SM, 10mm; 9.95
				10.0	Hole Terminated at 10.00 m Target depth		
				11.0			
				12.0			
				13.0			
				14.0			
				15.0			
				16.0			

ESTIMATED STRENGTH Is(50): ● - Axial, ○ - Diametral; EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH

NATURAL FRACTURE (mm): 20 40 100 300 1000

VISUAL

GRAPHIC LOG

See Explanatory Notes for details of abbreviations & basis of descriptions.

PointID : BH4 Depth Range: 4.40 - 10.00 m

JACOBS	CLIENT Transport for NSW			
	PROJECT Redfern Station Investigation			
	DRAWN MG	DRAWING CHECK MF	REVIEWED	APPROVED
	DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE Core Photo - BH4		
SCALE Not To Scale	DRAWING No 1/1	REV

NON-CORE DRILL HOLE - GEOLOGICAL LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH5
FILE / JOB NO : IA157700
SHEET : 1 OF 3

POSITION : E: 333481.4, N: 6248345.8 (MGA94 Zone 56) SURFACE ELEVATION : 24.03 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Commachio 205 MOUNTING : Track CONTRACTOR : Terratest DRILLER : AZ

DATE STARTED : 28/11/2017 DATE COMPLETED : 28/11/2017 DATE LOGGED : 28/11/2017 LOGGED BY : MG CHECKED BY :

DRILLING & CASING	WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION (Soil Type, Colour, Plasticity or Particle Characteristic; Secondary and Minor Components)	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
AD/T — CASING (0.0–3.20m)		E	Not Observed	ES 0.10m; 0.50m SPT 3,2,3 N=5 0.95m	0.0		FILL: Sandy Gravelly CLAY: Brown and red-brown, low to medium plasticity, gravel is fine to medium. From 0.5m, coal layer (100mm).	M		FILL
					0.60m		FILL: Silty Sandy CLAY: Brown and red-brown, medium to high plasticity, sand is fine to coarse grained, with a trace of siltstone lenses.			
				1.30m D 1.50m; SPT 4,2,7 N=9 1.95m	1.30m	CH	Silty CLAY: Grey and orange-brown, high plasticity, with some siltstone lenses.		St - VSt	RESIDUAL SOIL
		F		2.80m D 3.00m; SPT 10/50mm, HB N=R 3.05m	2.60m		SHALE: Grey, highly weathered, very low strength.			BEDROCK
					3.20m		Continued as Cored Drill Hole			

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

HOLE NO : BH5
FILE / JOB NO : IA157700
SHEET : 2 OF 3

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333481.4, N: 6248345.8 (MGA94 Zone 56)
SURFACE ELEVATION : 24.03 (AHD)
ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Commachio 205
MOUNTING : Track
CONTRACTOR : Terratest
DRILLER : AZ

DATE STARTED : 28/11/2017
DATE COMPLETED : 28/11/2017
DATE LOGGED : 28/11/2017
LOGGED BY : MG
CHECKED BY :

CASING DIAMETER : HQ
BARREL (Length) : 3.00 m
BIT :
BIT CONDITION :

DRILLING: PROGRESS (DRILLING & CASING, WATER), (CORE LOSS RUN %) DRILL DEPTH, SAMPLES & FIELD TESTS, DEPTH (m)

MATERIAL: GRAPHIC LOG, DESCRIPTION (ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)), Weathering, ESTIMATED STRENGTH Is(50) (● - Axial, ○ - Diametral; EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)

FRACTURES: NATURAL FRACTURE (mm) (20, 40, 100, 300, 1000), VISUAL, ADDITIONAL DATA ((joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other)

Depth (m)	Drilling & Casing	Water	Core Loss / Drill Depth	Samples & Field Tests	Description	Weathering	Additional Data
3.20	NMLC	0% LOSS (to 4.40)	0% LOSS		3.20m START CORING AT 3.20m INTERLAMINATED SILTSTONE & SANDSTONE (65% siltstone 35% sandstone): Dark grey, sandstone is pale grey and fine grained, with some iron staining in defects, distinctly laminated at 0-5°.	MW	~~ALL DEFECTS ARE~~ SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5°) 3.20 to 3.28: Clay SM 3.30 3.35 3.41 3.48 to 3.84: Highly fractured with iron. 3.93
4.0				Is(50) d=0.01 a=0.23 MPa			4.10
4.40		10% LOSS (4.40 to 7.40)	4.40 0% LOSS			MW - SW	4.22 to 4.52: Highly fractured. 4.59 to 4.84: Highly fractured. 4.89
5.0					From 5.50m, increasing in sandstone, 40-50%.		5.13 5.23 to 5.50: Highly fractured. 5.54 5.67 5.70 to 5.77: Pale grey. 5.88 5.95
6.0				Is(50) d=0.31 a=1.02 MPa Is(50) d=0.02 a=0.26 MPa			6.08 6.13 6.17 to 7.61: St, 80°, Pl, R, Fe (No Fe from 6.86m). 6.33 6.42 6.44 6.53 6.58 6.68 6.69
7.0					From 6.86m, iron absent in defects.	SW	6.72 6.76 6.84 6.87: St. 6.91, St. 6.93 6.96
7.40		90% LOSS (7.40 to 8.00)	7.40 0% LOSS	Is(50) d=0.08 a=0.19 MPa			7.10: St. 7.16 7.23 7.31 7.5 7.54 7.61
8.0					8.00m		

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH5
FILE / JOB NO : IA157700
SHEET : 3 OF 3

POSITION : E: 333481.4, N: 6248345.8 (MGA94 Zone 56) | SURFACE ELEVATION : 24.03 (AHD) | ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Commachio 205 | MOUNTING : Track | CONTRACTOR : Terratest | DRILLER : AZ

DATE STARTED : 28/11/2017 | DATE COMPLETED : 28/11/2017 | DATE LOGGED : 28/11/2017 | LOGGED BY : MG | CHECKED BY :

CASING DIAMETER : HQ | BARREL (Length) : 3.00 m | BIT : | BIT CONDITION :

DRILLING & CASING	WATER	(CORE LOSS RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	90% LOSS	0% LOSS		8.0	INTERLAMINATED SILTSTONE & SANDSTONE (55% siltstone 45% sandstone): Dark grey, sandstone is pale grey and fine grained, distinctly laminated at 0-5°.	SW	7.65 7.75 7.84 to 7.92: JT, Pl, 80°, SR. 8.03 8.11 8.23: Clay SM 5mm. 8.25: Clay SM 5mm. 8.37 8.50 8.61: Clay SM 10mm. 8.82 8.87
			Is(50) d=0.26 a=2.09 MPa	9.0	From 9.10m, decreasing in sandstone (30%).	SW - FR	9.04 9.10 9.16 9.28
			Is(50) d=0.26 a=2.24 MPa				
		10.40	Is(50) d=0.25 a=1 MPa	10.0	10.40m		
					Hole Terminated at 10.40 m Target depth		
				11.0			
				12.0			
				13.0			
				14.0			
				15.0			
				16.0			

ESTIMATED STRENGTH Is(50): ● - Axial, ○ - Diametral; EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH

NATURAL FRACTURE (mm): 20, 40, 100, 300, 1000

See Explanatory Notes for details of abbreviations & basis of descriptions.

PointID : BH5 Depth Range: 3.20 - 10.40 m

JACOBS	CLIENT: Transport for NSW				TITLE: Core Photo - BH5
	PROJECT: Redfern Station Investigation				
	DRAWN: MG	DRAWING CHECK: MF	REVIEWED	APPROVED	SCALE: Not To Scale
	DESIGNED	DESIGN REVIEW	DATE	DATE	DRAWING No: 1/1
					REV

JACOBS

NON-CORE DRILL HOLE - GEOLOGICAL LOG

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH6
FILE / JOB NO : IA157700
SHEET : 1 OF 3

POSITION : E: 333452.6, N: 6248279.5 (MGA94 Zone 56) | SURFACE ELEVATION : 25.14 (AHD) | ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hanjin DB8 | MOUNTING : Track | CONTRACTOR : Terratest | DRILLER : BM

DATE STARTED : 07/11/2017 | DATE COMPLETED : 07/11/2017 | DATE LOGGED : 07/11/2017 | LOGGED BY : MG | CHECKED BY : MF

DRILLING: PROGRESS – DRILLING & CASING	WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	MATERIAL: CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION (Soil Type, Colour, Plasticity or Particle Characteristic, Secondary and Minor Components)	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
NDD (0.0–1.0)		E	Not Observed		0.0–0.20m		Asphaltic CONCRETE			FILL
				0.20m ES 0.30m; 0.60m ES 0.70m	0.20–1.00m		FILL: Sandy Clayey GRAVEL: Dark grey and brown, fine to coarse, subanagular to subrounded. At 0.4m, some broken bricks. At 0.6m, some shale cobbles and boulders up to 300mm.	D		
AD/V – CASING (1.0–5.50)		E (to 3.70)		1.00m SPT 3,6,7 N=13 1.45m; 2.50m SPT 8,21,11/90mm HB, N=R 2.89m; 3.80m D 4.00m	1.00–4.50m	CH	Silty CLAY: Grey mottled red-brown, high plasticity. At 2.5m, as above, with some orange-brown mottling.	D	St (1.0–2.0); VSt (2.0–4.50)	RESIDUAL SOIL. 1.20: Hole collapse prior to SPT. 2.50: Hole collapse prior to SPT. 2.80: SPT bouncing on lense of dark grey shale. 3.70: Increased drilling resistance. 4.00: SPT unable to be performed due to hole cave-in.
		F (3.70–5.50)		5.30m D 5.50m	4.50–5.50m		SHALE: Dark grey, extremely weathered, extremely low strength, remoulds to silty clay.			WEATHERED ROCK
					5.50m		Continued as Cored Drill Hole			5.50: SPT bouncing when attempted.

Depth scale: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS

CORED DRILL HOLE LOG

HOLE NO : BH6
FILE / JOB NO : IA157700
SHEET : 2 OF 3

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333452.6, N: 6248279.5 (MGA94 Zone 56) SURFACE ELEVATION : 25.14 (AHD) ANGLE FROM HORIZONTAL : 90°
RIG TYPE : Hanjin DB8 MOUNTING : Track CONTRACTOR : Terratest DRILLER : BM
DATE STARTED : 07/11/2017 DATE COMPLETED : 07/11/2017 DATE LOGGED : 07/11/2017 LOGGED BY : MG CHECKED BY : MF
CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : BIT CONDITION :

DRILLING & CASING	WATER	CORE LOSS (CORE RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	NATURAL FRACTURE (mm) (20, 40, 100, 300, 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0 – 5.50		5.50m START CORING AT 5.50m					
NMLC	5% Water LOSS	20% LOSS		5.50–5.80		CORE LOSS 0.30m (5.50-5.80)					~~ALL DEFECTS ARE~~ SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5°)
			Is(50) d=0.27 a=0.36 MPa	5.80–8.00		5.80m INTERLAMINATED SILTSTONE & SANDSTONE (70% siltstone 30% sandstone): Dark grey and pale grey, sandstone is fine grained, distinctly laminated at 0-10°, some iron staining along defects.	SW				5.80 5.95 6.05 6.25: JT, 70°, Fe, Pl, R 6.36 6.63: Fe 6.75: Fe 6.83: SM, 10mm, Fe, Pl, R 6.85: SM, 5mm, Fe, Pl, R 6.9: 15°
		7.00	Is(50) d=0.45 a=0.55 MPa	7.0							
	5% Water LOSS	0% LOSS									7.26 7.27 7.28: SM, 10mm, Fe 7.36 7.58
			Is(50) d=0.16 a=0.43 MPa	8.0		At 7.75m, sandstone section 100mm, grey, high strength. 8.00m					

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS 3.01.2 LIB.GLB Log IS AU CORED BOREHOLE 2 IA157700.GPJ <<DrawingFile>> 18/12/2017 09:34 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: Jacobs 3.01.2 2017-03-09 Prj: Jacobs 3.00.0 2016-07-17

JACOBS

CORED DRILL HOLE LOG

HOLE NO : BH6
FILE / JOB NO : IA157700
SHEET : 3 OF 3

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333452.6, N: 6248279.5 (MGA94 Zone 56) SURFACE ELEVATION : 25.14 (AHD) ANGLE FROM HORIZONTAL : 90°
RIG TYPE : Hanjin DB8 MOUNTING : Track CONTRACTOR : Terratest DRILLER : BM
DATE STARTED : 07/11/2017 DATE COMPLETED : 07/11/2017 DATE LOGGED : 07/11/2017 LOGGED BY : MG CHECKED BY : MF
CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : BIT CONDITION :

DRILLING & CASING	WATER	(CORE LOSS RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	5% Water Loss	0% LOSS		8.0		INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Dark grey and pale grey, sandstone is fine grained, distinctly laminated at 0-10°, some iron staining along defects.	SW	8.08: SM, 10mm; 8.22; 8.25; 8.33: JT, 30-40°, ST, R; 8.47: JT, 80-90°, Wa, R; 8.57; 8.7; 8.75; 8.76; 8.93: SM, 10mm, Pl, R
			Is(50) d=0.6 a=0.12 MPa	9.0				9.12; 9.45; 9.61: SM, 5mm, Pl, R; 9.82: St.
		9.90	Is(50) d=0.13 a=0.99 MPa		9.90m			
				10.0		Hole Terminated at 9.90 m Target depth		
				11.0				
				12.0				
				13.0				
				14.0				
				15.0				
				16.0				

ESTIMATED STRENGTH Is(50): ● - Axial ○ - Diametral; EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH

NATURAL FRACTURE (mm): 20 40 100 300 1000

VISUAL

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS 3.01.2 LIB.GLB Log IS AU CORED BOREHOLE 2 IA157700.GPJ <<DrawingFile>> 18/12/2017 09:34 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: Jacobs 3.01.2 2017-03-09 Prj: Jacobs 3.00.0 2016-07-17

PointID : BH6 Depth Range: 5.50 - 9.90 m

JACOBS

CLIENT	Transport for NSW		
PROJECT	Redfern Station Investigation		
DRAWN MG	DRAWING CHECK MF	REVIEWED	APPROVED
DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE	Core Photo - BH6	
SCALE Not To Scale	DRAWING No 1/1	REV

Appendix C. Laboratory certificates

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 179707

Client Details

Client	Jacobs Group (Australia) Pty Ltd
Attention	Michael Stacey
Address	Level 7, 177 Pacific Highway, North Sydney, NSW, 2060

Sample Details

Your Reference	**IA157700**
Number of Samples	5 Soil
Date samples received	13/11/2017
Date completed instructions received	13/11/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	20/11/2017
Date of Issue	17/11/2017

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Asbestos Approved By
Analysed by Asbestos Approved Identifier: Lucy Zhu
Authorised by Asbestos Approved Signatory: Paul Ching

Results Approved By
Dragana Tomas, Senior Chemist
Long Pham, Team Leader, Metals
Nick Sarlamis, Inorganics Supervisor
Paul Ching, Senior Analyst
Steven Luong, Senior Chemist

Authorised By

David Springer, General Manager

vTRH(C6-C10)/BTEXN in Soil				
Our Reference		179707-1	179707-3	179707-5
Your Reference	UNITS	BH4 - 0.4	BH4 - 1.5	BH6 - 0.6
Date Sampled		11/11/2017	11/11/2017	07/11/2017
Type of sample		Soil	Soil	Soil
Date extracted	-	14/11/2017	14/11/2017	14/11/2017
Date analysed	-	15/11/2017	15/11/2017	15/11/2017
TRH C_6 - C_9	mg/kg	<25	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1
Total +ve Xylenes	mg/kg	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	83	85	85

svTRH (C10-C40) in Soil				
Our Reference		179707-1	179707-3	179707-5
Your Reference	UNITS	BH4 - 0.4	BH4 - 1.5	BH6 - 0.6
Date Sampled		11/11/2017	11/11/2017	07/11/2017
Type of sample		Soil	Soil	Soil
Date extracted	-	14/11/2017	14/11/2017	14/11/2017
Date analysed	-	15/11/2017	15/11/2017	15/11/2017
TRH C_{10} - C_{14}	mg/kg	<50	<50	<50
TRH C_{15} - C_{28}	mg/kg	<100	<100	<100
TRH C_{29} - C_{36}	mg/kg	<100	160	<100
TRH >C_{10} -C_{16}	mg/kg	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50	<50	<50
TRH >C_{16} -C_{34}	mg/kg	<100	130	<100
TRH >C_{34} -C_{40}	mg/kg	<100	100	<100
Total +ve TRH (>C10-C40)	mg/kg	<50	240	<50
Surrogate o-Terphenyl	%	77	78	77

PAHs in Soil				
Our Reference		179707-1	179707-3	179707-5
Your Reference	UNITS	BH4 - 0.4	BH4 - 1.5	BH6 - 0.6
Date Sampled		11/11/2017	11/11/2017	07/11/2017
Type of sample		Soil	Soil	Soil
Date extracted	-	14/11/2017	14/11/2017	14/11/2017
Date analysed	-	14/11/2017	14/11/2017	14/11/2017
Naphthalene	mg/kg	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	<0.1	<0.1	<0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	<0.1	<0.1	<0.1
Pyrene	mg/kg	<0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	<0.1	<0.1	<0.1
Chrysene	mg/kg	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	<0.2	<0.2
Benzo(a)pyrene	mg/kg	<0.05	<0.05	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	<0.1
Total +ve PAH's	mg/kg	<0.05	<0.05	<0.05
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5
Surrogate p-Terphenyl-d14	%	87	95	90

Organochlorine Pesticides in soil				
Our Reference		179707-1	179707-3	179707-5
Your Reference	UNITS	BH4 - 0.4	BH4 - 1.5	BH6 - 0.6
Date Sampled		11/11/2017	11/11/2017	07/11/2017
Type of sample		Soil	Soil	Soil
Date extracted	-	14/11/2017	14/11/2017	14/11/2017
Date analysed	-	14/11/2017	14/11/2017	14/11/2017
HCB	mg/kg	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1	<0.1
Surrogate TCMX	%	94	90	91

PCBs in Soil				
Our Reference	UNITS	179707-1	179707-3	179707-5
Your Reference		BH4 - 0.4	BH4 - 1.5	BH6 - 0.6
Date Sampled		11/11/2017	11/11/2017	07/11/2017
Type of sample		Soil	Soil	Soil
Date extracted	-	14/11/2017	14/11/2017	14/11/2017
Date analysed	-	14/11/2017	14/11/2017	14/11/2017
Aroclor 1016	mg/kg	<0.1	<0.1	<0.1
Aroclor 1221	mg/kg	<0.1	<0.1	<0.1
Aroclor 1232	mg/kg	<0.1	<0.1	<0.1
Aroclor 1242	mg/kg	<0.1	<0.1	<0.1
Aroclor 1248	mg/kg	<0.1	<0.1	<0.1
Aroclor 1254	mg/kg	<0.1	<0.1	<0.1
Aroclor 1260	mg/kg	<0.1	<0.1	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1	<0.1	<0.1
Surrogate TCLMX	%	94	90	91

Acid Extractable metals in soil				
Our Reference		179707-1	179707-3	179707-5
Your Reference	UNITS	BH4 - 0.4	BH4 - 1.5	BH6 - 0.6
Date Sampled		11/11/2017	11/11/2017	07/11/2017
Type of sample		Soil	Soil	Soil
Date prepared	-	14/11/2017	14/11/2017	14/11/2017
Date analysed	-	14/11/2017	14/11/2017	14/11/2017
Arsenic	mg/kg	8	<4	6
Cadmium	mg/kg	<0.4	<0.4	<0.4
Chromium	mg/kg	8	5	7
Copper	mg/kg	14	<1	35
Lead	mg/kg	31	8	21
Mercury	mg/kg	0.2	<0.1	<0.1
Nickel	mg/kg	1	<1	9
Zinc	mg/kg	13	220	37

Clay 50-120g		
Our Reference		179707-3
Your Reference	UNITS	BH4 - 1.5
Date Sampled		11/11/2017
Type of sample		Soil
Date prepared	-	14/11/2017
Date analysed	-	17/11/2017
Clay in soils <2µm	% (w/w)	54

Misc Inorg - Soil		
Our Reference		179707-3
Your Reference	UNITS	BH4 - 1.5
Date Sampled		11/11/2017
Type of sample		Soil
Date prepared	-	15/11/2017
Date analysed	-	15/11/2017
pH 1:5 soil:water	pH Units	5.5

CEC		
Our Reference		179707-3
Your Reference	UNITS	BH4 - 1.5
Date Sampled		11/11/2017
Type of sample		Soil
Date prepared	-	15/11/2017
Date analysed	-	15/11/2017
Exchangeable Ca	meq/100g	0.3
Exchangeable K	meq/100g	0.2
Exchangeable Mg	meq/100g	1.2
Exchangeable Na	meq/100g	0.26
Cation Exchange Capacity	meq/100g	2.0

Moisture				
Our Reference		179707-1	179707-3	179707-5
Your Reference	UNITS	BH4 - 0.4	BH4 - 1.5	BH6 - 0.6
Date Sampled		11/11/2017	11/11/2017	07/11/2017
Type of sample		Soil	Soil	Soil
Date prepared	-	14/11/2017	14/11/2017	14/11/2017
Date analysed	-	15/11/2017	15/11/2017	15/11/2017
Moisture	%	12	22	10

Asbestos ID - soils				
Our Reference		179707-1	179707-3	179707-5
Your Reference	UNITS	BH4 - 0.4	BH4 - 1.5	BH6 - 0.6
Date Sampled		11/11/2017	11/11/2017	07/11/2017
Type of sample		Soil	Soil	Soil
Date analysed	-	17/11/2017	17/11/2017	17/11/2017
Sample mass tested	g	Approx. 30g	Approx. 30g	Approx. 55g
Sample Description	-	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected

Method ID	Methodology Summary
AS1289.3.6.3	Determination Particle Size Analysis using AS1289.3.6.3 and AS1289.3.6.1 and in house method INORG-107. Clay fraction at <2µm reported.
ASB-001	Asbestos ID - Qualitative identification of asbestos in bulk samples using Polarised Light Microscopy and Dispersion Staining Techniques including Synthetic Mineral Fibre and Organic Fibre as per Australian Standard 4964-2004.
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
Metals-009	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's. Note, the Total +ve reported DDD+DDE+DDT PQL is reflective of the lowest individual PQL and is therefore simply a sum of the positive individually report DDD+DDE+DDT.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD. Note, the Total +ve PCBs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PCBs" is simply a sum of the positive individual PCBs.

Method ID	Methodology Summary
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013. For soil results:- 1. ‘EQ PQL’values are assuming all contributing PAHs reported as <PQL are actually at the PQL. This is the most conservative approach and can give false positive TEQs given that PAHs that contribute to the TEQ calculation may not be present. 2. ‘EQ zero’values are assuming all contributing PAHs reported as <PQL are zero. This is the least conservative approach and is more susceptible to false negative TEQs when PAHs that contribute to the TEQ calculation are present but below PQL. 3. ‘EQ half PQL’values are assuming all contributing PAHs reported as <PQL are half the stipulated PQL. Hence a mid-point between the most and least conservative approaches above. Note, the Total +ve PAHs PQL is reflective of the lowest individual PQL and is therefore "Total +ve PAHs" is simply a sum of the positive individual PAHs.
Org-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date extracted	-			14/11/2017	[NT]	[NT]	[NT]	[NT]	14/11/2017	[NT]
Date analysed	-			15/11/2017	[NT]	[NT]	[NT]	[NT]	15/11/2017	[NT]
TRH C_6 - C_9	mg/kg	25	Org-016	<25	[NT]	[NT]	[NT]	[NT]	88	[NT]
TRH C_6 - C_{10}	mg/kg	25	Org-016	<25	[NT]	[NT]	[NT]	[NT]	88	[NT]
Benzene	mg/kg	0.2	Org-016	<0.2	[NT]	[NT]	[NT]	[NT]	81	[NT]
Toluene	mg/kg	0.5	Org-016	<0.5	[NT]	[NT]	[NT]	[NT]	88	[NT]
Ethylbenzene	mg/kg	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	89	[NT]
m+p-xylene	mg/kg	2	Org-016	<2	[NT]	[NT]	[NT]	[NT]	90	[NT]
o-Xylene	mg/kg	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	88	[NT]
naphthalene	mg/kg	1	Org-014	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-016	92	[NT]	[NT]	[NT]	[NT]	91	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date extracted	-			14/11/2017	[NT]	[NT]	[NT]	[NT]	14/11/2017	[NT]
Date analysed	-			15/11/2017	[NT]	[NT]	[NT]	[NT]	15/11/2017	[NT]
TRH C_{10} - C_{14}	mg/kg	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	95	[NT]
TRH C_{15} - C_{28}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	97	[NT]
TRH C_{29} - C_{36}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	91	[NT]
TRH $>C_{10}$ -C_{16}	mg/kg	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	95	[NT]
TRH $>C_{16}$ -C_{34}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	97	[NT]
TRH $>C_{34}$ -C_{40}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	91	[NT]
Surrogate o-Terphenyl	%		Org-003	78	[NT]	[NT]	[NT]	[NT]	86	[NT]

QUALITY CONTROL: PAHs in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date extracted	-			14/11/2017	[NT]	[NT]	[NT]	[NT]	14/11/2017	[NT]
Date analysed	-			14/11/2017	[NT]	[NT]	[NT]	[NT]	14/11/2017	[NT]
Naphthalene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	85	[NT]
Acenaphthylene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Acenaphthene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluorene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	89	[NT]
Phenanthrene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	84	[NT]
Anthracene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluoranthene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	78	[NT]
Pyrene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	82	[NT]
Benzo(a)anthracene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chrysene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	93	[NT]
Benzo(b,j+k)fluoranthene	mg/kg	0.2	Org-012	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(a)pyrene	mg/kg	0.05	Org-012	<0.05	[NT]	[NT]	[NT]	[NT]	88	[NT]
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	90	[NT]	[NT]	[NT]	[NT]	118	[NT]

QUALITY CONTROL: Organochlorine Pesticides in soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date extracted	-			14/11/2017	[NT]	[NT]	[NT]	[NT]	14/11/2017	[NT]
Date analysed	-			14/11/2017	[NT]	[NT]	[NT]	[NT]	14/11/2017	[NT]
HCB	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	88	[NT]
gamma-BHC	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
beta-BHC	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	85	[NT]
Heptachlor	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	76	[NT]
delta-BHC	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aldrin	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	73	[NT]
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	74	[NT]
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
pp-DDE	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	76	[NT]
Dieldrin	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	81	[NT]
Endrin	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	73	[NT]
pp-DDD	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	79	[NT]
Endosulfan II	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
pp-DDT	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	78	[NT]
Methoxychlor	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate TCMX	%		Org-005	85	[NT]	[NT]	[NT]	[NT]	99	[NT]

QUALITY CONTROL: PCBs in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date extracted	-			14/11/2017	[NT]	[NT]	[NT]	[NT]	14/11/2017	[NT]
Date analysed	-			14/11/2017	[NT]	[NT]	[NT]	[NT]	14/11/2017	[NT]
Aroclor 1016	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aroclor 1221	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aroclor 1232	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aroclor 1242	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aroclor 1248	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aroclor 1254	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	124	[NT]
Aroclor 1260	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate TCLMX	%		Org-006	85	[NT]	[NT]	[NT]	[NT]	101	[NT]

QUALITY CONTROL: Acid Extractable metals in soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date prepared	-			14/11/2017	[NT]	[NT]	[NT]	[NT]	14/11/2017	[NT]
Date analysed	-			14/11/2017	[NT]	[NT]	[NT]	[NT]	14/11/2017	[NT]
Arsenic	mg/kg	4	Metals-020	<4	[NT]	[NT]	[NT]	[NT]	118	[NT]
Cadmium	mg/kg	0.4	Metals-020	<0.4	[NT]	[NT]	[NT]	[NT]	108	[NT]
Chromium	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	117	[NT]
Copper	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	114	[NT]
Lead	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	109	[NT]
Mercury	mg/kg	0.1	Metals-021	<0.1	[NT]	[NT]	[NT]	[NT]	103	[NT]
Nickel	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	108	[NT]
Zinc	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	112	[NT]

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date prepared	-			15/11/2017	[NT]	[NT]	[NT]	[NT]	15/11/2017	[NT]
Date analysed	-			15/11/2017	[NT]	[NT]	[NT]	[NT]	15/11/2017	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]

QUALITY CONTROL: CEC					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			15/11/2017	[NT]	[NT]	[NT]	[NT]	15/11/2017	[NT]
Date analysed	-			15/11/2017	[NT]	[NT]	[NT]	[NT]	15/11/2017	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	102	[NT]
Exchangeable K	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	109	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Exchangeable Na	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	102	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

Asbestos: A portion of the supplied sample was sub-sampled for asbestos analysis according to Envirolab procedures.
We cannot guarantee that this sub-sample is indicative of the entire sample. Envirolab recommends supplying
40-50g of sample in its own container.
Note: Samples 179707-1, 3, 5 were sub-sampled from jars provided by the client.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details	
Client	Jacobs Group (Australia) Pty Ltd
Attention	Michael Stacey

Sample Login Details	
Your reference	IA157700
Envirolab Reference	179707
Date Sample Received	13/11/2017
Date Instructions Received	13/11/2017
Date Results Expected to be Reported	20/11/2017

Sample Condition	
Samples received in appropriate condition for analysis	YES
No. of Samples Provided	5 Soil
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	9.3
Cooling Method	Ice
Sampling Date Provided	YES

Comments
Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
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www.envirolab.com.au

Sample ID	vTRH(C6-C10)/BTEXN in Soil	svTRH (C10-C40) in Soil	PAHs in Soil	Organochlorine Pesticidesin soil	PCBsin Soil	Acid Extractable metalsin soil	Clay 50-120g	pH1:5 soil:water	CEC	Asbestos ID - soils	On Hold
BH4 - 0.4	✓	✓	✓	✓	✓	✓				✓	
BH4 - 0.8											✓
BH4 - 1.5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
BH6 - 0.2											✓
BH6 - 0.6	✓	✓	✓	✓	✓	✓				✓	

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info
Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.

COC 13/11

ENVIROLAB GROUP

CHAIN OF CUSTODY - Client

22526

ENVIROLAB GROUP - National Phone number 1300 42 43 44

Sydney Lab - Envirolab Services
12 Ashley St, Chatswood, NSW 2067
Ph 02 9910 6200 / sydney@envirolab.com.au

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7 Palmerton Road Windsor Gardens, SA 5087
Ph 0406 350 706 / adelaide@envirolab.com.au

Client: Jacobs
Contact Person: Michael Stacey
Project Mgr:
Sampler: Michael Grasso
Address: 177 Pacific Hwy North Sydney 2060
Phone: 9032 1467 **Mob:** 0406 861835
Fax:
Email: michael.stacey@jacobs.com

Client Project Name / Number / Site etc (ie report title): IA157700
PO No.:
Envirolab Quote No. :
Date results required:
Or choose: standard / same day / 1 day / 2 day / 3 day
Note: Inform lab in advance if urgent turnaround is required - surcharges apply
Lab comments:

Envirolab Sample ID	Client Sample ID or information	Depth	Date sampled	Type of sample	Comb. SA	PH, CEC, % clay	Comments (Provide as much information about the sample as you can)
1	BH4-0.4		11-11-17		/		
2	BH4-0.8		11-11-17				HOLD
3	BH4-1.5		11-11-17		/	/	
4	BH6-0.2		7-11-17				HOLD
5	BH6-0.6		7-11-17		/		
					/		
				Soil			

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 179707
Date Received: 13.11.17
Time Received: 11:00
Received by: JE
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by (company): Jacobs
Print Name: MICHAEL STACEY
Date & Time: 13-11-17 14:45
Signature:

Received by (company): ELS
Print Name: JE
Date & Time: 13.11.17 11:00
Signature:

Lab use only:
Samples Received: Cool or Ambient (circle one)
Temperature Received at: 9.3°C **(if applicable)**
Transported by: Hand delivered / courier

White - Lab copy / Blue - Client copy / Pink - Retain in Book

Page No:

Envirolab Services Pty Ltd
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CERTIFICATE OF ANALYSIS 180317

Client Details

Client	Jacobs Group (Australia) Pty Ltd
Attention	Michael Stacey
Address	Level 7, 177 Pacific Highway, North Sydney, NSW, 2060

Sample Details

Your Reference	**IA157700**
Number of Samples	13 Soil
Date samples received	21/11/2017
Date completed instructions received	21/11/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	28/11/2017
Date of Issue	28/11/2017

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Asbestos Approved By
Analysed by Asbestos Approved Identifier: Matt Tang
Authorised by Asbestos Approved Signatory: Paul Ching

Results Approved By
Dragana Tomas, Senior Chemist
Long Pham, Team Leader, Metals
Nick Sarlamis, Inorganics Supervisor
Paul Ching, Senior Analyst
Priya Samarawickrama, Senior Chemist
Steven Luong, Senior Chemist

Authorised By

David Springer, General Manager

vTRH(C6-C10)/BTEXN in Soil						
Our Reference		180317-1	180317-2	180317-5	180317-6	180317-9
Your Reference	UNITS	BH1	BH1	BH2	BH2	BH3
Depth		0.0-0.1	0.3-0.4	0.8-0.9	1.0-1.1	0.6-0.7
Date Sampled		18/11/2017	18/11/2017	18/11/2017	18/11/2017	18/11/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	23/11/2017	23/11/2017	23/11/2017	23/11/2017	23/11/2017
Date analysed	-	24/11/2017	24/11/2017	24/11/2017	24/11/2017	24/11/2017
TRH C_6 - C_9	mg/kg	<25	<25	<25	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	<25	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1	<1	<1
Total +ve Xylenes	mg/kg	<1	<1	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	128	118	118	114	114

vTRH(C6-C10)/BTEXN in Soil		
Our Reference		180317-10
Your Reference	UNITS	BH3
Depth		1.1-1.2
Date Sampled		18/11/2017
Type of sample		Soil
Date extracted	-	23/11/2017
Date analysed	-	24/11/2017
TRH C_6 - C_9	mg/kg	<25
TRH C_6 - C_{10}	mg/kg	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25
Benzene	mg/kg	<0.2
Toluene	mg/kg	<0.5
Ethylbenzene	mg/kg	<1
m+p-xylene	mg/kg	<2
o-Xylene	mg/kg	<1
naphthalene	mg/kg	<1
Total +ve Xylenes	mg/kg	<1
Surrogate aaa-Trifluorotoluene	%	123

svTRH (C10-C40) in Soil						
Our Reference		180317-1	180317-2	180317-5	180317-6	180317-9
Your Reference	UNITS	BH1	BH1	BH2	BH2	BH3
Depth		0.0-0.1	0.3-0.4	0.8-0.9	1.0-1.1	0.6-0.7
Date Sampled		18/11/2017	18/11/2017	18/11/2017	18/11/2017	18/11/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	23/11/2017	23/11/2017	23/11/2017	23/11/2017	23/11/2017
Date analysed	-	24/11/2017	24/11/2017	24/11/2017	24/11/2017	24/11/2017
TRH C_{10} - C_{14}	mg/kg	<50	<50	<50	<50	<50
TRH C_{15} - C_{28}	mg/kg	150	<100	<100	<100	<100
TRH C_{29} - C_{36}	mg/kg	240	<100	<100	<100	<100
TRH >C_{10} -C_{16}	mg/kg	<50	<50	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50	<50	<50	<50	<50
TRH >C_{16} -C_{34}	mg/kg	290	<100	<100	<100	<100
TRH >C_{34} -C_{40}	mg/kg	180	<100	<100	<100	<100
Total +ve TRH (>C10-C40)	mg/kg	470	<50	<50	<50	<50
Surrogate o-Terphenyl	%	85	77	76	78	79

svTRH (C10-C40) in Soil		
Our Reference		180317-10
Your Reference	UNITS	BH3
Depth		1.1-1.2
Date Sampled		18/11/2017
Type of sample		Soil
Date extracted	-	23/11/2017
Date analysed	-	24/11/2017
TRH C_{10} - C_{14}	mg/kg	<50
TRH C_{15} - C_{28}	mg/kg	<100
TRH C_{29} - C_{36}	mg/kg	<100
TRH >C_{10} -C_{16}	mg/kg	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50
TRH >C_{16} -C_{34}	mg/kg	<100
TRH >C_{34} -C_{40}	mg/kg	<100
Total +ve TRH (>C10-C40)	mg/kg	<50
Surrogate o-Terphenyl	%	79

PAHs in Soil						
Our Reference		180317-1	180317-2	180317-5	180317-6	180317-9
Your Reference	UNITS	BH1	BH1	BH2	BH2	BH3
Depth		0.0-0.1	0.3-0.4	0.8-0.9	1.0-1.1	0.6-0.7
Date Sampled		18/11/2017	18/11/2017	18/11/2017	18/11/2017	18/11/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	23/11/2017	23/11/2017	23/11/2017	23/11/2017	23/11/2017
Date analysed	-	23/11/2017	23/11/2017	23/11/2017	23/11/2017	23/11/2017
Naphthalene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	0.2	<0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	0.8	0.4	0.4	0.1	<0.1
Anthracene	mg/kg	0.2	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	2.0	0.9	0.4	0.2	<0.1
Pyrene	mg/kg	1.8	1	0.3	0.1	<0.1
Benzo(a)anthracene	mg/kg	1.0	0.5	0.1	<0.1	<0.1
Chrysene	mg/kg	0.9	0.5	0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	2	0.8	<0.2	<0.2	<0.2
Benzo(a)pyrene	mg/kg	0.87	0.4	0.1	<0.05	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	0.4	0.2	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	0.4	0.3	<0.1	<0.1	<0.1
Total +ve PAH's	mg/kg	10	5.0	1.4	0.4	<0.05
Benzo(a)pyrene TEQ calc (zero)	mg/kg	1.3	0.6	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	1.3	0.6	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	1.3	0.6	<0.5	<0.5	<0.5
Surrogate p-Terphenyl-d14	%	85	90	91	94	94

PAHs in Soil		
Our Reference		180317-10
Your Reference	UNITS	BH3
Depth		1.1-1.2
Date Sampled		18/11/2017
Type of sample		Soil
Date extracted	-	23/11/2017
Date analysed	-	23/11/2017
Naphthalene	mg/kg	<0.1
Acenaphthylene	mg/kg	<0.1
Acenaphthene	mg/kg	<0.1
Fluorene	mg/kg	<0.1
Phenanthrene	mg/kg	<0.1
Anthracene	mg/kg	<0.1
Fluoranthene	mg/kg	<0.1
Pyrene	mg/kg	<0.1
Benzo(a)anthracene	mg/kg	<0.1
Chrysene	mg/kg	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2
Benzo(a)pyrene	mg/kg	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1
Total +ve PAH's	mg/kg	<0.05
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5
Surrogate p-Terphenyl-d14	%	92

Organochlorine Pesticides in soil						
Our Reference		180317-1	180317-2	180317-5	180317-6	180317-9
Your Reference	UNITS	BH1	BH1	BH2	BH2	BH3
Depth		0.0-0.1	0.3-0.4	0.8-0.9	1.0-1.1	0.6-0.7
Date Sampled		18/11/2017	18/11/2017	18/11/2017	18/11/2017	18/11/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	23/11/2017	23/11/2017	23/11/2017	23/11/2017	23/11/2017
Date analysed	-	23/11/2017	23/11/2017	23/11/2017	23/11/2017	23/11/2017
HCB	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	77	80	76	77	77

Organochlorine Pesticides in soil		
Our Reference		180317-10
Your Reference	UNITS	BH3
Depth		1.1-1.2
Date Sampled		18/11/2017
Type of sample		Soil
Date extracted	-	23/11/2017
Date analysed	-	23/11/2017
HCB	mg/kg	<0.1
alpha-BHC	mg/kg	<0.1
gamma-BHC	mg/kg	<0.1
beta-BHC	mg/kg	<0.1
Heptachlor	mg/kg	<0.1
delta-BHC	mg/kg	<0.1
Aldrin	mg/kg	<0.1
Heptachlor Epoxide	mg/kg	<0.1
gamma-Chlordane	mg/kg	<0.1
alpha-chlordane	mg/kg	<0.1
Endosulfan I	mg/kg	<0.1
pp-DDE	mg/kg	<0.1
Dieldrin	mg/kg	<0.1
Endrin	mg/kg	<0.1
pp-DDD	mg/kg	<0.1
Endosulfan II	mg/kg	<0.1
pp-DDT	mg/kg	<0.1
Endrin Aldehyde	mg/kg	<0.1
Endosulfan Sulphate	mg/kg	<0.1
Methoxychlor	mg/kg	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1
Surrogate TCMX	%	75

PCBs in Soil						
Our Reference		180317-1	180317-2	180317-5	180317-6	180317-9
Your Reference	UNITS	BH1	BH1	BH2	BH2	BH3
Depth		0.0-0.1	0.3-0.4	0.8-0.9	1.0-1.1	0.6-0.7
Date Sampled		18/11/2017	18/11/2017	18/11/2017	18/11/2017	18/11/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	23/11/2017	23/11/2017	23/11/2017	23/11/2017	23/11/2017
Date analysed	-	23/11/2017	23/11/2017	23/11/2017	23/11/2017	23/11/2017
Aroclor 1016	mg/kg	<0.2	<0.1	<0.1	<0.1	<0.1
Aroclor 1221	mg/kg	<0.2	<0.1	<0.1	<0.1	<0.1
Aroclor 1232	mg/kg	<0.2	<0.1	<0.1	<0.1	<0.1
Aroclor 1242	mg/kg	<0.2	<0.1	<0.1	<0.1	<0.1
Aroclor 1248	mg/kg	<0.2	<0.1	<0.1	<0.1	<0.1
Aroclor 1254	mg/kg	<0.2	0.3	<0.1	<0.1	<0.1
Aroclor 1260	mg/kg	<0.2	<0.1	<0.1	<0.1	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.2	0.3	<0.1	<0.1	<0.1
Surrogate TCLMX	%	77	80	76	77	77

PCBs in Soil		
Our Reference		180317-10
Your Reference	UNITS	BH3
Depth		1.1-1.2
Date Sampled		18/11/2017
Type of sample		Soil
Date extracted	-	23/11/2017
Date analysed	-	23/11/2017
Aroclor 1016	mg/kg	<0.1
Aroclor 1221	mg/kg	<0.1
Aroclor 1232	mg/kg	<0.1
Aroclor 1242	mg/kg	<0.1
Aroclor 1248	mg/kg	<0.1
Aroclor 1254	mg/kg	<0.1
Aroclor 1260	mg/kg	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1
Surrogate TCLMX	%	75

Acid Extractable metals in soil						
Our Reference		180317-1	180317-2	180317-5	180317-6	180317-9
Your Reference	UNITS	BH1	BH1	BH2	BH2	BH3
Depth		0.0-0.1	0.3-0.4	0.8-0.9	1.0-1.1	0.6-0.7
Date Sampled		18/11/2017	18/11/2017	18/11/2017	18/11/2017	18/11/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	23/11/2017	23/11/2017	23/11/2017	23/11/2017	23/11/2017
Date analysed	-	23/11/2017	23/11/2017	23/11/2017	23/11/2017	23/11/2017
Arsenic	mg/kg	16	25	<4	<4	5
Cadmium	mg/kg	0.5	2	<0.4	<0.4	<0.4
Chromium	mg/kg	12	12	3	9	33
Copper	mg/kg	140	510	2	14	<1
Lead	mg/kg	300	840	19	18	11
Mercury	mg/kg	1.2	5.9	<0.1	<0.1	<0.1
Nickel	mg/kg	48	18	<1	2	2
Zinc	mg/kg	240	880	7	12	2

Acid Extractable metals in soil			
Our Reference		180317-10	180317-11
Your Reference	UNITS	BH3	BH2_STP
Depth		1.1-1.2	3.0
Date Sampled		18/11/2017	18/11/2017
Type of sample		Soil	Soil
Date prepared	-	23/11/2017	23/11/2017
Date analysed	-	23/11/2017	23/11/2017
Arsenic	mg/kg	10	<4
Cadmium	mg/kg	<0.4	<0.4
Chromium	mg/kg	45	13
Copper	mg/kg	2	<1
Lead	mg/kg	18	11
Mercury	mg/kg	<0.1	<0.1
Nickel	mg/kg	1	<1
Zinc	mg/kg	3	8

Moisture						
Our Reference		180317-1	180317-2	180317-5	180317-6	180317-9
Your Reference	UNITS	BH1	BH1	BH2	BH2	BH3
Depth		0.0-0.1	0.3-0.4	0.8-0.9	1.0-1.1	0.6-0.7
Date Sampled		18/11/2017	18/11/2017	18/11/2017	18/11/2017	18/11/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	23/11/2017	23/11/2017	23/11/2017	23/11/2017	23/11/2017
Date analysed	-	24/11/2017	24/11/2017	24/11/2017	24/11/2017	24/11/2017
Moisture	%	7.6	11	19	23	19

Moisture			
Our Reference		180317-10	180317-11
Your Reference	UNITS	BH3	BH2_STP
Depth		1.1-1.2	3.0
Date Sampled		18/11/2017	18/11/2017
Type of sample		Soil	Soil
Date prepared	-	23/11/2017	23/11/2017
Date analysed	-	24/11/2017	24/11/2017
Moisture	%	20	16

Asbestos ID - soils						
Our Reference		180317-1	180317-2	180317-5	180317-6	180317-9
Your Reference	UNITS	BH1	BH1	BH2	BH2	BH3
Depth		0.0-0.1	0.3-0.4	0.8-0.9	1.0-1.1	0.6-0.7
Date Sampled		18/11/2017	18/11/2017	18/11/2017	18/11/2017	18/11/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date analysed	-	27/11/2017	27/11/2017	27/11/2017	27/11/2017	27/11/2017
Sample mass tested	g	Approx. 35g	Approx. 35g	Approx. 35g	Approx. 40g	Approx. 35g
Sample Description	-	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Red clayey soil
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected

Asbestos ID - soils		
Our Reference		180317-10
Your Reference	UNITS	BH3
Depth		1.1-1.2
Date Sampled		18/11/2017
Type of sample		Soil
Date analysed	-	27/11/2017
Sample mass tested	g	Approx. 35g
Sample Description	-	Red clayey soil
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected
Trace Analysis	-	No asbestos detected

Misc Inorg - Soil			
Our Reference		180317-9	180317-11
Your Reference	UNITS	BH3	BH2_STP
Depth		0.6-0.7	3.0
Date Sampled		18/11/2017	18/11/2017
Type of sample		Soil	Soil
Date prepared	-	24/11/2017	24/11/2017
Date analysed	-	24/11/2017	24/11/2017
pH 1:5 soil:water	pH Units	7.8	5.0
Chloride, Cl 1:5 soil:water	mg/kg	<10	20
Sulphate, SO4 1:5 soil:water	mg/kg	52	39
Resistivity	ohm m	110	240

Clay 50-120g		
Our Reference		180317-11
Your Reference	UNITS	BH2_STP
Depth		3.0
Date Sampled		18/11/2017
Type of sample		Soil
Date prepared	-	22/11/2017
Date analysed	-	23/11/2017
Clay in soils <2μm	% (w/w)	71

CEC		
Our Reference		180317-11
Your Reference	UNITS	BH2_STP
Depth		3.0
Date Sampled		18/11/2017
Type of sample		Soil
Date prepared	-	24/11/2017
Date analysed	-	24/11/2017
Exchangeable Ca	meq/100g	0.4
Exchangeable K	meq/100g	0.2
Exchangeable Mg	meq/100g	2.1
Exchangeable Na	meq/100g	<0.1
Cation Exchange Capacity	meq/100g	2.7

Method ID	Methodology Summary
AS1289.3.6.3	Determination Particle Size Analysis using AS1289.3.6.3 and AS1289.3.6.1 and in house method INORG-107. Clay fraction at <2μm reported.
ASB-001	Asbestos ID - Qualitative identification of asbestos in bulk samples using Polarised Light Microscopy and Dispersion Staining Techniques including Synthetic Mineral Fibre and Organic Fibre as per Australian Standard 4964-2004.
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Inorg-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.
Metals-009	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's. Note, the Total +ve reported DDD+DDE+DDT PQL is reflective of the lowest individual PQL and is therefore simply a sum of the positive individually report DDD+DDE+DDT.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD. Note, the Total +ve PCBs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PCBs" is simply a sum of the positive individual PCBs.

Method ID	Methodology Summary
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013. For soil results:- 1. 'EQ PQL'values are assuming all contributing PAHs reported as <PQL are actually at the PQL. This is the most conservative approach and can give false positive TEQs given that PAHs that contribute to the TEQ calculation may not be present. 2. 'EQ zero'values are assuming all contributing PAHs reported as <PQL are zero. This is the least conservative approach and is more susceptible to false negative TEQs when PAHs that contribute to the TEQ calculation are present but below PQL. 3. 'EQ half PQL'values are assuming all contributing PAHs reported as <PQL are half the stipulated PQL. Hence a mid-point between the most and least conservative approaches above. Note, the Total +ve PAHs PQL is reflective of the lowest individual PQL and is therefore "Total +ve PAHs" is simply a sum of the positive individual PAHs.
Org-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			23/11/2017	1	23/11/2017	23/11/2017		23/11/2017	[NT]
Date analysed	-			24/11/2017	1	24/11/2017	24/11/2017		24/11/2017	[NT]
TRH C_6 - C_9	mg/kg	25	Org-016	<25	1	<25	<25	0	106	[NT]
TRH C_6 - C_{10}	mg/kg	25	Org-016	<25	1	<25	<25	0	106	[NT]
Benzene	mg/kg	0.2	Org-016	<0.2	1	<0.2	<0.2	0	100	[NT]
Toluene	mg/kg	0.5	Org-016	<0.5	1	<0.5	<0.5	0	111	[NT]
Ethylbenzene	mg/kg	1	Org-016	<1	1	<1	<1	0	103	[NT]
m+p-xylene	mg/kg	2	Org-016	<2	1	<2	<2	0	109	[NT]
o-Xylene	mg/kg	1	Org-016	<1	1	<1	<1	0	101	[NT]
naphthalene	mg/kg	1	Org-014	<1	1	<1	<1	0	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-016	126	1	128	124	3	119	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			23/11/2017	1	23/11/2017	23/11/2017		23/11/2017	[NT]
Date analysed	-			24/11/2017	1	24/11/2017	24/11/2017		24/11/2017	[NT]
TRH C_{10} - C_{14}	mg/kg	50	Org-003	<50	1	<50	<50	0	105	[NT]
TRH C_{15} - C_{28}	mg/kg	100	Org-003	<100	1	150	120	22	102	[NT]
TRH C_{29} - C_{36}	mg/kg	100	Org-003	<100	1	240	280	15	106	[NT]
TRH >C_{10} -C_{16}	mg/kg	50	Org-003	<50	1	<50	<50	0	105	[NT]
TRH >C_{16} -C_{34}	mg/kg	100	Org-003	<100	1	290	290	0	102	[NT]
TRH >C_{34} -C_{40}	mg/kg	100	Org-003	<100	1	180	240	29	106	[NT]
Surrogate o-Terphenyl	%		Org-003	78	1	85	82	4	86	[NT]

QUALITY CONTROL: PAHs in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			23/11/2017	1	23/11/2017	23/11/2017		23/11/2017	[NT]
Date analysed	-			23/11/2017	1	23/11/2017	23/11/2017		23/11/2017	[NT]
Naphthalene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	89	[NT]
Acenaphthylene	mg/kg	0.1	Org-012	<0.1	1	0.2	<0.1	67	[NT]	[NT]
Acenaphthene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Fluorene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	93	[NT]
Phenanthrene	mg/kg	0.1	Org-012	<0.1	1	0.8	0.5	46	91	[NT]
Anthracene	mg/kg	0.1	Org-012	<0.1	1	0.2	0.2	0	[NT]	[NT]
Fluoranthene	mg/kg	0.1	Org-012	<0.1	1	2.0	1.9	5	93	[NT]
Pyrene	mg/kg	0.1	Org-012	<0.1	1	1.8	1.7	6	99	[NT]
Benzo(a)anthracene	mg/kg	0.1	Org-012	<0.1	1	1.0	1.1	10	[NT]	[NT]
Chrysene	mg/kg	0.1	Org-012	<0.1	1	0.9	0.9	0	99	[NT]
Benzo(b,j+k)fluoranthene	mg/kg	0.2	Org-012	<0.2	1	2	2	0	[NT]	[NT]
Benzo(a)pyrene	mg/kg	0.05	Org-012	<0.05	1	0.87	0.88	1	78	[NT]
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012	<0.1	1	0.4	0.4	0	[NT]	[NT]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012	<0.1	1	0.1	0.1	0	[NT]	[NT]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012	<0.1	1	0.4	0.5	22	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	98	1	85	88	3	110	[NT]

QUALITY CONTROL: Organochlorine Pesticides in soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			23/11/2017	1	23/11/2017	23/11/2017		23/11/2017	[NT]
Date analysed	-			23/11/2017	1	23/11/2017	23/11/2017		23/11/2017	[NT]
HCB	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	92	[NT]
gamma-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
beta-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	97	[NT]
Heptachlor	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	90	[NT]
delta-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aldrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	90	[NT]
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	91	[NT]
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
pp-DDE	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	102	[NT]
Dieldrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	97	[NT]
Endrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	89	[NT]
pp-DDD	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	100	[NT]
Endosulfan II	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
pp-DDT	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	80	[NT]
Methoxychlor	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCMX	%		Org-005	76	1	77	79	3	92	[NT]

QUALITY CONTROL: PCBs in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			23/11/2017	1	23/11/2017	23/11/2017		23/11/2017	[NT]
Date analysed	-			23/11/2017	1	23/11/2017	23/11/2017		23/11/2017	[NT]
Aroclor 1016	mg/kg	0.1	Org-006	<0.1	1	<0.2	<0.2	0	[NT]	[NT]
Aroclor 1221	mg/kg	0.1	Org-006	<0.1	1	<0.2	<0.2	0	[NT]	[NT]
Aroclor 1232	mg/kg	0.1	Org-006	<0.1	1	<0.2	<0.2	0	[NT]	[NT]
Aroclor 1242	mg/kg	0.1	Org-006	<0.1	1	<0.2	<0.2	0	[NT]	[NT]
Aroclor 1248	mg/kg	0.1	Org-006	<0.1	1	<0.2	<0.2	0	[NT]	[NT]
Aroclor 1254	mg/kg	0.1	Org-006	<0.1	1	<0.2	<0.2	0	109	[NT]
Aroclor 1260	mg/kg	0.1	Org-006	<0.1	1	<0.2	<0.2	0	[NT]	[NT]
Surrogate TCLMX	%		Org-006	76	1	77	79	3	77	[NT]

QUALITY CONTROL: PCBs in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	2	23/11/2017	23/11/2017		[NT]	[NT]
Date analysed	-			[NT]	2	23/11/2017	23/11/2017		[NT]	[NT]
Aroclor 1016	mg/kg	0.1	Org-006	[NT]	2	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1221	mg/kg	0.1	Org-006	[NT]	2	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1232	mg/kg	0.1	Org-006	[NT]	2	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1242	mg/kg	0.1	Org-006	[NT]	2	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1248	mg/kg	0.1	Org-006	[NT]	2	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1254	mg/kg	0.1	Org-006	[NT]	2	0.3	0.3	0	[NT]	[NT]
Aroclor 1260	mg/kg	0.1	Org-006	[NT]	2	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCLMX	%		Org-006	[NT]	2	80	91	13	[NT]	[NT]

QUALITY CONTROL: Acid Extractable metals in soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date prepared	-			23/11/2017	1	23/11/2017	23/11/2017		23/11/2017	[NT]
Date analysed	-			23/11/2017	1	23/11/2017	23/11/2017		23/11/2017	[NT]
Arsenic	mg/kg	4	Metals-020	<4	1	16	21	27	108	[NT]
Cadmium	mg/kg	0.4	Metals-020	<0.4	1	0.5	0.6	18	101	[NT]
Chromium	mg/kg	1	Metals-020	<1	1	12	14	15	107	[NT]
Copper	mg/kg	1	Metals-020	<1	1	140	180	25	105	[NT]
Lead	mg/kg	1	Metals-020	<1	1	300	350	15	101	[NT]
Mercury	mg/kg	0.1	Metals-021	<0.1	1	1.2	1.7	34	106	[NT]
Nickel	mg/kg	1	Metals-020	<1	1	48	54	12	103	[NT]
Zinc	mg/kg	1	Metals-020	<1	1	240	310	25	108	[NT]

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date prepared	-			24/11/2017	[NT]	[NT]	[NT]	[NT]	24/11/2017	[NT]
Date analysed	-			24/11/2017	[NT]	[NT]	[NT]	[NT]	24/11/2017	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	99	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	107	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	109	[NT]
Resistivity	ohm m	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

QUALITY CONTROL: CEC					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date prepared	-			24/11/2017	[NT]	[NT]	[NT]	[NT]	24/11/2017	[NT]
Date analysed	-			24/11/2017	[NT]	[NT]	[NT]	[NT]	24/11/2017	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	103	[NT]
Exchangeable K	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	106	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	99	[NT]
Exchangeable Na	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	97	[NT]

Result Definitions

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

Quality Control Definitions

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

PCBs in Soil (sample 1,1d) - PQL has been raised due to interference from analytes(other than those being tested) in the sample/s.

Asbestos: A portion of the supplied sample was sub-sampled for asbestos analysis according to Envirolab procedures.
We cannot guarantee that this sub-sample is indicative of the entire sample. Envirolab recommends supplying
40-50g of sample in its own container.
Note: Samples 180317-1, 2, 5, 6, 9 & 10 were sub-sampled from jars provided by the client.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details	
Client	Jacobs Group (Australia) Pty Ltd
Attention	Michael Stacey

Sample Login Details	
Your reference	IA157700
Envirolab Reference	180317
Date Sample Received	21/11/2017
Date Instructions Received	21/11/2017
Date Results Expected to be Reported	28/11/2017

Sample Condition	
Samples received in appropriate condition for analysis	YES
No. of Samples Provided	13 Soil
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	12.6
Cooling Method	Ice
Sampling Date Provided	YES

Comments
Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

Sample ID	vTRH(C6-C10)/BTEXN in Soil	svTRH (C10-C40) in Soil	PAHs in Soil	Organochlorine Pesticidesin soil	PCBsin Soil	Acid Extractable metalsin soil	Asbestos ID - soils	pH1:5 soil:water	Chloride, Cl1:5 soil:water	Sulphate, SO41:5 soil:water	Resistivity	Clay 50-120g	CEC	On Hold
BH1-0.0-0.1	✓	✓	✓	✓	✓	✓	✓							
BH1-0.3-0.4	✓	✓	✓	✓	✓	✓	✓							
BH1-0.6-0.7														✓
BH1-1.0-1.1														✓
BH2-0.8-0.9	✓	✓	✓	✓	✓	✓	✓							
BH2-1.0-1.1	✓	✓	✓	✓	✓	✓	✓							
BH3-0.05-0.15														✓
BH3-0.3-0.4														✓
BH3-0.6-0.7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
BH3-1.1-1.2	✓	✓	✓	✓	✓	✓	✓							
BH2_STP-3.0						✓		✓	✓	✓	✓	✓	✓	
BH3-1.5														✓
DUPA														✓

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.

Requests for longer term sample storage must be received in writing.

CHAIN OF CUSTODY - Client

ENVIROLAB GROUP - National Phone number 1300 42 43 44

22527

Sydney Lab - Envirolab Services
12 Ashley St, Chatswood, NSW 2067
Ph 02 9910 6200 / sydney@envirolab.com.au

Perth Lab - MPL Laboratories
16-18 Hayden Crt Myaree, WA 6154
Ph 08 9317 2505 / lab@mpl.com.au

Melbourne Lab - Envirolab Services
1A Dalmore Drive Scoresby VIC 3179
Ph 03 9763 2500 / melbourne@envirolab.com.au

Brisbane Lab - Envirolab Services
20a, 10-20 Depot St, Banyo, QLD 4014
Ph 07 3266 9532 / brisbane@envirolab.com.au

Adelaide Lab - Envirolab Services
7 Palmerton Road Windsor Gardens, SA 5087
Ph 0406 350 706 / adelaide@envirolab.com.au

Client: Jacobs
Contact Person: Michael Stacey
Project Mgr:
Sampler: Michael Granno
Address: 177 Pacific Hwy North Sydney 2060.
Phone: 9032 1467 Mob: 0406 861 835
Fax:
Email: michael.stacey@jacobs.com

Client Project Name / Number / Site etc (ie report title): IA157700
PO No.:
Envirolab Quote No. :
Date results required:
Or choose: standard / same day / 1 day / 2 day / 3 day
Note: Inform lab in advance if urgent turnaround is required - surcharges apply
Lab comments:

Sample information | **Tests Required** | **Comments**

Envirolab Sample ID	Client Sample ID or information	Depth	Date sampled	Type of sample	Comb. SA	Comments (Provide as much information about the sample as you can)
1	BH1 / 0.0-0.1		18 to 20 November 17	Soil	/	
2	BH1 / 0.3-0.4				/	
3	BH1 / 0.6-0.7					Hold
4	BH1 / 1.0-1.1					Hold
5	BH2 / 0.8-0.9				/	
6	BH2 / 1.0-1.1				/	
7	BH3 / 0.05-0.15					Hold
8	BH3 / 0.3-0.4					Hold.
9	BH3 / 0.6-0.7				/	
10	BH3 / 1.1-1.2				/	
11	BH2 SPT 3.0m	extra MT				
12	BH3 1.5m					
13	Dup A					

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 180317
Date Received: 21/11/17
Time Received: 10:30
Received by: MT
Temp: Cool/Ambient 12.6
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by (company): Jacobs
Print Name: Michael Stacey
Date & Time: 21.11.17 / 14:20
Signature:

Received by (company): ELS
Print Name: MT
Date & Time: 21/11/17 10:30
Signature:

Lab use only:
Samples Received: Cool or Ambient (circle one)
Temperature Received at: 12.6 (if applicable)
Transported by: Hand delivered / courier

White - Lab copy / Blue - Client copy / Pink - Retain in Book

Page No: 1 of 1

Form: 302 - Chain of Custody-Client, Issued 22/05/12, Version 5, Page 1 of 1.

Ellen Wandala Gamage

From: Stacey, Michael <Michael.Stacey@jacobs.com>
Sent: Tuesday, 21 November 2017 5:05 PM
To: Ellen Wandala Gamage
Cc: Grasso, Michael
Subject: RE: IA157700

Apologies Ellen.

Can I get sample BH2_STP-3.0 analysed for heavy metals, pH, CEC and %clay.

The other samples can be put on hold.

Thanks for picking this up.

Michael Stacey, BAppSc, GradCertEnvEng
Jacobs
Principal Environmental Scientist | Buildings & Infrastructure | Eastern Asia Pacific
+ 61 2 9032 1467
+ 61 (0)406 861 835 mobile
Michael.Stacey@jacobs.com

Level 7
177 Pacific Highway
North Sydney NSW 2060
Australia
www.jacobs.com

#180317.

From: Ellen Wandala Gamage [mailto:EWandalaGamage@envirolab.com.au]
Sent: Tuesday, 21 November 2017 4:30 PM
To: Stacey, Michael <Michael.Stacey@jacobs.com>
Subject: [EXTERNAL] IA157700

Hi Michael,
Just informing you that extra samples BH2_STP-3.0, BH3-1.5 and DUPA have been received, would these be scheduled for any analysis?
Much appreciated
Ellen

Regards,

Ellen Wandala Gamage | Customer Service (12pm - 8pm) | Envirolab Services Pty Ltd

Ellen Wandala Gamage

From: Grasso, Michael <Michael.Grasso@jacobs.com>
Sent: Wednesday, 22 November 2017 2:40 PM
To: Ellen Wandala Gamage
Cc: Stacey, Michael; Raynsford, Scott
Subject: Re: [EXTERNAL] FW: IA157700

Hi Ellen, sorry for the confusion.

For Durability (pH, SO4, CL, Resistivity), could we get the following samples tested only
BH2 SPT 3.0m #11
BH3 0.6 to 0.7m #9
BH4 SPT 1.5m (#179707-A)

Kind Regards,

ELS Ref 180317

Michael Grasso

Kind Regards,

Michael Grasso, BE (Hons)
Jacobs
Geotechnical Engineer | Buildings & Infrastructure | Eastern Asia Pacific
+61 2 9032 1032
+61 434 043 795
Michael.Grasso@jacobs.com

177 Pacific Highway
North Sydney NSW 2060
Australia
www.jacobs.com

From: Ellen Wandala Gamage <EWandalaGamage@envirolab.com.au>
Sent: Wednesday, November 22, 2017 1:54:52 PM
To: Grasso, Michael
Cc: Stacey, Michael; Raynsford, Scott
Subject: [EXTERNAL] FW: IA157700

Hi Michael,
Just wondering if you can confirm the questions below?
Thanks
Ellen

Regards,

Ellen Wandala Gamage | Customer Service (12pm - 8pm) | Envirolab Services Pty Ltd

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
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CERTIFICATE OF ANALYSIS 180317-A

Client Details

Client	Jacobs Group (Australia) Pty Ltd
Attention	Michael Stacey
Address	Level 7, 177 Pacific Highway, North Sydney, NSW, 2060

Sample Details

Your Reference	**IA157700**
Number of Samples	Additional Testing on 2 Soils
Date samples received	21/11/2017
Date completed instructions received	28/11/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	05/12/2017
Date of Issue	04/12/2017

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Asbestos Approved By
Analysed by Asbestos Approved Identifier: Matt Tang
Authorised by Asbestos Approved Signatory: Paul Ching

Results Approved By
Jeremy Faircloth, Organics Supervisor
Long Pham, Team Leader, Metals

Authorised By

David Springer, General Manager

Metals in TCLP USEPA1311			
Our Reference		180317-A-1	180317-A-2
Your Reference	UNITS	BH1	BH1
Depth		0.0-0.1	0.3-0.4
Date Sampled		18/11/2017	18/11/2017
Type of sample		Soil	Soil
Date extracted	-	30/11/2017	30/11/2017
Date analysed	-	30/11/2017	30/11/2017
pH of soil for fluid# determ.	pH units	7.5	8.9
pH of soil TCLP (after HCl)	pH units	1.8	1.8
Extraction fluid used	-	1	1
pH of final Leachate	pH units	5.0	5.0
Lead in TCLP	mg/L	[NA]	1.1
Mercury in TCLP	mg/L	[NA]	<0.0005
Nickel in TCLP	mg/L	<0.02	[NA]

PAHs in TCLP (USEPA 1311)		
Our Reference		180317-A-1
Your Reference	UNITS	BH1
Depth		0.0-0.1
Date Sampled		18/11/2017
Type of sample		Soil
Date extracted	-	30/11/2017
Date analysed	-	30/11/2017
Naphthalene in TCLP	mg/L	<0.001
Acenaphthylene in TCLP	mg/L	<0.001
Acenaphthene in TCLP	mg/L	<0.001
Fluorene in TCLP	mg/L	<0.001
Phenanthrene in TCLP	mg/L	<0.001
Anthracene in TCLP	mg/L	<0.001
Fluoranthene in TCLP	mg/L	<0.001
Pyrene in TCLP	mg/L	<0.001
Benzo(a)anthracene in TCLP	mg/L	<0.001
Chrysene in TCLP	mg/L	<0.001
Benzo(bjk)fluoranthene in TCLP	mg/L	<0.002
Benzo(a)pyrene in TCLP	mg/L	<0.001
Indeno(1,2,3-c,d)pyrene - TCLP	mg/L	<0.001
Dibenzo(a,h)anthracene in TCLP	mg/L	<0.001
Benzo(g,h,i)perylene in TCLP	mg/L	<0.001
Total +ve PAH's	mg/L	NIL (+)VE
Surrogate p-Terphenyl-d14	%	82

Method ID	Methodology Summary
EXTRACT.7	Toxicity Characteristic Leaching Procedure (TCLP) using Zero Headspace Extraction (zHE) using AS4439 and USEPA 1311.
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-004	Toxicity Characteristic Leaching Procedure (TCLP) using in house method INORG-004.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.
Metals-021 CV-AAS	Determination of Mercury by Cold Vapour AAS.
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS.
Org-012	Leachates are extracted with Dichloromethane and analysed by GC-MS.
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013.

QUALITY CONTROL: Metals in TCLP USEPA1311						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			30/11/2017	[NT]	[NT]	[NT]	[NT]	30/11/2017	[NT]
Date analysed	-			30/11/2017	[NT]	[NT]	[NT]	[NT]	30/11/2017	[NT]
Lead in TCLP	mg/L	0.03	Metals-020 ICP-AES	<0.03	[NT]	[NT]	[NT]	[NT]	110	[NT]
Mercury in TCLP	mg/L	0.0005	Metals-021 CV-AAS	<0.0005	[NT]	[NT]	[NT]	[NT]	108	[NT]
Nickel in TCLP	mg/L	0.02	Metals-020 ICP-AES	<0.02	[NT]	[NT]	[NT]	[NT]	114	[NT]

QUALITY CONTROL: PAHs in TCLP (USEPA 1311)						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date extracted	-			30/11/2017	[NT]	[NT]	[NT]	[NT]	30/11/2017	[NT]
Date analysed	-			30/11/2017	[NT]	[NT]	[NT]	[NT]	30/11/2017	[NT]
Naphthalene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	72	[NT]
Acenaphthylene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Acenaphthene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluorene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	80	[NT]
Phenanthrene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	81	[NT]
Anthracene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluoranthene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	72	[NT]
Pyrene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	77	[NT]
Benzo(a)anthracene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chrysene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	89	[NT]
Benzo(bjk)fluoranthene in TCLP	mg/L	0.002	Org-012	<0.002	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(a)pyrene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	82	[NT]
Indeno(1,2,3-c,d)pyrene - TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Dibenzo(a,h)anthracene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(g,h,i)perylene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	77	[NT]	[NT]	[NT]	[NT]	74	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

Aileen Hie

From: Stacey, Michael <Michael.Stacey@jacobs.com>
Sent: Tuesday, 28 November 2017 2:38 PM
To: SydneyMailbox
Cc: Grasso, Michael; Raynsford, Scott
Subject: TCLP testing - Envirolab Lab Batch 180317

Can I get the following testing undertaken on samples from Envirolab batch 180317.

- Sample 180317-1 (BH1/0.0-0.1): TCLP nickel and benzo(a)pyrene
- Sample 180317-2 (BH2/0.3-0.4): TCLP lead and mercury.

Standard TAT is fine.

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Envirolab Ref: 180317A
Due: 5/12/17
Std T/A.

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CERTIFICATE OF ANALYSIS 180999

Client Details

Client	Jacobs Group (Australia) Pty Ltd
Attention	Michael Grasso, Michael Stacey
Address	Level 7, 177 Pacific Highway, North Sydney, NSW, 2060

Sample Details

Your Reference	IA157700
Number of Samples	4 soil
Date samples received	29/11/2017
Date completed instructions received	30/11/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	07/12/2017
Date of Issue	06/12/2017

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Asbestos Approved By
Analysed by Asbestos Approved Identifier: Lucy Zhu
Authorised by Asbestos Approved Signatory: Lulu Scott

Results Approved By
Dragana Tomas, Senior Chemist
Long Pham, Team Leader, Metals
Lulu Scott, Asbestos Supervisor
Steven Luong, Senior Chemist

Authorised By

David Springer, General Manager

vTRH(C6-C10)/BTEXN in Soil				
Our Reference		180999-1	180999-2	180999-4
Your Reference	UNITS	BH5	BH5	DUP B
Depth		0.0-0.1	0.5-0.95	-
Type of sample		soil	soil	soil
Date extracted	-	01/12/2017	01/12/2017	01/12/2017
Date analysed	-	04/12/2017	04/12/2017	04/12/2017
TRH C_6 - C_9	mg/kg	<25	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1
Total +ve Xylenes	mg/kg	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	103	103	107

svTRH (C10-C40) in Soil				
Our Reference		180999-1	180999-2	180999-4
Your Reference	UNITS	BH5	BH5	DUP B
Depth		0.0-0.1	0.5-0.95	-
Type of sample		soil	soil	soil
Date extracted	-	01/12/2017	01/12/2017	01/12/2017
Date analysed	-	02/12/2017	02/12/2017	02/12/2017
TRH C_{10} - C_{14}	mg/kg	<50	<50	<50
TRH C_{15} - C_{28}	mg/kg	<100	<100	<100
TRH C_{29} - C_{36}	mg/kg	<100	<100	<100
TRH >C_{10} -C_{16}	mg/kg	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50	<50	<50
TRH >C_{16} -C_{34}	mg/kg	<100	<100	<100
TRH >C_{34} -C_{40}	mg/kg	<100	<100	<100
Total +ve TRH (>C10-C40)	mg/kg	<50	<50	<50
Surrogate o-Terphenyl	%	88	92	88

PAHs in Soil				
Our Reference		180999-1	180999-2	180999-4
Your Reference	UNITS	BH5	BH5	DUP B
Depth		0.0-0.1	0.5-0.95	-
Type of sample		soil	soil	soil
Date extracted	-	01/12/2017	01/12/2017	01/12/2017
Date analysed	-	01/12/2017	01/12/2017	01/12/2017
Naphthalene	mg/kg	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	0.1	<0.1	0.2
Acenaphthene	mg/kg	<0.1	<0.1	<0.1
Fluorene	mg/kg	0.1	<0.1	0.2
Phenanthrene	mg/kg	0.9	<0.1	1.4
Anthracene	mg/kg	0.4	<0.1	0.7
Fluoranthene	mg/kg	1.3	0.1	1.8
Pyrene	mg/kg	1.3	0.1	1.8
Benzo(a)anthracene	mg/kg	0.8	<0.1	0.9
Chrysene	mg/kg	0.6	<0.1	0.8
Benzo(b,j+k)fluoranthene	mg/kg	1	<0.2	1
Benzo(a)pyrene	mg/kg	0.61	<0.05	0.69
Indeno(1,2,3-c,d)pyrene	mg/kg	0.3	<0.1	0.3
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	0.3	<0.1	0.4
Total +ve PAH's	mg/kg	7.7	0.3	10
Benzo(a)pyrene TEQ calc (zero)	mg/kg	0.8	<0.5	0.9
Benzo(a)pyrene TEQ calc(half)	mg/kg	0.8	<0.5	0.9
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	0.8	<0.5	0.9
Surrogate p-Terphenyl-d14	%	86	95	84

Organochlorine Pesticides in soil			
Our Reference		180999-1	180999-2
Your Reference	UNITS	BH5	BH5
Depth		0.0-0.1	0.5-0.95
Type of sample		soil	soil
Date extracted	-	01/12/2017	01/12/2017
Date analysed	-	01/12/2017	01/12/2017
HCB	mg/kg	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1
Surrogate TCMX	%	87	91

PCBs in Soil			
Our Reference		180999-1	180999-2
Your Reference	UNITS	BH5	BH5
Depth		0.0-0.1	0.5-0.95
Type of sample		soil	soil
Date extracted	-	01/12/2017	01/12/2017
Date analysed	-	01/12/2017	01/12/2017
Aroclor 1016	mg/kg	<0.1	<0.1
Aroclor 1221	mg/kg	<0.1	<0.1
Aroclor 1232	mg/kg	<0.1	<0.1
Aroclor 1242	mg/kg	<0.1	<0.1
Aroclor 1248	mg/kg	<0.1	<0.1
Aroclor 1254	mg/kg	<0.1	<0.1
Aroclor 1260	mg/kg	<0.1	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1	<0.1
Surrogate TCLMX	%	87	91

Acid Extractable metals in soil					
Our Reference		180999-1	180999-2	180999-4	180999-5
Your Reference	UNITS	BH5	BH5	DUP B	BH5 - [TRIPLICATE]
Depth		0.0-0.1	0.5-0.95	-	0.0-0.1
Type of sample		soil	soil	soil	soil
Date prepared	-	01/12/2017	01/12/2017	01/12/2017	01/12/2017
Date analysed	-	01/12/2017	01/12/2017	01/12/2017	01/12/2017
Arsenic	mg/kg	8	16	5	6
Cadmium	mg/kg	<0.4	1	<0.4	<0.4
Chromium	mg/kg	6	23	8	8
Copper	mg/kg	30	42	51	47
Lead	mg/kg	32	48	84	75
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	3	6	4	7
Zinc	mg/kg	92	91	150	150

Moisture				
Our Reference		180999-1	180999-2	180999-4
Your Reference	UNITS	BH5	BH5	DUP B
Depth		0.0-0.1	0.5-0.95	-
Type of sample		soil	soil	soil
Date prepared	-	01/12/2017	01/12/2017	01/12/2017
Date analysed	-	04/12/2017	04/12/2017	04/12/2017
Moisture	%	17	58	19

Asbestos ID - soils			
Our Reference		180999-1	180999-2
Your Reference	UNITS	BH5	BH5
Depth		0.0-0.1	0.5-0.95
Type of sample		soil	soil
Date analysed	-	06/12/2017	06/12/2017
Sample mass tested	g	Approx. 30g	Approx. 10g
Sample Description	-	Brown coarse-grained soil & rocks	Black fine-grained soil
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected
Trace Analysis	-	No asbestos detected	No asbestos detected

Method ID	Methodology Summary
ASB-001	Asbestos ID - Qualitative identification of asbestos in bulk samples using Polarised Light Microscopy and Dispersion Staining Techniques including Synthetic Mineral Fibre and Organic Fibre as per Australian Standard 4964-2004.
Inorg-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's. Note, the Total +ve reported DDD+DDE+DDT PQL is reflective of the lowest individual PQL and is therefore simply a sum of the positive individually report DDD+DDE+DDT.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD. Note, the Total +ve PCBs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PCBs" is simply a sum of the positive individual PCBs.

Method ID	Methodology Summary
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013. For soil results:- 1. 'EQ PQL'values are assuming all contributing PAHs reported as <PQL are actually at the PQL. This is the most conservative approach and can give false positive TEQs given that PAHs that contribute to the TEQ calculation may not be present. 2. 'EQ zero'values are assuming all contributing PAHs reported as <PQL are zero. This is the least conservative approach and is more susceptible to false negative TEQs when PAHs that contribute to the TEQ calculation are present but below PQL. 3. 'EQ half PQL'values are assuming all contributing PAHs reported as <PQL are half the stipulated PQL. Hence a mid-point between the most and least conservative approaches above. Note, the Total +ve PAHs PQL is reflective of the lowest individual PQL and is therefore "Total +ve PAHs" is simply a sum of the positive individual PAHs.
Org-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	180999-2
Date extracted	-			01/12/2017	1	01/12/2017	01/12/2017		01/12/2017	01/12/2017
Date analysed	-			04/12/2017	1	04/12/2017	04/12/2017		04/12/2017	04/12/2017
TRH C_6 - C_9	mg/kg	25	Org-016	<25	1	<25	<25	0	100	72
TRH C_6 - C_{10}	mg/kg	25	Org-016	<25	1	<25	<25	0	100	72
Benzene	mg/kg	0.2	Org-016	<0.2	1	<0.2	<0.2	0	104	80
Toluene	mg/kg	0.5	Org-016	<0.5	1	<0.5	<0.5	0	103	76
Ethylbenzene	mg/kg	1	Org-016	<1	1	<1	<1	0	99	69
m+p-xylene	mg/kg	2	Org-016	<2	1	<2	<2	0	98	67
o-Xylene	mg/kg	1	Org-016	<1	1	<1	<1	0	96	66
naphthalene	mg/kg	1	Org-014	<1	1	<1	<1	0	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-016	103	1	103	110	7	98	102

QUALITY CONTROL: svTRH (C10-C40) in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	180999-2
Date extracted	-			01/12/2017	1	01/12/2017	01/12/2017		01/12/2017	01/12/2017
Date analysed	-			02/12/2017	1	02/12/2017	02/12/2017		02/12/2017	02/12/2017
TRH C_{10} - C_{14}	mg/kg	50	Org-003	<50	1	<50	<50	0	109	107
TRH C_{15} - C_{28}	mg/kg	100	Org-003	<100	1	<100	<100	0	116	114
TRH C_{29} - C_{36}	mg/kg	100	Org-003	<100	1	<100	<100	0	109	108
TRH >C_{10} -C_{16}	mg/kg	50	Org-003	<50	1	<50	<50	0	109	107
TRH >C_{16} -C_{34}	mg/kg	100	Org-003	<100	1	<100	<100	0	116	114
TRH >C_{34} -C_{40}	mg/kg	100	Org-003	<100	1	<100	<100	0	109	108
Surrogate o-Terphenyl	%		Org-003	98	1	88	88	0	97	92

QUALITY CONTROL: PAHs in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	180999-2
Date extracted	-			01/12/2017	1	01/12/2017	01/12/2017		01/12/2017	01/12/2017
Date analysed	-			01/12/2017	1	01/12/2017	01/12/2017		01/12/2017	01/12/2017
Naphthalene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	94	90
Acenaphthylene	mg/kg	0.1	Org-012	<0.1	1	0.1	<0.1	0	[NT]	[NT]
Acenaphthene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Fluorene	mg/kg	0.1	Org-012	<0.1	1	0.1	<0.1	0	97	96
Phenanthrene	mg/kg	0.1	Org-012	<0.1	1	0.9	0.3	100	98	97
Anthracene	mg/kg	0.1	Org-012	<0.1	1	0.4	0.2	67	[NT]	[NT]
Fluoranthene	mg/kg	0.1	Org-012	<0.1	1	1.3	0.6	74	92	92
Pyrene	mg/kg	0.1	Org-012	<0.1	1	1.3	0.7	60	100	98
Benzo(a)anthracene	mg/kg	0.1	Org-012	<0.1	1	0.8	0.4	67	[NT]	[NT]
Chrysene	mg/kg	0.1	Org-012	<0.1	1	0.6	0.4	40	107	105
Benzo(b,j+k)fluoranthene	mg/kg	0.2	Org-012	<0.2	1	1	0.7	35	[NT]	[NT]
Benzo(a)pyrene	mg/kg	0.05	Org-012	<0.05	1	0.61	0.4	42	91	81
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012	<0.1	1	0.3	0.2	40	[NT]	[NT]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012	<0.1	1	0.3	0.3	0	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	92	1	86	87	1	102	103

QUALITY CONTROL: Organochlorine Pesticides in soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	180999-2
Date extracted	-			01/12/2017	1	01/12/2017	01/12/2017		01/12/2017	01/12/2017
Date analysed	-			01/12/2017	1	01/12/2017	01/12/2017		01/12/2017	01/12/2017
HCB	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	96	99
gamma-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
beta-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	99	102
Heptachlor	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	94	97
delta-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aldrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	91	94
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	95	98
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
pp-DDE	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	105	109
Dieldrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	102	105
Endrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	92	95
pp-DDD	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	100	103
Endosulfan II	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
pp-DDT	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	88	89
Methoxychlor	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCMX	%		Org-005	89	1	87	89	2	104	109

QUALITY CONTROL: PCBs in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	180999-2
Date extracted	-			01/12/2017	1	01/12/2017	01/12/2017		01/12/2017	01/12/2017
Date analysed	-			01/12/2017	1	01/12/2017	01/12/2017		01/12/2017	01/12/2017
Aroclor 1016	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1221	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1232	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1242	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1248	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1254	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	100	88
Aroclor 1260	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCLMX	%		Org-006	89	1	87	89	2	87	89

QUALITY CONTROL: Acid Extractable metals in soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	180999-2
Date prepared	-			01/12/2017	1	01/12/2017	01/12/2017		01/12/2017	01/12/2017
Date analysed	-			01/12/2017	1	01/12/2017	01/12/2017		01/12/2017	01/12/2017
Arsenic	mg/kg	4	Metals-020	<4	1	8	4	67	110	86
Cadmium	mg/kg	0.4	Metals-020	<0.4	1	<0.4	<0.4	0	101	90
Chromium	mg/kg	1	Metals-020	<1	1	6	7	15	108	94
Copper	mg/kg	1	Metals-020	<1	1	30	34	12	108	100
Lead	mg/kg	1	Metals-020	<1	1	32	70	75	108	94
Mercury	mg/kg	0.1	Metals-021	<0.1	1	<0.1	<0.1	0	102	99
Nickel	mg/kg	1	Metals-020	<1	1	3	4	29	103	90
Zinc	mg/kg	1	Metals-020	<1	1	92	130	34	106	75

Result Definitions

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

Quality Control Definitions

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

PAHs in Soil - The RPD for duplicate results is accepted due to the non homogenous nature of sample 1.

Acid Extractable Metals in Soil: The laboratory RPD acceptance criteria
has been exceeded for 180999-1 for Pb. Therefore a triplicate result has
been issued as laboratory sample number 180999-5.

Asbestos: A portion of the supplied samples were sub-sampled for asbestos
analysis according to Envirolab procedures.
We cannot guarantee that these sub-samples are indicative of the entire sample.
Envirolab recommends supplying 40-50g of sample in its own container.
Note: Samples 180999-1 & 2 were sub-sampled from jars provided by the client.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details	
Client	Jacobs Group (Australia) Pty Ltd
Attention	Michael Grasso, Michael Stacey

Sample Login Details	
Your reference	IA157700
Envirolab Reference	180999
Date Sample Received	29/11/2017
Date Instructions Received	30/11/2017
Date Results Expected to be Reported	07/12/2017

Sample Condition	
Samples received in appropriate condition for analysis	YES
No. of Samples Provided	4 soil
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	8.8
Cooling Method	Ice
Sampling Date Provided	YES

Comments
Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
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customerservice@envirolab.com.au
www.envirolab.com.au

Sample ID	vTRH(C6-C10)/BTEXN in Soil	svTRH (C10-C40) in Soil	PAHs in Soil	Organochlorine Pesticidesin soil	PCBsin Soil	Acid Extractable metalsin soil	Asbestos ID - soils	On Hold
BH5-0.0-0.1	✓	✓	✓	✓	✓	✓	✓	
BH5-0.5-0.95	✓	✓	✓	✓	✓	✓	✓	
BH5-1.5-1.95								✓
DUP B	✓	✓	✓			✓		

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info
Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.

ENVIROLAB GROUP

CHAIN OF CUSTODY - Client

22528

ENVIROLAB GROUP - National Phone number 1300 42 43 44

Sydney Lab - Envirolab Services
12 Ashley St, Chatswood, NSW 2067
Ph 02 9910 6200 / sydney@envirolab.com.au

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Client: Jacobs
Contact Person: Michael Stacey
Project Mgr:
Sampler: Michael Grasso
Address: 177 Pacific Hwy North Sydney NSW 2060
Phone: 9032 1467 **Mob:** 0406 861 835
Fax:
Email: michael.stacey@jacobs.com

Client Project Name / Number / Site etc (ie report title): IA157700
PO No.:
Envirolab Quote No. :
Date results required:
Or choose: standard / same day / 1 day / 2 day / 3 day
Note: Inform lab in advance if urgent turnaround is required - surcharges apply
Lab comments:

Envirolab Sample ID	Client Sample ID or information	Depth	Date sampled	Type of sample	Comb. 5A	Comb. 3	Comments: Provide as much information about the sample as you can
1	BHS/0.0-0.1				/		
2	BHS/0.5-0.95				/		
3	BHS/1.5-1.95						Hold
4	Dup B.					/	

ENVIROLAB Envirolab Services 12 Ashley St Chatswood NSW 2067 Ph: (02) 9910 6200
Job No: 180999
Date Received: COC 30/11/2017
Time Received: 9.45
Received by: PR
Temp: Cool/Ambient 21.8
Cooling: Ice/Icepack
Security: Intact/Broken/None

samples 29/11 12:00

Relinquished by (company): Jacobs
Print Name: Michael Stacey
Date & Time: 20.11.17 / 9:00
Signature:

Received by (company): ELS
Print Name: P. Ray COC
Date & Time: 29/11/2017 12:00 30/11/2017 945
Signature:

Lab use only:
Samples Received: Cool or Ambient (circle one)
Temperature Received at: (if applicable)
Transported by: Hand delivered / courier

White - Lab copy / Blue - Client copy / Pink - Retain in Book

Page No: 1 of 1

Appendix D. EIL calculations

NEPM 2013 Ecological Investigation Limits Methodology

Ecological investigation levels (EILs) for the protection of terrestrial ecosystems have been derived for common contaminants in soil based on a species sensitivity distribution (SSD) model developed for Australian conditions. EILs have been derived for As, Cu, CrIII, DDT, naphthalene, Ni, Pb and Zn.

EILs apply principally to contaminants in the top 2 metres of soil at the finished surface/ground level which corresponds to the root zone and habitation zone of many species. In arid regions, where the predominant species may have greater root penetration, specific considerations may result in their application to 3 metres depth.

The methodology assumes that the ecosystem is adapted to the ambient background concentration (ABC) for the locality and that it is only adding contaminants over and above this background concentration which has an adverse effect on the environment.

The ABC of a contaminant is the soil concentration in a specified locality that is the sum of the naturally occurring background level and the contaminant levels that have been introduced from diffuse or non-point sources by general anthropogenic activity not attributed to industrial, commercial, or agricultural activities, for example, motor vehicle emissions.

The preferred method to determine the ABC is to measure the ABC at an appropriate reference site. This approach is essential in areas where there is a high naturally occurring background level such as will occur in mineralised areas.

An added contaminant limit (ACL) is the added concentration (above the ABC) of a contaminant above which further appropriate investigation and evaluation of the impact on ecological values is required. **The EIL is derived by summing the ACL and the ABC.**

ACLs are based on the soil characteristics of pH, CEC and clay content. Empirical relationships that can model the effect of these soil properties on toxicity are used to develop soil-specific values. These soil-specific values take into account the biological availability of the element in various soils. In this approach different soils will have different contaminant EILs rather than a single generic EIL for each contaminant.

The adopted soil characteristics (pH, clay content and cation exchange capacity) have been selected from samples BH4/1.5 (silty clay) and BH2SPT/3.0 (silty clay) as the samples were considered to be representative of the natural conditions across the site and that the soil/rock at these locations were unlikely to be impacted by anthropogenic sources due to the sample depths.

Table 1.1: Calculating the ACL

ACLs	mg/kg								
	BH4/1.5	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
pH	5.5				190				
CEC	2				140			55	280
% clay	54			660					
Generic	-					1800			

ACLs	mg/kg								
	BH2SPT/3.0	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
pH	5.0				190				
CEC	2.7				140			55	210
% clay	71			660					
Generic	-					1800			

Information derived from **Table 1B(1)** *Soil-specific added contaminant limits for aged zinc in soils*, **Table 1B(2)** *Soil-specific added contaminant limits for aged copper in soils*, **Table 1B(3)** *Soil-specific added contaminant limits for aged chromium III and nickel in soils*, **Table 1B(4)** *Generic added contaminant limits for lead in soils (commercial/industrial) irrespective of their physicochemical properties (NEPM 2013.*

Table 1.2: Calculating the ABC

ABC	mg/kg							
	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
BH4/1.5	n/a	n/a	665	140	1808	n/a	55	500

ABC	mg/kg							
	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
BH2SPT/3.0	n/a	n/a	673	140	1811	n/a	55	218

The EIL is derived by summing the ACL and the ABC. The following rounding rules are applicable to EILs:

- <1 to nearest 0.1
- 1 to <10 to nearest integer
- 10 to < 100 to nearest 5
- 100 to <1000 to nearest 10
- ≥1000 to nearest 100

The EIL have been calculated using the lowest criteria from both of the reference locations.

Table 1.3: Calculating the EIL

EILs	mg/kg									
	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	DDT	Naphth.
ABC + ACL			665 [3]	140 [3]	1808 [3]		55 [3]	218 [3]		
NEPM 2013	160 [1]								640 [1]	370 [1]
NEPM 1999		3 [2]				1 [2]				

[1]Generic EILs for aged arsenic, DDT and Naphthalene from **Table 1B(5)** for commercial/industrial land use**.**
[2]EILs from NEPM 1999 (no EILs specified for contaminants in NEPM 2013).
[3]EILs derived from NEPM 2013 equation ABC+ACL.

Redfern Station Investigation Works

Transport for NSW

Geotechnical Investigation Report

IA157700-RP-GI-0023 | 02

5 February 2018

TfNSW Project Number - 150031

JACOBS

Redfern Station Investigation Works

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Revision	Date	Description	By	Review	Approved
01	22/12/17	Draft – Geotechnical Investigation Report	M Grasso	S Raynsford	J Cowley
02	05/02/18	Final – Geotechnical Investigation Report	M Grasso	S Raynsford	J Cowley

Contents

1. Introduction

Jacobs has been commissioned by Transport for NSW (TfNSW) to undertake a combined land survey, geotechnical investigation and contamination study to inform future development plans for Redfern Station and the surrounding precinct.

The combined geotechnical and contamination scope of work consisted of six (6) boreholes, contamination sampling and resistivity testing at the locations nominated by TfNSW. The investigation works were completed between the 7 and 28 November, including works during two planned weekend rail track shutdowns (WE20 – 11/12 November 2017 and WE21 – 18/19 November 2017).

This report presents the geotechnical investigation results, including the results of fieldwork and laboratory testing, together with comments and recommendations on the following:

- Inferred subsurface conditions and ground model, including likely depth of soil and rock (and characteristics).
- Summary of the geotechnical test results.
- Discussion on soil resistivity test results.
- Recommendations on foundation types and preliminary design parameters for structures.
- Discussion on excavation conditions (of identified units) including preliminary recommendations on design parameters for support design.
- Preliminary comments on geotechnical issues and risks.

Results from the contamination testing undertaken as part of these works are provided under the Contamination Investigation Report (IA157700-RP-CI-0025_Rev02) dated 5 February 2018.

2. Site setting

2.1 Site description

Redfern Station is located approximately 1.3 km south of Central Station. The station has 12 platforms, two of which are underground (Platforms 11 and 12). Redfern Station is served by a single concourse connecting all 12 platforms with frontage onto the Lawson Street overbridge at the northern end of the station. There are three entrances to the Station; Lawson Street, Gibbons Street and an entrance at the southern end of Platform 10 which connects with the walkway to the Australian Technology Park (ATP).

Platforms 1 through 10 are each provided with a single set of stairs and are connected by the concourse. Platforms 11 and 12 are located underground and are accessed via stairs and escalators from the Gibbons Street entrance end of the concourse. Select photographs are provided on plates 1 to 4.

Plate 1: Redfern Station, looking south-west from Platform 10

Plate 2: Redfern Station, looking north-east from Platform 4

Plate 3: Illawarra Relief compound area, looking south-west

Plate 4: Rock outcropping within the Illawarra Relief compound area

2.2 Geology and soils

The following information documents were available at the time of preparing this report:

- Sydney 1:100 000 Soil Landscape Series Sheet 9130
- Sydney 1:100 000 Geological Series Sheet 9130
- 1:25,000 Acid Sulfate Soils (ASS) Risk Map Sheet 91 30S3

2.2.1 Soil landscapes and site geology

An understanding of the soils and geology expected for the area surrounding the station site has been based on the available 1:100 000 soil landscape and geological maps. The expected soil and geological units at the station site are summarised in Table 2.1.

Table 2.1 – Geological units

Unit	Description
Soil landscape	
(bt) Blacktown	The landscape is characterised by gentle undulating rises (slopes <5%) on Wianamatta Group shales and Hawkesbury Sandstone with local reliefs of up 30 m. This area is further denoted as “developed terrain”. The expected residual soils are either: • Red and brown residual podzolic soils, shallow to moderately deep (up to 100 cm) located on crests, upper slopes and well drained areas; or • Yellow podzolic soils and soloths, deep (between 150 to 300 cm) located on lower slopes and in areas of poor drainage.
Geology	
(Rwa) Ashfield Shale	The site is expected to be underlain by Ashfield Shale unit which is a sequence of the Wianamatta Group. The Ashfield Shale sequence in the area typically comprises interbedded black to dark grey shales, laminites and fine to medium grained sandstones. These materials typically weather to form a residual profile of 1 to 3 metres of medium to high plasticity clays.

The presence of the above geotechnical units was confirmed from the results of the geotechnical investigations with approximately 1.5 m thick layer of fill overlying 3.5 m of residual clay profile then shale/laminite bedrock.

2.2.2 Acid Sulphate soils

Office of Environment and Heritage Acid Sulfate Soil mapping of the area suggests that no known occurrence of Acid Sulfate Soils has been noted within the Redfern area.

2.3 Previous reports

The following documents were sourced during the preparation of this assessment. Copies of relevant information are included in **Appendix B** and investigation locations have been plotted onto the site plan in **Appendix A**, based on available records and have not been verified.

- ***(Jacobs May 2017)*** – Station Upgrade Project – Redfern Station SP3, Geotechnical Investigation Memorandum.
  - Four boreholes (BH1 to BH4) on the concourse area located at the corner of Gibbons and Lawson Street were progressed to depths of up to 5.0 m below ground level. The logs indicated fill up to 2.4 m underlain by residual and then extremely weathered shale.
- ***(GeoEnviro Consultancy Pty April 2015)*** - Proposed Railway Platform Nos 6 and 7 Upgrade, Redfern Station, Geotechnical Investigation Report
  - Nine boreholes (BH1 to BH9) were drilled along the platform and were progressed to depths ranging from 0.3 to 3.3 m below existing platform level. The logs indicated fill up to 1.6 m underlain by residual and then extremely weathered shale at approximately 2.5 to 3 m depth below platform level.
  - One (1) test pit was excavated on the south west side of the existing station building in order to assess the existing footing conditions underlying foundation material. The test pit was excavated to a depth of 1.0m below existing platform level.
- ***(Novo Rail Alliance January 2015)*** – Transport Access Program – Redfern Station Easy Access Upgrade, Geotechnical Interpretive Report.
  - A single exploratory hole was advanced using push tube and rotary auger techniques to a depth of 12m below ground level. The ground conditions comprised poorly compacted granular fill (up to 0.5 m bgl) over residual soil (0.5 to 2.3 m bgl) becoming weathered shale from 2.3 m grading to low strength shale from 4.2 m. No coring was undertaken in this borehole, with the borehole terminated at 12 m.
- ***(RailCorp February 2010/2011)*** – Formation Investigation and platform stability during track upgrading – Redfern, Platform 6.
  - Eight test pits (8573-TP1 to 8573-TP8) were excavated within the ‘four-foot’ of the Down Local to depths between 0.68 and 1.0 m below track level. Generally, the test pits indicated Ballast overlying a capping layer up to 1.0 m depth. In some locations, this was underlain by residual soil or weathered shale bedrock.
  - Three boreholes (8573-BH1 to 8573-BH3) were drilled through platform 6 to depths between 3.0 to 3.4m. The borehole indicated fill up to 2.0 m overlying residual soils and weathered shale bedrock at the base of the borehole (approximately 3 m).
- ***(J&K January 2009)*** – Proposed Track Reconditioning – Redfern Station Platform Four, Geotechnical Investigation Report (proposed Redfern Station Platform 4 track reconditioning works between track kilometrages 0.950 km and 1.405 km)
  - During the initial field investigations in 2007, nine test pits (TL1 to TL9) were excavated at 50 m centres within the ‘four-foot’ using a 3.5 tonne excavator. The test pits were excavated to depths between 0.5 m and 1.35 m and dynamic cone penetration (DCP) tests were carried out within the test pit to depths extending between 1.2m and 2.0 m.
  - RailCorp then excavated six additional test pits in 2008 (8376-1 to 8376-6) in close proximity to the test pits excavated by J&K. The test pits were excavated to depths between 0.7 m and 1.1 m.
  - Generally, the test pits from both investigations encountered granular railway ballast overlying fill or natural clayey soils, then in a number of test pits, weathered shale bedrock.

3. Geotechnical Investigation

3.1 General

The current geotechnical investigation was undertaken between 7 November and 28 November 2017, part of which was undertaken during planned weekend shutdowns of the rail line (WE20 and WE21). Works were undertaken under the full time supervision of a Jacobs' geotechnical engineer. The investigation comprised the drilling of six (6) boreholes, undertaking in-situ SPTs (Standard Penetration Tests) and sampling for laboratory testing purposes including contamination. The surveyed positions of Jacobs' field investigation locations are as shown on the site plan included in **Appendix A**. The details of the fieldwork including in-situ testing, potholing, laboratory testing program and resistivity testing are described below.

3.2 Borehole investigation

The field investigation comprised six boreholes (Boreholes BH1 to BH6) drilled to depths of 8.50 m to 10.40 m below existing ground level. Borehole BH1 was drilled in Eveleigh Carriage Works Yard behind platform one. Boreholes BH2, BH3 and BH4 were drilled in the country ends of Platforms 3, 4 and 9 respectively. Borehole BH5 was drilled in the Illawarra Relief Site Compound Excavation and Borehole BH6 was drilled in the Illawarra Relief Site Compound South Entry Forecourt.

Boreholes BH1, BH2, BH3 and BH4 were drilled using the XC rig, BH5 was drilled using the Commachio 205 and BH6 was drilled using the Hanjin DB8, all of which were track mounted drill rigs. Boreholes were drilled using a tungsten carbide drill bit (TC) and then rock coring. All boreholes were extended by NMLC core drilling techniques to the levels provided in Table 3.1 below.

SPTs were carried out during borehole drilling at regular intervals within the soil and weathered rock horizons, to assess in-situ strength/relative density of materials and to recover representative samples. Samples were also collected for contamination testing purposes, with results of this testing reported under a separate cover (refer to the '*Contamination Investigation Report*'). Rock core recovered from the drilling was packed in core trays, then logged and photographed.

Materials encountered in each borehole were logged by the Jacobs geotechnical engineer in accordance with Australian Standards AS1726-2017 and Jacobs 'Field Investigation Explanatory Notes' which are included along with the engineering logs in **Appendix C**. The investigated borehole locations were surveyed by a surveyor from Jacobs. A summary of the borehole survey information, including elevation and termination depths are provided in Table 3.1.

Table 3.1 – Summary of borehole locations and termination depth

Borehole No.	Termination Depth (m BGL)[1]	Easting (m)[2]	Northing (m)[2]	Surface Elevation (m AHD)[3]
BH1	9.15	333321.8	6248324.6	25.9
BH2	8.50	333351.6	6248322.8	26.4
BH3	9.00	333359.7	6248314.2	26.5
BH4	10.00	333412.4	6248312.4	26.3
BH5	10.40	333481.4	6248345.8	24.0
BH6	9.90	333452.6	6248279.5	25.1

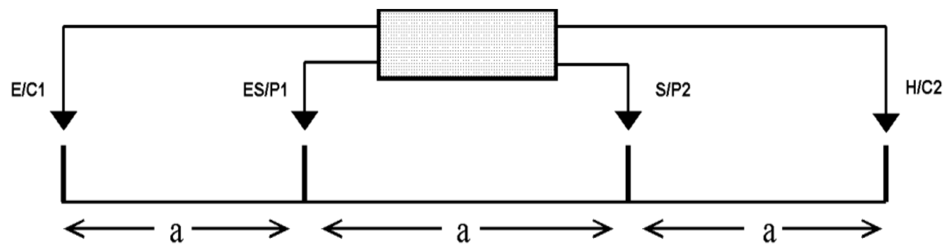
Notes:

1. m BGL = metres below ground level
2. Coordinate system MGA94 Zone 56 H
3. m AHD = metres above Australian height datum

3.3 Soil electrical resistivity

Soil resistivity testing was undertaken in Gibbons Street Reserve. The resistivity tests were carried out using a 4-electrode Wenner configuration (refer Figure 3-1) to measure the electrical resistivity properties of the soils. All test locations were set out by tape measurement. The location of the traverses is provided on the site investigation plan (Figure 1) in **Appendix A** and summarised below in Table 3.2. At each test location, two traverses were undertaken at right angles to each other (test A and B); with a series of readings undertaken for each traverse with electrode spacing's ranging from 0.5 m to 10 m.

Figure 3-1: Resistivity Test Configuration and Calculation



Calculation: Material Resistivity ρ (Ω.m) = 2 * π * a (m) * R(Ω) (where a is the probe spacing and R is the measured resistivity)

The tests were undertaken using a Megger DET4TC Four Pole Soil Resistivity Testing Kit. Calculation sheets of the resistivity tests are provided in **Appendix E**.

Table 3.2 - Summary of Electrical Resistivity Locations and Spacing's

Location ID	Site	Traverse Spacing's (m) Test A / Test B
ER01	Gibbons Street Reserve	0.5,1,2,4,8,10 / 0.5,1,2,4,8
ER02	Gibbons Street Reserve	0.5,1,2,4 / 0.5,1,2,4,8,10

3.4 Service locating

As part of the geotechnical investigations, a review of Dial Before You Dig (DBYD) and Detailed Service Survey (DSS) drawings were carried out for the site area to obtain information on the services and utilities (under and above ground) within the site area and around the site.

Prior to drilling, services were also located using GPR techniques, followed by non-destructive digging (NDD) to confirm no services in high risks areas prior to drilling. All boreholes were backfilled on completion with cement, stabilised sand, bentonite plug and reinstated with a cold mix asphalt layer for locations within the platforms.

3.5 Laboratory testing

Laboratory tests were conducted on selected soil and rock samples retrieved from the boreholes to assess the chemical and mechanical properties of the materials. The samples, including disturbed, SPT and rock core samples were submitted to a laboratory for the type and quantity of testing outlined in Table 3.3.

Laboratory testing was performed using a NATA registered laboratory in accordance with the relevant Australian Standard. Laboratory test certificates presented in **Appendix D**.

Table 3.3 – Proposed laboratory testing

Laboratory Test	Quantity	Methodology
Moisture Content	10	AS1289.2.1.1, 2.1.4
Atterberg Limits and Linear Shrinkage	6	AS1289.3.1.1, 3.2.1, 3.3.1 and 3.4.1
Grading (19 to 0.075 mm)	6	AS1289.3.6.1
Durability Suite (pH, chlorides, sulphates and resistivity)	3	APHA
Point Load Test	27	AS4133.4.1

4. Laboratory & field testing

This section of the report provides the details of the laboratory test results. The purpose of the completed laboratory testing was to confirm visual descriptions and material classifications adopted by Jacobs's geotechnical engineer during field work and derive the engineering properties of each material unit based on standardised test methods and published correlations to assist with developing design parameters.

4.1 Soil mechanical testing

Selected soil samples collected during the field investigation were tested in the laboratory for the measurements of field moisture content (FMC), Atterberg limits, and Particle Size Distribution (PSD). The results of testing are summarised in Table 4.1.

Table 4.1 – Summary of soil mechanical test results

Borehole No.	Sample Depth (m)	Description	FMC[1]	LL[1]	PL[1]	PI[1]	LS[1]	Grading[2]		
			(%)	(%)	(%)	(%)	(%)	Clay/Silt (%)	Sand (%)	Gravel (%)
BH1	3.5-3.7	Silty CLAY	19.1	66	23	43	12.5	-	-	-
BH1	4.1-4.3	Gravelly Silty CLAY	18.3	-	-	-	-	62	4	34
BH2	4.5-4.8	Silty CLAY	16.9	64	24	40	10.0	92	6	2
BH3	3.0-3.45	Silty CLAY	16.4	63	21	42	13.0	85	9	6
BH4	2.5-2.7	Silty CLAY	17.0	62	22	40	10.5	-	-	-
BH4	2.7-3.15	Silty CLAY	15.8	-	-	-	-	79	12	9
BH5	1.3-1.5	Sandy Silty CLAY	11.1	29	16	13	5.5	43	35	22
BH5	2.8-3.0	Sandy Silty CLAY	10.3	-	-	-	-	-	-	-
BH6	2.5-2.95	Silty CLAY	13.2	-	-	-	-	71	12	17
BH6	3.8-4.0	Silty CLAY	12.2	50	20	30	10.0	-	-	-

Notes:

1. FMC = Field Moisture Content, LL = Liquid Limit, PI = Plasticity Index, LS = Linear Shrinkage
2. Grading: Clay/Silt <0.075 mm, Sand 0.075 to 2.36mm, Gravel > 2.36mm

Based on the results of the laboratory testing, the residual clay soils classify as a silty clay of high plasticity and are considered moderately to highly reactive based on a LL of 50 to 66% and PI's in the range of 30 to 43%.

4.2 Chemical testing

Selected soil samples collected during the field investigation were tested in the laboratory for the measurement of pH, sulphates, chlorides, conductivity/resistivity to assess durability for buried structures. The results of testing are summarised in Table 4.2.

Table 4.2 – Summary of soil chemical test results

Borehole No.	Sample Depth (m)	Soil Conditions[1] (A or B)	pH	Sulphate (mg/kg)	Chloride (mg/kg)	Resistivity[2] (ohm cm)
BH2	3.0-3.45	B	5.0	39	20	24,000
BH3	0.6-0.7	B	7.8	52	<10	11,000

Borehole No.	Sample Depth (m)	Soil Conditions[1] (A or B)	pH	Sulphate (mg/kg)	Chloride (mg/kg)	Resistivity[2] (ohm cm)
BH4	1.5-1.95	B	5.3	90	10	13,000

Notes:

1. Soil Types A (High permeability – sands and gravel) and B (low permeability – clays) based on classification in AS2159
2. 1:2 dry sample basis

Results from durability testing indicated pH in range of (5.3 to 7.8), low chlorides (<10 to 20 mg/kg) and sulfates (39 to 90 mg/kg) and resistivity value of (11,000 to 24,000 ohm.cm). Reference to the AS2159 'Piling – Design and Installation' indicates that the results are generally in accordance with the 'non aggressive' classification for steel and 'mild' for concrete structures buried below ground.

The designers should review the results and make due allowance in their design for corrosion based on the recommended allowances in AS2159 or from local experience or other relevant references. Please note that no sampling or testing for durability has been undertaken for groundwater.

4.3 Rock testing

Representative samples of rock core recovered from the boreholes were tested to determine Point Load Strength index (Is50). The test results are summarised in Table 4.3, with point load data also plotted on the individual borehole logs included in **Appendix C**. The laboratory test certificates are attached in **Appendix D**.

Table 4.3 – Summary of rock test results

Borehole No.	Sample Depth (m)	Uncorrected Point Load Strength (Is)		Point Load Strength (Is50)	
		Diametral (MPa)	Axial (MPa)	Diametral (MPa)	Axial (MPa)
BH1	6.50-6.58	0.06	0.15	0.05	0.12
BH1	7.94-7.99	0.01	0.09	0.01	0.07
BH1	8.52-8.60	0.03	0.10	0.03	0.09
BH1	9.00-9.07	0.04	0.09	0.04	0.08
BH2	6.92-6.98	0.05	0.06	0.05	0.05
BH2	7.92-7.98	0.01	0.12	0.01	0.10
BH2	8.42-8.49	0.04	0.11	0.04	0.09
BH3	7.33-7.99	0.00	0.01	0.00	0.01
BH3	8.87-8.94	0.00	0.05	0.00	0.04
BH4	4.90-4.98	0.10	0.07	0.10	0.07
BH4	5.90-6.00	0.13	0.06	0.13	0.06
BH4	6.90-7.00	0.00	0.08	0.00	0.08
BH4	7.71-7.82	0.00	0.11	0.00	0.11
BH4	8.68-8.77	0.11	0.18	0.11	0.19
BH4	9.83-9.95	0.20	0.05	0.20	0.05
BH5	3.92-3.99	0.01	0.25	0.01	0.23
BH5	5.87-5.93	0.32	1.20	0.31	1.02
BH5	6.32-6.36	0.02	0.37	0.02	0.26

Borehole No.	Sample Depth (m)	Uncorrected Point Load Strength (Is)		Point Load Strength (Is50)	
		Diametral (MPa)	Axial (MPa)	Diametral (MPa)	Axial (MPa)
BH5	7.90-7.98	0.08	0.24	0.08	0.19
BH5	8.93-8.99	0.27	2.41	0.26	2.09
BH5	9.48-9.56	0.26	2.45	0.26	2.24
BH5	10.31-10.39	0.26	1.11	0.25	1.00
BH6	5.88-5.96	0.27	0.35	0.27	0.36
BH6	6.90-7.00	0.46	0.58	0.45	0.55
BH6	7.86-7.94	0.16	0.43	0.16	0.43
BH6	8.92-9.00	0.60	0.13	0.60	0.12
BH6	9.82-9.90	0.13	1.03	0.13	0.99

The results from point load testing were used to calibrate the field assessment of recovered rock core and generally confirmed field assessments. This information has been used to inform the rock mass classification undertaken in Section 5.

4.4 Soil resistivity test results

The results for the soil resistivity testing are summarised in Table 4.4 below with the location of the traverses provided on the site investigation plan in **Appendix A**, with calculation sheets provided in **Appendix E**.

Table 4.4 – Soil resistivity test results

Probe Spacing, a (m)	Test A		Test B	
	Measured resistivity R (Ω)	Material resistivity[1] ρ (Ω.m)	Measured resistivity R (Ω)	Material resistivity[1] ρ (Ω.m)
Test ID: ER01				
10	1.63	102	-	-
8	1.88	94	0.82	41
4	5.45	137	5.18	130
2	9.81	123	11.44	144
1	6.11	38	21.1	133
0.5	Error	-	40.9	128
Test ID: ER02				
10	-	-	2.66	167
8	-	-	4.14	208
4	9	226	10.17	256
2	10	126	16	201
1	12	75	26	163
0.5	43.4	136	45.8	144

Notes:

1. Material resistivity (ρ) = 2 * π * a * R (where *a* is the probe spacing and *R* is the measured resistivity)

Results from soil resistivity testing indicated the material resistivity in range of (38 to 256 Ω.m) with an average of 137 Ω.m. Reference to Table 2-3 in the literature '*Military Handbook 419 (MIL-HDBK-419A)*' indicates that the subsurface material is generally in accordance with clay with a varying proportion of sand and gravel. These results correspond to the site conditions experienced during the field investigations.

5. Geotechnical design profile

5.1 Subsurface Profile

Based on the review of available geotechnical information and results of the investigation, a geotechnical model has been developed for the site to assess the excavation and foundation conditions. A brief description of each of the identified geotechnical units is provided in Table 5.1, in order of increasing depth. The soil types and strengths have been inferred based on SPT testing and field assessment for the soil units, with point load testing results and field assessment used for the rock units. A classification of the rock-mass has also been provided which has generally been undertaken in accordance with the guidelines presented in 'Foundations on Sandstone and Shale in the Sydney Basin' (Pells et al, 1998).

This rock mass classification along with the inferred boundary between geotechnical units is provided on Sections 1 to 6 included in **Appendix A**. Note that the location of sections prepared were requested by TfNSW, with the subsurface information shown on the drawings only considered accurate at borehole locations (witnessed by Jacobs). The subsurface conditions between these locations represent Jacobs interpretation and is considered approximate only.

Table 5.1 – Subsurface profile summary

Topography	20 to 30 m AHD[1]		
Soils	(bt) Blacktown		
Geology	(Rwa) Ashfield Shale		
Unit	**Origin**	**Material Description**	**Relevant Jacobs Boreholes**
1	Fill	Variable, Gravelly/silty clay and gravelly sand, gravel is fine to coarse, sub-angular to angular, clay is medium to high plasticity	All
2	Residual Soils	Silty clay: typically, very stiff to hard, dry to moist, pale grey and red-brown with ironstone gravel.	All
3A	Shale Bedrock *(Class V)*[2]	Shale/ Interlaminated Siltstone & Sandstone: typically, extremely to very low strength, extremely to highly weathered, highly fractured, grey-brown	BH3, BH6
3B	Shale Bedrock *(Class IV)*[2]	Interlaminated Siltstone & Sandstone: typically, low strength, moderately weathered, moderately fractured, grey and dark grey	BH1, BH2, BH3, BH4, BH5
3C	Shale Bedrock *(Class III)*[2]	Interlaminated Siltstone & Sandstone: typically, medium to high strength, moderately to slightly weathered, dark grey and pale grey	BH4, BH5, BH6

Notes:

1. m AHD = metres above Australian height datum
2. A classification rock mass undertaken in accordance with the guidelines presented in 'Foundations on Sandstone and Shale in the Sydney Basin' (Pells et al, 1998)

5.2 Groundwater considerations

No free groundwater was observed in the overburden soils or bedrock whilst the bores remained open. It is noted that the boreholes were backfilled immediately following drilling and sampling, thus precluding any longer-term monitoring or observation of groundwater levels. Introduction of water during core drilling may have obscured any observations.

6. Recommendations

6.1 General

At the time of preparing this report, the strategic concepts for the Redfern Station and precinct upgrade were in development and not known. The following preliminary recommendations have been made to assist designers in developing concepts with regards to foundation conditions and general excavation support and retaining wall design requirements. It is recommended that once concepts have been developed that additional geotechnical advice be sought and report updated to confirm assumptions made including any recommendations on further testing that may be warranted.

6.2 Excavation support

Based on the results of the investigations, the ground conditions are expected to comprise Unit 1 and 2 (and possibly 3A) within the platform areas. Excavation in the overlying soil and rock (Units 1, 2 and 3A) should be achievable using conventional excavation type equipment pending access constraints for equipment (i.e. confined excavation footprints). Excavation into rock units 3B and 3C (if required) may need assistance with hydraulic rock breakers, hammers and rock saws. It should be noted that the classification provided is for design of foundations and incorporates recommended allowances for rock defects such as fracture zones and clay seams.

The actual intact rock strength in some cases may be higher than the rock classification suggests, and reference should be made to the bore log when assessing the excavation characteristics of these materials. The approximate boundaries for the different classes of rock have been provided on Figures 2 to 4 in **Appendix A**.

Specific information on excavation requirements at the site was not known at the time of preparing this report. Further geotechnical advice should be sought on specific recommendations for excavation support types and design, once known given proximity to sensitive infrastructure (services, tunnels, structures, track, roadways etc.). As such, temporary battered excavations are unlikely to be viable, with structural support/retaining walls systems required for any excavation works near the station.

For preliminary design of such retaining systems, either temporary or permanent, the soil properties given in Table 6.1 have been provided. Any excavation support system should consider surcharge loads (e.g. construction traffic, footings from adjoining buildings, etc.) and short and long term groundwater pressures as appropriate.

Table 6.1 – Recommended parameters for preliminary excavation support design

Geotechnical Units	Summary Description	Bulk Density kN/m^3	Undrained Strength Cu (kPa)	Drained Strength C' (kPa)	Friction Angle ø' (deg)	Elastic Modulus E' (MPa)
Unit 1	Stiff Gravelly and Silty CLAY	20	100	0	26	30
Unit 2	Very stiff to hard Silty CLAY	20	200	10	30	50
Unit 3A	Class V *(Shale)*	21	-	30	35	100
Unit 3B	Class IV *(Shale)*	22	-	100	35	500

Note:

1. Parameters provided above estimated based on published correlations with field results and Foundation Analysis and Design, Bowles, 1997

6.3 Foundation conditions

Currently there is no information available on foundation loads and foundation layouts for the proposed station upgrade, however, it is anticipated that the following foundation systems may be feasible for canopy, OHWS or walkway type structures.

- Shallow foundations (strip footings, pad footings, slab on grade) founded within residual clay (Unit 2) or weathered shale/sandstone (Unit 3A); or
- Piled Foundation systems (bored piers) extended to found within Units 3A (or better).

Jacobs notes that there are various footing options available for the project and it is recommended that foundation design and foundation layouts be subject to a geotechnical review once structure types, typical loads and layouts are established.

6.3.1 High Level Foundations

Consideration could be given to the use of high level pad or strip footings where depth to good foundation materials are less than a few metres. The recommended design parameters in terms of serviceability and ultimate bearing pressure for shallow foundations are given in Table 6.2 assuming minimum 500 mm embedment into each unit.

Table 6.2 – Serviceability and Ultimate bearing pressures for shallow foundation on rock

Unit	Description	Serviceability End Bearing Capacity (kPa)	Ultimate End Bearing Capacity (kPa)
Unit 2	Stiff (or better) residual soils	150	450
Unit 3A	Class V – Shale	700	3000

Notes:

1. The recommended values given in the table above assume that the bearing surfaces are clean and free from spoil and other soft and loose material and free of water at the time of placement of concrete. The bases of the pad and strip footings should be swept clean.
2. Predictions on foundation settlements can be estimated once foundation loads and layouts are known. For foundations on soil, consideration should be given to shrink/swell movement. For foundations on rock, proportioned for the above serviceability bearing pressures, settlements of <1% of minimum footing dimension could be expected.

6.3.2 Piled Foundation Systems

Alternatively, the use of bored piers founded on rock may be preferred. Recommended geotechnical design parameters for pile foundations are provided below in Table 6.3 below. Jacobs has interpreted the underlying bedrock, based on the guidelines presented in Pells et al. “Design Loadings for Foundations on Shale and Sandstone in the Sydney Region”, Australian Geomechanics Journal, 1978 and the more recent paper also Pells et al (December 1998) “Foundations on Sandstone Shale in the Sydney Region” and provided preliminary end bearing and shaft adhesion parameters.

The approximate boundaries for the different classes of rock have been provided on Figures 2 to 4 in **Appendix A**.

Table 6.3 – Rock Classification and Preliminary Allowable Design Pressures

Material and Classification	Allowable End Bearing Pressure (kPa)	Ultimate End Bearing Pressure (kPa)	Ultimate Shaft Adhesion (kPa)
Unit 3: Bedrock			
Unit 3A – Class V *(Shale)*	700	3000	50
Unit 3B – Class IV *(Shale)*	1000	3000	150
Unit 3C - Class III *(Shale)*	2500	8000	350

Notes:

1. Parameters provided above estimated based on published correlations with field results based on recommendation contained within "Foundations on Sandstone and Shale in the Sydney Region", December 1998
2. Clean socket of R2 roughness or better
3. Serviceability end bearing pressures to result in settlements of 1% or less of minimum footing dimension.

These above values assume that piles are socketed a minimum of 500 mm. For bored pile construction, it will be necessary to use a cleaning bucket to ensure that the base of the pile is clean of drilling debris. If pile capacities rely on shaft adhesion, then it will also be necessary to use a sidewall roughing tool to ensure that the design shaft adhesion values can be achieved. Shaft adhesion in the fill and overburden soils should be ignored for design of rock end bearing and socketed piles.

6.3.3 Inspection and Checking Procedures

All foundation excavations (including those for high level footings and piles) should be kept free of ponded water to prevent softening of the founding strata. Excavations should not be left open overnight. All footings should be excavated, cleaned, and poured with minimal delay to avoid deterioration of the bearing surface. Where appropriate side wall support/pile casing should be provided to support unstable excavation conditions are encountered. The base of all excavations should be inspected immediately prior to foundation construction to check that loose debris has been removed.

For bored piles founded in rock, it will be necessary to conduct geotechnical inspections of footing sites. The recommended minimum investigation or proving techniques are as outlined in (Pells et al., 1978) for the Class of rock being specified.

6.3.4 Durability for structures (soil)

Reference to the AS2159 *'Piling – Design and Installation'* indicates that the results are generally in accordance with a 'mild' classification for concrete and 'non-aggressive' classification for steel structures buried below ground in soil. The designers should review the results and make due allowance in their design for corrosion based on the recommended allowances from the codes. It is recommended that groundwater testing should also be undertaken to further assess durability.

6.3.5 Earthquake considerations

Structural design for earthquake loads should be carried out in accordance with the relevant provisions as detailed in AS1170.4 *"Structural Design Actions Part 4: Earthquake Actions in Australia"* or other specified standard. The following lists the site sub-soil class and hazard factors based on reference to AS1170.4:

- Based on soil conditions (up to 6.5 m soil over bedrock) - the sub-soil class is assessed as "Ce – Shallow Soil Site".
- Based on location - Hazard Factor (Z) of 0.08.

7. Summary

Some preliminary geotechnical constraints/risks identified as part of these early geotechnical investigations are listed as follows:

- Moderately deep clay and deeply weathered shale/laminite profile (Specifically Platform areas) was encountered in BH1 to BH4. Generally better quality shale/laminate (medium strength or better) was only observed in the eastern side of the alignment (BH5 and BH6). As such, there may be some limitation in available pile bearing and shaft adhesion capacities for rock socketed piles.
- The location of new foundations and structures may be in close proximity to existing tunnel infrastructure. A number of existing rail tunnels (operational and disused) have been identified including Up Eveleigh Engine Dive (Active), Wells Street Dive (Disused), Eastern Underbridge and the Up and Down Illawarra Relief Tunnels (Active). Any works would need to consider the current Sydney Trains guideline for any development works (excavation/foundations etc.) near the railway tunnels (Refer - Transport for NSW document, 'Development Near Rail Tunnels' T HR CI 12051 ST').
- Condition and stability of the existing railway platforms. A structural and geotechnical review of the stability of the existing platforms is recommended, depending on proposal for upgrading the station. Assessment would need to consider current stability and condition and also potential for piling equipment on platforms for canopy, stairs, overbridge or other structure foundation construction.
- Condition and stability of the existing disused Illawarra Relief compound area. The existing structures (primarily sheet pile wall) and retaining walls in this area appear in poor to moderate condition, and possibly installed as temporary support measures only for planned additional rail tunnels that never progressed. Structural inspection and review of this area is recommended to assess condition and any temporary repairs that may be required in the interim for planned construction works. Permanent solutions will need to consider the decommissioning and replacement pending final plans for this area.
- Currently no information on groundwater quality or depth has been obtained. If deeper works are proposed at the site, then specific piezometer installation and sampling of groundwater quality and levels may be required to inform on any minor dewatering requirements.

It should be note that at the time of preparing this report, the strategic concepts for the Redfern Station and precinct upgrade were in development and not known or provided for comment. The assessment and recommendations have been made to assist designers in developing concepts with regards to foundations conditions and general excavation support design. Once concepts have been developed, additional geotechnical advice will be required to confirm assumptions made. This includes any recommendations on further testing that may be warranted to address potential geotechnical risks listed above and/or identify additional geotechnical risks for the project.

8. Limitations

The sole purpose of this report is to present the interpretive results from geotechnical investigations carried out by Jacobs for Transport for NSW ('the Client') in connection with the Redfern Station Investigation Works. This report was produced in general accordance with and is limited to the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

An assessment or study of on-site conditions investigates the potential for exposure to the presence of inadequate bearing ground. All reports and conclusions that deal with sub-surface conditions are based on interpretation and judgement and as a result have uncertainty attached to them. You should be aware that this report contains interpretations and conclusions which are uncertain, due to the nature of the investigations. No study can investigate every risk, and even a rigorous assessment and/or sampling programme may not detect all problem areas within a site.

This report is based on assumptions that the site conditions as revealed through sampling are indicative of conditions throughout the site. The findings are the result of standard assessment techniques used in accordance with normal practices and standards, and (to the best of Jacobs' knowledge) they represent a reasonable interpretation of the current conditions on the site.

Sampling techniques, by definition, cannot determine the conditions between the sample points and so this report cannot be taken to be a full representation of the sub-surface conditions. This report only provides an indication of the likely sub surface conditions.

Conditions encountered when site work commences may be different from those inferred in this report, for the reasons explained in this limitation statement. If site conditions encountered during site works are different from those encountered during Jacobs' site investigation, Jacobs reserves the right to revise any of the findings, observations and conclusions expressed in this report.

The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report.

In preparing this report, Jacobs has relied upon, and presumed accurate, information provided by the Client and from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report does not address environmental or geo-environmental issues including the presence of any contaminants or hazardous materials at the site unless Jacobs was specifically and expressly retained to do so. Except as specifically stated in this report, Jacobs makes no statement or representation of any kind concerning the suitability of the site for any purpose or the permissibility of any use.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, the Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

9. References

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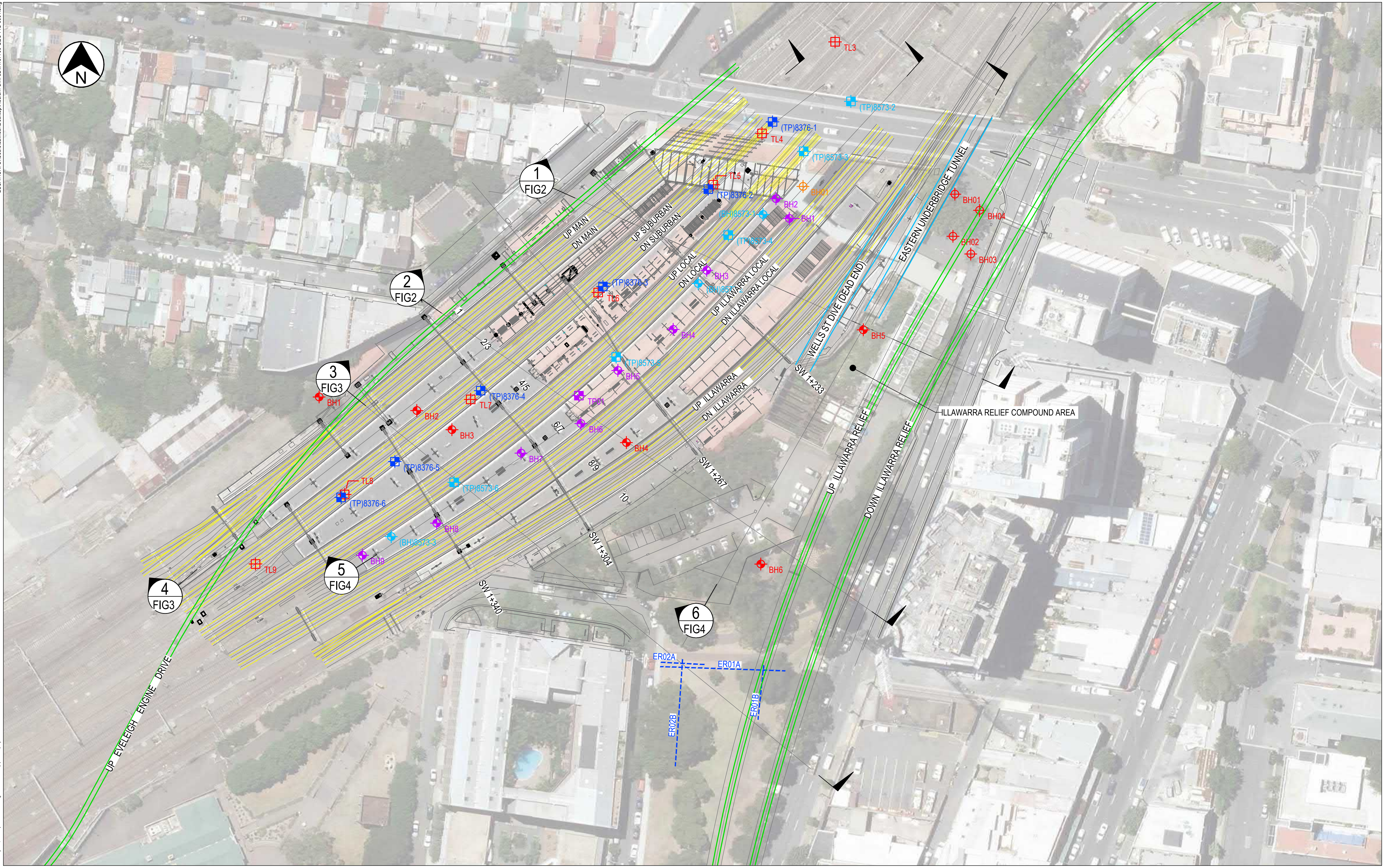
- Standards Australia International (2002), Australian Standard AS1170.0– 2002 Structural Design Actions Part 0: General Principles
- Standards Australia International (2007), Australian Standard AS1170.4– 2007 Structural Design Actions, Part 4: Earthquake Actions in Australia

Appendix A. Site investigation plan and cross sections



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JACOBS

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

CURRENT INVESTIGATION	PREVIOUS STUDIES		
Borehole (JACOBS Nov 2017)	Borehole (JACOBS May 2017)	Borehole (Railcorp 2010)	Test Pit (J&K 2007)
Electrical Resistivity Test	Borehole (NovoRail 2014)	Test Pit (Railcorp 2010)	
	Borehole (GeoEnviro 2015)	Test Pit (Railcorp 2008)	

SCALES ON A3 SIZE DRAWING
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AT A3

REDFERN STATION INVESTIGATION WORKS
GEOTECHNICAL INVESTIGATION
SITE PLAN
IA157700-0000-CI-SKT-001
Figure 1

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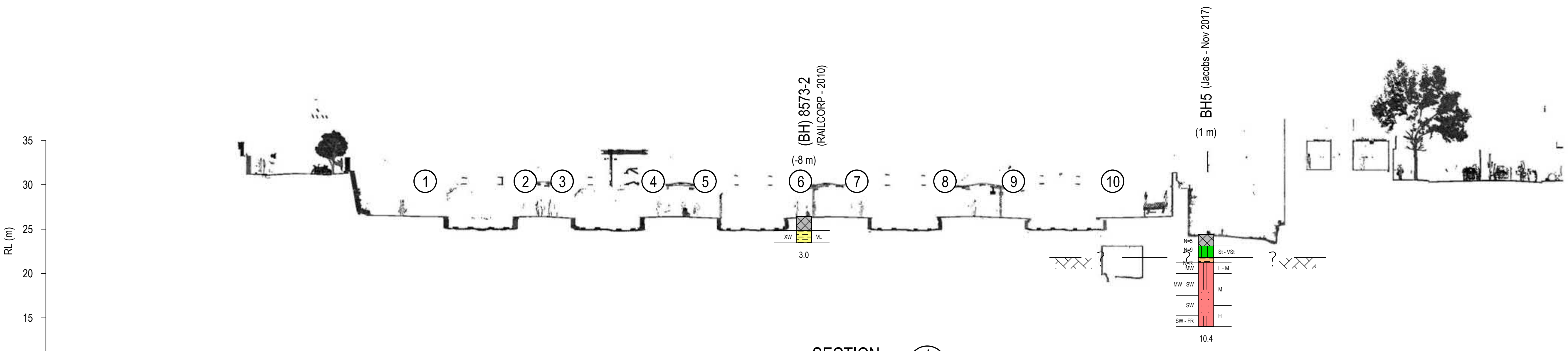
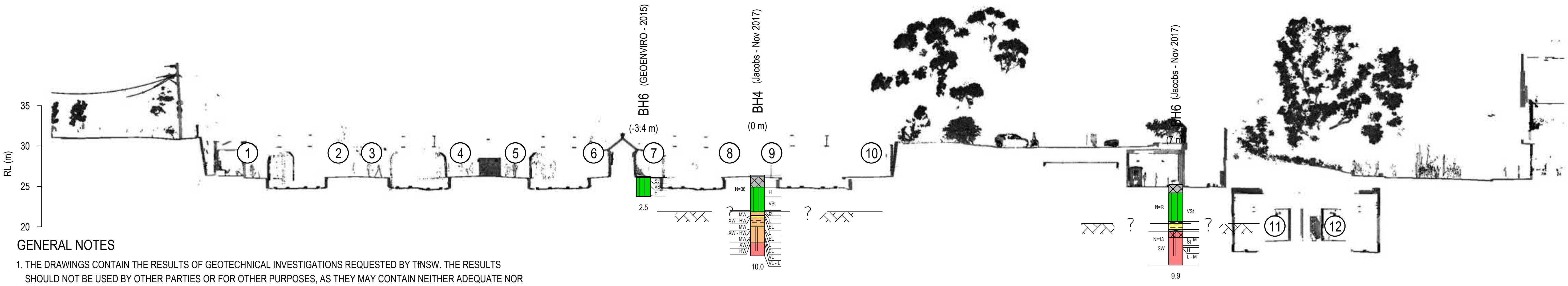


SECTION 1
1:500 FIG1



GENERAL NOTES

1. THE DRAWINGS CONTAIN THE RESULTS OF GEOTECHNICAL INVESTIGATIONS REQUESTED BY TfNSW. THE RESULTS SHOULD NOT BE USED BY OTHER PARTIES OR FOR OTHER PURPOSES, AS THEY MAY CONTAIN NEITHER ADEQUATE NOR APPROPRIATE INFORMATION.
2. SURFACE LEVELS FOR SECTIONS HAVE BEEN PREPARED FROM 2017 POINT CLOUD / STATIC SCANNER DATA BY JACOBS.
3. SUBSURFACE CONDITIONS HAVE BEEN ASSUMED BY INTERPRETATION AND/OR EXTRAPOLATION FROM DISCRETE AND WIDELY SPACED EXPLORATORY HOLES. AS SUCH THE CONDITIONS SHOWN ARE AN INTERPRETATION OF THE GROUND CONDITIONS AND MUST BE CONSIDERED AS A GUIDE ONLY.
4. LOCAL VARIATIONS OR ANOMALIES IN GROUND CONDITIONS CAN OCCUR IN THE NATURAL ENVIRONMENT, PARTICULARLY BETWEEN DISCRETE EXPLORATORY HOLE LOCATIONS.
5. ALL DRAWINGS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GEOTECHNICAL REPORT.

SECTION 2
1:500 FIG1

LEGEND

1 PLATFORM No
? INFERRED ROCK LEVEL

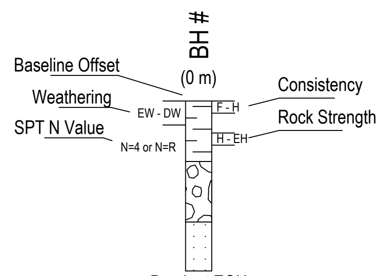
MATERIAL GRAPHIC

- FILL
- CH - High Plasticity CLAY
- CORE LOSS
- INTERBEDDED SILTSTONE & SANDSTONE
- SHALE
- GC - Clayey GRAVEL
- Asphaltic Concrete

GEOLOGY UNIT

- FILL (UNIT 1)
- RESIDUAL (UNIT 2)
- Class V (UNIT 3A)
- Class IV (UNIT 3B)
- Class III (UNIT 3C)

POST LEGEND



SOIL CONSISTENCY

VS	VERY SOFT	(su <12 kPa)
S	SOFT	(su 12 to 25 kPa)
F	FIRM	(su 25 to 50 kPa)
St	STIFF	(su 50 to 100 kPa)
VSt	VERY STIFF	(su 100 to 200 kPa)
H	HARD	(su >200 kPa)

ROCK WEATHERING

XW	EXTREMELY WEATHERED
HW	HIGHLY WEATHERED
MW	MODERATELY WEATHERED
SW	SLIGHTLY WEATHERED
FR	FRESH

ROCK STRENGTH

EL	EXTREMELY LOW STRENGTH
VL	VERY LOW STRENGTH
L	LOW STRENGTH
M	MEDIUM STRENGTH
H	HIGH STRENGTH
VH	VERY HIGH STRENGTH
EH	EXTREMELY HIGH STRENGTH

JACOBS

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

SCALES ON A3 SIZE DRAWING
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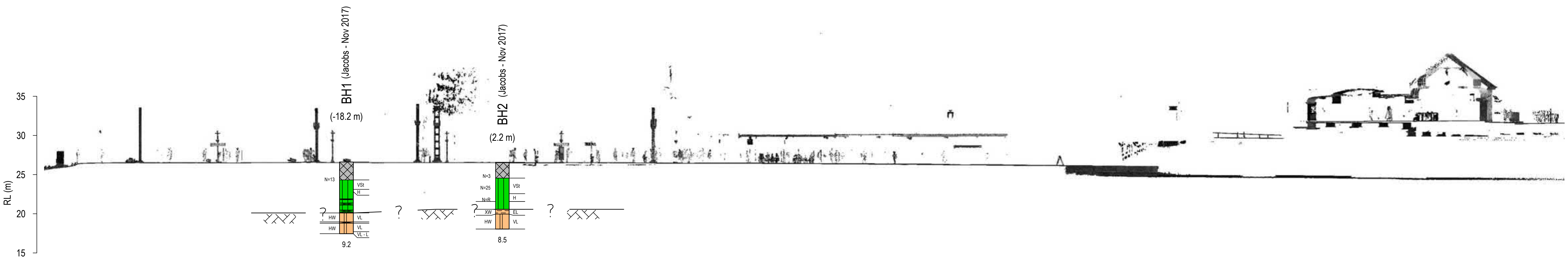
REDFERN STATION INVESTIGATION WORKS
GEOTECHNICAL INVESTIGATION
SECTIONS
IA157700-0000-CI-SKT-002
Figure 2

SECTION 3
1:500
3
FIG1



SECTION 4
1:500
4
FIG1

LEGEND

1 PLATFORM No

? INFERRED ROCK LEVEL

MATERIAL GRAPHIC

- FILL
- CH - High Plasticity CLAY
- CORE LOSS
- INTERBEDDED SILTSTONE & SANDSTONE
- SHALE
- GC - Clayey GRAVEL
- Asphaltic Concrete

GEOLOGY UNIT

- FILL (UNIT 1)
- RESIDUAL (UNIT 2)
- Class V (UNIT 3A)
- Class IV (UNIT 3B)
- Class III (UNIT 3C)

POST LEGEND

BH #
(0 m)
Baseline Offset
Weathering
SPT N Value
EW - DW
N=4 or N=R
Consistency
Rock Strength
F - H
H - EH
Depth at EOH

SOIL CONSISTENCY

VS	VERY SOFT	(su <12 kPa)
S	SOFT	(su 12 to 25 kPa)
F	FIRM	(su 25 to 50 kPa)
St	STIFF	(su 50 to 100 kPa)
VSt	VERY STIFF	(su 100 to 200 kPa)
H	HARD	(su >200 kPa)

ROCK WEATHERING

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MW	MODERATELY WEATHERED
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FR	FRESH

ROCK STRENGTH

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L	LOW STRENGTH
M	MEDIUM STRENGTH
H	HIGH STRENGTH
VH	VERY HIGH STRENGTH
EH	EXTREMELY HIGH STRENGTH

JACOBS

SCALES ON A3 SIZE DRAWING
SCALE 1:500 5 0 5 10 AT A3

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

REDFERN STATION INVESTIGATION WORKS
GEOTECHNICAL INVESTIGATION
SECTIONS
IA157700-0000-CI-SKT-002

Figure 3

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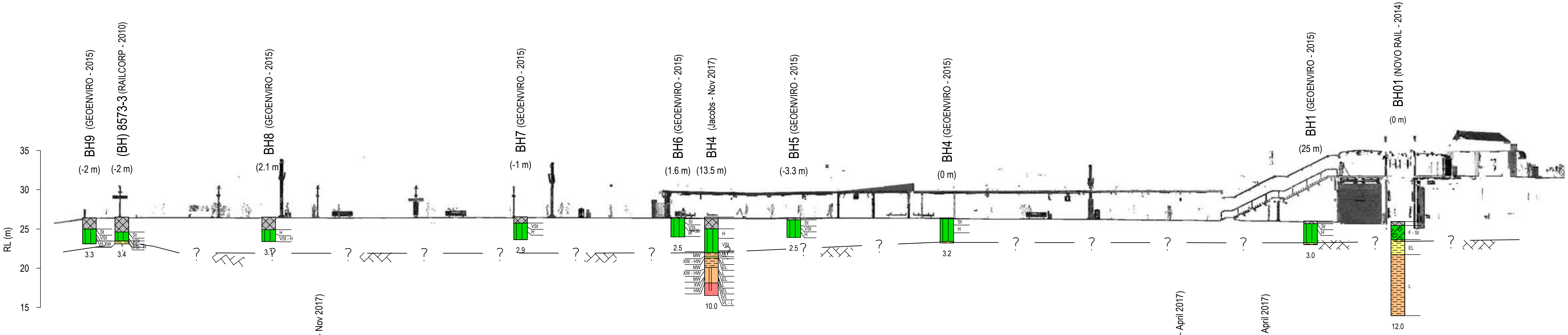
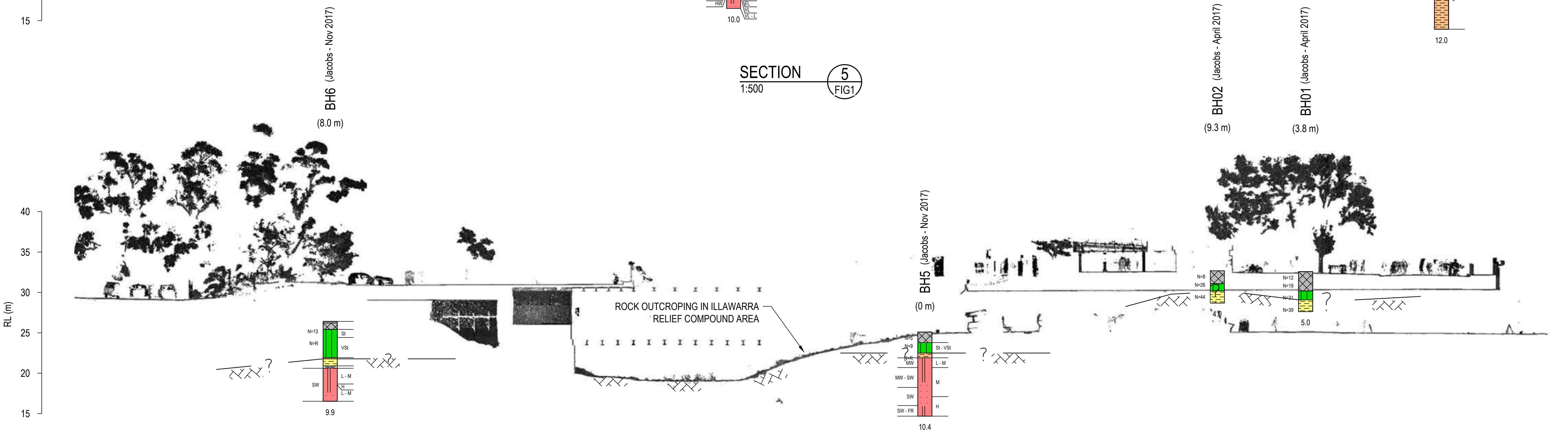


SECTION 5
1:500
FIG1



SECTION 6
1:500
FIG1

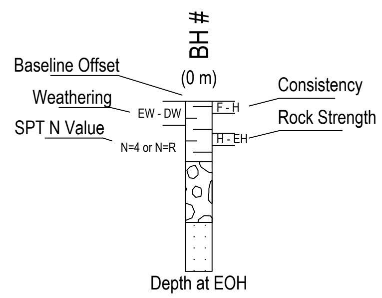
MATERIAL GRAPHIC

- FILL
- CH - High Plasticity CLAY
- CORE LOSS
- INTERBEDDED SILTSTONE & SANDSTONE
- SHALE
- GC - Clayey GRAVEL
- Asphaltic Concrete
- ? INFERRED ROCK LEVEL

GEOLOGY UNIT

- FILL (UNIT 1)
- RESIDUAL (UNIT 2)
- Class V (UNIT 3A)
- Class IV (UNIT 3B)
- Class III (UNIT 3C)

POST LEGEND



SOIL CONSISTENCY

VS	VERY SOFT	(su <12 kPa)
S	SOFT	(su 12 to 25 kPa)
F	FIRM	(su 25 to 50 kPa)
St	STIFF	(su 50 to 100 kPa)
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MW	MODERATELY WEATHERED
SW	SLIGHTLY WEATHERED
FR	FRESH

ROCK STRENGTH

EL	EXTREMELY LOW STRENGTH
VL	VERY LOW STRENGTH
L	LOW STRENGTH
M	MEDIUM STRENGTH
H	HIGH STRENGTH
VH	VERY HIGH STRENGTH
EH	EXTREMELY HIGH STRENGTH

JACOBS

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

SCALES ON A3 SIZE DRAWING
SCALE 1:500 — 5 0 5 10 — AT A3

REDFERN STATION INVESTIGATION WORKS
GEOTECHNICAL INVESTIGATION
SECTIONS
IA157700-0000-CI-SKT-002
Figure 4

Appendix B. Background information

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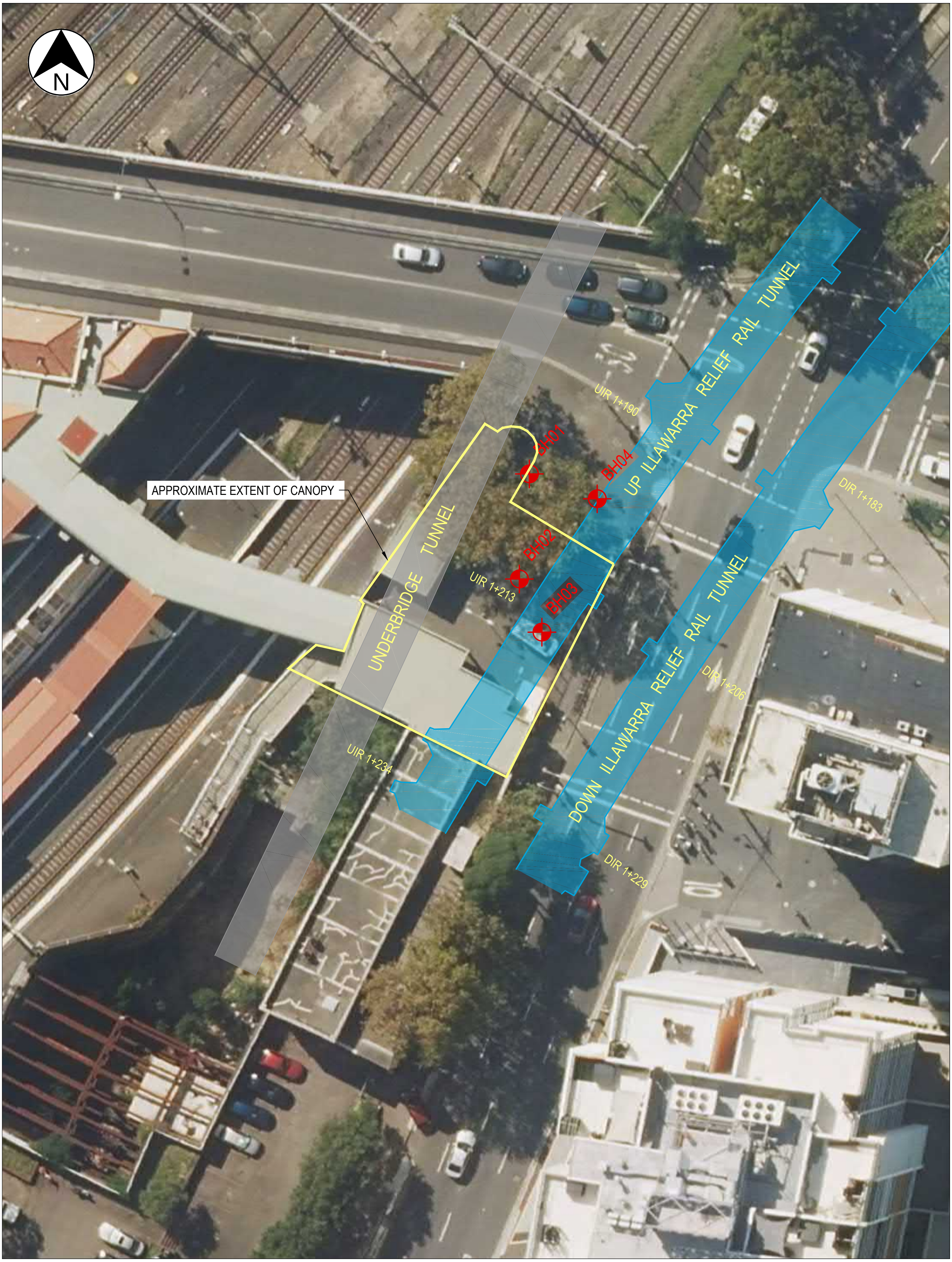


SCALE 1:500 — 5 0 5 10 — AT A4

JACOBS

LEGEND

Borehole Location

CO-ORDINATE SYSTEM: MGA ZONE 56

HEIGHT DATUM: AHD

Transport for NSW - Sydney Trains

Station Upgrade Project - Redfern Station SP3

Borehole Location Plan

IA134800-017-GE-FIG-0001

FIGURE 1

JACOBS

Soil Description

MATERIAL DESCRIPTION

Soil description is based on an assessment of disturbed samples, as recovered from boreholes and excavation, and from undisturbed materials as seen in excavation and exposures or in undisturbed samples.

CLASSIFICATION

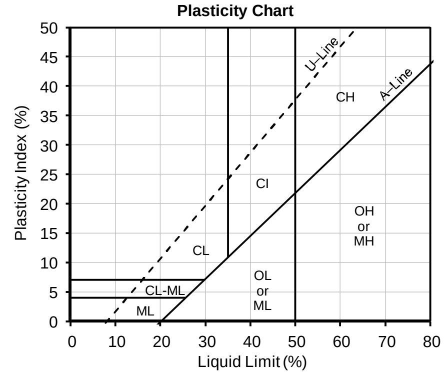
Soils are described in general accordance with AS1726-1993 and the Unified Soil Classification (USC) as shown below.

Field Identification procedures (Excluding particles larger than 63 mm and basing fractions on estimated mass)				Code	Typical Names	Describing Soils	Laboratory Classification Criteria		
COARSE GRAINED SOILS More than 50% of material less than 63 mm is larger than 0.075 mm	GRAVELS More than 50% of coarse fraction is larger than 2.36 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name, symbol, indicate approximate % of sand and gravel, maximum size, angularity, surface condition, and strength of coarse grains: colour, amount plasticity of fine component. For undisturbed soils add information on moisture content, degree of compactness, stratification, cementation, and odour. Give local and other pertinent descriptive information. Example: SILTY SAND (SM), fine to coarse, light grey, about 20% strong angular gravel particles – 10mm max. size, rounded and sub-angular sand, about 12% non-plastic fines, moist, dense alluvial sand.	Use grain size curve in identifying the fractions as given under field identification	Determine percentages of gravel and sand from grain size curve Depending on percentage smaller than 0.075 mm size coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP More than 12% GM, GC, SM, SC 5% to 12% Borderline cases requiring use of dual symbols	Greater than 4 $c_u = \frac{D_{60}}{D_{10}}$ Between 1 & 3 $c_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$
			Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels				Not meeting all gradation requirements for GW.
		GRAVELS WITH FINE (Appreciable fines)	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	GM	Silty gravels, gravel-sand-silt mixtures				Atterberg limits below 'A' line or PI less than 4 — Above 'A' line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			'Dirty' materials with excess of plastic fines, medium to high dry strength	GC	Clayey gravels, gravel-sand-clay mixtures				Atterberg limits above 'A' line with PI greater than 7
	SANDS More than 50% of coarse fraction is smaller than 2.36 mm	CLEAN SANDS (little or no fines)	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	SW	Well graded sands, gravelly sands, little or no fines				Greater than 6 $c_u = \frac{D_{60}}{D_{10}}$ Between 1 & 3 $c_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$
			Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands				Not meeting all gradation requirements for SW
		SANDS WITH FINES (Appreciable fines)	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	SM	Silty sands, sand-silt mixtures				Atterberg limits below 'A' line or PI less than 4 — Above 'A' line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			'Dirty' materials with excess of plastic fines, medium to high dry strength	SC	Clayey sands, sand-clay mixtures				Atterberg limits above 'A' line with PI greater than 7

IDENTIFICATION PROCEEDURES ON FRACTIONS < 0.075 mm

		DRY STRENGTH	DILATANCY	TOUGHNESS	Code	Typical Names	Describing Soils
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm	SILTS AND CLAYS Liquid limit <50	None to low	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with low plasticity. Silts of low to medium Liquid Limit	Give typical name, symbol, and indicate degree and character of plasticity, colour, amount and size of coarse grains. For undisturbed soils add information on moisture content, consistency, structure, stratification, and odour. Give local or geologic name and other pertinent descriptive information. Example: CLAYEY SILT (ML), brown, low plasticity, trace sand, firm, dry, numerous vertical root holes.
		Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays	
		Low to medium	Slow	Low	OL*	Organic silts and organic silt-clays of low to medium plasticity	
	SILTS AND CLAYS Liquid limit >50	Low to medium	Slow to none	Low to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, silts of high Liquid Limit	
		High to very high	None	High	CH	Inorganic clays of high plasticity	
		Medium to high	None to very slow	Low to medium	OH*	Organic clays of high plasticity	
HIGHLY ORGANIC SOILS		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			Pt*	Peat and other highly organic soils	

Plasticity Chart



Laboratory:

MC	Moisture Content	MDD	Maximum Dry Density
LL	Liquid Limit	OMC	Optimum Moisture Content
PL	Plastic Limit	PSD	Particle Size Distribution
PI	Plasticity Index	UU	Undrained Unconsolidated
LS	Linear Shrinkage	CU	Consolidated Undrained
ρ_p	Particle Density	CD	Consolidated Drained
ρ_b	Bulk Density	$I_{s(50)}$	Point Load Index
ρ_d	Dry Density	UCS	Uniaxial Compressive Strength

Boundary classifications – Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.

* effervesces with H_2O_2

DESCRIPTION OF A SOIL

i. Colour
ii. Plasticity or particle characteristics of soil
iii. Secondary components name
iv. Estimated proportion
v. Secondary component plasticity or particle characteristics
vi. Other minor soil components
vii. Structure of soil, geological origin
viii. Consistency / density
ix. Moisture condition

Term		Grain Size	Shape and Texture	Field Guide
CLAY		< 2 µm	Shiny	Not visible under 10x
SILT		7 – 75 µm	Dull	Visible under 10x
SAND	Fine	0.075 – 0.2 mm	Angular / sub - angular / sub - rounded / rounded	Visible by eye
	Medium	0.2 – 0.6 mm		Visible at < 1 mm
	Course	0.6 – 2.36 mm		Visible at < 3 mm
GRAVEL	Fine	2.36 – 6 mm		Visible at < 5 mm
	Medium	6 – 20 mm		Road Gravel
	Course	20 – 63 mm		Rail ballast
COBBLES		63 – 200 mm		Beaching
BOULDERS		> 200 mm		

COLOUR

The colour of a soil should be described using simple terns, such as black, white, grey, red, brown, orange, yellow green or blue. These may be modified as necessary by 'pale', 'dark' or 'mottled'. Borderline colours may be described as a combination of these colours (e.g. orange brown). Where a soil consists of a primary colour with a secondary mottling it should be described as (primary colour) mottled (first colour) and (secondary colour). Where a soil consists of two colours presented in roughly equal proportions the colour description should be mottled (first colour) and (secondary).

PARTICLE CHARACTERISTICS – COARSE GRAINED SOILS

Term	Description
Well Graded	Having good representation of all particle sizes
Poorly graded	With one or more intermediate size poorly represented
Gap graded	With one or more intermediate sizes absent
Uniform	Essentially of one size

ANGULARITY – COARSE GRAINED SOILS

Rounded Sub-rounded Sub-angular Angular

PLASTICITY

Liquid limit (%)	Description
≤ 35	Low plasticity
>35 to ≤ 50	Medium plasticity
> 50	High plasticity

DESCRIPTIVE TERMS FOR SECONDARY AND MINOR COMPONENTS

Coarse Grained Soils		Fine grained soils	
% Fines	Modifier	% Coarse	Modifier
≤ 5	Omit or use 'trace'	≤ 15	Omit, or use 'trace'
>5 to ≤12	Describe as 'with clay/ silt' as applicable	>15 to ≤ 30	Describe as 'with sand/ gravel' as applicable
> 12	Prefix soil type as 'clayey/silt' as applicable	> 30	Prefix soil type as 'sandy/ gravelly' as applicable

CONSISTENCY TERMS – COHESIVE SOILS

Term	Undrained shear strength	SPT (N) Blow Count	Field Guide to consistency
Very Soft (VS)	<12	0 – 2	Easily penetrated several centimetres by fist, exudes between fingers when squeezed in fist
Soft (S)	12 – 25	2 – 4	Easily penetrated several centimetres by thumb, easily moulded by light finger pressure
Firm (F)	25 – 50	4 – 8	Can be penetrated several centimetres by thumb with moderate effort, and moulded between the fingers by strong pressure
Stiff (St)	50 – 100	8 – 15	Readily indented by thumb but penetrated only with difficultly. Cannot be moulded by fingers
Very Stiff (VSt)	100 – 200	15 –30	Readily intended by thumb nail, still very tough
Hard (H)	>200	>30	Indented with difficulty by thumb nail, brittle

CONSISTENCY TERMS – NON COHESIVE SOILS

Term	Density Index (%)	SPT (N) Blow Count	Field Guide to Density
Very Loose (VL)	< 15	0 – 4	Ravels
Loose (L)	15 – 35	4 – 10	Shovels easily
Medium Dense (MD)	35 – 65	10 – 30	Shovelling very difficult
Dense (D)	65 – 85	30 – 50	Pick required
Very Dense (VD)	> 85	50 -100	Pick difficult

MOISTURE

Term (Symbol)	Description
Dry	Looks and feels dry, cohesive soils hard and friable
Moist	Soil feels cool, darkened in colour, tends to cohere
Wet	Free water on remoulding
< Wp	Hard and friable or powdery, moisture content well below plastic limit
Wp	Soil feels cool, darkened in colour, can be moulded, near plastic limit
> Wp	Soil feels cool, dark, usually weakened, free water, moisture content well above plastic limit

STRUCTURE

Term	Description
Zoning	Soils may consist of separate zones different in colour, grain size or other properties. The thickness, orientation and any distinguishing features of the zone should be described i.e. gradational or distinct boundaries. The patterns of these zones may be described using layer (zone is continuous), lens (a discontinuous layer of different material, with lenticular shape) or pocket (irregular inclusion of different materials).
Defects	The dimensions, orientation and spacing of the defects should be given. The surface of the defects should be described in terms of texture (rough, polished) and coating. Defects may be re-cemented and may be stronger than the parent soils. Defects may include fissures, cracks, roots, roots and tube holes, infill tubes, in-filled seams, dykes.
Cementing	Soils or defects within soils may be cemented together by various agencies. The nature of the cementing agent should be identified if possible, strength, reaction to acid and the like. Weakly cemented – If the cementing agent allows the particle aggregation to be easily fractured by hand when the soil is saturated. Strongly cemented – If the cementing agent prevents fracturing by hand of the particle when the soil is saturated (use strength classification as per rock)

ADDITIONAL OBSERVATIONS

Geological origin

Term	Description
Weathered in place soils	Extremely weathered soil - Structure and fabric of parent rock visible
	Residual soil - Structure and fabric of parent rock not visible
Transported soils	Aeolian soil - Deposited by wind
	Alluvial soil - Deposited by streams and rivers
	Colluvial soil -Deposited on slopes (transported down slope)
	Lacustrine soil - Deposited by lakes
	Marine soil - Deposited in ocean, bays, beaches and estuaries
Fill materials	Soil Fill - Describe soil type, UCS symbol and add 'FILL'
	Rock Fill - Rock type, degree of weathering, and word 'FILL'
	Domestic Fill - Percent soil or rock, whether pretrucible or not
	Industrial Fill - Percent soil, whether contaminated, particle size & type of waste product, i.e. – brick, concrete, metal

Any scour should be noted.

ORGANIC OR ARTIFICIAL MATERIALS

Preferred Terms	Secondary Description
Organic matter	Fibrous peat, charcoal, wood fragments, roots (greater than 2 mm diameter), root fibres (less than 2 mm diameter)
Waste fill	Domestic refuse, oil, bitumen, brickbats, concrete rubble, fibrous plaster, wood pieces, wood shavings, saw dust, iron filings, drums, steel bars, steel scrap, bottles, broken glass, leather.

Rock Description

ROCK TYPE

Composition of the rock material i.e. colour, grain size, structure, texture, fabric, mineral composition, hardness alteration, cementation etc. as applicable. Condition of the material i.e. estimated strength, weathering and moisture condition. Rock mass properties i.e. structure of rock, defects – type, orientation spacing, roughness, waviness and continuity and weathering (of the rock mass).

GRAIN SIZE

Particle size scales depends on rock type. For sedimentary rocks, the following descriptors can be used:

- Sand terms for sandstone
- Gravel terms for conglomerates and breccias
- No description of grainsize is required for claystone, siltstone, shale and mudstone etc.

For metamorphic and igneous rocks, record the typical grain size in millimetres

COLOUR

The colour of a rock should be described using simple terms, such as black, white, grey, red, brown, orange, yellow, green or blue. These may be modified as necessary by 'pale', 'dark' or 'mottled'. Borderline colours may be described as a combination of these colours (e.g. grey green).

STRUCTURE

Terms typically used to describe the structure of a rock mass where possible include:

- Sedimentary rocks – bedded, laminated
- Metamorphic – foliated, banded, cleaved
- Igneous rocks – massive, flow banded.

The spacing or thickness of these structural features should be given as described in the table below:

Thickness	Bedding Term
< 6 mm	Very thinly laminated
6 – 20 mm	Thinly laminated
20 – 60 mm	Laminated
60 – 200 mm	Thinly Bedded
0.2 – 0.6 m	Medium bedding
0.6 – 2 m	Thickly bedded
> 2 m	Very thickly bedded

TEXTURE

Type	Definition
Massive	Effectively Homogeneous and isotropic. Bulky or equidimensional and elongated or tabular grains uniformly distributed.
Distinct	Bedded, foliated, cleaved – effectively homogeneous with planar anisotropy. Elongated or tabular grains or pores in a layered arrangement. The arrangement of grains, referred to as the rock fabric, may show a preferred orientation.

STRENGTH

Term	Code	$I_{s(50)}$ (MPa)	Field Guide to Strength
Extremely Low	EL	≤ 0.30	Easily remoulded by hand to a material with soil properties.
Very Low	VL	> 0.03 to ≤0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 3 cm thick can be broken by finger pressure.
Low	L	> 0.1 to ≤ 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blow of the pick point; has dull sound under hammer. A piece of core 150 mm long 50 mm in diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	> 0.3 to ≤ 1.0	Readily scored with a knife; a piece of core 150 mm long by 50 mm in diameter can be broken by hand with difficulty.
High	H	> 1 to ≤ 3	A piece of core 150 mm long by 50 mm in diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	VH	> 3 to ≤ 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High	EH	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

1. These terms refer to the strength of the rock material and not to the strength of the rock mass which may be considered weaker due to the effect of rock defects.
2. The field guide visual assessment of rock strength may be used for preliminary assessment or when point load testing is not available.
3. Anisotropy of rock material samples may affect the field assessment of strength

WEATHERING CLASSIFICATION

Degree of weathering		Definition
Residual soil (RS)		Soil developed from weathering of rock in-situ. The mass structure and substance fabric are no longer evident.
Extremely weathered rock (EW)		Rock is weathered to such an extent that it has soil properties. It disintegrates or can be remoulded in water. It shows a rock fabric but is described as a soil.
Highly weathered rock (HW)	Distinctly weathered (DW)*	Secondary minerals often weathered to clay. Staining of most grain boundaries and some disintegration due to weakening of grain bonds. Often significant loss of strength. However cementing of joints can occasionally lead to strengthening.
Moderately weathered rock (MW)		Staining and pitting of most secondary minerals and other grain boundaries. The loss of strength depends on the weathering and extent of secondary minerals in the rock matrix. The rock substance may be highly discoloured, usually by iron staining.
Slightly weathered rock (SW)		Secondary minerals are stained but not pitted, slight staining at some grain boundaries. Little or no change of strength indicated by amount of colour change.
Fresh rock (F)		Rock shows no sign of decomposition or staining. Relatively strong.

*Distinctly Weathered indicates a distinct change in colour, hardness and/or friability and not distinguishable into HW or MW

DESCRIPTION OF A DISCONTINUITY

- Depth
- Dip
- Infill material
- Aperture observation
- Planarity
- Small scale roughness
- Aperture measurement (mm)
- Remark
- Roughness Class

INFILL MATERIAL

Code	Description
CA	Calcite
CH	Clay
CG	Clayey gravel
GM/ GP/ GW	Gravel
Fe	Iron oxide
Fe Clay	Iron oxide clay
Qz	Quartz
X	Carbonaceous

APERTURE OBSERVATION

Term	Code	Description
Clean	CN	No visible coating or infill
Stain	Sn	No visible coating or infill but surfaces are discoloured by mineral staining
Veneer <1 mm	VR	A visible coating or soil or mineral substance but usually unable to be measured. If discontinuous over the plane, patchy veneer.
Coating >1 mm to <10mm	CT	A visible coating or infilling of soil or mineral substance. Describe composition and thickness.
Filling (Filled) >10 m	Filled	A visible filling of soil or mineral substance. Describe composition and thickness.

PLANARITY

Code	Description
CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped

SMALL SCALE ROUGHNESS

Code	Description
POL	Polished
RF	Rough
S	Smooth
SL	Slickensided
VR	Very rough

ROUGHNESS CLASS

Code	Description
I	Rough or irregular, stepped
II	Smooth, stepped
III	Slickensided, stepped
IV	Rough or irregular, undulating
IX	Slickensided, planar
V	Smooth, undulating
VI	Slickensided, undulating
VII	Rough or irregular, planar

TYPE OF DISCONTINUITY

Term	Code	Description	
Bedding	BP	Generally no micro fractures	Arrangement in layers, of mineral grains of similar sizes or composition, and/or arrangement of elongated to tabular minerals near parallel to one another, and/ or to the layers.
Foliation	FL	Discontinuous micro fractures may be present, near parallel to the layering	
Cleavage	CL		
Schistosity	SH		
Contact	CO	A contact is the surface along which one rock touches another.	
Joint	JT	A discontinuity or crack, planar, curved, irregular, across which the rock usually has little tensile strength. The joint may be open (filled with air or water) or filled by soil substance or by rock substance or rock substance which acts as a cement, joint surface may be rough, smooth or slickensided	
Shear seam/ zone	SS/ SZ	Zone, with roughly parallel planar boundaries of rock material intersected by closely spaced (generally <50 mm) joints and/ or microscopic fractures (cleavage) planes. The joints are at small angles to the zone boundaries. They are usually slightly curved and divide the mass into blocks of lenticular or wedge space.	
Crushed seam/ zone	CS/ CZ	Zone with roughly parallel planar boundaries, composed of disoriented, usually angular fragments of the host rock substance. The fragments may be of clay, silt, sand or gravel size, or mixtures of any of these. Some minerals maybe altered or decomposed but this is not necessarily so.	
Decomposed seam / zone	DS/ DZ	Seam or zone of any shape, but commonly with roughly parallel boundaries in which the rock material is discoloured and usually weakened. The boundaries with fresh rock are usually gradational. Geological structures in the fresh rock are usually preserved in the decomposed rock.	
Infill seam/ zone	IS	Seam or zone of any shape, but commonly with roughly parallel boundaries composed of soil substance. The infill is caused by migration of soil and into open joints. May show layering roughly parallel to the zone boundaries. Geological structures in the adjacent rock do not continue into the infill substance.	
Vein	VN	vein is a distinct sheet like body of crystallized minerals within a rock	
Dyke	DK	Dykes are sheet-like bodies of igneous rock that cut across sedimentary bedding or foliations in rocks. They may be single or multiple in nature.	
Sill	SI	A sill is an intrusion of magma that spreads underground between the layers of another kind of rock	
Void	VO	A completely empty space.	

Refer to Table A10 in AS1726-1993

Drilling

DRILLING / EXCAVATION METHOD

Code	Description
AD/V	Auger drilling V-bit
AD/T	Auger drilling with TC-bit
AT	Air track
B	Bulldozer
BD	Backhoe bucket
BH	Washbore drag pit
CA	Casing advancer
E	Excavator
EH	Excavator with hammer
HA	Hand auger
NMLC	NMLC core barrel
HMLC	HMLC core barrel
NQ3	Wire line NQ core barrel
HQ3	Wire line HQ core barrel
PQ3	Wire line PQ core barrel
PT	Push tube
RR	Rock roller
WB	Washbore
X	Existing excavation
N	Natural exposure

WATER/ DRILLING FLUID

Symbol	Description
	Water loss: partial
	Water loss: complete
	Water inflow
	Water outflow
	Water level: drilling
	Water level: standing

DRILLING PENETRATION

Ease of penetration in non-core drilling

Code	Description
VE	Very easy
E	Easy
F	Firm
H	Hard
VH	Very hard

SAMPLES AND FIELD TEST

Code	Description
B	Bulk disturbed sample
BLK	Block sample
DS	Small disturbed sample
ES	Soil sample for environmental testing
EW	Water sample for environmental testing
LB	Large bulk disturbed sample
P	Piston sample
SPT	Standard Penetration Test
VS	Vane shear test
HP	Hand penetrometer test
U	Undisturbed push in sample

BACKFILL / WELL DETAIL

Symbol	Description
	Cement seal
	Grout backfill
	Blank pipe
	Slotted pipe
	Filter pack: sand filter
	Bentonite seal
	Backfill – excavated material

NON-CORE DRILL HOLE - GEOLOGICAL LOG

JACOBS

CLIENT : Sydney Trains
LOCATION : Redfern, NSW

PROJECT : Redfern Station ENE SP3

HOLE NO : BH01
FILE / JOB NO : IA134800
SHEET : 1 OF 1

POSITION :
SURFACE ELEVATION :
ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Drill Rig
MOUNTING : Track
CONTRACTOR : Terratest Pty Ltd
DRILLER : D. Jones

DATE STARTED : 13/04/2017
DATE COMPLETED : 13/04/2017
DATE LOGGED : 13/04/2017
LOGGED BY : MG
CHECKED BY :

DRILLING: PROGRESS – DRILLING & CASING	DRILLING: PROGRESS – WATER	DRILLING: DRILLING PENETRATION	DRILLING: GROUND WATER LEVELS	DRILLING: SAMPLES & FIELD TESTS	DEPTH (m)	MATERIAL: GRAPHIC LOG	MATERIAL: CLASSIFICATION SYMBOL	MATERIAL: MATERIAL DESCRIPTION (Soil Type, Colour, Plasticity or Particle Characteristic; Secondary and Minor Components)	MATERIAL: MOISTURE CONDITION	MATERIAL: CONSISTENCY RELATIVE DENSITY	MATERIAL: STRUCTURE & Other Observations
PT (0.0–4.95m)		E (0.0–3.50m)	Not Observed		0.0			0.03m Asphaltic CONCRETE: 30mm thick.			PAVEMENT
								0.15m FILL: Sandy GRAVEL: Grey and dark grey, fine to medium, subangular to angular, sand is fine to coarse grained.			FILL
				0.30m–0.50m ES				FILL: Silty SAND: Brown and grey, fine to medium grained, with some fine to medium subangular to angular gravel and a trace of clay fines.	D		
				0.50m–0.95m SPT 5,6,6 N=12							
					1.0			0.90m FILL: Silty CLAY: Brown and grey mottled red-brown, medium plasticity, with a trace of sand and fine subangular to angular gravel.	D - M		
				1.30m–1.50m ES							
				1.50m–1.95m SPT 6,8,11 N=19				At 1.50m, with some fine to coarse subangular to angular gravel.			
					2.0						
							CI	2.40m Silty CLAY: Grey mottled red-brown, high plasticity.	M	H	RESIDUAL SOIL
				2.80m–3.00m ES							
				3.00m–3.45m SPT 10,14,17 N=31	3.0			From 3.00m, with some iron indurated bands.			3.00: HP: >600, >600, >600 kPa
		F (3.50–4.95m)						3.50m SHALE: Grey mottled red-brown, extremely weathered, extremely low strength, indistinctly laminated.			BEDROCK
					4.0						
				4.50m–4.95m SPT 10,18,21 N=39				From 4.50m, becoming grey mottled red-brown and orange-brown.			
					5.0			4.95m Hole Terminated at 4.95 m			
					6.0						
					7.0						
					8.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS 3.01.2 LIB.GLB Log IS AU BOREHOLE 2 IA134800.GPJ <<DrawingFile>> 02/05/2017 15:46 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: Jacobs 3.01.2 2017-03-09 Prj: Jacobs 3.00.0 2016-07-17

JACOBS

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BH02
FILE / JOB NO : IA134800
SHEET : 1 OF 1

CLIENT : Sydney Trains
LOCATION : Redfern, NSW
PROJECT : Redfern Station ENE SP3

POSITION :
SURFACE ELEVATION :
ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Drill Rig
MOUNTING : Track
CONTRACTOR : Terratest Pty Ltd
DRILLER : D. Jones

DATE STARTED : 13/04/2017
DATE COMPLETED : 13/04/2017
DATE LOGGED : 13/04/2017
LOGGED BY : MG
CHECKED BY :

DRILLING & CASING	WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil Type, Colour, Plasticity or Particle Characteristic, Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
PT (0.0–4.00m)		E (0.0–2.50m)	Not Observed		0.0–0.03m		Asphaltic CONCRETE: 30mm thick.			PAVEMENT
					0.03–0.20m		FILL: Sandy GRAVEL: Grey and dark grey, fine to medium, subangular to angular, sand is fine to coarse grained.	D		FILL
				0.30m ES 0.50m; 0.50m SPT 4,3,5 N=8 0.95m	0.20–0.75m		FILL: Silty SAND: Brown, fine to medium grained, with some fine to medium subangular to angular gravel and some clay fines.			
				1.30m ES 1.50m; 1.50m SPT 6,9,17 N=26 1.95m	0.75–1.60m		FILL: Silty CLAY: Brown and grey mottled red-brown, medium plasticity, with some iron indurated bands.	D - M		0.80: HP: 470, 550, 500 kPa
					1.60–2.50m	CI	Silty CLAY: Grey mottled red-brown, high plasticity.	M	H	RESIDUAL SOIL 1.70: HP: >600, >600, >600 kPa
		F (2.50–4.00m)		2.80m ES 3.00m; 3.00m SPT 11,17,27 N=44 3.45m; 3.50m ES 3.70m; 3.70m D 4.00m	2.50–4.00m		SHALE: Grey mottled red-brown and orange-brown, extremely weathered, extremely low strength, indistinctly laminated. From 3.70m, becoming grey and dark grey.			BEDROCK
					4.00m		Hole Terminated at 4.00 m			

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS 3.01.2 LIB.GLB Log IS AU BOREHOLE 2 IA134800.GPJ <<DrawingFile>> 02/05/2017 15:47 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: Jacobs 3.01.2 2017-03-09 Prj: Jacobs 3.00.0 2016-07-17

NON-CORE DRILL HOLE - GEOLOGICAL LOG

JACOBS

CLIENT : Sydney Trains
LOCATION : Redfern, NSW
PROJECT : Redfern Station ENE SP3

HOLE NO : BH03
FILE / JOB NO : IA134800
SHEET : 1 OF 1

POSITION : | SURFACE ELEVATION : | ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Drill Rig | MOUNTING : Track | CONTRACTOR : Terratest Pty Ltd | DRILLER : D. Jones

DATE STARTED : 13/04/2017 | DATE COMPLETED : 13/04/2017 | DATE LOGGED : 13/04/2017 | LOGGED BY : MG | CHECKED BY :

Depth (m)	Progress: Drilling & Casing	Progress: Water	Drilling Penetration	Ground Water Levels	Samples & Field Tests	Classification Symbol	Material Description (Soil Type, Colour, Plasticity or Particle Characteristic, Secondary and Minor Components)	Moisture Condition	Consistency / Relative Density	Structure & Other Observations
0.00–0.03m	PT (0.0–4.0m)		E (0.0–3.0m)	Not Observed			Asphaltic CONCRETE: 30mm thick.	D		PAVEMENT
0.03–0.20m							FILL: Sandy GRAVEL: Grey and dark grey, fine to medium, subangular to angular, sand is fine to coarse grained.	D		FILL
0.20–0.30m					0.30m ES 0.50m		FILL Silty SAND: Brown and yellow-brown, fine to medium grained, with some fine to medium subangular to angular gravel and a trace of clay fines.	D - M		
0.30–1.10m					0.50m SPT 2,4,6 N=10 0.95m; 1.00m ES 1.20m		FILL: Silty CLAY: Brown and grey mottled red-brown, medium plasticity, with some fine to medium subangular gravel.	D - M		
1.10–3.00m					1.30m ES 1.50m; 1.50m SPT 8,11,12 N=23 1.95m; 2.50m D	CI	Silty CLAY: Grey mottled red-brown, high plasticity.	M	VSt - H (to ~2.5m); H	RESIDUAL SOIL 1.50: HP: 580, 440, 450 kPa
3.00–4.00m			F (3.0–4.0m)		3.00m SPT 9,17,16 N=33 3.45m; 3.50m D 4.00m		SHALE: Grey mottled red-brown and orange-brown, extremely weathered, extremely low strength, with some iron indurated bands. From 3.50m, becoming grey and dark grey.			BEDROCK
4.00m							Hole Terminated at 4.00 m			

See Explanatory Notes for details of abbreviations & basis of descriptions.

NON-CORE DRILL HOLE - GEOLOGICAL LOG

JACOBS

CLIENT : Sydney Trains
LOCATION : Redfern, NSW
PROJECT : Redfern Station ENE SP3

HOLE NO : BH04
FILE / JOB NO : IA134800
SHEET : 1 OF 1

POSITION :
SURFACE ELEVATION :
ANGLE FROM HORIZONTAL : 90°

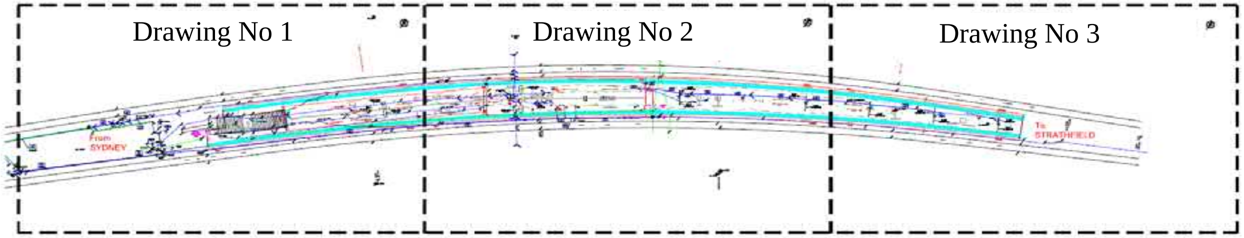
RIG TYPE : Drill Rig
MOUNTING : Track
CONTRACTOR : Terratest Pty Ltd
DRILLER : D. Jones

DATE STARTED : 13/04/2017
DATE COMPLETED : 13/04/2017
DATE LOGGED : 13/04/2017
LOGGED BY : MG
CHECKED BY :

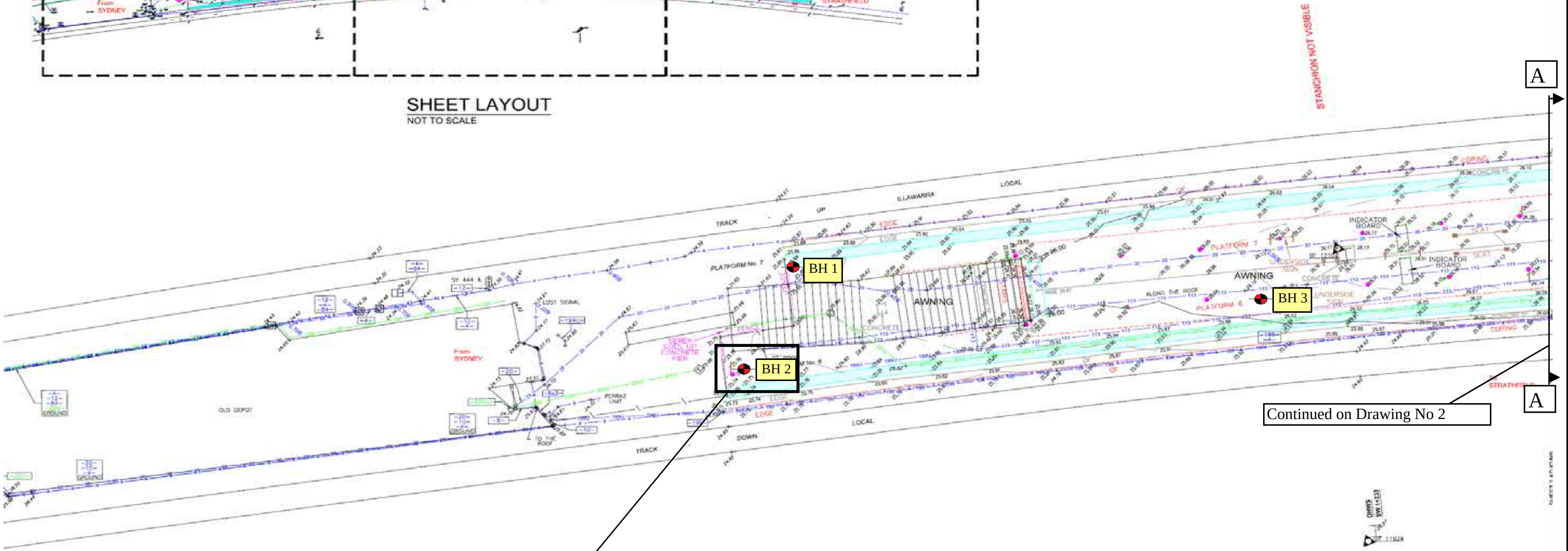
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION (Soil Type, Colour, Plasticity or Particle Characteristic, Secondary and Minor Components)	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
PT (0.0–4.0)		E (0.0–3.0)	Not Observed		0.03m		Asphaltic CONCRETE: 30mm thick.	D		PAVEMENT
					0.15m		FILL: Sandy GRAVEL: Grey and dark grey, fine to medium, subangular to angular, sand is fine to coarse grained.			FILL
				0.30m–0.50m ES; 0.50m–0.95m SPT 2,2,3 N=5; 1.30m–1.50m ES; 1.50m–1.95m SPT 4,4,4 N=8	2.00m		FILL: Silty CLAY: Dark brown, grey, low to medium plasticity, with a trace of fine subangular gravel. At 0.50m, with a trace of tree roots. At 1.50m, with some fine to coarse subangular to angular gravel. From 1.80 m to 1.90 m, pale grey sandstone.	D - M		
				2.30m–2.50m ES; 2.50m–2.70m D	3.00m	CI	Silty CLAY: Grey mottled red-brown, high plasticity with some iron indurated bands.	M	H	RESIDUAL SOIL 2.50: HP: 540, 510, 570 kPa
		F (3.0–4.0)		3.00m–3.45m SPT 8,16,23 N=39; 3.70m–4.00m D	4.00m		SHALE: Grey mottled red-brown and orange-brown, extremely weathered, extremely low strength.			BEDROCK
							Hole Terminated at 4.00 m			

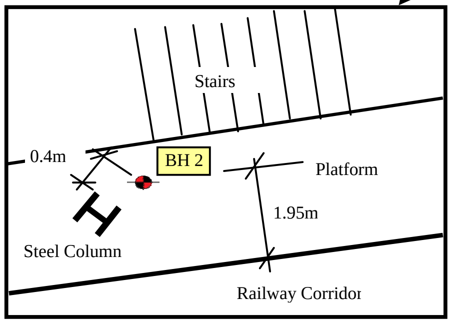
Depth scale: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0

See Explanatory Notes for details of abbreviations & basis of descriptions.



SHEET LAYOUT
NOT TO SCALE



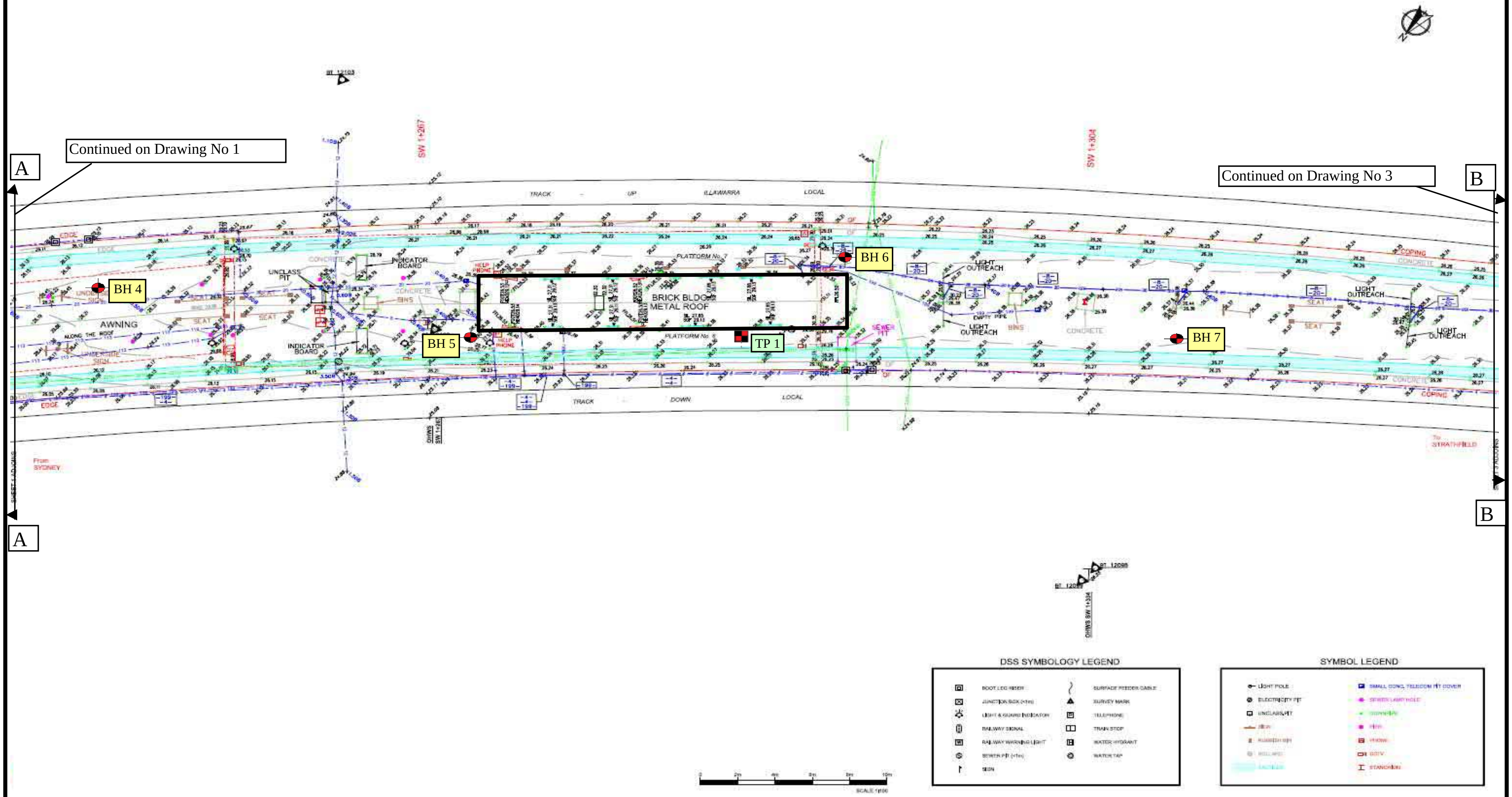


Legend

BH 1 **Borehole Location**

GeoEnviro Consultancy
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Drawn By: SG	**Date: 27/04/2015**	**Mott MacDonald Pty Ltd**
Checked By: SL	**Date: 27/04/2015**	**Redfern Station Platform 6/7**
Revision By:	**Date:**	**Borehole Location Plan (Page 1 of 3)**
Scale: Proportional	**A3**	**Project No: JG15894A** — **Drawing No: 1**



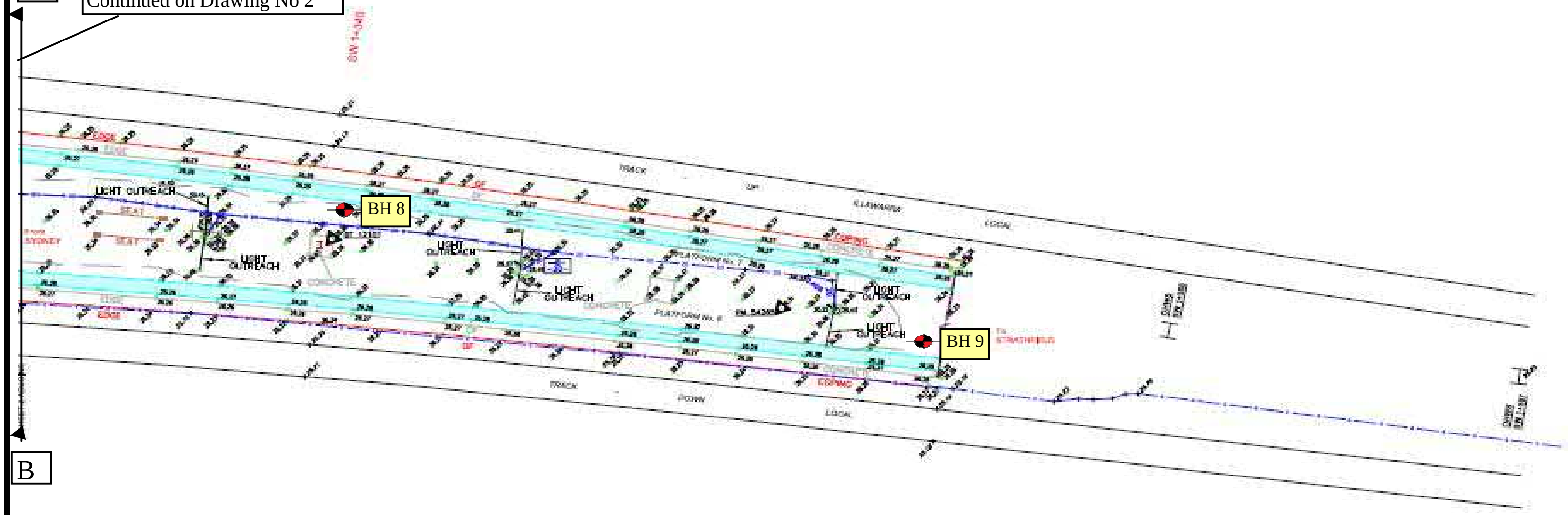
Legend

BH 1	**Borehole Location**
TP 1	**Test Pit Location**

GeoEnviro Consultancy Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia Tel: (02) 96798733 Fax: (02) 96798744	**Drawn By: SG**	**Date: 27/04/2015**	**Mott MacDonald Pty Ltd**
	Checked By: SL	**Date: 27/04/2015**	**Redfern Station Platform 6/7**
	Revision By:	**Date:**	**Borehole Location Plan (Page 2 of 3)**
	Scale: Proportional	**A3**	**Project No: JG15894A** — **Drawing No: 2**

B

Continued on Drawing No 2



B

Legend

BH 1 **Borehole Location**

GeoEnviro Consultancy Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia Tel: (02) 96798733 Fax: (02) 96798744	**Drawn By: SG**	**Date: 27/04/2015**	**Mott MacDonald Pty Ltd**	
	Checked By: SL	**Date: 27/04/2015**	**Redfern Station Platform 6/7**	
	Revision By:	**Date:**	**Borehole Location Plan (Page 3 of 3)**	
	Scale: Proportional	A3	**Project No: JG15894A**	**Drawing No: 3**

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Borehole Report

Borehole no: 1

Client: Mott MacDaonald Pty Ltd
Job no: JG15894A
Project: Proposed Station Platform Upgrade
Date: 09/04/2015
Location: Redfern Station Platform 6/7
Logged by: SL

Drill Model and Mounting: Track DM40 | Slope: 90 degrees | R.L. Surface:
Hole Diameter: 100mm | Bearing: - | Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetrometer	Structure and Additional Observations
SPIRAL AUGER	NIL	NIL					Asphaltic Concrete- 40mm		ST	3	
							Crushed rock - 90mm			2	
							Fill: Silty Clay: Medium plasticity, grey brown	D-M		3	
										4	
				0.5		CI	Silty Clay: Medium plasticity, grey	D-M	H	13	
										14	
										21	
										20	
										12	
				1.0						20	
										18	DCP Terminated at 1.07m
				1.5		CI	Silty Clay: Medium plasticity, grey	D-M			
				2.0							
						CI	Silty Clay: Medium plasticity, grey	D			
				2.5							
						CI	Silty Clay: Medium plasticity, grey, with weak shale bands, very stiff to hard	D			
				3.0			Shale: Grey, extremely to distinctly weathered, low strength				Auger Refusal
							End BH 1 at 3.0m				
				3.5							
				4.0							

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Borehole Report

Borehole no: 2

Client: Mott MacDaonald Pty Ltd

Job no: JG15894A

Project: Proposed Station Platform Upgrade

Date: 09/04/2015

Location: Redfern Station Platform 6/7

Logged by: SL

Drill Model and Mounting: Track DM40

Slope: 90 degrees

R.L. Surface:

Hole Diameter: 100mm

Bearing: -

Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetrometer	Structure and Additional Observations
SPIRAL AUGER	NIL	NIL					Asphaltic Concrete - 40mm				
							Crushed rock: 210mm thick				
				0.5			Fill: Silty Sand, fine to medium grained, with some gravel				
							Fill: Silty Clay: Medium plasticity, with gravel	M-W			
				1.0			End BH 2 at 0.65m				Hand Auger Refusal on Concrete. A steel bolt was noted on top of the concrete
				1.5							
				2.0							
				2.5							
				3.0							
				3.5							
				4.0							

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Borehole Report

Borehole no: 3

Client: Mott MacDaonald Pty Ltd
Project: Proposed Station Platform Upgrade
Location: Redfern Station Platform 6/7

Job no: JG15894A
Date: 09/04/2015
Logged by: SL

Drill Model and Mounting: Track DM40
Slope: 90 degrees
R.L. Surface:
Hole Diameter: 100mm
Bearing: -
Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetrometer	Structure and Additional Observations
SPIRAL AUGER	NIL	NIL					Asphaltic Concrete - 40mm				
							Crushed rock			5	
										2	
							End BH 3 at 0.3m			7	Fill?
				0.5						27	
										8	
										6	
										4	Natural clay
										4	
				1.0						7	
										6	
										6	
										11	
										11	
				1.5						16	
										17	
										20	
										22	
				2.0							
				2.5							
				3.0							
				3.5							
				4.0							

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Borehole Report

Borehole no: 4

Client: Mott MacDaonald Pty Ltd
Job no: JG15894A

Project: Proposed Station Platform Upgrade
Date: 09/04/2015

Location: Redfern Station Platform 6/7
Logged by: SL

Drill Model and Mounting: Track DM40
Slope: 90 degrees
R.L. Surface:

Hole Diameter: 100mm
Bearing: -
Datum:

Method: SPIRAL AUGER | Support: NIL | Water: NIL | Notes: Samples, Tests, etc: -

Depth(m)	Unified Soil Classification	Material Description (Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component)	Moisture Content	Consistency/Density Index	Structure and Additional Observations
0.00–0.05		Asphaltic Concrete - 50mm			
0.05–0.10		Crushed rock - 50mm			
0.10–1.70	CI-CH	Silty Clay: Medium to high plasticity, grey with red mottle with trace ironstone gravel	D-M	St (to 0.9), H (from 0.9)	
1.70–2.10	CI-CH	Silty Clay: Medium to high plasticity, grey with red mottle with trace ironstone gravel	D-M	H	DCP Terminated at 1.90m
2.10–2.80	CI-CH	Silty Clay: Medium to high plasticity, red-brown, with some ironstone gravel	D-M		
2.80–3.00	CI-CH	Silty Clay: Medium to high plasticity, grey, with some shale bands	D-M		
3.00–3.20		Shale, extremely low strenght, extremely weathered rock			Auger Refusal

End Bh 4 at 3.20m

Dynamic Cone Penetrometer:

Depth (m)	DCP
0.0–0.1	-
0.1–0.2	2
0.2–0.3	2
0.3–0.4	2
0.4–0.5	4
0.5–0.6	6
0.6–0.7	3
0.7–0.8	3
0.8–0.9	5
0.9–1.0	9
1.0–1.1	11
1.1–1.2	13
1.2–1.3	17
1.3–1.4	11
1.4–1.5	11
1.5–1.6	13
1.6–1.7	11
1.7–1.8	13
1.8–1.9	16

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Borehole Report

Borehole no: 5

Client: Mott MacDaonald Pty Ltd
Job no: JG15894A

Project: Proposed Station Platform Upgrade
Date: 09/04/2015

Location: Redfern Station Platform 6/7
Logged by: SL

Drill Model and Mounting: Track DM40
Slope: 90 degrees
R.L. Surface:

Hole Diameter: 100mm
Bearing: -
Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Unified Soil Classification	Material Description (Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component)	Moisture Content	Consistency/Density Index	Structure and Additional Observations
SPIRAL AUGER	NIL	NIL		0.00–0.05		Asphaltic Concrete :50mm thick			
				0.05–0.20		Fill: Silty Clay: Medium plasticity, red yellow brown, some gravel, 150mm thick		St	
				0.20–0.80	CI-CH	Silty Clay: Medium to high plasticity, grey with red mottle with trace ironstone gravel	M		
				0.80–1.00	CI-CH	Silty Clay: Medium to high plasticity, grey with red mottle with gravel	M-W		
				1.00–2.50	CI-CH	Silty Clay: Medium to high plasticity, grey with red mottle with ironstone gravel	D-M	VSt (1.0–1.3), H (1.3–1.9)	DCP Terminated at 1.83m; Auger Refusal on weathered shale
				2.50		End BH 5 at 2.50m			

Dynamic Cone Penetrometer:

Depth (m)	Dynamic Cone Penetrometer
0.0–0.1	-
0.1–0.2	4
0.2–0.3	1
0.3–0.4	1
0.4–0.5	3
0.5–0.6	2
0.6–0.7	4
0.7–0.8	3
0.8–0.9	2
0.9–1.0	2
1.0–1.1	8
1.1–1.2	8
1.2–1.3	8
1.3–1.4	15
1.4–1.5	13
1.5–1.6	12
1.6–1.7	14
1.7–1.8	22
1.8–1.9	7

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Borehole Report

Borehole no: 6

Client: Mott MacDaonald Pty Ltd
Job no: JG15894A

Project: Proposed Station Platform Upgrade
Date: 09/04/2015

Location: Redfern Station Platform 6/7
Logged by: SL

Drill Model and Mounting: Track DM40
Slope: 90 degrees
R.L. Surface:

Hole Diameter: 100mm
Bearing: -
Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetrometer	Structure and Additional Observations
SPIRAL AUGER	NIL	NIL					Asphaltic Concrete: 50mm thick			-	
							Base Coarse: 80mm thick		St	3	
							Fill: Sand and Gravel, 50mm thick			4	
						CI-CH	Silty Clay: Medium to high plasticity, grey with brown mottle	D-M		2	
				0.5						6	
										5	
									VSt	6	
										7	
										8	
				1.0						6	
										5	
										7	
						CI-CH	Silty Clay: Medium to high plasticity, grey with red mottle	D-M	H	9	
										11	
				1.5						8	
										8	
										8	
										9	
										14	
				2.0						15	
										12	
										13	
										15	
										22	DCP Terminated at 2.40m
				2.5			End BH 6 at 2.50m				
				3.0							
				3.5							
				4.0							

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Borehole Report

Borehole no: 7

Client: Mott MacDaonald Pty Ltd	Job no: JG15894A
Project: Proposed Station Platform Upgrade	Date: 09/04/2015
Location: Redfern Station Platform 6/7	Logged by: SL

Drill Model and Mounting: Track DM40	Slope: 90 degrees	R.L. Surface:
Hole Diameter: 100mm	Bearing: -	Datum:

Method: SPIRAL AUGER; Support: NIL; Water: NIL

Depth(m)	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetrometer	Structure and Additional Observations
0.0–0.07		Asphaltic Concrete: 70mm thick			-	
0.07–0.17		Fill: Crushed rock, 100mm thick			-	
to 0.8		Fill: Silty Clay: Medium plasticity, red-brown	M	St	3, 2, 5, 10, 5, 4	Appeared loose
0.8–1.2	CI-CH	Silty Clay: Medium to high plasticity, grey with reddish-brown mottle		VSt	5, 7, 7, 7	
1.2–2.0	CI-CH	Silty Clay: Medium to high plasticity, pale grey with red mottle, with some ironstone gravel	M	H	8, 11, 11, 9, 9, 12, 11	DCP Terminated at 1.90m
2.0–2.9	CI-CH	Silty Clay: Medium to high plasticity, pale grey	D-M			
2.9		End BH 7 at 2.90m				

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Borehole Report

Borehole no: 8

Client: Mott MacDaonald Pty Ltd
Job no: JG15894A

Project: Proposed Station Platform Upgrade
Date: 09/04/2015

Location: Redfern Station Platform 6/7
Logged by: SL

Drill Model and Mounting: Track DM40 | Slope: 90 degrees | R.L. Surface:

Hole Diameter: 100mm | Bearing: - | Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetrometer	Structure and Additional Observations
SPIRAL AUGER	NIL	NIL					Asphaltic Concrete: 65mm thick			-	
							Fill: Crushed rock, 90mm thick		L	6	
							Fill: Silty Clay: Medium plasticity, grey-brown to red-brown,	M		3 2 3 2	Loose Fill
				0.5							
							Fill: Clayey Sand, fine to medium grained, yellow-brown	M		2 3 3	
				1.0					St-VSt	8 5	
							Fill: Sandy Clay/Clayey Sand, medium plasticity, yellow-brown			4 4 5 6 7	
				1.5							
						CI-CH	Silty Clay: Medium to high plasticity	M		7 8	
				2.0					H	13 17 22	DCP Terminated at 2.10m
				2.5		CI-CH	Silty Clay: Medium to high plasticity, pale grey to hard	MC =PL	(Vst -H)		
				3.0							
				3.5			End BH 8 at 3.10m				
				4.0							

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Borehole Report

Borehole no: 9

Client: Mott MacDaonald Pty Ltd
Job no: JG15894A
Project: Proposed Station Platform Upgrade
Date: 09/04/2015
Location: Redfern Station Platform 6/7
Logged by: SL

Drill Model and Mounting: Track DM40 Slope: 90 degrees R.L. Surface:
Hole Diameter: 100mm Bearing: - Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetrometer	Structure and Additional Observations
SPIRAL AUGER	NIL	NIL					Asphaltic Concrete: 50mm thick			-	
							Base Coarse: 100mm thick			-	
							Fill: Silty Clay: Medium plasticity, red-brown		St	3	
							Fill: Silty Clay: Medium to high plasticity, grey-brown, with trace gravel	M		2	
				0.5						2	
										3	Appeared Loose
									F	2	
										1	
										1	
				1.0						1	
										1	
										2	
									St	3	
										2	
				1.5		CI-CH	Silty Clay: Medium to high plasticity	M	St	2	
										4	
									VSt	10	
										9	
						CI-CH	Silty Clay: Medium to high plasticity, yellow-brown, with some sand	M-W		6	
				2.0						5	
						SC	Sandy Clay/Clayey Sand: Medium plasticity, fine to medium grained, yellow brown	M-W		6	
									H	10	
										11	
						CI	Silty Clay: Medium plasticity to very stiff	MC >= PL		13	
				2.5						17	DCP Terminated at 2.50m
				3.0							
				3.5			End BH 9 at 3.30m				
				4.0							

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Test Pit Report

Test Pit No: 1

Client: Mott MacDonald Pty Ltd	Job no: JG15894A
Project: Proposed Station Platform Upgrade	Date: 09/04/2015
Location: Redfern Station Platform 6/7	Logged by: SG
Equipment: Manual	R.L.Surface:
Pit Dimensions: 0.7m x 0.5m x 1.0m	Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
MANUAL EXCAVATION	NIL	DRY		0.0–0.1			Asphaltic Concrete - 60mm			-	
				0.1–0.2			Crushed Rock		F	4	
				0.2–0.3			Fill: Gravelly Silty Clay: Medium plasticity, grey red, with ironstone gravel	M-W		1	
				0.3–0.4						1	
				0.4–0.5					St	5	
				0.5–0.6						3	
				0.6–0.7		CI-CH	Silty Clay: Medium to high plasticity, grey with red mottle, with fine to coarse grained ironstone gravel	M		2	
				0.7–0.8						5	
				0.8–0.9						5	
				0.9–1.0						3	
				1.0–1.1			End Test Pit 1 at 1.0m		VSt	5	
				1.1–1.2						7	
				1.2–1.3						8	
				1.3–1.4						9	
				1.4–1.5						8	
				1.5–1.6						8	
				1.6–1.7						7	
				1.7–1.8					H	9	
				1.8–1.9						13	
				1.9–2.0						13	
				2.0–2.1						13	
				2.1–2.2						14	
				2.2–2.3						17	DCP Terminated at 2.30m

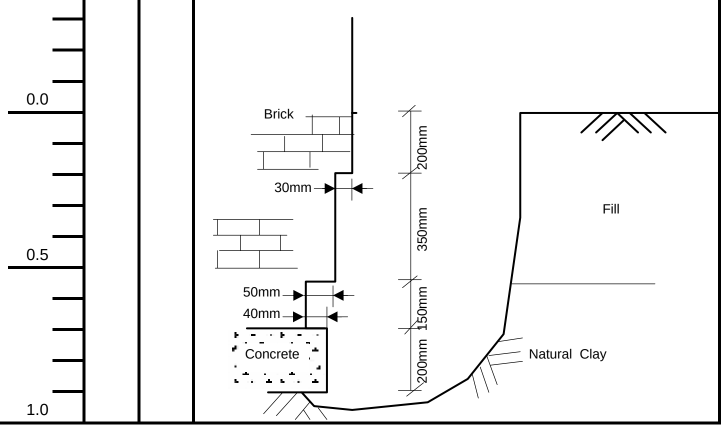
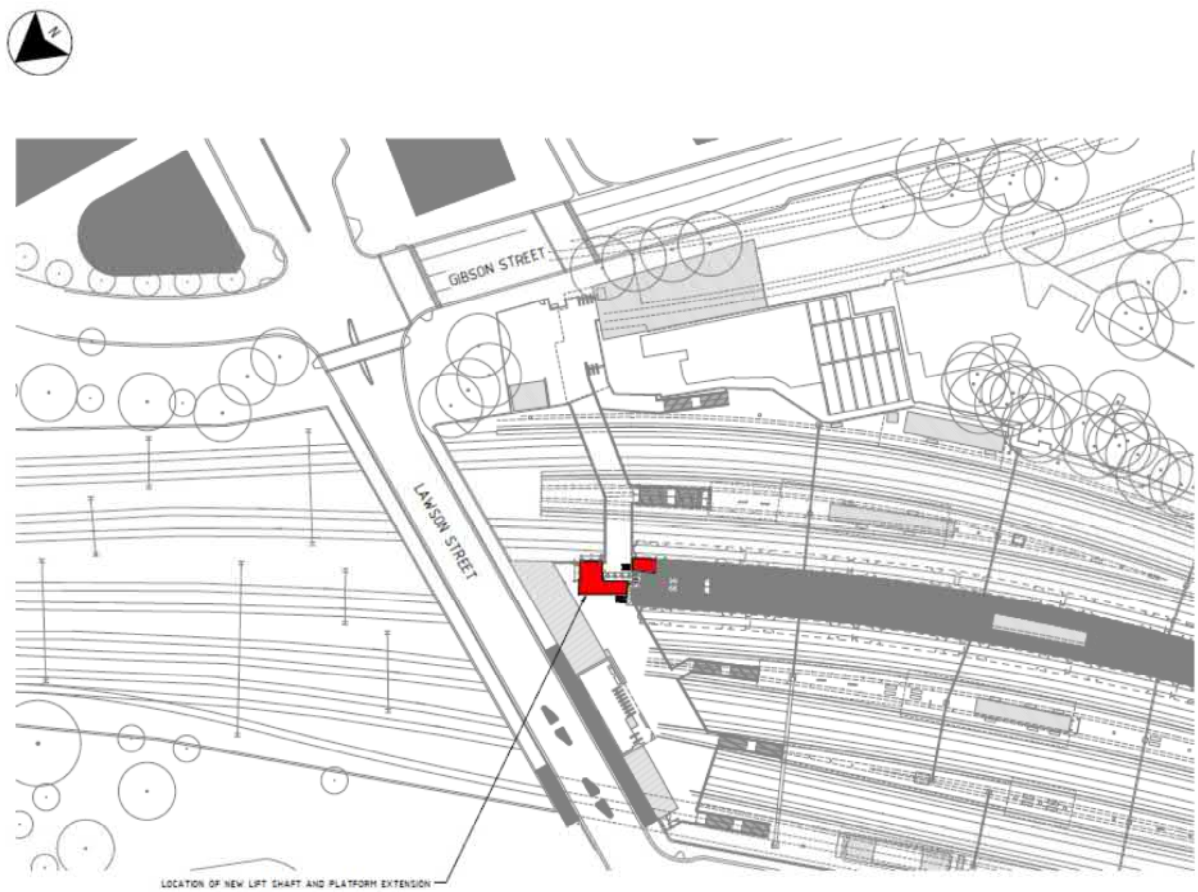


Photo 1: Footing excavation for Station Building

Photo 2: Test Pit 1

Photo 3: Concrete footing at the base of the test pit,

Figure 1 Site Location Plan



Borehole No: BH01

Engineering Log - Borehole

SHEET 1 OF 2

Client	Novo Rail	Project No.	39525-338-3000
Project	Novo Rail Transport Access Program - Redfern Station	Logged By	SE
Location	Redfern	Checked By	JD

Started Drilling	22.11.14	Northing	1248365.10	Slope	90°	Equipment	Geoprobe 7822DT
Completed Drilling	22.11.14	Easting	318302.30	Bearing	---	Ground Level	24.85 AHD

DRILLING | MATERIAL DESCRIPTION | TESTING, SAMPLING & OTHER INFORMATION

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
NDD					SM	FILL: Sandy GRAVEL: fine to coarse grained, pale grey, subangular, fine to medium sand, with some vegetation, appears poorly compacted	D			D	FILL
		24	1		CI	Clayey GRAVEL: grey, with iron staining				D	RESIDUAL SOIL
PT		23	2		CL-CI	Gravelly CLAY: low to medium plasticity, grey, with iron staining and extremely weathered, thinly laminated, very low strength shale		F to St		D, D, D, D	
AD/T		22, 21	3, 4			SHALE: grey mottled pale brown, with iron staining, low strength As above, but difficult to break through, suspected shale lense of medium strength					EXTREMELY WEATHERED ROCK
	▶	20, 19, 18, 17	5, 6, 7, 8			SHALE: grey, low strength	M W				

Remarks:

novo rail

Engineering Log - Borehole

Client	Novo Rail	Project No.	39525-338-3000
Project	Novo Rail Transport Access Program - Redfern Station	Logged By	SE
Location	Redfern	Checked By	JD

Started Drilling	22.11.14	Northing	1248365.10	Slope	90°	Equipment	Geoprobe 7822DT
Completed Drilling	22.11.14	Easting	318302.30	Bearing	---	Ground Level	24.85 AHD

DRILLING				MATERIAL DESCRIPTION					TESTING, SAMPLING & OTHER INFORMATION		
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
AD/T		16, 15, 14, 13	9, 10, 11, 12			SHALE: grey, low strength *(continued)*	W			D	
		12, 11, 10, 9	13, 14, 15, 16			Borehole BH01 Terminated at 12.00 m					Target depth

Remarks:

novo rail

BALLAST DEPTH & CONDITION SURVEY RESULTS

Transport NSW | RailCorp

LOCATION : REDFERN 1.020KM to 1.460KM – Down Local	PROJ NO: 8573	
DATE OF INVESTIGATION : 23/01/10	LOGGED BY: PG	REVIEWED BY: PG

				BALLAST			CAPPING			FORMATION	* End Of	TRACK ENVIRON		CESS LEVEL BELOW RAIL LEVEL		TCM to	TCM to	REMARKS
Mast Structure Number	Km	Sleeper Type	Thickness Sleeper + Rail	* Base	Thickness	Description	* Base	Thickness	Description	Description	Hole	Dnside	Upside	Dnside	Upside	Dn Rail	Up Rail	
TP1 SW1+080	1.081	Timber	320	700	380	Moderately fouled with silts, gravels & trace clay, medium dense, dry. 700 – Non Woven Geofabric	950	250	Sandy gravels & clay, medium dense, moist. 950 – Woven Geofabric	950-1000 – Clayey silt, grey, loose to medium dense. 1000 – Bedrock – Shale, EW-VW, CW-HW.	1030	Cutting	Cutting	Tracks	Tracks	920	970	Pipes across the track. Sump on the Downside. Invert ~1750mm BRL
TP2 Lawson Street Over Bridge 4 foot	1.167	Timber	320	700	380	320-550 Slightly fouled with silts. 550-700 Moderately fouled with silts & gravels, medium dense, dry. 700 – Non Woven Geofabric ***See Excavation Log***	880	180	Sandy gravels & clay, medium dense, moist. 880 – Woven Geofabric	880 – Clayey silt & ironstone, grey, medium dense, moist. 1000 – Dense.	1000	Cutting	Cutting	Pier O/B	Pier O/B			Pipes across the track. Sump on the Down Cess. Invert ~1500mm BRL Sump in 6ft at O/B at 1.168km
TP3 Lawson Street Over Bridge Country end Downside 4 foot	1.187	Timber	320			***See Excavation Log***						Cutting	Cutting	Pier O/B	Pier O/B			
TP4 Platform 4 foot	1.220	Timber	330	920	590	Moderately fouled with sands, silts & gravels, medium dense, dry to damp. 920 – Non Woven Geofabric ***See Excavation Log***	1000	80	Sandy gravels & clay, thin layer.	1000 – Compacted brick fill, very dense. ***1000 – Bucket Refusal***	1000	Platform	Platform					

BALLAST DEPTH & CONDITION SURVEY RESULTS

Transport NSW RailCorp

Mast Structure Number	Km	Sleeper Type	Thickness Sleeper + Rail	BALLAST * Base	BALLAST Thickness	BALLAST Description	CAPPING * Base	CAPPING Thickness	CAPPING Description	FORMATION Description	* End Of Hole	TRACK ENVIRON Dnside	TRACK ENVIRON Upside	CESS LEVEL BELOW RAIL LEVEL Dnside	CESS LEVEL BELOW RAIL LEVEL Upside	TCM to Dn Rail	TCM to Up Rail	REMARKS
TP5 Platform 4 foot	1.271	Timber	320	600	280	Moderately fouled with silts, sands & gravels, medium dense, damp. 600 – Non Woven Geofabric ***See Excavation Log***	850	250	Sandy gravels & clay, medium dense. 850 – Woven Geofabric	850 – Compacted stabilised layer, very dense. ***880 – Bucket Refusal***	880	Platform	Platform					
TP6 Platform 4 foot	1.330	Timber	320	560	240	Moderately fouled with sands, silts & gravels. 560 – Non Woven Geofabric ***See Excavation Log***	780	220	Sandy gravels & clay, medium dense to dense, damp. 780 – Woven Geofabric	780 – Compacted ironstone, some bricks & slag, very dense. ***850 – Bucket Refusal***	850	Platform	Platform			600		Contamination sample taken Pin on the wall at 1.331km
TP7 SW1+412 + 10.0m Engine Dive 4 foot		Timber	300	650	350	Moderately fouled with silts & gravels.				***650mm BRL – Top of dive***	650							
TP8 SW1+412 + 12.5m 4 foot		Timber	300	680	30	Moderately fouled with silts & gravels.				***680mm BRL – Top of dive***	680							

Quantitive Descriptor to Field Classification	
	% passing 9.5mm sieve
Slightly Fouled	0-5
Moderately Fouled	5-10
Heavily Fouled	>10

Legend	
*	mm below the low rail level
MC	Moisture content
PL	Plastic
PP	Pocket penetrometer reading in kPa
Emb	Embankment

Transport NSW RailCorp

RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

TEST PIT Nº: 8573-2

PROJECT: REDFERN

FEATURE: FORMATION / FOOTING INVESTIGATION

LOCATION: LAWSON ST OVERBRIDGE @ 1.167KM - DOWN LOCAL

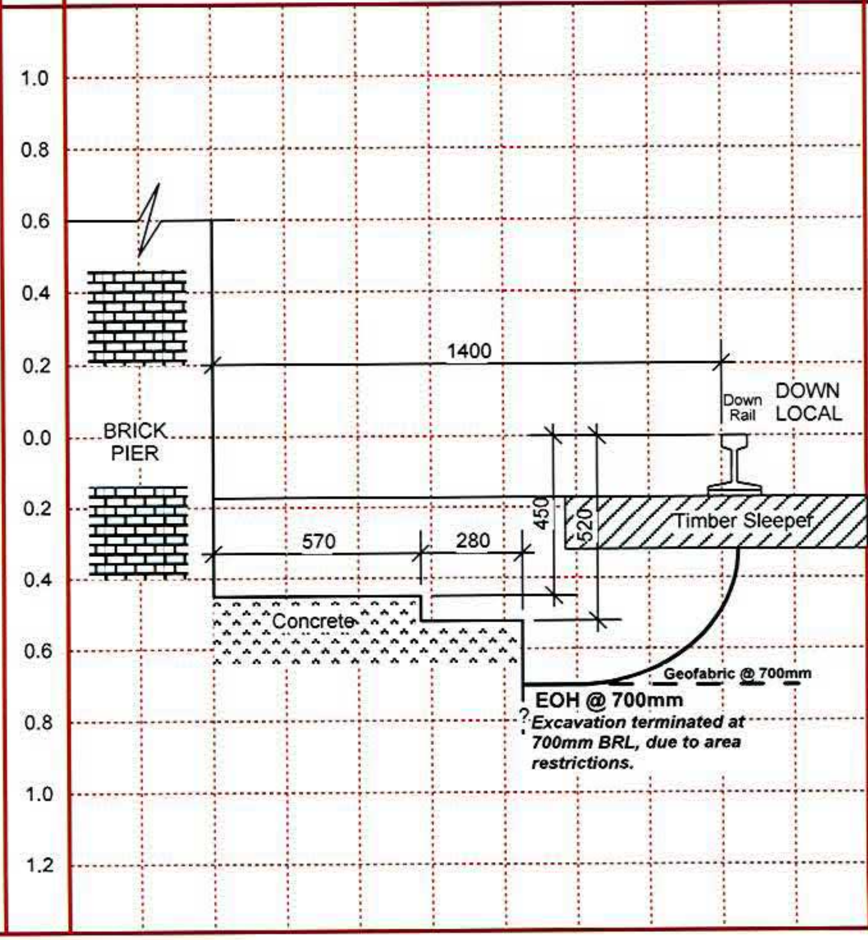
START OF TEST PIT: TOP OF RAIL = 00

EXCAVATION DIMENSION : BETWEEN SLEEPERS

LOGGED BY: PG DATE: 23/01/10

DRAWN BY: HC DATE: 03/02/10

CHECKED BY: PG DATE : 15/02/10

GEOLOGICAL DESCRIPTION		DEPTH (m)	GRAPHIC REPRESENTATION	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
Type of Deposit	Characteristics							
								

RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

Transport NSW RailCorp

TEST PIT Nº: 8573-3

PROJECT: REDFERN

FEATURE: FORMATION / FOOTING INVESTIGATION

LOCATION: LAWSON ST OVERBRIDGE @ 1.187KM - DOWN LOCAL, Country end

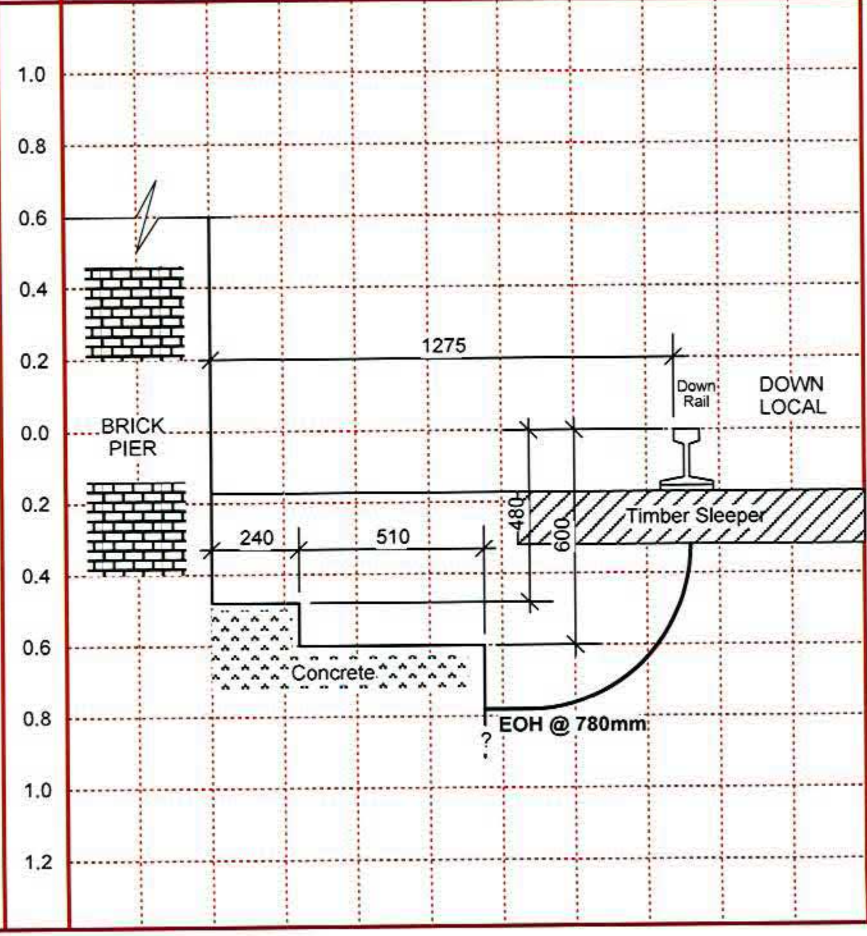
START OF TEST PIT: TOP OF RAIL = 00

EXCAVATION DIMENSION : BETWEEN SLEEPERS

LOGGED BY: PG DATE: 23/01/10

DRAWN BY: HC DATE: 03/02/10

CHECKED BY: PG DATE : 15/02/10

GEOLOGICAL DESCRIPTION		DEPTH (m)	GRAPHIC REPRESENTATION	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
Type of Deposit	Characteristics							
								

RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

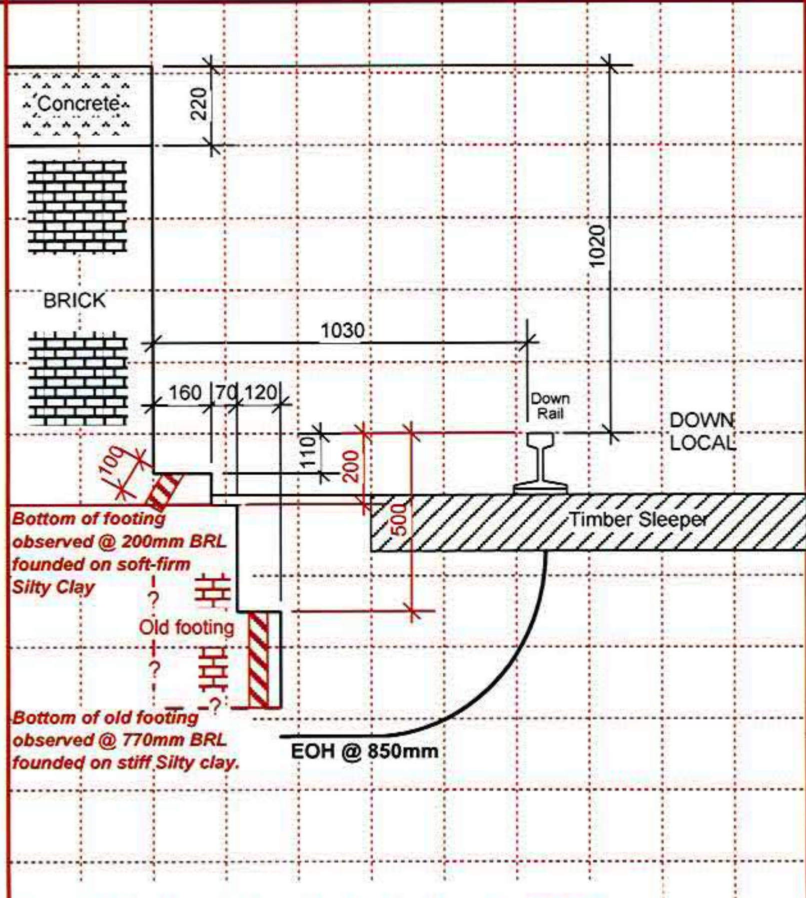
Transport NSW RailCorp

TEST PIT Nº: 8573-4

PROJECT:	REDFERN	START OF TEST PIT:	TOP OF RAIL = 00	LOGGED BY: PG	DATE: 23/01/10
FEATURE:	FORMATION / FOOTING INVESTIGATION	EXCAVATION DIMENSION :	BETWEEN SLEEPERS	DRAWN BY: HC	DATE: 03/02/10
LOCATION:	PLATFORM @ 1.220KM - DOWN LOCAL			CHECKED BY: PG	DATE : 15/02/10

GEOLOGICAL DESCRIPTION: Type of Deposit	GEOLOGICAL DESCRIPTION: Characteristics	DEPTH (m)	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
PLATFORM FOOTING		1.0					
		0.8					
		0.6					
		0.4					
		0.2					
	Rail Level	0.0					
	Silty clay.	0.2	Soft to Firm				
		0.4					
		0.6					
	Silty clay.	0.8	Stiff				
	EOH @ 850mm	1.0					
		1.2					

GRAPHIC REPRESENTATION



Note - (Additional investigation shown in red - done on the 29/01/11)

Transport NSW RailCorp

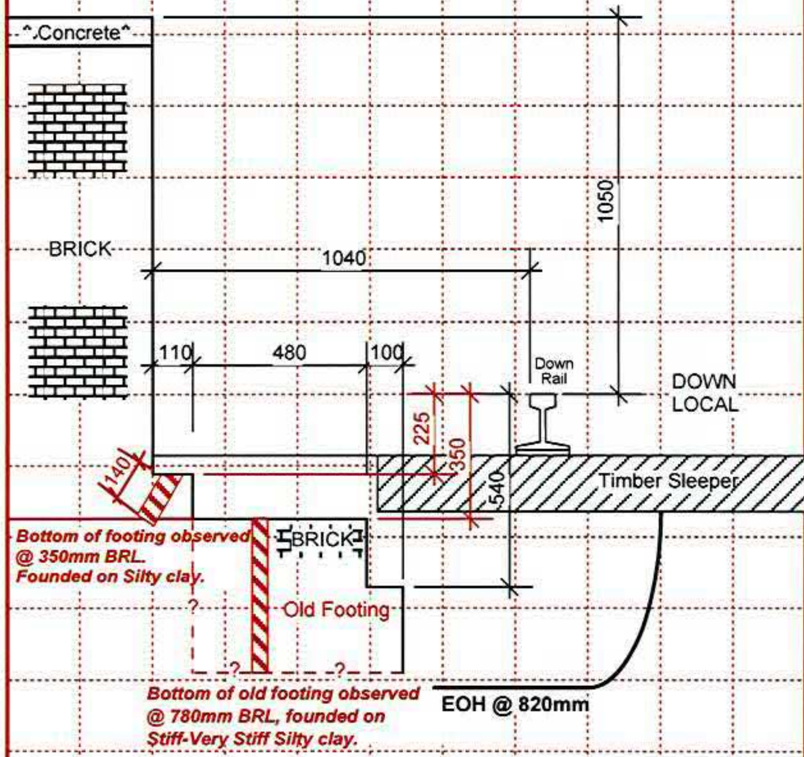
RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

TEST PIT Nº: 8573-5

PROJECT:	REDFERN	START OF TEST PIT:	TOP OF RAIL = 00	LOGGED BY: PG	DATE: 23/01/10
FEATURE:	FORMATION / FOOTING INVESTIGATION	EXCAVATION DIMENSION :	BETWEEN SLEEPERS	DRAWN BY: HC	DATE: 03/02/10
LOCATION:	PLATFORM @ 1.271KM - DOWN LOCAL			CHECKED BY: PG	DATE : 15/02/10

GEOLOGICAL DESCRIPTION: Type of Deposit	GEOLOGICAL DESCRIPTION: Characteristics	DEPTH (m)	GRAPHIC REPRESENTATION	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
PLATFORM FOOTING		1.0 – 0.2						
	Rail Level	0.0						
		0.2						
	Silty clay.	0.4 – 0.6						
	Silty clay	0.8		Stiff-Very Stiff				
	EOH @ 820mm	1.0 – 1.2						



Note - (Additional investigation shown in red - done on the 29/01/11)

RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

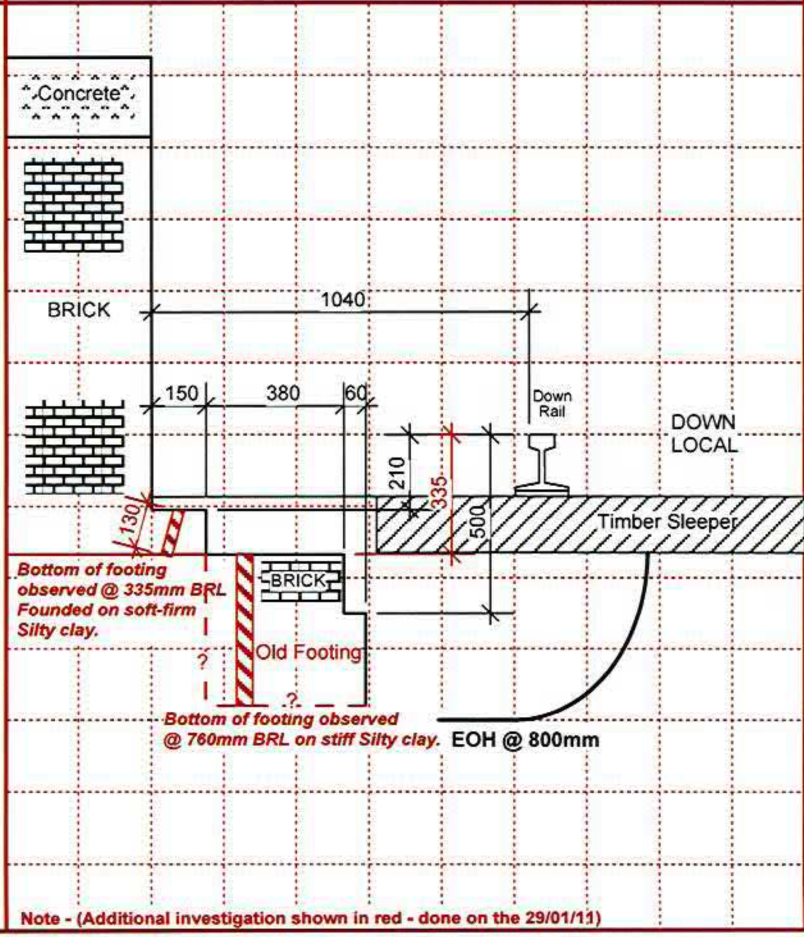
Transport NSW RailCorp

TEST PIT Nº: 8573-6

PROJECT:	REDFERN	START OF TEST PIT:	TOP OF RAIL = 00	LOGGED BY: PG	DATE: 23/01/10
FEATURE:	FORMATION / FOOTING INVESTIGATION	EXCAVATION DIMENSION :	BETWEEN SLEEPERS	DRAWN BY: HC	DATE: 03/02/10
LOCATION:	PLATFORM @ 1.330KM - DOWN LOCAL			CHECKED BY: PG	DATE : 15/02/10

GEOLOGICAL DESCRIPTION: Type of Deposit	GEOLOGICAL DESCRIPTION: Characteristics	DEPTH (m)	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
PLATFORM FOOTING		1.0, 0.8, 0.6, 0.4, 0.2					
	Rail Level	0.0, 0.2					
	Silty clay.	0.4, 0.6	Soft-firm				
	Silty clay.	0.8	Stiff				
	EOH @ 800mm	1.0, 1.2					

GRAPHIC REPRESENTATION



1	2	3	4	5	6	7	8

LEGEND:

- BALLAST Slightly Fouled
- BALLAST Moderately Fouled
- BALLAST Heavily Fouled
- CAPPING
- FILL
- RESIDUAL SOIL
- ALLUVIUM
- BEDROCK
- WATER SEEPAGE

Rock Weathering	
CW	Completely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

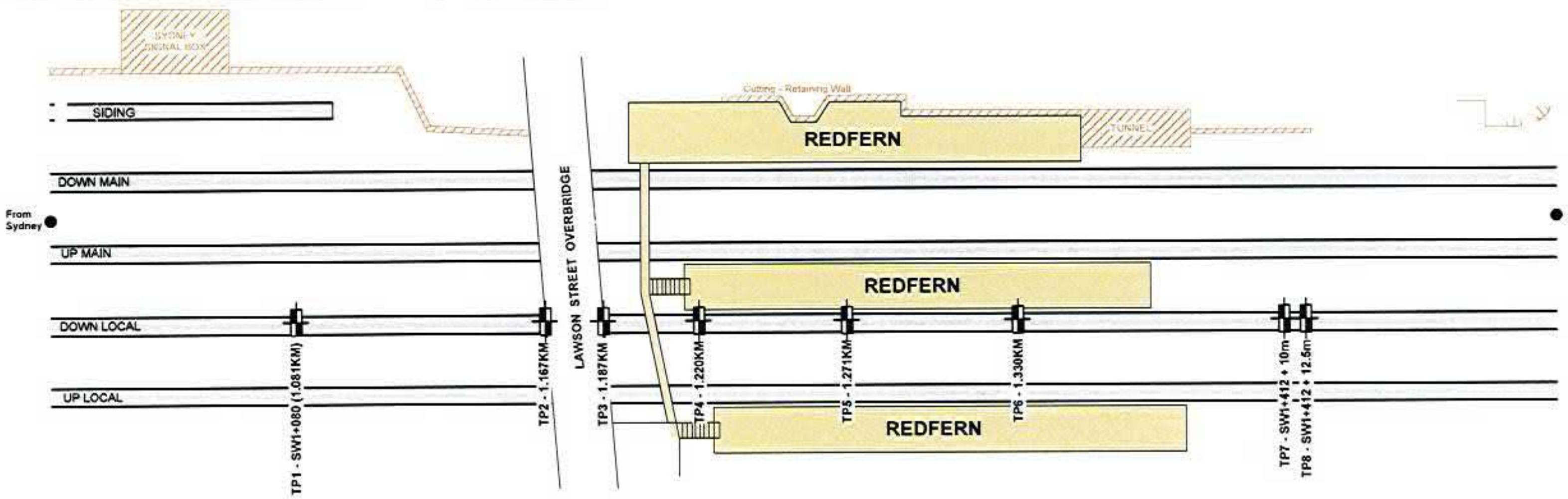
Rock Strength	
EW	Extremely Weak
MH	Medium High
HI	High
W	Weak
VH	Very High

Relative Density	
VL	Very Loose
L	Loose
MD	Medium Dense
D	Dense
VD	Very Dense

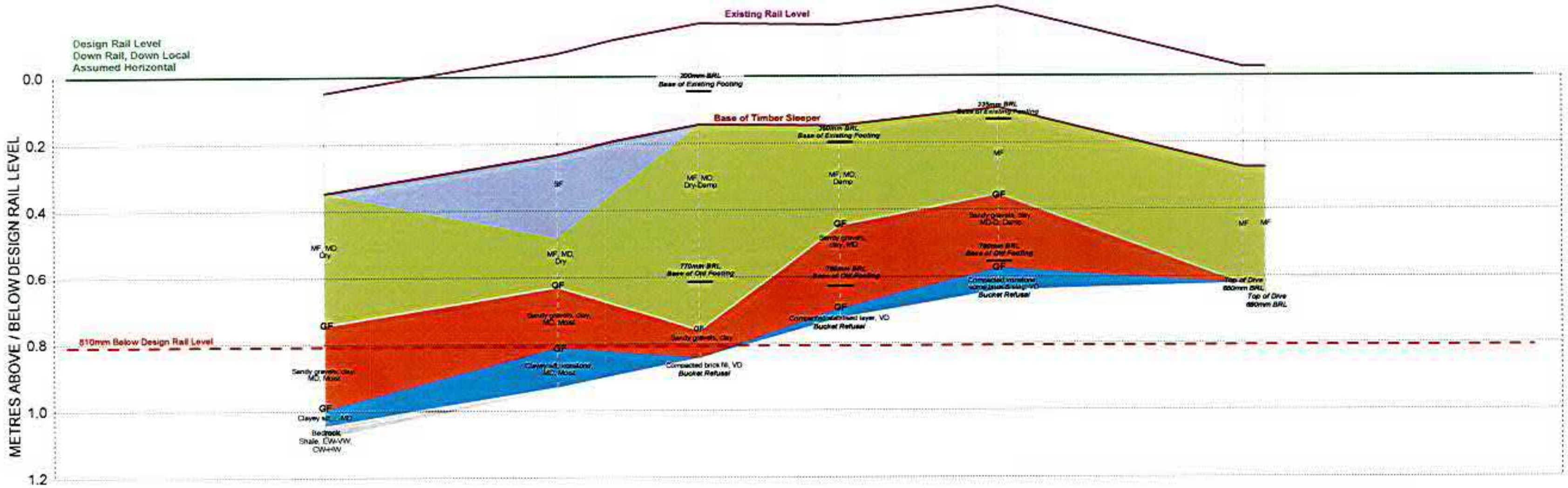
Ballast Fouling	
SF	Slightly Fouled
MF	Moderately Fouled
HF	Heavily Fouled

Fabrics	
GF	Geofabric
GT	Geotextile
WGT	Woven Geotextile
GC	Geocomposite

- TEST PIT LOCATION
- EXISTING RAIL LEVEL
- BASE OF TIMBER SLEEPER
- EXISTING CESS LEVEL



TEST PIT LOCATION PLAN



LONGITUDINAL SECTION

AMD	REFERENCE	DESCRIPTION	SIGN./DATE

DRAWN	H Corscadden	03/02/10
DRG CHECK	P Ganewatta	15/02/10
per / PRINCIPAL GEOTECHNICAL ENGINEER		16/02/11

NSW Transport RailCorp
ENGINEERING & PROJECTS GROUP
PROFESSIONAL SERVICES DIVISION
GEOTECHNICAL SERVICES

REDFERN

1.081KM to 1+412 + 12.5m - DOWN LOCAL

TEST PIT PLAN & LONGITUDINAL SECTION

CAD FILENAME: GS 10 8573 SI 1	SHEET 1 OF 1	A2
	DWG No. GS10-8573 SI 1	

QGSP-3.1F4/B

ENGINEERING BOREHOLE LOG

HOLE Nº **8573-1**

PROJECT: REDFERN
FEATURE: FOUNDATION INVESTIGATION FOR PLATFORM STABILITY
LOCATION: PLATFORM 6 - 1.207KM - DOWN LOCAL

SURFACE ELEVATION: Platform Level
ANGLE FROM HORIZONTAL: 90°
DIRECTION: Down

TYPE OF DEPOSIT	CHARACTERISTICS Material, colour, grain size, structure	DEPTH	WEATHERING	DEFECTS DESCRIPTION	FRAGMENTN	ADDITIONAL SOIL / ROCK DATA	TESTS	PROGRESS Drilling method / Lifts / Core loss
STRUCTURE	Brick, red-brown and mortar, grey.	0				F, Hi strength		DIAMOND CORING
		1		Void? Core Loss 730mm				
SEDIMENTARY BEDROCK	Shale, grey.	2	CW		FR	Soft, PP=30kPa, MC>PL; Very Dense, PP=300-400kPa, MC>PL; Hard, PP=450kPa, MC<PL; Very Stiff, PP=250kPa, MC>PL	DCP #1	
	Shale, brown.		HW	J, SM, PNR, VT				
	Shale, grey.		CW			Very Stiff, PP=270-300kPa, MC>PL		
	Shale, dark grey.		HW					
		3		Core Loss 150mm				

	OVERBURDEN	ROCK
DRILL		PROLINE
BIT TYPE		TT BARREL
SIZE		70mm DIA

DRILLERS: DG / ST / PG
COMMENCED: 22/05/10 COMPLETED: 22/05/10
INCLINOMETER ☐ To.................m depth
PIEZO / Standpipe ☐ To.................m depth
CORE PHOTOGRAPHED ☒

RailCorp
9-13 Unwins Bridge Road SYDENHAM 2044
Ph: 02 9563 7111 Fax: 02 9563 7786

Geotechnical Services

REMARKS

1. Bore Hole collar at top of coping (G.L)

See Explanatory Notes for abbrevations and explanations.

Logged:	RC	Date:	22/05/10
Drawn:	HC	Date:	31/05/10
Checked:	JS	Date:	01/06/10
Core Checked:	JS	Date:	01/06/10

ENGINEERING BOREHOLE LOG

HOLE Nº **8573-1**

PROJECT: REDFERN
FEATURE: FOUNDATION INVESTIGATION FOR PLATFORM STABILITY
LOCATION: PLATFORM 6 - 1.207KM - DOWN LOCAL

SURFACE ELEVATION: Platform Level
ANGLE FROM HORIZONTAL: 90°
DIRECTION: Down

TYPE OF DEPOSIT	CHARACTERISTICS Material, colour, grain size, structure	GRAPHIC LOG	DEPTH	WEATHERING	ROCK STRENGTH Field estimation (EW VW W MH HI VH EH)	VISUAL	DEFECTS DESCRIPTION	FRAGMNTN	SPACING (mm) 0-30 30-100 100-300 300-1000 >1000	ADDITIONAL SOIL / ROCK DATA	MOISTURE	SAMPLES (type) Ground Water Level	TESTS	PROGRESS Drilling method / Lifts / Core loss	CASING
SEDIMENTARY BEDROCK			3				Core Loss 150mm							*DIAMOND CORING*	
							EOH @ 3.09m								
			4												
			5												
			6												

	OVERBURDEN	ROCK
DRILL		PROLINE
BIT TYPE		TT BARREL
SIZE		70mm DIA

DRILLERS: DG / ST / PG
COMMENCED: 22/05/10 COMPLETED: 22/05/10
INCLINOMETER ☐ To.................m depth
PIEZO / Standpipe ☐ To.................m depth
CORE PHOTOGRAPHED ☒

RailCorp
9-13 Unwins Bridge Road SYDENHAM 2044
Ph: 02 9563 7111 Fax: 02 9563 7786

Geotechnical Services

REMARKS

See Explanatory Notes for abbrevations and explanations.

Logged:	RC	Date:	22/05/10
Drawn:	HC	Date:	31/05/10
Checked:	JS	Date:	01/06/10
Core Checked:	JS	Date:	01/06/10

BORE HOLE '1'

RailCorp	ASSET MANAGEMENT GROUP PROFESSIONAL SERVICES DIVISION GEOTECHNICAL SERVICES 9-13 Unwins Bridge Road Sydenham NSW 2044 phone: 9563 7111 fax:9563 7786 DX-7047 RS	REDFERN	Platform 6 Stability 1.207KM - Down Local Bore Hole 1

SHEET 1 OF 5

8573 - Pht 1

QGSP-3.1F4/B

ENGINEERING BOREHOLE LOG

HOLE Nº 8573-2

PROJECT: REDFERN
FEATURE: FOUNDATION INVESTIGATION FOR PLATFORM STABILITY
LOCATION: PLATFORM 6 - 1.235KM - DOWN LOCAL

SURFACE ELEVATION: Platform Level
ANGLE FROM HORIZONTAL: 90°
DIRECTION: Down

TYPE OF DEPOSIT	CHARACTERISTICS Material, colour, grain size, structure	DEPTH	WEATHERING	DEFECTS DESCRIPTION	FRAGMNTN	ADDITIONAL SOIL / ROCK DATA	PROGRESS Drilling method / Lifts / Core loss
STRUCTURE	Cementitious concrete, grey. 20mm nominal size rounded & angular aggregate.	0		7mm dia steel reinforcement		F, Hi strength	DIAMOND CORING
	Brick, red-brown and mortar, grey.	1				F, Hi strength	
				Core Loss 290mm			
SEDIMENTARY BEDROCK	Shale, medium grey.	2	CW	J, SM, PNR, VT J, IRR, RF, 80° to 85° J, PNR, RF, 65° J's, SM, PNR, 70° to 75°	HF FR	Hard, PP=450-550kPa, MC<PL Very Stiff, PP=280-320kPa, MC>PL Very Stiff, PP=320kPa, MC>PL Very Stiff, PP=230kPa, MC>PL	
				360mm Retained in barrel			
SEDIMENTARY BEDROCK	Shale, light grey.		CW	Ptg's, SM, PNR, HZ to < 5°	FR	Hard, PP=450-550kPa, MC<PL	
	Shale, brown.	3					

EOH @ 2.96m

	OVERBURDEN	ROCK
DRILL		PROLINE
BIT TYPE		THINWALL
SIZE		50mm DIA

DRILLERS: DG / ST
COMMENCED: 22/05/10 COMPLETED: 22/05/10

INCLINOMETER ☐ To.................m depth
PIEZO / Standpipe ☐ To.................m depth
CORE PHOTOGRAPHED ☒

RailCorp
9-13 Unwins Bridge Road SYDENHAM 2044
Ph: 02 9563 7111 Fax: 02 9563 7786

Geotechnical Services

REMARKS

1. Bore Hole collar 0.32m to edge of coping.

See Explanatory Notes for abbreviations and explanations.

Logged:	RC	Date:	22/05/10
Drawn:	HC	Date:	31/05/10
Checked:	JS	Date:	01/06/10
Core Checked:	JS	Date:	01/06/10

SHEET 1 OF 1

1 2

A A

BORE HOLE '2'

B B

RailCorp
ASSET MANAGEMENT GROUP
PROFESSIONAL SERVICES DIVISION
GEOTECHNICAL SERVICES
9-13 Unwins Bridge Road Sydenham NSW 2044
phone: 9563 7111 fax:9563 7786 DX-7047 RS

REDFERN	Platform 6 Stability 1.235KM - Down Local Bore Hole 2	SHEET 3 OF 5 8573 - Pht 2

1 2

ENGINEERING BOREHOLE LOG

HOLE Nº 8573-3

PROJECT: REDFERN
FEATURE: FOUNDATION INVESTIGATION FOR PLATFORM STABILITY
LOCATION: PLATFORM 6 - 1.355KM - DOWN LOCAL

SURFACE ELEVATION: Country end ramp
ANGLE FROM HORIZONTAL: 90°
DIRECTION: Down

TYPE OF DEPOSIT	CHARACTERISTICS Material, colour, grain size, structure	DEPTH	DEFECTS DESCRIPTION	ADDITIONAL SOIL / ROCK DATA	MOISTURE	PROGRESS Drilling method / Lifts / Core loss
STRUCTURE	Asphaltic concrete	0				HAND AUGER
	Sandy gravel, trace ash, dark grey. Sandy gravels to approx 100x60x60mm recovered.			Loose	Dry	
	Sandy clay, grey.			Firm	MC>PL	
	Sandy clay, brown.	1		Soft	MC>PL	
FILL	Cementitious concrete, grey			SW, Hi strength		DIAMOND CORING
			Core Loss 530mm			
			Core Loss 240mm			
FILL	Sandy clay, brown.					
RESIDUAL SOIL	Silty clay, brown.	2		Stiff, PP=140kPa, MC>PL; Very Stiff, PP=250kPa, MC>PL		
	Silty clay, grey, mottled red-brown.			Very Stiff, PP=350-400kPa, MC>PL; Hard, PP=450-550kPa, MC<PL		
	Silty clay, grey.	3		Very Stiff, PP=350-400kPa, MC<PL		

	OVERBURDEN	ROCK
DRILL		PROLINE
BIT TYPE	HAND AUGER	STEPFACE
SIZE	110mm DIA	NMLC

DRILLERS: DG / ST
COMMENCED: 22/05/10 COMPLETED: 22/05/10
INCLINOMETER ☐ To................m depth
PIEZO / Standpipe ☐ To................m depth
CORE PHOTOGRAPHED ☒

RailCorp
9-13 Unwins Bridge Road SYDENHAM 2044
Ph: 02 9563 7111 Fax: 02 9563 7786
Geotechnical Services

REMARKS
1. Bore Hole collar 0.90m to edge of coping.
2. Bore Hole collar 0.35m country side of country end of platform on ramp. (touching edge of wall)

See Explanatory Notes for abbrevations and explanations.

Logged:	RC	Date:	22/05/10
Drawn:	HC	Date:	31/05/10
Checked:	JS	Date:	01/06/10
Core Checked:	JS	Date:	01/06/10

SHEET 1 OF 2

ENGINEERING BOREHOLE LOG

HOLE Nº 8573-3

PROJECT: REDFERN
FEATURE: FOUNDATION INVESTIGATION FOR PLATFORM STABILITY
LOCATION: PLATFORM 6 - 1.355KM - DOWN LOCAL

SURFACE ELEVATION: Country end ramp
ANGLE FROM HORIZONTAL: 90°
DIRECTION: Down

TYPE OF DEPOSIT	CHARACTERISTICS Material, colour, grain size, structure	DEPTH	WEATHERING	DEFECTS DESCRIPTION	FRAGMENTN	ADDITIONAL SOIL / ROCK DATA	PROGRESS Drilling method / Lifts / Core loss
RES. SOIL	Silty clay, grey.	3				Hard, PP=420kPa, MC<PL	DIAMOND CORING
SEDIMENTARY BEDROCK	Shale, grey, mottled red-brown.		CW	Fe	FR	Hard, PP=400 to > 600kPa, MC<PL	DIAMOND CORING

EOH @ 3.38m

Depth scale: 4, 5, 6

	OVERBURDEN	ROCK
DRILL		PROLINE
BIT TYPE		STEPFACE
SIZE		NMLC

DRILLERS: DG / ST

COMMENCED: 22/05/10 COMPLETED: 22/05/10

INCLINOMETER ☐ To................m depth
PIEZO / Standpipe ☐ To................m depth
CORE PHOTOGRAPHED ☒

RailCorp
9-13 Unwins Bridge Road SYDENHAM 2044
Ph: 02 9563 7111 Fax: 02 9563 7786
Geotechnical Services

REMARKS

See Explanatory Notes for abbrevations and explanations.

Logged:	RC	Date:	22/05/10
Drawn:	HC	Date:	31/05/10
Checked:	JS	Date:	01/06/10
Core Checked:	JS	Date:	01/06/10

SHEET 2 OF 2

1 2

A A

B B

BORE HOLE '3'

ASSET MANAGEMENT GROUP
PROFESSIONAL SERVICES DIVISION
GEOTECHNICAL SERVICES
9-13 Unwins Bridge Road Sydenham NSW 2044
phone: 9563 7111 fax:9563 7786 DX-7047 RS

RailCorp

REDFERN

Platform 6 Stability
1.355KM - Down Local
Bore Hole 3

SHEET 5 OF 5

8573 - Pht 3

1 2

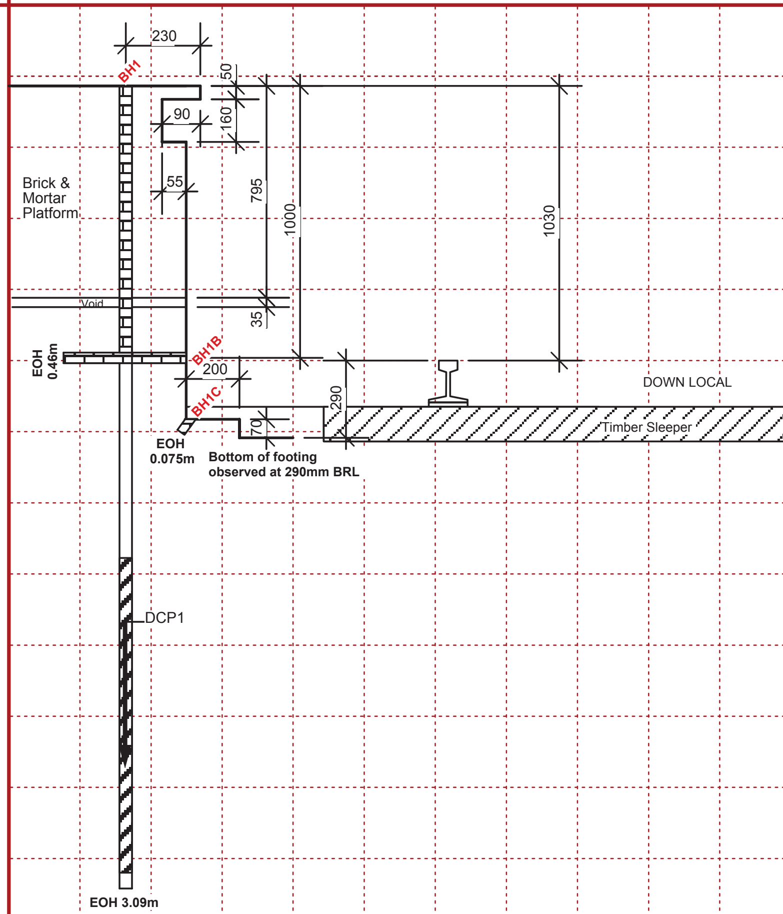
RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

RailCorp

TEST PIT Nº: 8573-1

PROJECT:	REDFERN	START OF TEST PIT:	TOP OF RAIL = 00	LOGGED BY: RC	DATE: 22/05/10
FEATURE:	PLATFORM STABILITY INVESTIGATION	EXCAVATION DIMENSION :	BETWEEN SLEEPERS	DRAWN BY: HC	DATE: 31/05/10
LOCATION:	PLATFORM 6 - 1.207KM - DOWN LOCAL			CHECKED BY: JS	DATE : 01/06/10

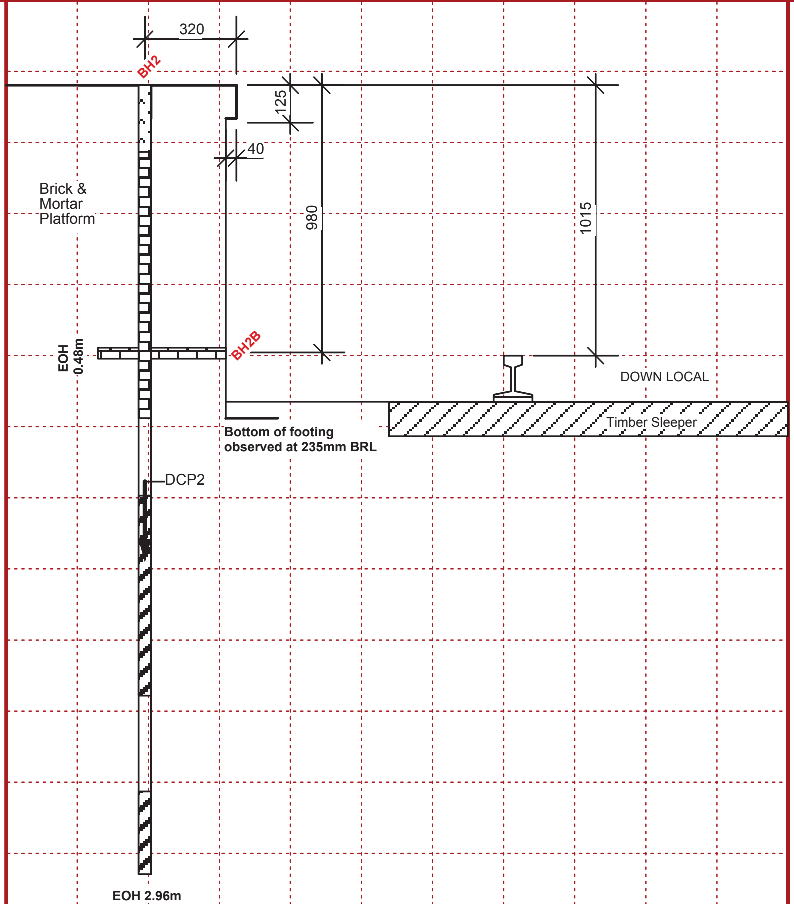
GEOLOGICAL DESCRIPTION		DEPTH (m)	GRAPHIC REPRESENTATION	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
Type of Deposit	Characteristics							
		0.0						

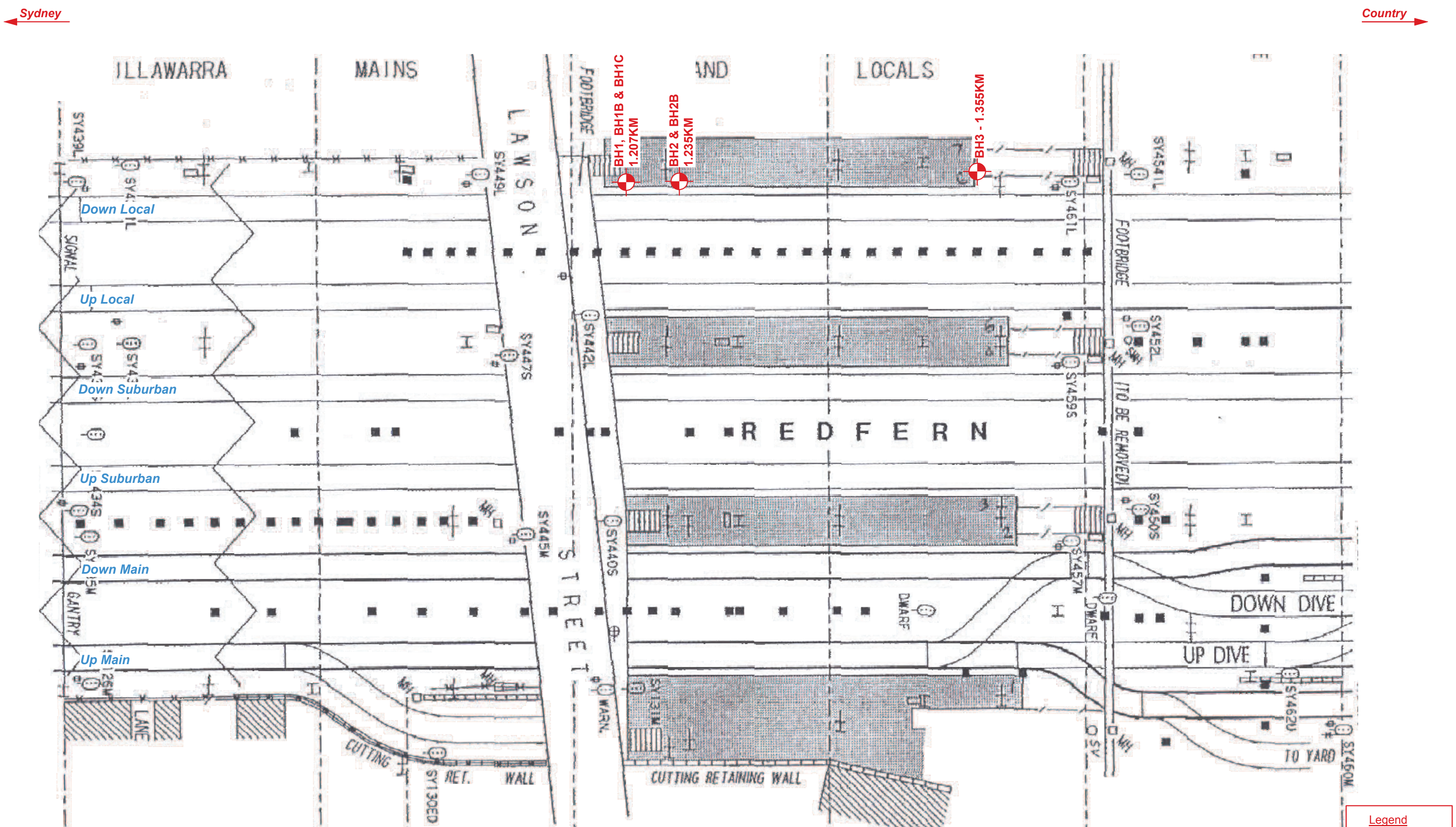
RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

TEST PIT Nº: 8573-2

PROJECT:	REDFERN	START OF TEST PIT:	TOP OF RAIL = 00	LOGGED BY: RC	DATE: 22/05/10
FEATURE:	PLATFORM STABILITY INVESTIGATION	EXCAVATION DIMENSION :	BETWEEN SLEEPERS	DRAWN BY: HC	DATE: 31/05/10
LOCATION:	PLATFORM 6 - 1.235KM - DOWN LOCAL			CHECKED BY: JS	DATE : 01/06/10

GEOLOGICAL DESCRIPTION		DEPTH (m)	GRAPHIC REPRESENTATION	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
Type of Deposit	Characteristics							
		0.0						



TEST PIT LOCATION PLAN
Not to Scale

AMD	REFERENCE	DESCRIPTION	SIGN./DATE

DRAWN H Corscadden 31/05/10
DRG CHECK J Singh 01/06/10
01/06/10
per / PRINCIPAL GEOTECHNICAL ENGINEER DATE

RailCorp
ENGINEERING & PROJECTS GROUP
PROFESSIONAL SERVICES DIVISION
GEOTECHNICAL SERVICES
9-13 Unwins Bridge Road Sydenham NSW 2044
phone: 9563 7111 fax:9563 7786 DX-7047 RS

REDFERN

1.207KM to 1.355KM- DOWN LOCAL

PLATFORM STABILITY

CAD FILENAME: GS 10 8573 SI 1 | SHEET 1 OF 1 | A3

DWG No. GS10-8573 SI 1

1 2

A A

B B

RailCorp — ASSET MANAGEMENT GROUP PROFESSIONAL SERVICES DIVISION GEOTECHNICAL SERVICES 9-13 Unwins Bridge Road Sydenham NSW 2044 phone: 9563 7111 fax:9563 7786 DX-7047 RS	REDFERN — Platform 6 Stability 1.207KM - Down Local Bore Holes 1, 1B & 1C	SHEET 1 OF 3 8573 - Pht 1

1 2

1 2

A

A

B B

RailCorp
ASSET MANAGEMENT GROUP
PROFESSIONAL SERVICES DIVISION
GEOTECHNICAL SERVICES
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REDFERN

Platform 6 Stability
1.207KM - Down Local
Bore Holes 1B & 1C

SHEET 2 OF 3

8573 - Pht 2

1 2

1 2

A A

B B

ASSET MANAGEMENT GROUP
PROFESSIONAL SERVICES DIVISION
GEOTECHNICAL SERVICES

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RailCorp

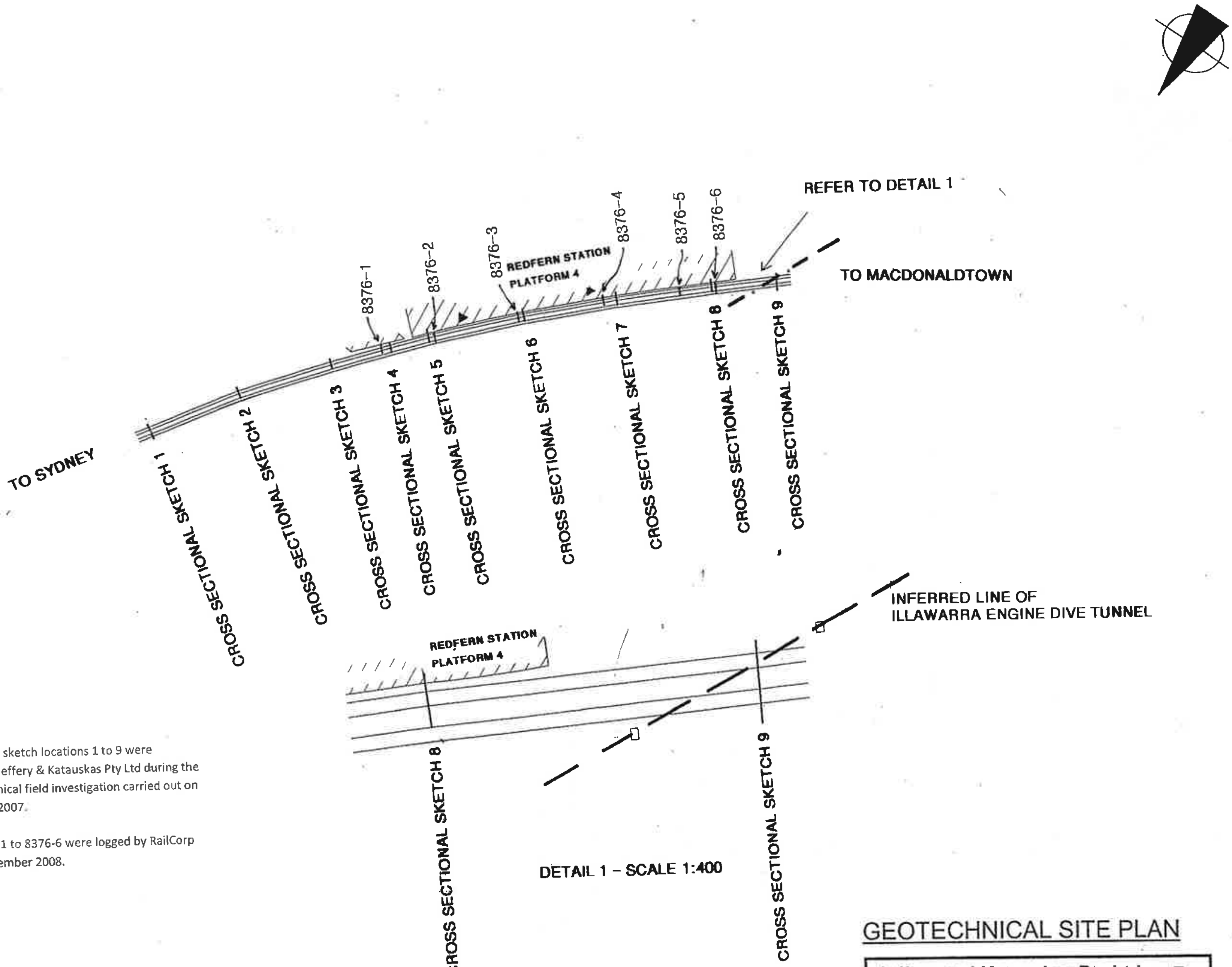
REDFERN

Platform 6 Stability
1.207KM - Down Local
Bore Hole 1C

SHEET 3 OF 3

8573 - Pht 3

1 2



Notes:

1. Cross sectional sketch locations 1 to 9 were completed by Jeffery & Katauskas Pty Ltd during the initial geotechnical field investigation carried out on 24 November 2007.

2. Test Pits 8376-1 to 8376-6 were logged by RailCorp staff on 1 November 2008.

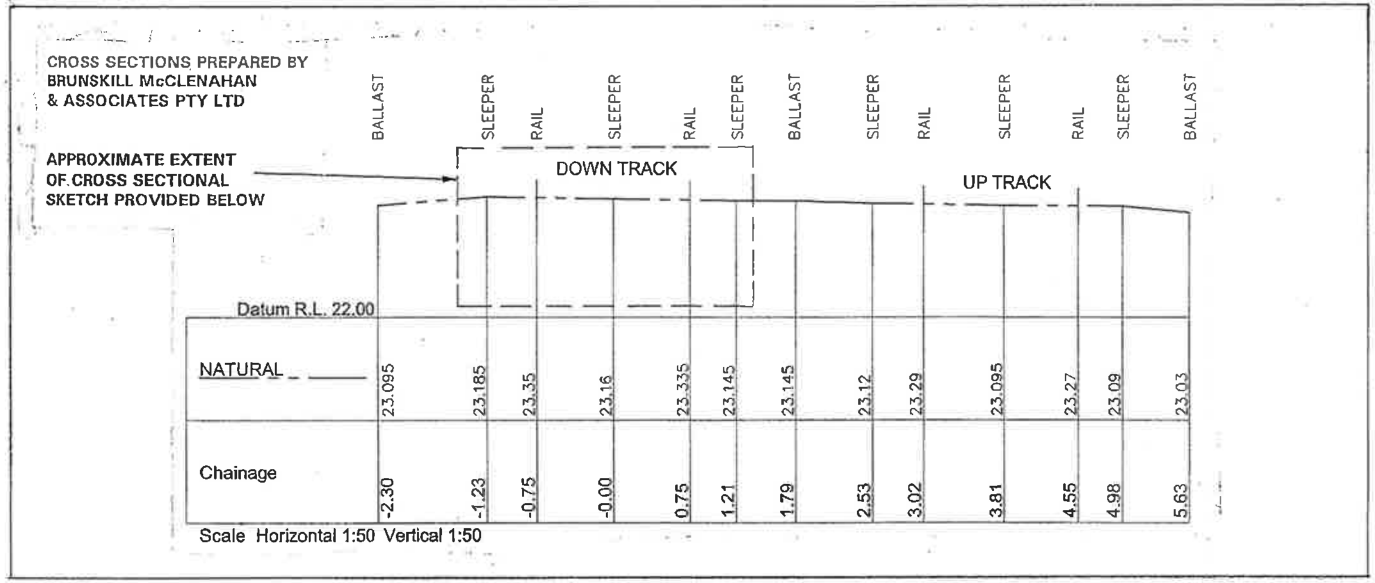
SCALE (m)
0 100

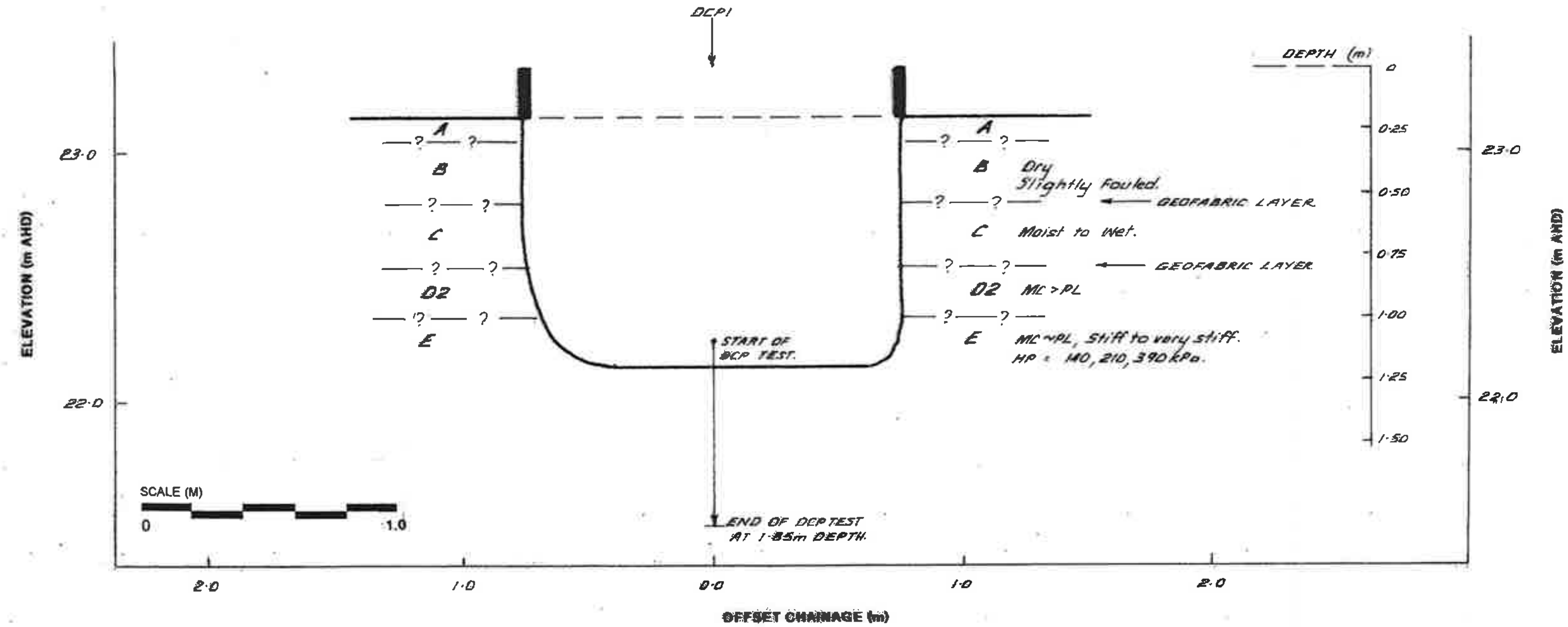
GEOTECHNICAL SITE PLAN

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

Report No. 21693ZH

Figure No. 1





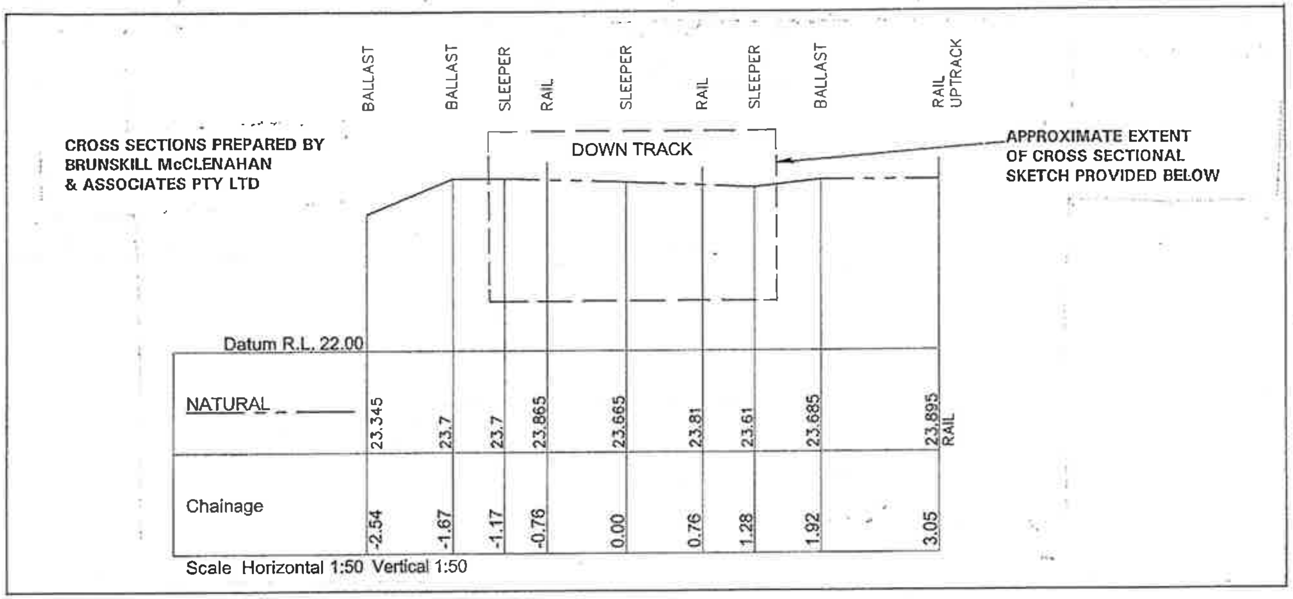
NOTE

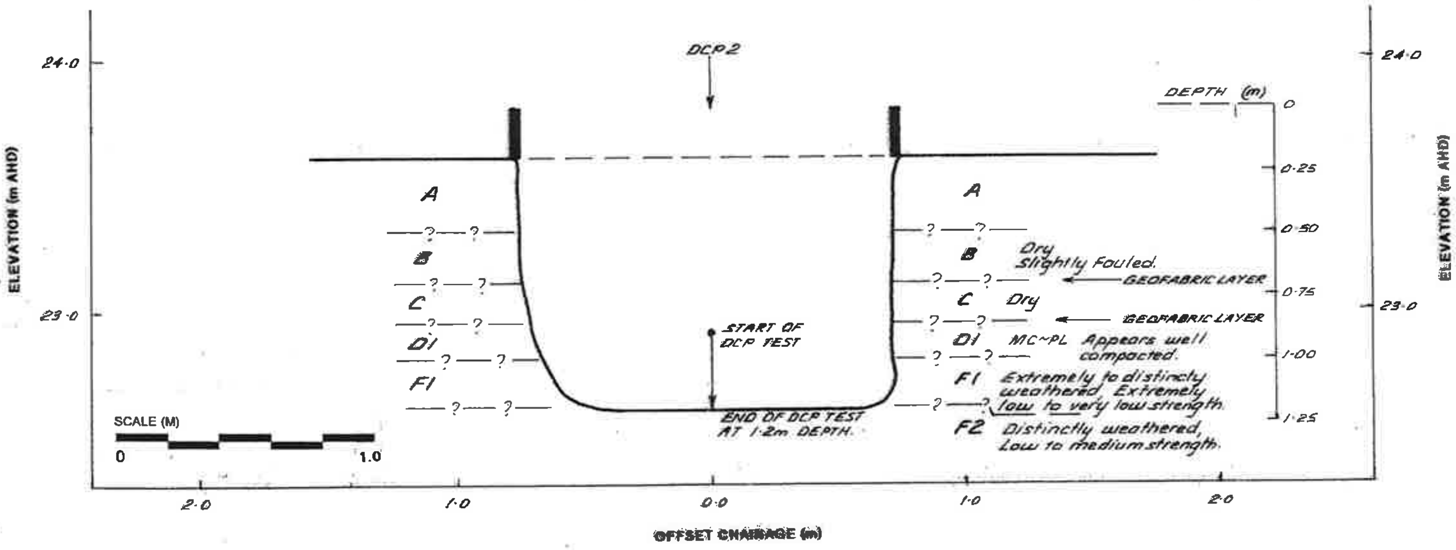
1. All track formation layer depths are approximate. For details refer to Table A.
2. Refer to DCP Test Results.
3. Test Pit 'Dry on Completion'

CROSS SECTIONAL SKETCH 1
TRACK KILOMETRAGE 1.058km
DOWN SUBURBAN TRACK
LOOKING AWAY FROM SYDNEY

Jeffery & Katauskas Pty Ltd

Report No. 21693ZH Figure No. 2



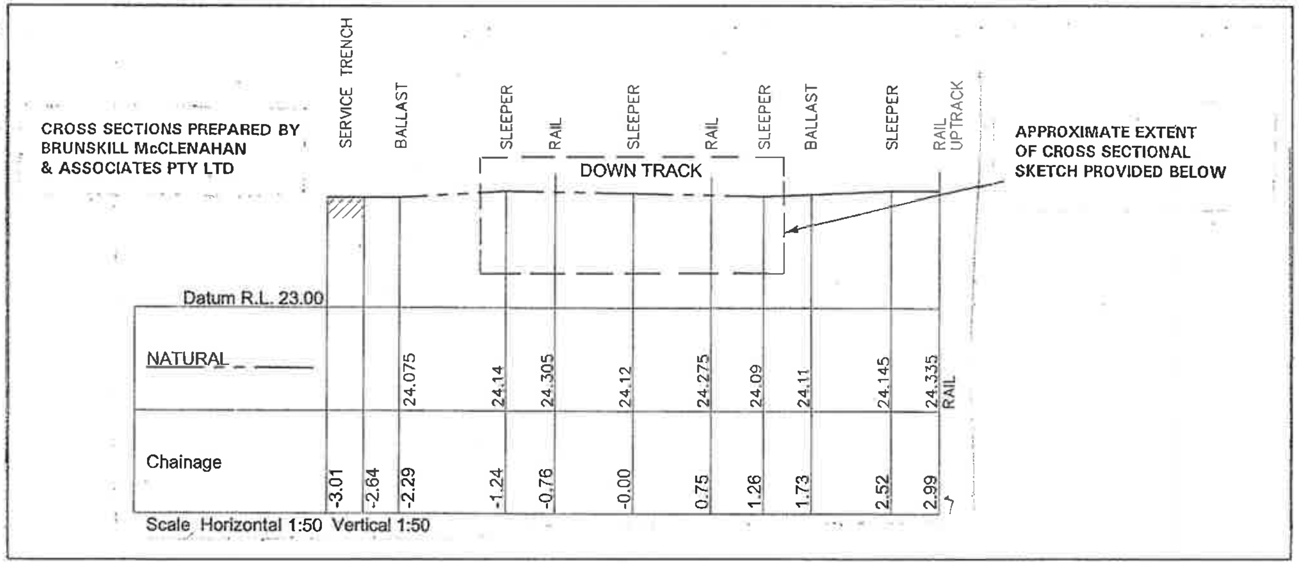


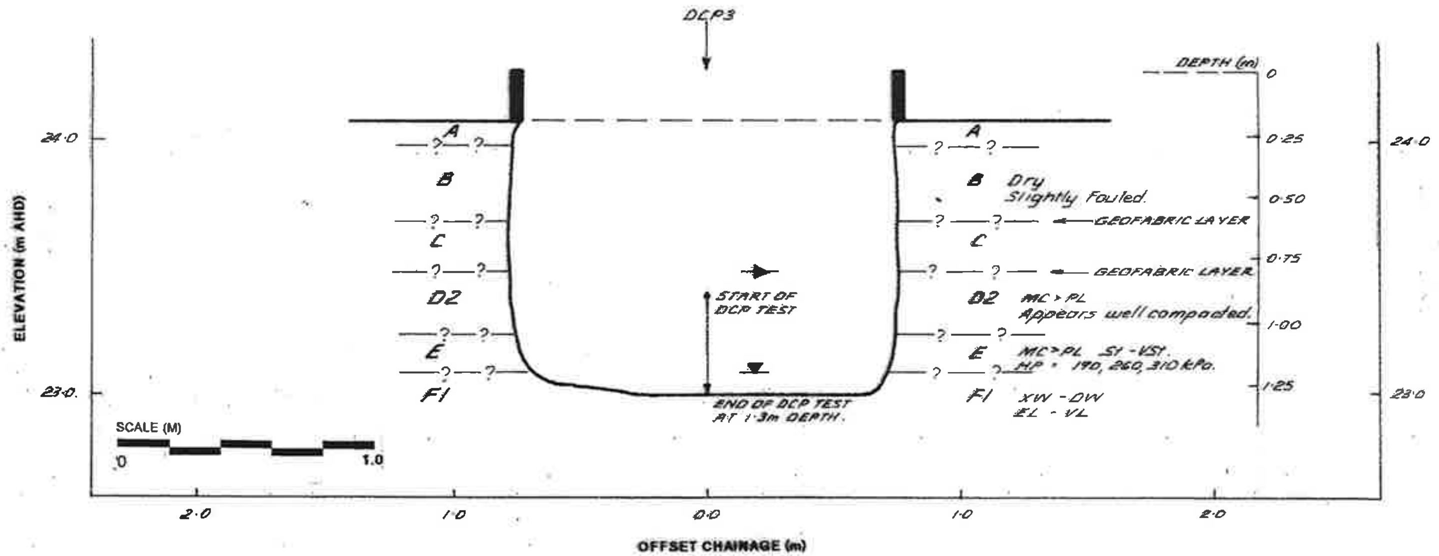
NOTE

1. All track formation layer depths are approximate. For details refer to Table A.
2. Refer to DCP Test Results.
3. Test Pit 'Dry on Completion'

CROSS SECTIONAL SKETCH 2
TRACK KILOMETRAGE 1.108km
DOWN SUBURBAN TRACK
LOOKING AWAY FROM SYDNEY

Jeffery & Katauskas Pty Ltd
Report No. 21693ZH Figure No. 3

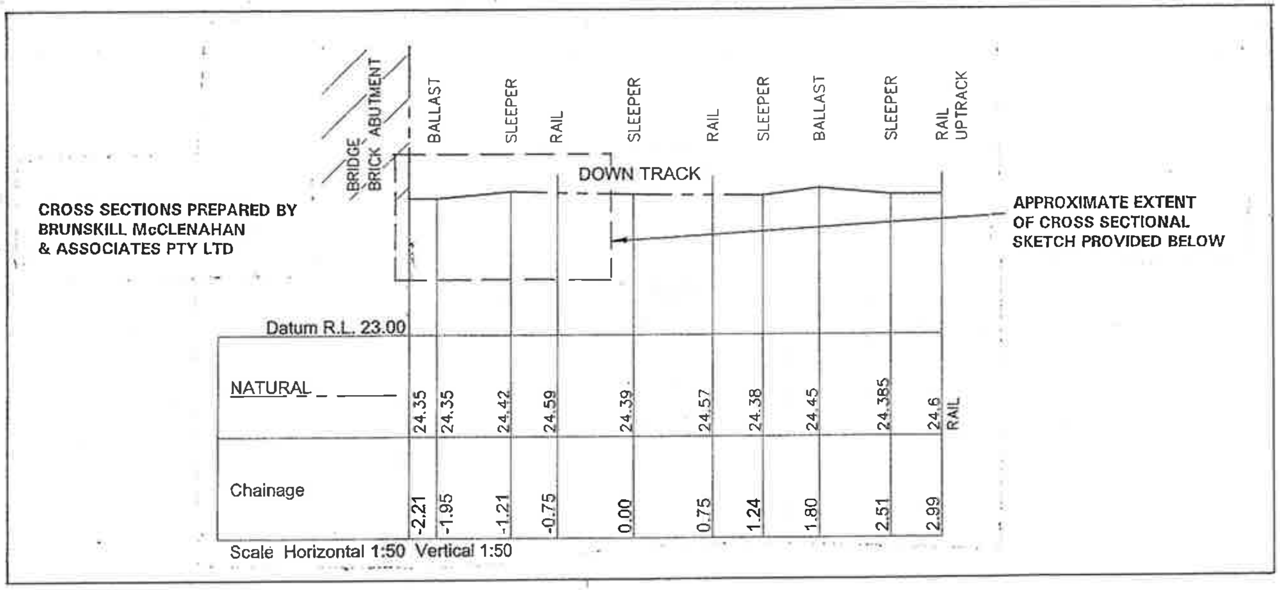


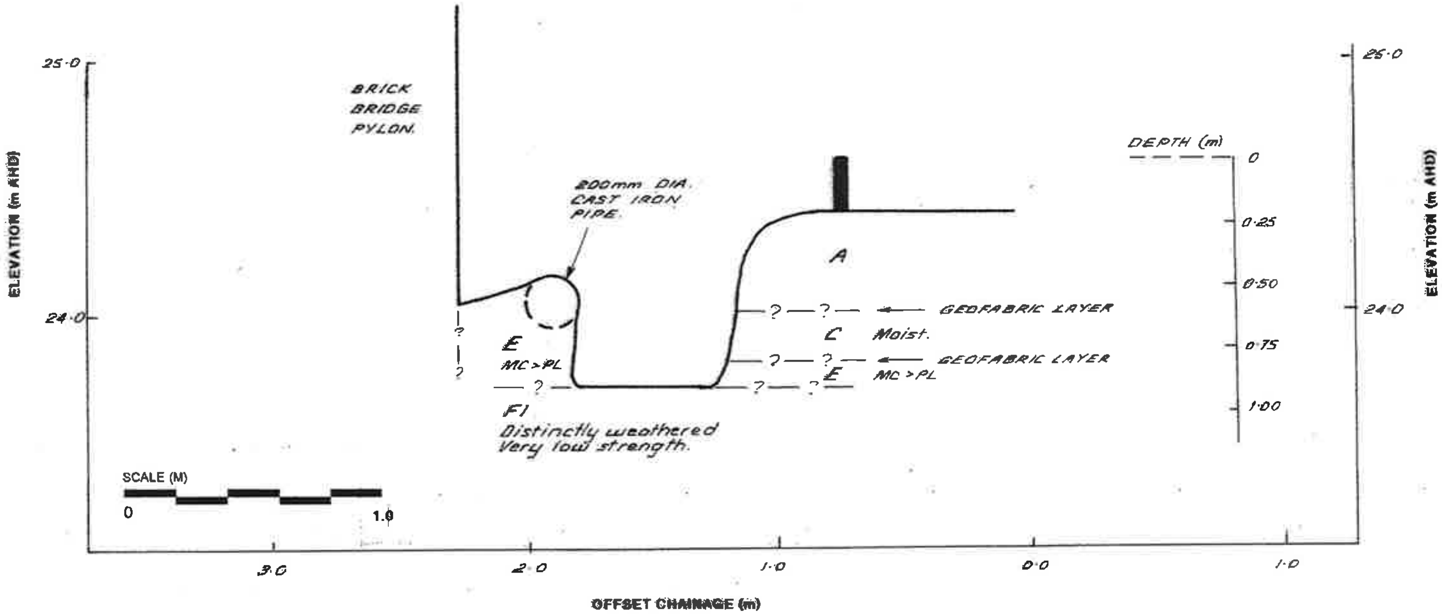


NOTE
1. All track formation layer depths are approximate. For details refer to Table A.
2. Refer to DCP Test Results

CROSS SECTIONAL SKETCH 3
TRACK KILOMETRAGE 1.158km
DOWN SUBURBAN TRACK
LOOKING AWAY FROM SYDNEY

Jeffery & Katauskas Pty Ltd
Report No. 21693ZH Figure No. 4



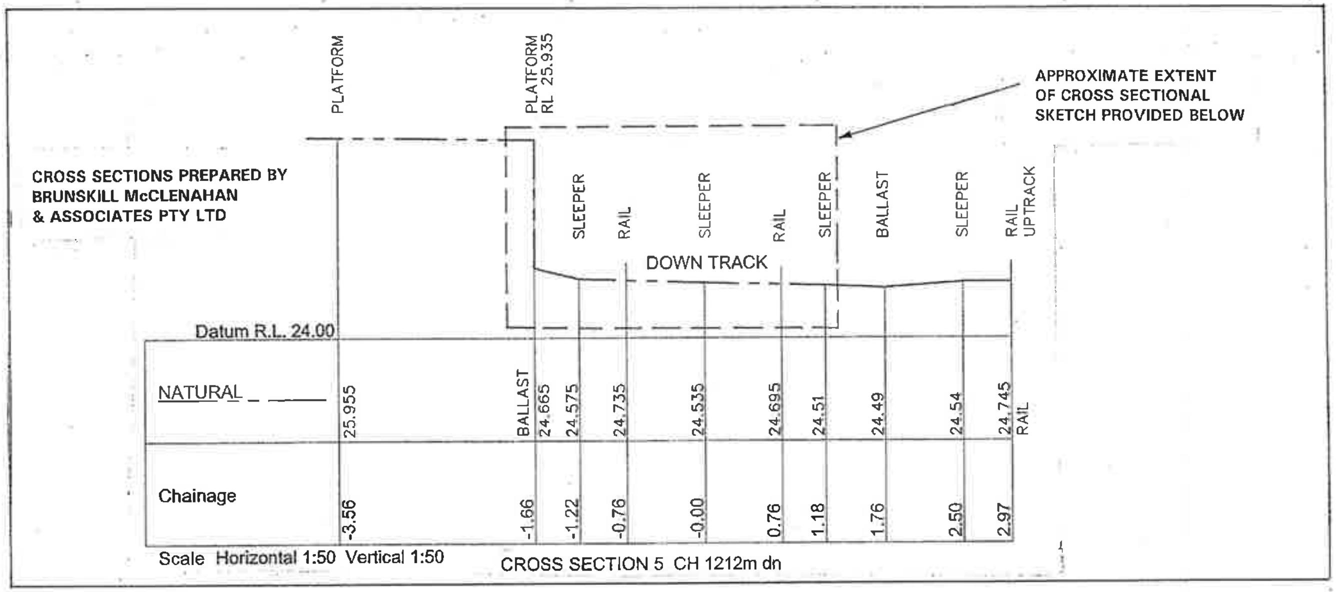


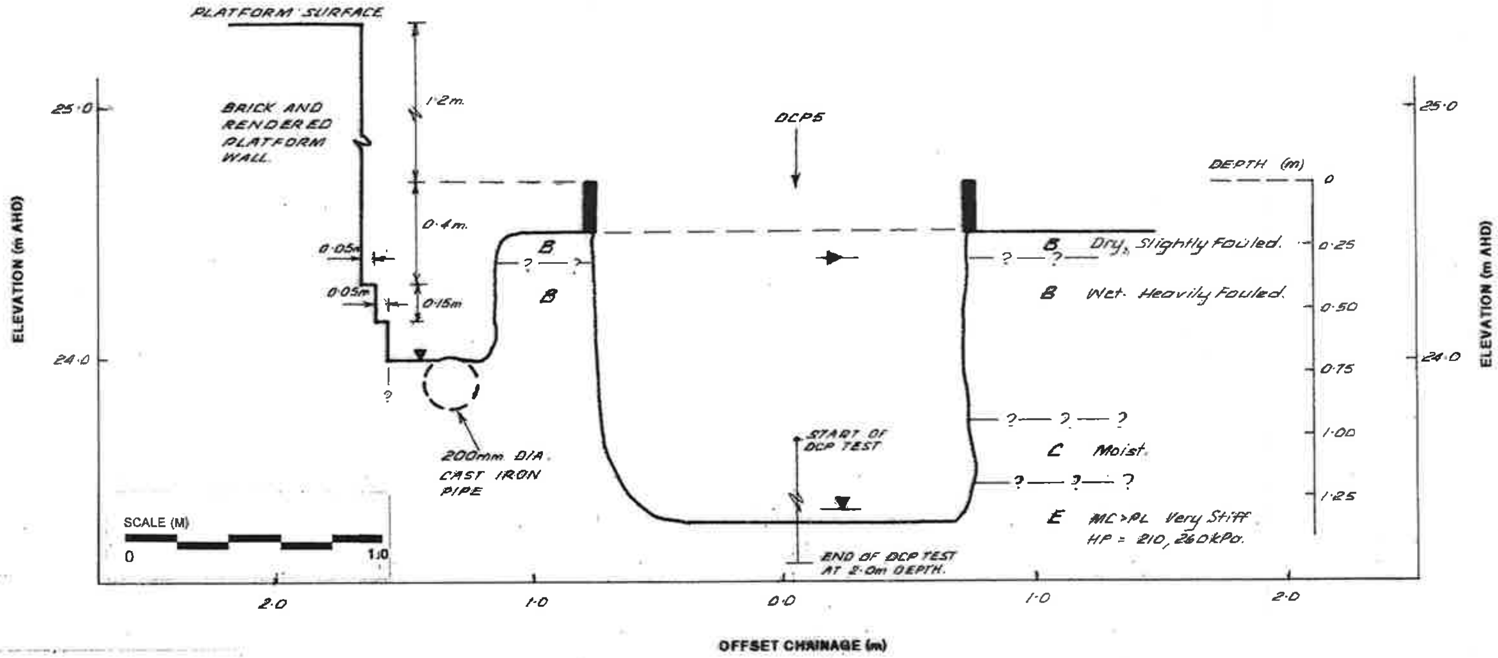
NOTE

1. All track formation layer depths are approximate. For details refer to Table A.
2. Test Pit 'Dry on Completion'

CROSS SECTIONAL SKETCH 4
TRACK KILOMETRAGE 1.191km
DOWN SUBURBAN TRACK
LOOKING AWAY FROM SYDNEY

Jeffery & Katauskas Pty Ltd
Report No. 21693ZH Figure No. 5



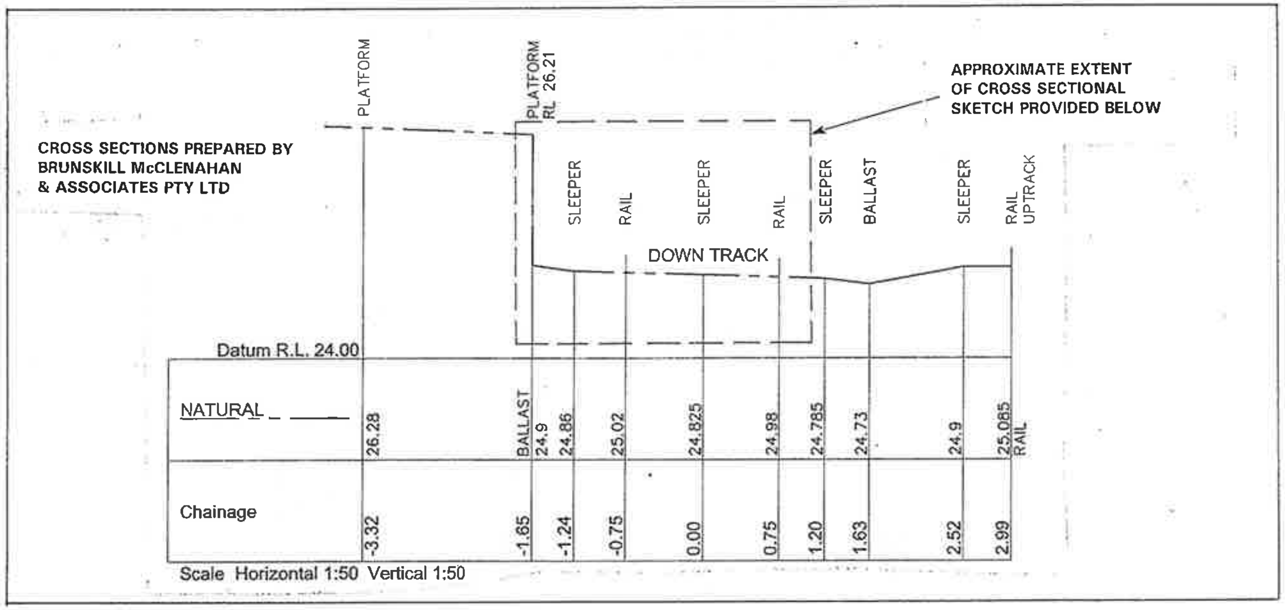


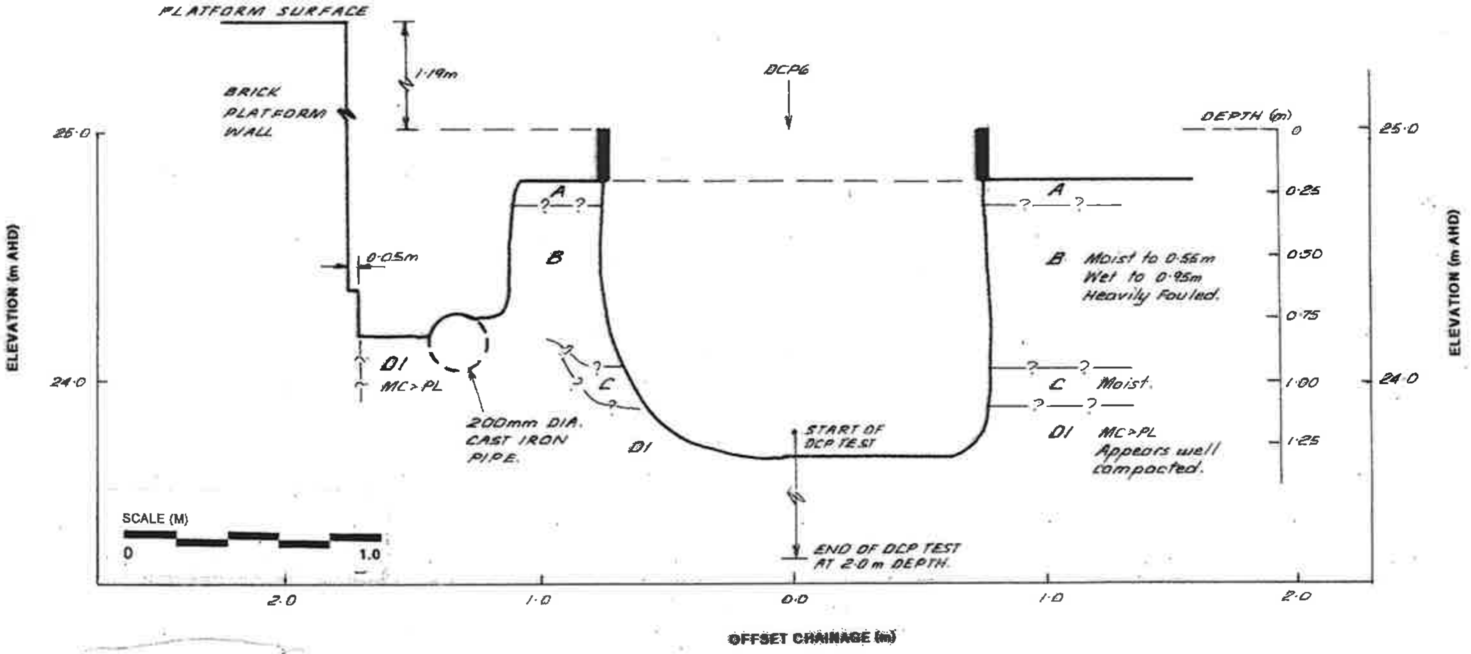
NOTE

3. All track formation layer depths are approximate. For details refer to Table A.
4. Refer to DCP test results.

CROSS SECTIONAL SKETCH 5
TRACK KILOMETRAGE 1.212km
DOWN SUBURBAN TRACK
LOOKING AWAY FROM SYDNEY

Jeffery and Katauskas Pty Ltd		
Report No.	21693ZH	Figure No. 6





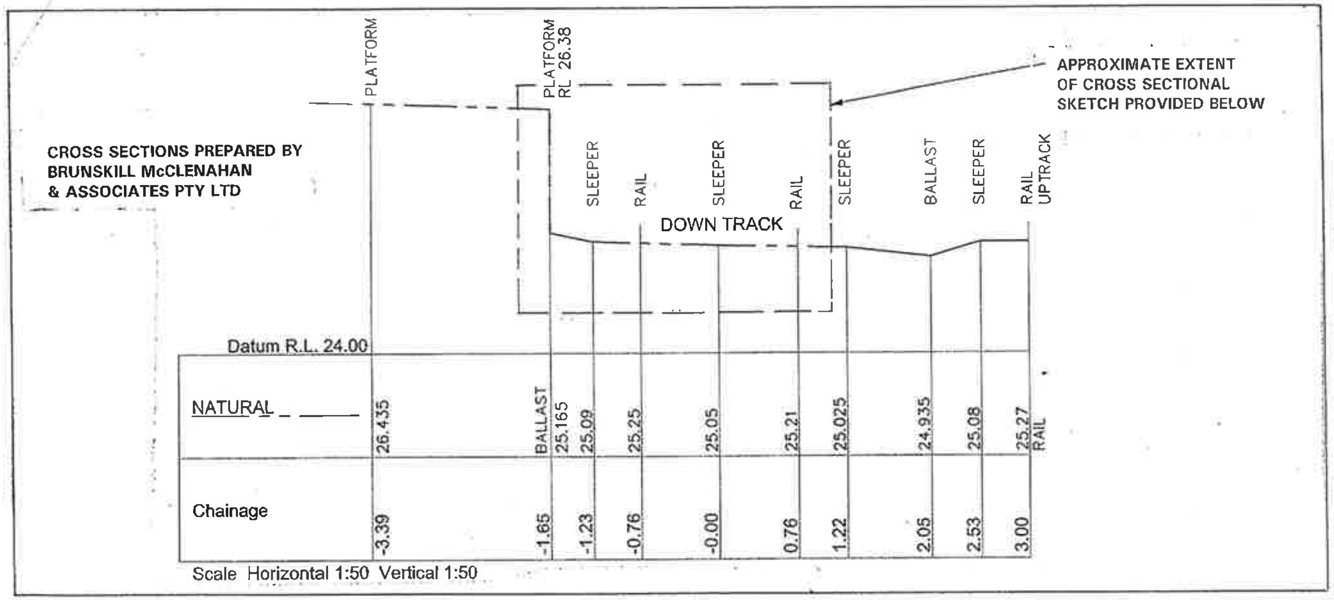
NOTE

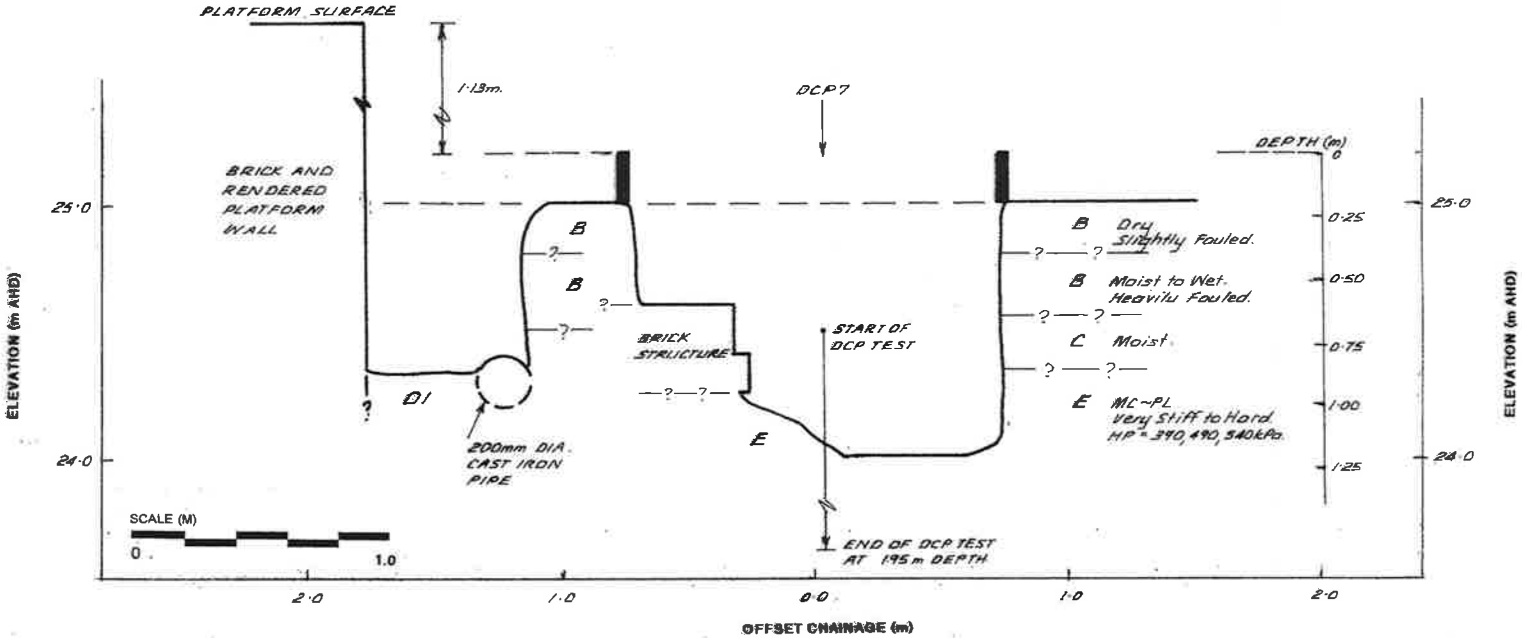
1. All track formation layer depths are approximate. For details refer to Table A.
2. Refer to DCP Test Results.
3. Test Pit 'Dry on Completion'

CROSS SECTIONAL SKETCH 6
TRACK KILOMETRAGE 1.262km
DOWN SUBURBAN TRACK
LOOKING AWAY FROM SYDNEY

Jeffery & Katauskas Pty Ltd

Report No. 21693ZH Figure No. 7



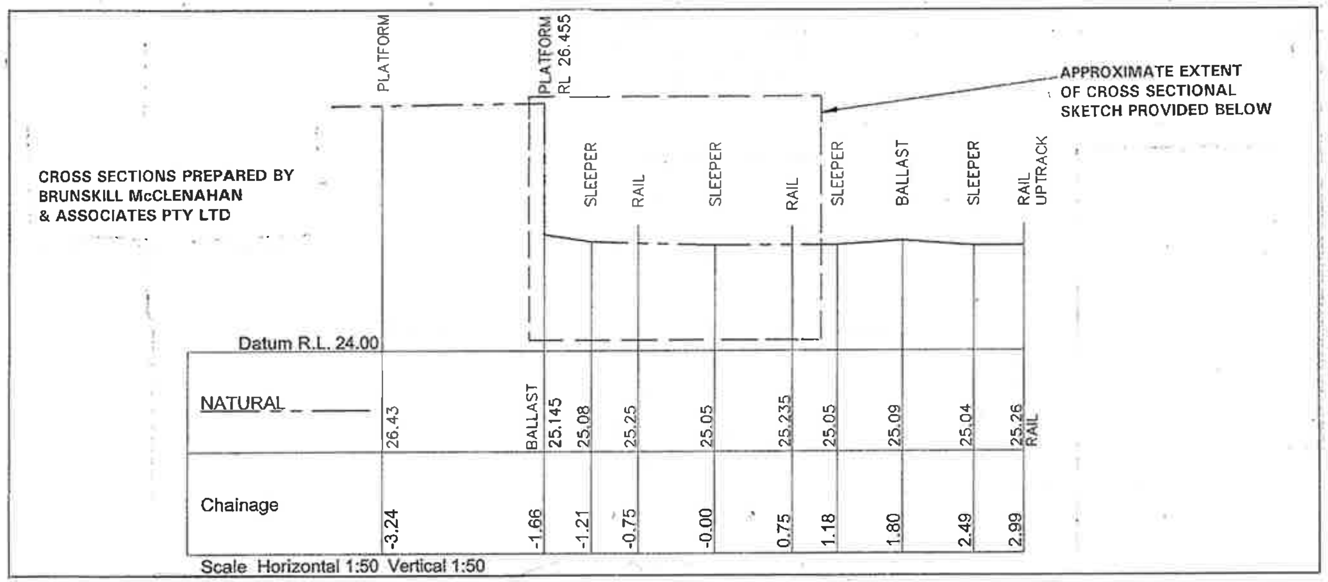


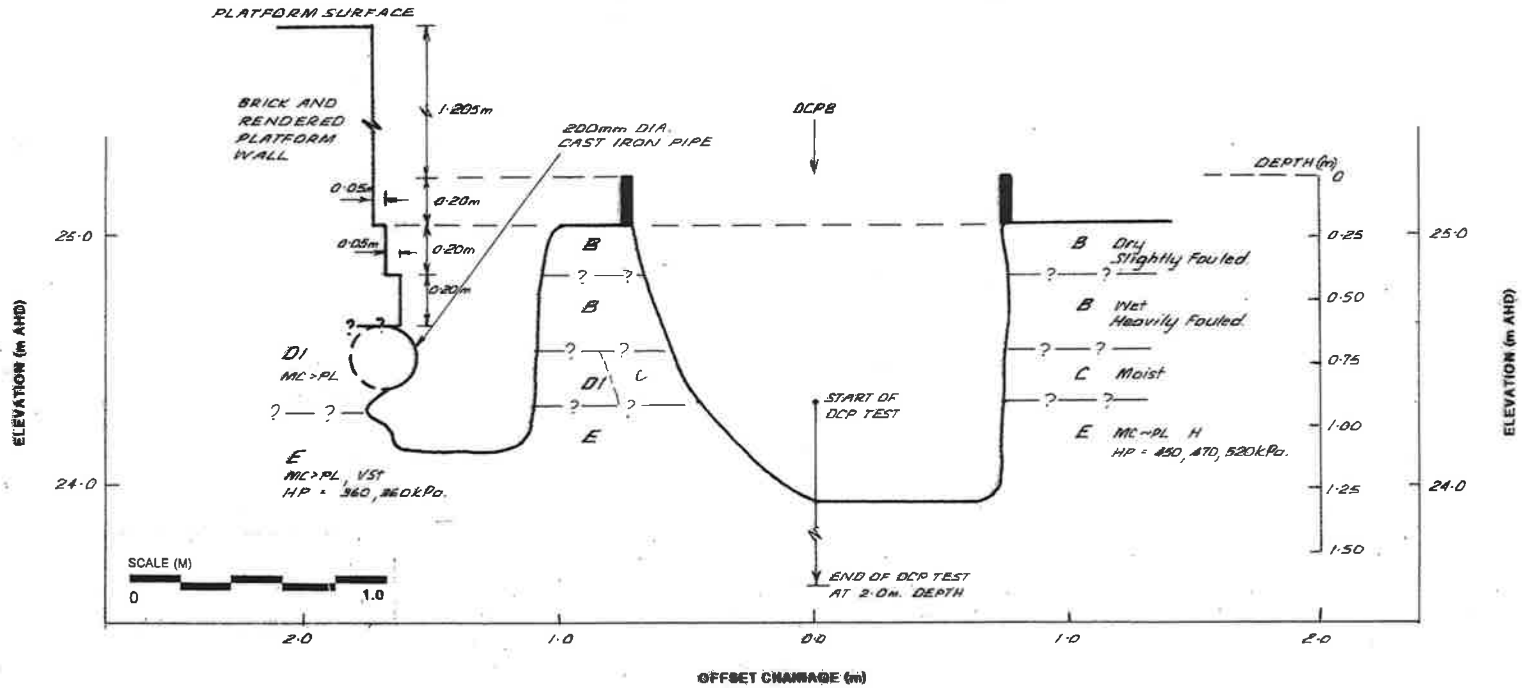
NOTE

1. All track formation layer depths are approximate. For details refer to Table A.
2. Refer to DCP Test Results.
3. Test Pit 'Dry on Completion'

CROSS SECTIONAL SKETCH 7
TRACK KILOMETRAGE 1.312km
DOWN SUBURBAN TRACK
LOOKING AWAY FROM SYDNEY

Jeffery & Katauskas Pty Ltd
Report No. 21693ZH Figure No. 8

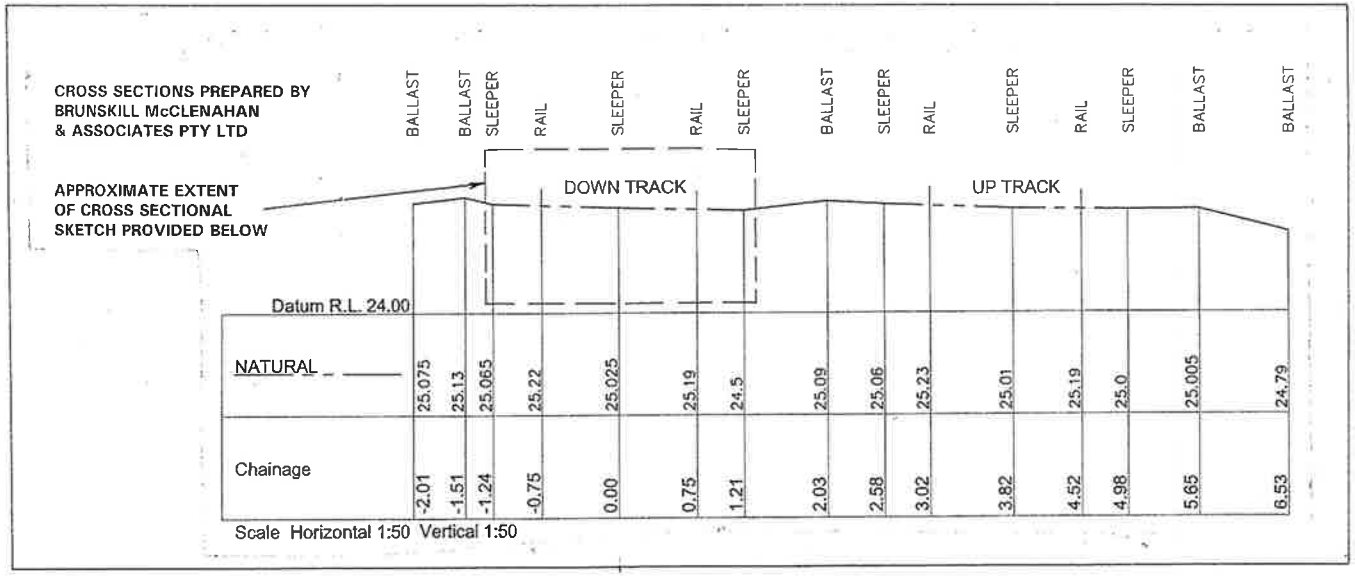


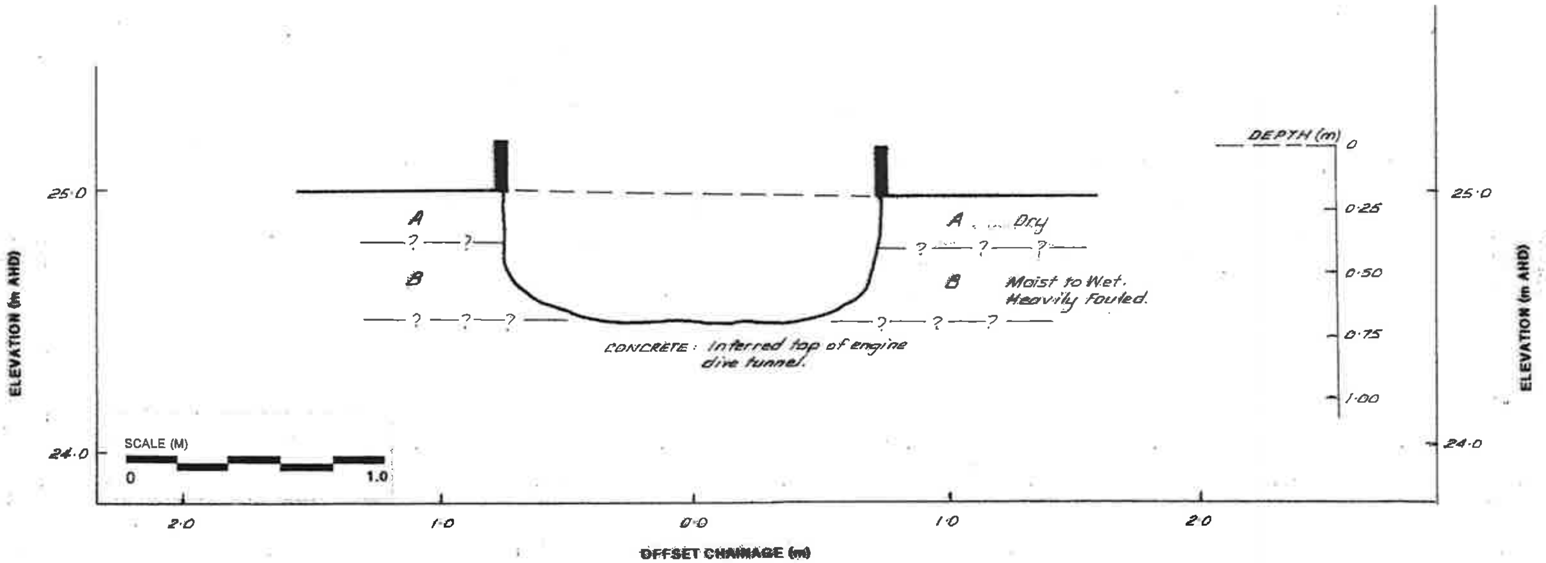


NOTE
1. All track formation layer depths are approximate. For details refer to Table A.
2. Refer to DCP Test Results.
3. Test Pit 'Dry on Completion'

CROSS SECTIONAL SKETCH 8
TRACK KILOMETRAGE 1.359km
DOWN SUBURBAN TRACK
LOOKING AWAY FROM SYDNEY

Jeffery & Katauskas Pty Ltd
Report No. 21693ZH Figure No. 9





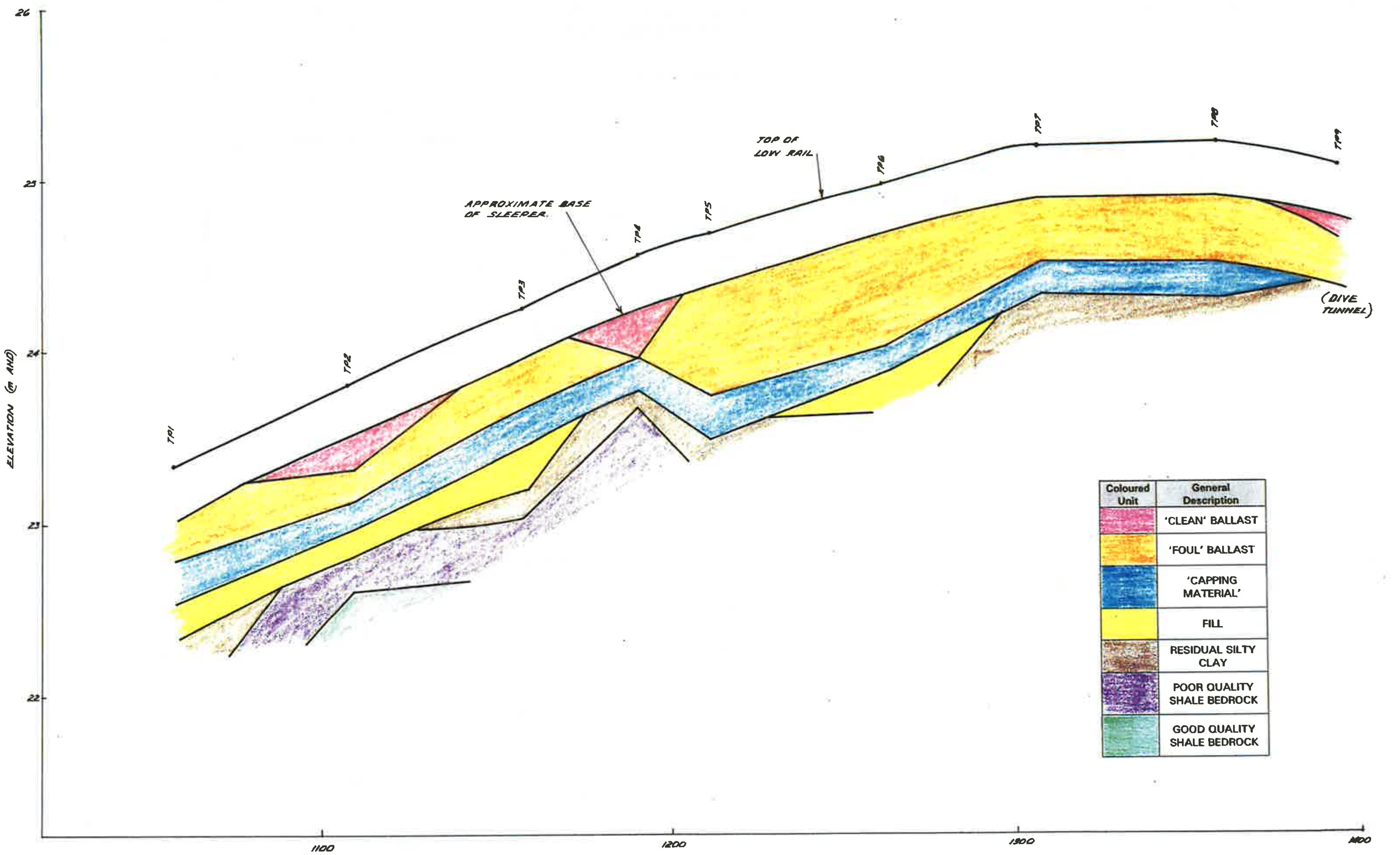
NOTE

1. All track formation layer depths are approximate. For details refer to Table A.
2. Test Pit 'Dry on Completion'

CROSS SECTIONAL SKETCH 9
TRACK KILOMETRAGE 1.394km
DOWN SUBURBAN TRACK
LOOKING AWAY FROM SYDNEY

Jeffery & Katauskas Pty Ltd

Report No. 21693ZH Figure No. 10

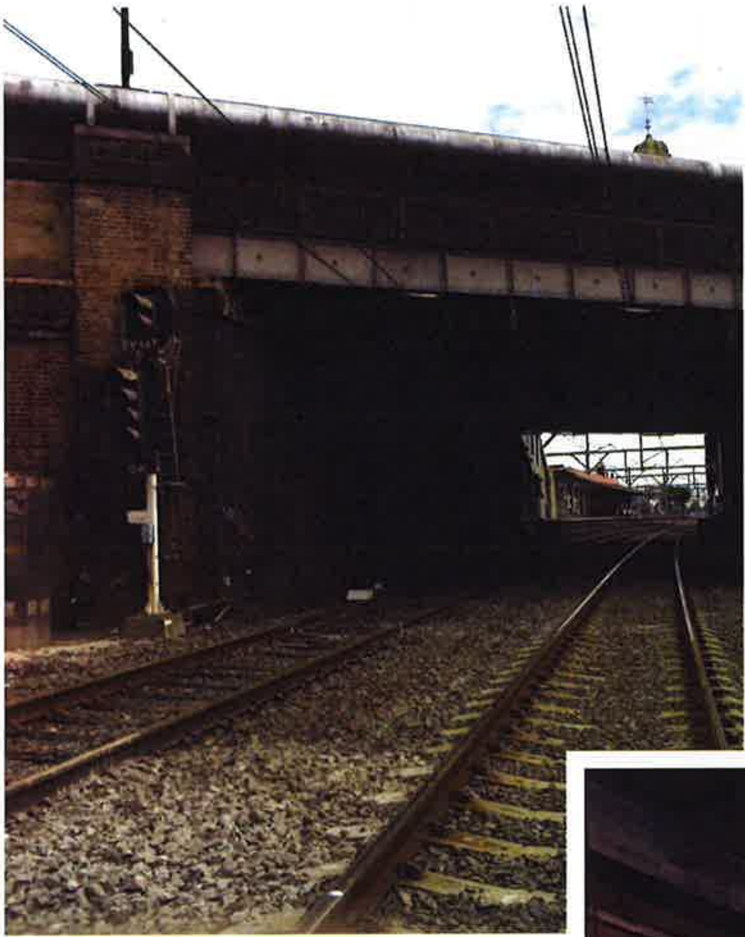


LONGITUDINAL SECTION

SCALE: 1:20 VERTICAL
1:1000 HORIZONTAL

Jeffery and Katauskas Pty Ltd
Report No. 21693ZH Figure No. 11

Lawson Street Overbridge



Looking to Macdonaldtown

Looking To Sydney

Looking to Macdonaldtown

Redfern Station Platform 4

Looking to Sydney

Brick Chimneys

Illawarra Engine Dive Tunnel Chimneys

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

DYNAMIC CONE PENETRATION TEST RESULTS

Client:	RAILCORP		
Project:	PROPOSED TRACK RECONDITIONING		
Location:	REDFERN STATION, PLATFORM 4		
Job No.	21693ZH	Hammer Weight & Drop: 9kg/510mm	
Date:	24-11-07	Rod Diameter: 16mm	
Tested By:	N.E.S.	Point Diameter: 20mm	

Number of Blows per 100mm Penetration

Test Location / Depth (mm)	1	2	3	5	6	7	8
0 - 100	RAIL	RAIL	RAIL	RAIL	RAIL	RAIL	RAIL
100 - 200	↓	↓	↓	↓	↓	↓	↓
200 - 300	EXCAVATED	EXCAVATED	EXCAVATED	EXCAVATED	EXCAVATED	EXCAVATED	EXCAVATED
300 - 400							
400 - 500							
500 - 600							
600 - 700						↓	
700 - 800						23	
800 - 900		↓	↓			8	↓
900 - 1000		7	6	↓		4	3
1000 - 1100	↓	18	6	4		6	4
1100 - 1200	1	30	16	5	↓	10	4
1200 - 1300	3	REFUSAL	22	3	4	6	6
1300 - 1400	9		REFUSAL	7	6	8	6
1400 - 1500	20			8	8	6	7
1500 - 1600	9			7	11	10	7
1600 - 1700	10			16	13	9	9
1700 - 1800	22			10/20mm	17	12	7
1800 - 1900	20/50mm			REFUSAL	16	16	8
1900 - 2000	REFUSAL				17	18/50mm	11
2000 - 2100					END	REFUSAL	END
2100 - 2200							
2200 - 2300							
2300 - 2400							
2400 - 2500							
2500 - 2600							
2600 - 2700							
2700 - 2800							
2800 - 2900							
2900 - 3000							

Remarks:
1. The procedure used for this test is similar to that described in AS1289.6.3.2-1997, Method 6.3.2.
2. Usually 8 blows per 20mm is taken as refusal

Table A: Subsurface Soil Unit Summary

Unit	General Description	Detailed Description
A	'CLEAN' BALLAST	Coarse grained angular & sub-angular igneous gravel & cobbles. Dry.
B	'FOUL' BALLAST	Medium and coarse grained angular & sub-angular igneous gravel & cobbles, with or without silt fines and clay fines and sand. Generally Moist or Wet.
C	'CAPPING MATERIAL'	Gravelly Sand / Sandy gravel, fine to medium grained igneous gravel. Moist to Wet
D1	CLAYEY FILL	Silty clay or Sandy clay, medium to high plasticity. Generally appears well compacted. Moisture content generally above the plastic limit.
D2	GRAVELLY CLAY FILL	Gravelly silty clay, medium plasticity. Generally appear well compacted. Moisture content ranges from around the plastic limit to above the plastic limit.
E	RESIDUAL SILTY CLAY	Silty clay of high plasticity. Ranges from stiff to hard strength. Moisture content generally above the plastic limit.
F1	POOR QUALITY SHALE BEDROCK	Extremely or distinctly weathered shale of extremely low or very low strength.
F2	GOOD QUALITY SHALE BEDROCK	Distinctly weathered shale of low and greater strength.

To be read in conjunction with Figures 2 to 10

TABLE B
SUMMARY OF GEOTECHNICAL INFORMATION FOR PROPOSED TRACK RECONSTRUCTION

					Option A: Full Depth Reconditioning				Option B: New Capping and Ballast Only				Option C: Skim Reconditioning					
Test Location	Track Kilometrage (km)	Current RL at Top of Low Rail (see Notes 1&4)	Raise or Lower track?	Proposed RL at Top of Low Rail	RL at Proposed Bulk Excavation Level or RL at Surface of Good Quality Shale Bedrock	Approximate Depth of Excavation required to achieve Proposed Bulk Excavation Level (see Notes 2&4)	Likely Founding Material at Proposed Bulk Excavation Level	Estimated CBR of Founding Material at Base of Proposed Excavation	RL at Proposed Bulk Excavation Level or RL at Surface of Good Quality Shale Bedrock	Approximate Depth of Excavation required to achieve Proposed Bulk Excavation Level (see Notes 2&3)	Likely Founding Material at Proposed Bulk Excavation Level	Estimated CBR of Founding Material at Base of Proposed Excavation	Existing Ballast Depth (m)	Capping Present	Track Environment	Approximate Base of Existing Footing (RLm AHD)	Will the Base of the Footing be Above or Below the Proposed Bulk Excavation Level?	Additional Comments/ Likely Stabilisation Measures
1	1.058	23.335	+0.032	23.367	22.007	1.36	Residual Silty Clay	3≤CBR≤8	22.507	0.86	Gravelly Clay Fill	3≤CBR≤8	0.55	Yes	Cutting	N/A	N/A	
2	1.108	23.810	+0.018	23.828	21.610	1.218	Good Quality Shale Bedrock	Good Quality Shale Bedrock	22.968	0.86	Clayey Fill	3≤CBR≤8	0.70	Yes	Cutting	N/A	N/A	
3	1.158	24.275	-0.008	24.267	22.907	1.36	Poor Quality Shale	3≤CBR≤8	23.407	0.86	Gravelly Clay Fill	3≤CBR≤8	0.60m	Yes	Cutting	N/A	N/A	
4	1.191	24.570	-0.044	24.526	23.166	1.36	Poor Quality Shale	3≤CBR≤8	23.666	0.86	Poor Quality Shale	3≤CBR≤8	0.60	Yes	Cutting (Overbridge)	<23.70	Yes	Cast Iron Pipe adjacent to bridge abutment
5	1.212	24.695	-0.059	24.636	23.276	1.36	Residual; Silty Clay	3≤CBR≤8	23.776	0.86	Capping	3≤CBR≤8	0.95	Yes	Cutting (Station Platform)	<24.0	Maybe	Cast Iron pipe adjacent to station platform footing
6	1.262	24.980	-0.041	24.939	23.579	1.36	Clayey Fill	3≤CBR≤8	24.079	0.86	Capping	3≤CBR≤8	0.95	Yes	Cutting (Station Platform)	<24.20	Maybe	Cast Iron pipe adjacent to station platform footing
7	1.312	25.210	-0.100	25.110	23.750	1.36	Residual Silty Clay	3≤CBR≤8	24.250	0.86	Residual Silty Clay	3≤CBR≤8	0.65	Yes	Cutting (Station Platform)	<24.30	Maybe	Cast Iron pipe adjacent to station platform footing, Brick structure located under down rail.
8	1.359	25.235	-0.049	25.186	23.826	1.36	Residual Silty Clay	3≤CBR≤8	24.326	0.86	Residual Silty Clay	3≤CBR≤8	0.70	Yes	Cutting (Station Platform)	24.75m	Yes	Cast Iron pipe beneath station platform footing
9	1.394	25.190	0.000	25.190	24.490	0.70	Engine Dive Tunnel	Engine Dive Tunnel	24.490	0.70	Engine Dive Tunnel	Engine Dive Tunnel	0.70	No	Rail At Grade	N/A	N/A	Illawarra Engine Dive Tunnel

NOTES:

1 Proposed Track RLs (Top of Low rail) have been interpolated from the information provided in the Rail Infrastructure Corporation overhead wire survey dated 28 October 2007

2 Assumed track formation includes new rail and concrete sleeper (0.407m total thickness), minimum ballast thickness of 0.3m, capping layer (0.15m thickness) and structural fill thickness (H) will be 0.5m (subgrade CBR between 3% and 8%) giving total excavation depth of 1.36m, unless good quality shale bedrock encountered.

3 Assumed track formation includes new rail and concrete sleeper (0.407m total thickness), minimum ballast thickness of 0.3m, capping layer (0.15m thickness) giving total excavation depth of 0.86m, unless good quality shale bedrock encountered.

4 All depths referred to are distances below the top of the lowest rail.

5 Design RLs based on surveying completed during fieldwork and the information provided in the Existing Overhead Wire Survey: Flyovers to Redfern 0.600km to 1.500km provided by Railcorp.

6 For specific subsurface details at each test location, refer to Figures 2 to 10 and text of report.

JOB NO: 21693ZH
LOCATION: Redfern Station, Platform Four, 0.950km to 1.405km
TABLE C - BALLAST DEPTH & CONDITION SURVEY RESULTS
DATE OF INVESTIGATION: 24 November 2007

Test Location	Km	Sleeper Type	Approx. Thickness Sleeper + Rail (m)	BALLAST			CAPPING			FORMATION	* End Of Hole	TRACK ENVIRON		CESS LEVEL BELOW RAIL LEVEL		TCM to Dn Rail	TCM to Up Rail	REMARKS
				* Bas *	Thickness	Description **	* Base	Thickness	Description	Description		Dnside	Upside	Dnside	Upside			
1	1.058	Timber	0.27	550	380	'Clean' ballast, approx. 0.1m thick, 'Foul' ballast, approx 0.28m thick. Dry, slightly fouled.	800	250	Gravelly sand/ Sandy gravel	Gravelly clay fill MC > PL	1200	Cut						
2	1.108	Timber	0.27	700	530	'Clean' ballast, approx. 0.3m thick, 'Foul' ballast, approx. 0.2m thick. Dry, slightly fouled.	850	150	Gravelly sand/ sandy gravel	Clayey fill, MC > PL, appears well compacted	1200	Cut						
3	1.158	Timber	0.27	600	430	'Clean' ballast, approx. 0.1m thick. 'Foul' ballast, approx. 0.33m thick. Dry, slightly fouled.	800	200	Gravelly sand/ sandy gravel.	Gravelly clay fill, MC > PL. Appears well compacted.	1300	Cut						
4	1.191	Timber	0.27	600	430	'Clean' ballast	800	200	Gravelly sand/ sandy gravel.	Residual silty clay, MC > PL	950	Cut (overb -ridge)						Cast iron pipe adjacent to bridge abutment
5	1.212	Timber	0.27	900	730	'Foul' ballast Dry, slightly fouled, but mostly wet & heavily fouled	1200	250	Gravelly sand/ sandy gravel. Moist.	Residual silty clay MC > PL. PP= 210, 260kPa	1400	Cut (plat-form)						Cast iron pipe adjacent to station platform footing
6	1.262	Timber	0.27	900	730	'Clean' ballast, approx. 0.1m thick, 'Foul' ballast, approx. 0.63m thick, Moist and wet.	1100	150	Gravelly sand/ sandy gravel. Moist.	Clayey fill, MC > PL Appears well compacted	1300	Cut (plat-form)						Cast iron pipe adjacent to station platform footing

JOB NO: 21693ZH
LOCATION: Redfern Station, Platform Four, 0.950km to 1.405km
TABLE C - BALLAST DEPTH & CONDITION SURVEY RESULTS
DATE OF INVESTIGATION: 24 November 2007

Test Location	Km	Sleeper Type	Approx. Thickness Sleeper + Rail (m)	BALLAST * Base *	BALLAST Thickness	BALLAST Description **	CAPPING * Base	CAPPING Thickness	CAPPING Description	FORMATION Description	* End Of Hole	TRACK ENVIRON Dnside	TRACK ENVIRON Upside	CESS LEVEL BELOW RAIL LEVEL Dnside	CESS LEVEL BELOW RAIL LEVEL Upside	TCM to Dn Rail	TCM to Up Rail	REMARKS
7	1.312	Timber	0.27	600	430	'Foul' ballast, Slightly & heavily fouled. Dry, moist and wet.	800	200	Gravelly sand/ sandy gravel. Moist.	Residual silty clay, MC ~ PL, PP=390, 490, 540kPa.	1300	Cut (plat-form)						Cast iron pipe adjacent to station platform footing
8	1.359	Timber	0.27	700	530	'Foul' ballast, Slightly & heavily fouled. Dry and wet.	900	200	Gravelly sand/ sandy gravel. Moist.	Residual silty clay. MC-PL, PP=450, 470, 520kPa	1300	Cut (plat-form)						Cast iron pipe below station platform footing
9	1.394	Timber	0.27	700	530	'Foul' ballast, Heavily fouled. Dry, moist and wet.	900	200	Not evident	N/A	700	Rail at grade						Illawarra Engine Dive Tunnel

* = mm below the low rail level
MC = moisture content, PL = plastic
PP = pocket penetrometer reading in kPa
Emb = embankment, cut = cutting
** = For detailed descriptions, refer to Table A

APPENDIX D

RailCorp

RAIL CORP GEOTECHNICAL SERVICES

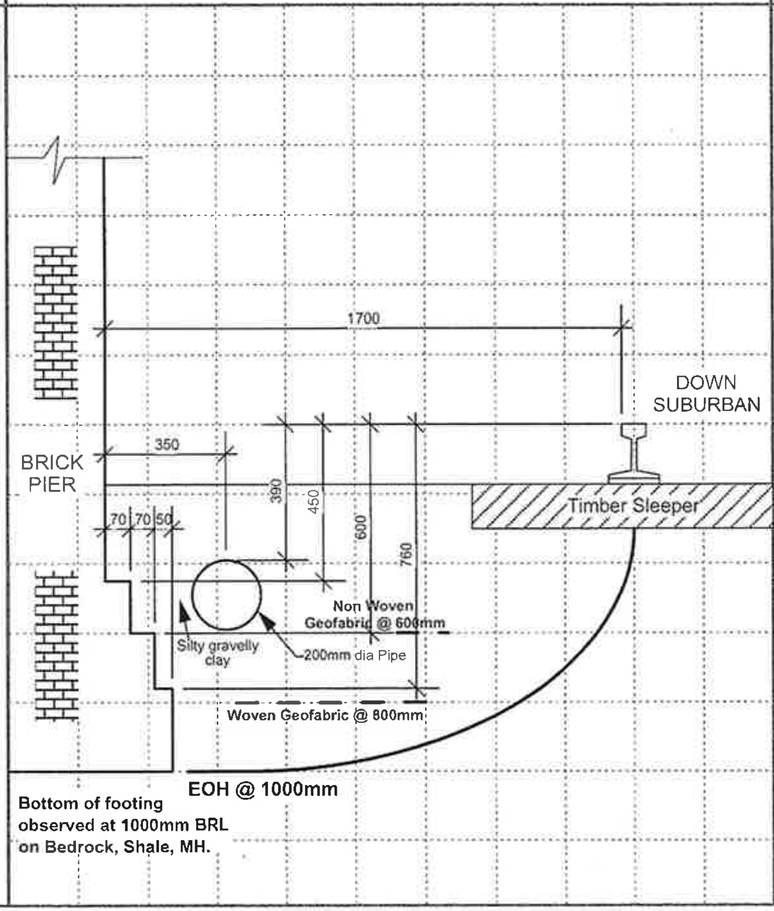
ENGINEERING EXCAVATION LOG

TEST PIT Nº: **8376-1**

PROJECT: **REDFERN**	START OF TEST PIT: **TOP OF RAIL = 00**	LOGGED BY: **PG**	DATE: **01/11/08**
FEATURE: **FORMATION / FOOTING INVESTIGATION**	EXCAVATION DIMENSION : **BETWEEN SLEEPERS**	DRAWN BY: **HC**	DATE: **18/11/08**
LOCATION: **LAWSON STREET OVERBRIDGE @ 1.186KM - DOWN SUBURBAN**		CHECKED BY: **PG**	DATE : **25/11/08**

GEOLOGICAL DESCRIPTION: Type of Deposit	GEOLOGICAL DESCRIPTION: Characteristics	DEPTH (m)	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
	Below Down Shoulder	1.0 0.8 0.6 0.4 0.2					
		0.0 0.2					
BALLAST	Moderately fouled with silts, gravels & clay.	0.4	Medium Dense		Wet		
	Heavily fouled with clay & gravel. **Non Woven Geofabric @ 600mm**		Medium Dense-Dense		Wet-Saturated		
CAPPING	Stabilised roadbase. **Woven Geofabric @ 800mm**	0.6	Very Dense		Moist		
RESIDUAL SOIL	Silty clay with some gravels.	0.8	Firm		MC>PL		
BEDROCK	Shale, W-MH.						
	EOH @ 1000mm	1.0 1.2					

GRAPHIC REPRESENTATION



RailCorp

RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

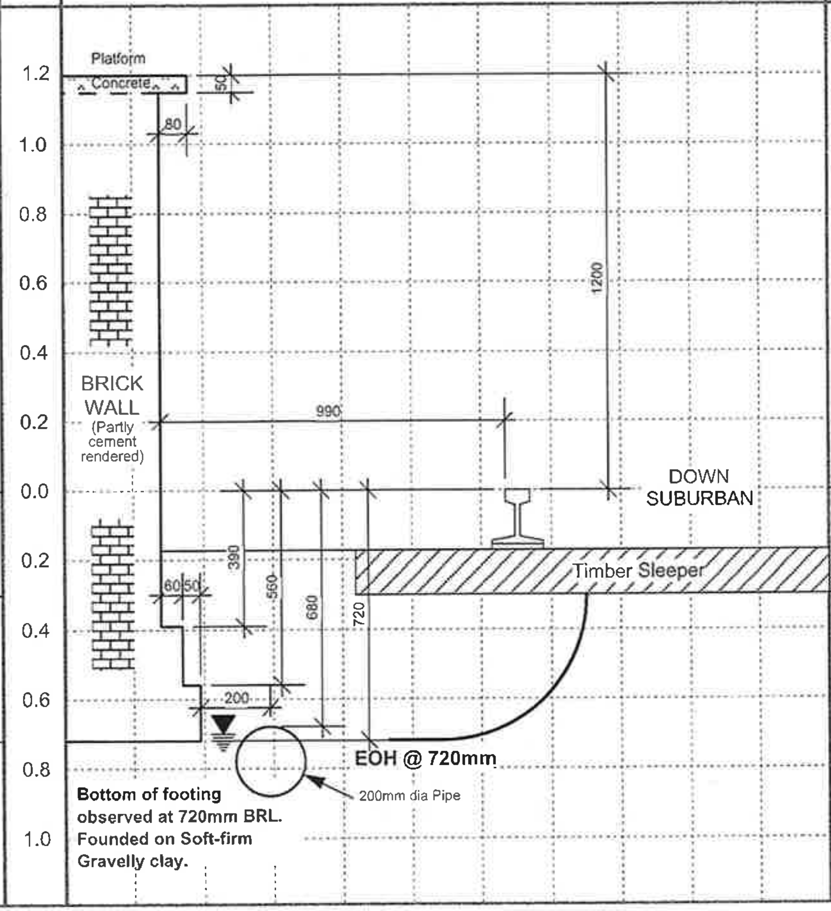
TEST PIT Nº: **8376-2**

PROJECT:	REDFERN	START OF TEST PIT:	TOP OF RAIL = 00	LOGGED BY: PG	DATE: 01/11/08
FEATURE:	FORMATION / FOOTING INVESTIGATION	EXCAVATION DIMENSION :	BETWEEN SLEEPERS	DRAWN BY: HC	DATE: 18/11/08
LOCATION:	PLATFORM 4 @ 1.214KM - DOWN SUBURBAN			CHECKED BY: PG	DATE : 25/11/08

GEOLOGICAL DESCRIPTION: Type of Deposit	GEOLOGICAL DESCRIPTION: Characteristics	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
	Below Down Rail					
BALLAST	Moderately fouled with silts, clay, sands & gravels. Water @ 700mm (Test Pit full of water)	Medium Dense		Wet		
	EOH @ 720mm					

DEPTH (m)

GRAPHIC REPRESENTATION



RailCorp

RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

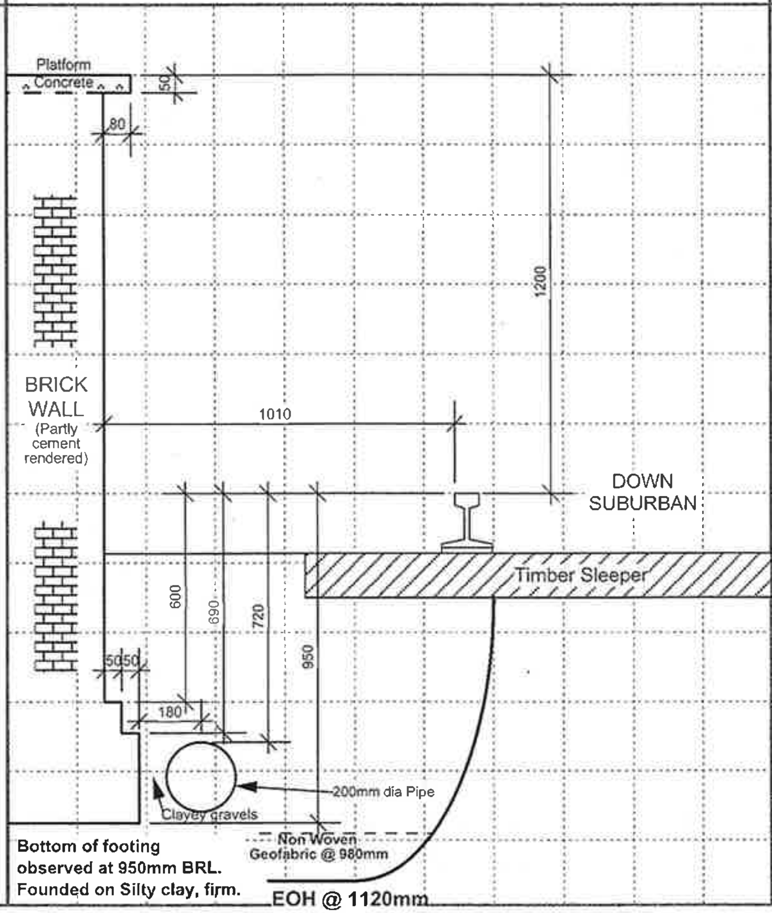
TEST PIT Nº: 8376-3

PROJECT:	REDFERN	START OF TEST PIT:	TOP OF RAIL = 00	LOGGED BY: PG	DATE: 01/11/08
FEATURE:	FORMATION / FOOTING INVESTIGATION	EXCAVATION DIMENSION :	BETWEEN SLEEPERS	DRAWN BY: HC	DATE: 18/11/08
LOCATION:	PLATFORM 4 @ 1.260KM - DOWN SUBURBAN			CHECKED BY: PG	DATE : 25/11/08

GEOLOGICAL DESCRIPTION: Type of Deposit	GEOLOGICAL DESCRIPTION: Characteristics	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
	Below Down Rail					
BALLAST	Moderately fouled with sands, clay, & gravels.	Medium Dense		Saturated Moist-Wet		
	Heavily fouled with clay & gravels.	Medium Dense-Dense				
CAPPING	Roadbase, sandy gravels, some clay. Non Woven Geofabric @ 980mm	Medium Dense		Moist		
FILL	Compacted gravels, some sand & clay.	Dense		Moist-Wet		
	EOH @ 1120mm					

DEPTH (m): 1.2, 1.0, 0.8, 0.6, 0.4, 0.2, 0.0, 0.2, 0.4, 0.6, 0.8, 1.0

GRAPHIC REPRESENTATION



RailCorp

RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

TEST PIT Nº: **8376-4**

PROJECT: REDFERN

FEATURE: FORMATION / FOOTING INVESTIGATION

LOCATION: PLATFORM 4 @ 1.308KM - DOWN SUBURBAN

START OF TEST PIT: TOP OF RAIL = 00

EXCAVATION DIMENSION : BETWEEN SLEEPERS

LOGGED BY: PG DATE: 01/11/08

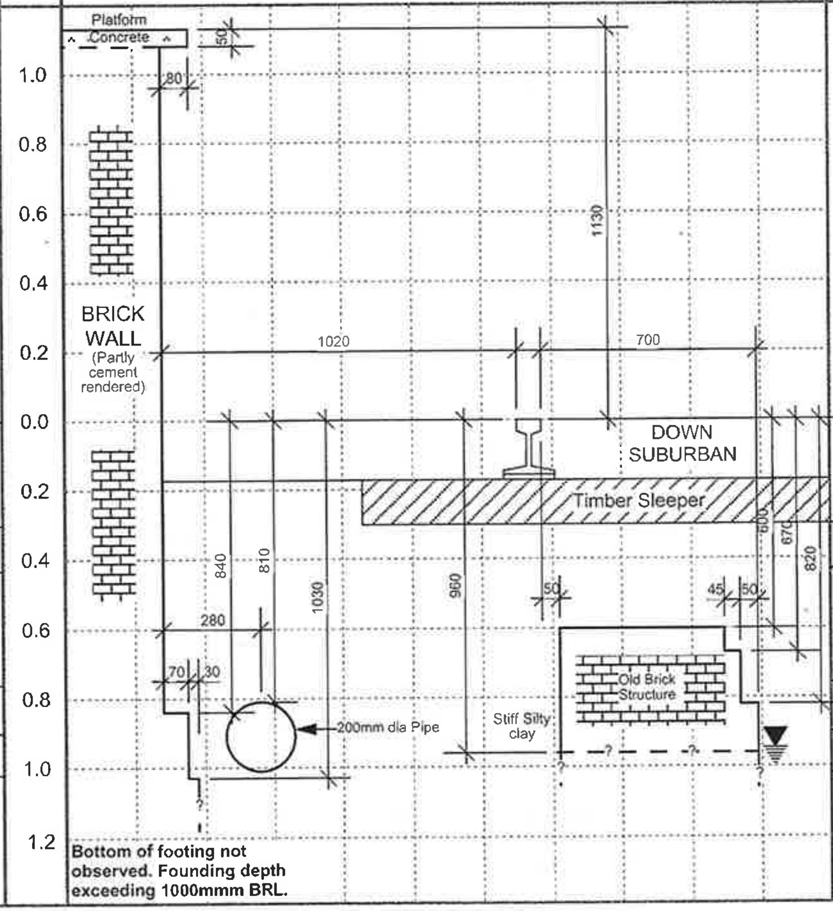
DRAWN BY: HC DATE: 18/11/08

CHECKED BY: PG DATE : 25/11/08

GEOLOGICAL DESCRIPTION: Type of Deposit	GEOLOGICAL DESCRIPTION: Characteristics	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
	4 foot					
BALLAST	Moderately fouled with sands, gravels, silts & clay.	Medium Dense		Moist		
	Heavily fouled with clay & gravels.	Medium Dense-Dense		Saturated		
CAPPING	Roadbase & clay.	Medium Dense				
RESIDUAL SOIL	Silty clay with ironstone.	Stiff		MC=PL		
	EOH @ 1020mm					

DEPTH (m)

GRAPHIC REPRESENTATION



RailCorp

RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

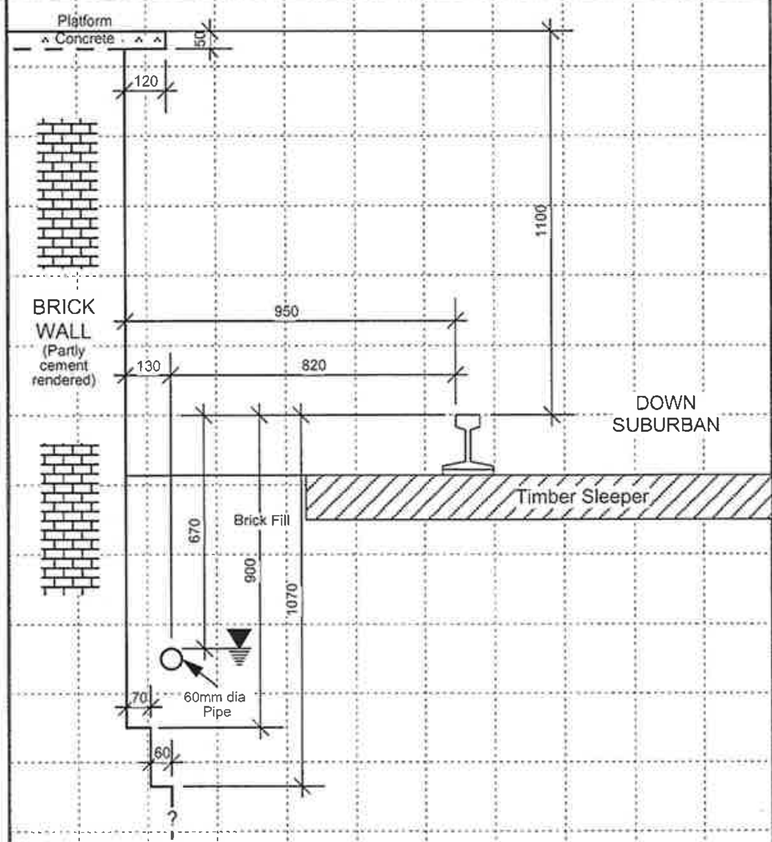
TEST PIT Nº: **8376-5**

PROJECT: **REDFERN** START OF TEST PIT: **TOP OF RAIL = 00** LOGGED BY: **PG** DATE: **01/11/08**

FEATURE: **FORMATION / FOOTING INVESTIGATION** EXCAVATION DIMENSION : **BETWEEN SLEEPERS** DRAWN BY: **HC** DATE: **18/11/08**

LOCATION: **PLATFORM 4 @ 1.342KM - DOWN SUBURBAN** CHECKED BY: **PG** DATE : **25/11/08**

GEOLOGICAL DESCRIPTION		DEPTH (m)	GRAPHIC REPRESENTATION	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
Type of Deposit	Characteristics							
	Below Down Shoulder	1.0 0.8 0.6 0.4 0.2 0.0						
		0.2						
FILL	Brick fill with ballast. Water @ 670mm	0.4 0.6						
	Brick fill with clay & gravels.	0.8						
	EOH @ 900mm	1.0 1.2						



Water obscured the view, bottom of footing not observed. Founding depth exceeding 1000mmm BRL.

RailCorp

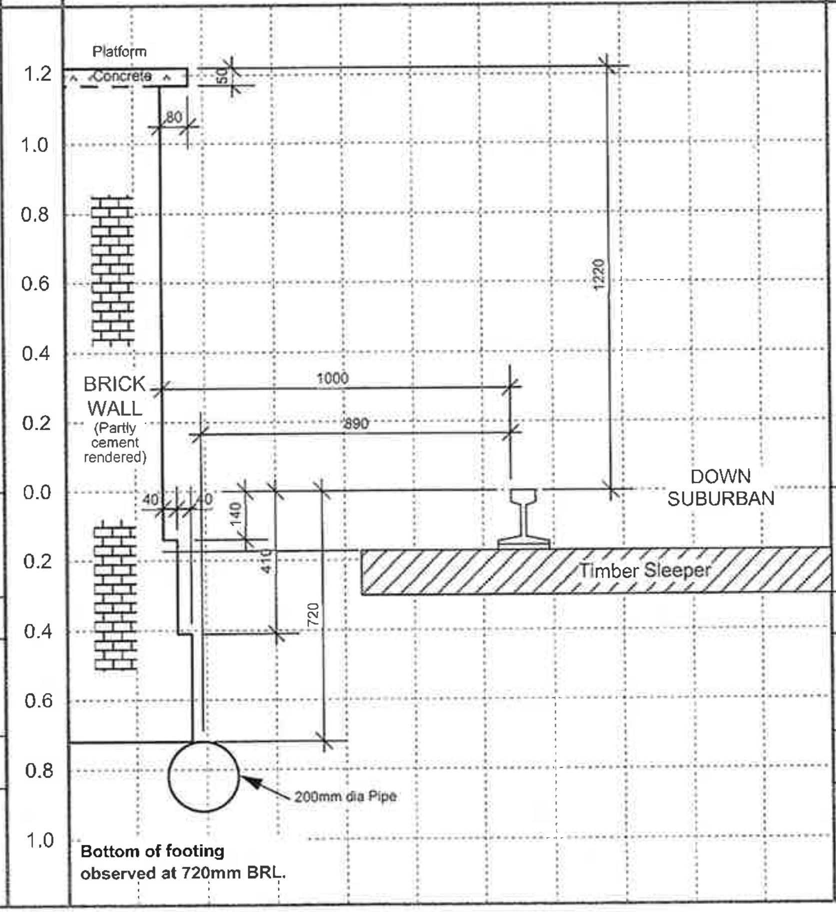
RAIL CORP GEOTECHNICAL SERVICES

ENGINEERING EXCAVATION LOG

TEST PIT Nº: **8376-6**

PROJECT: REDFERN	START OF TEST PIT: TOP OF RAIL = 00	LOGGED BY: PG	DATE: 01/11/08
FEATURE: FORMATION / FOOTING INVESTIGATION	EXCAVATION DIMENSION : BETWEEN SLEEPERS	DRAWN BY: HC	DATE: 18/11/08
LOCATION: PLATFORM 4 @ 1.360KM - DOWN SUBURBAN		CHECKED BY: PG	DATE : 25/11/08

GEOLOGICAL DESCRIPTION / GRAPHIC REPRESENTATION



Type of Deposit	Characteristics	SOIL PROPERTIES, STRUCTURE & DISCONTINUITIES	CONSISTTENCY REL. DENSITY	MOISTURE	GROUNDWATER	SAMPLES TESTS
	Below Down Shoulder					
BALLAST	Moderately fouled with clay & gravels.	Medium Dense		Moist		
	Heavily fouled with clay & gravels.	Dense		Saturated		
CAPPING	Roadbase & clay.	Medium Dense		Moist		
RESIDUAL SOIL	Silty clay.	Stiff		MC=PL		

Note

Excavation below the ramp at the country end of the Platform, approx at 1.369KM. A small pipe was observed below the footing at a depth of 740mm below the rail level. Footing depth is 740mm below rail at this location

'8376 TP5'

'8376 TP6'

Under the Ramp

CityRail RailCorp	ENGINEERING SERVICES & STANDARDS GEOTECHNICAL SERVICES 9-13 Unwins Bridge Road Sydenham NSW 2044 phone 9563 7111 fax 9563 7780 DX-7047 RS	**REDFERN** **PLATFORM 4 INVESTIGATION** **DOWN SUBURBAN**	Proj No. **8376** Dwg No. GS08-8372 Date 01/11/08

Appendix C. Explanatory notes and borehole logs

JACOBS

Soil Description

MATERIAL DESCRIPTION

Soil description is based on an assessment of disturbed samples, as recovered from boreholes and excavation, and from undisturbed materials as seen in excavation and exposures or in undisturbed samples.

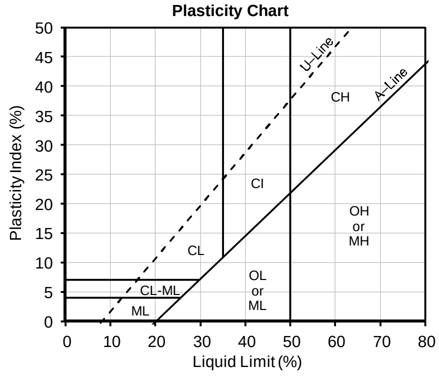
CLASSIFICATION

Soils are described in general accordance with AS1726-1993 and the Unified Soil Classification (USC) as shown below.

Field Identification procedures (Excluding particles larger than 63 mm and basing fractions on estimated mass)				Code	Typical Names	Describing Soils		Laboratory Classification Criteria		
COARSE GRAINED SOILS More than 50% of material less than 63 mm is larger than 0.075 mm	GRAVELS More than 50% of coarse fraction is larger than 2.36 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name, symbol, indicate approximate % of sand and gravel, maximum size, angularity, surface condition, and strength of coarse grains: colour, amount plasticity of fine component. For undisturbed soils add information on moisture content, degree of compactness, stratification, cementation, and odour. Give local and other pertinent descriptive information. Example: SILTY SAND (SM), fine to coarse, light grey, about 20% strong angular gravel particles – 10mm max. size, rounded and sub-angular sand, about 12% non-plastic fines, moist, dense alluvial sand.	Use grain size curve in identifying the fractions as given under field identification	Determine percentages of gravel and sand from grain size curve Depending on percentage smaller than 0.075 mm size coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP More than 12% GM, GC, SM, SC 5% to 12% Borderline cases requiring use of dual symbols	Greater than 4 $c_u = \frac{D_{60}}{D_{10}}$	Between 1 & 3 $c_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$
			Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels				Not meeting all gradation requirements for GW.	
		GRAVELS WITH FINE (Appreciable fines)	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	GM	Silty gravels, gravel-sand-silt mixtures				Atterberg limits below 'A' line or PI less than 4	Above 'A' line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			'Dirty' materials with excess of plastic fines, medium to high dry strength	GC	Clayey gravels, gravel-sand-clay mixtures				Atterberg limits above 'A' line with PI greater than 7	
	SANDS More than 50% of coarse fraction is smaller than 2.36 mm	CLEAN SANDS (little or no fines)	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	SW	Well graded sands, gravelly sands, little or no fines				Greater than 6 $c_u = \frac{D_{60}}{D_{10}}$	Between 1 & 3 $c_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$
			Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands				Not meeting all gradation requirements for SW	
		SANDS WITH FINES (Appreciable fines)	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	SM	Silty sands, sand-silt mixtures				Atterberg limits below 'A' line or PI less than 4	Above 'A' line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			'Dirty' materials with excess of plastic fines, medium to high dry strength	SC	Clayey sands, sand-clay mixtures				Atterberg limits above 'A' line with PI greater than 7	

FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm	IDENTIFICATION PROCEEDURES ON FRACTIONS < 0.075 mm						
		DRY STRENGTH	DILATANCY	TOUGHNESS	Code	Typical Names	Describing Soils
	SILTS AND CLAYS Liquid limit <50	None to low	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with low plasticity. Silts of low to medium Liquid Limit	Give typical name, symbol, and indicate degree and character of plasticity, colour, amount and size of coarse grains. For undisturbed soils add information on moisture content, consistency, structure, stratification, and odour. Give local or geologic name and other pertinent descriptive information. Example: CLAYEY SILT (ML), brown, low plasticity, trace sand, firm, dry, numerous vertical root holes.
		Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays	
		Low to medium	Slow	Low	OL*	Organic silts and organic silt-clays of low to medium plasticity	
	SILTS AND CLAYS Liquid limit >50	Low to medium	Slow to none	Low to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, silts of high Liquid Limit	
		High to very high	None	High	CH	Inorganic clays of high plasticity	
		Medium to high	None to very slow	Low to medium	OH*	Organic clays of high plasticity	
HIGHLY ORGANIC SOILS		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			Pt*	Peat and other highly organic soils	

Plasticity Chart



Laboratory:

MC	Moisture Content	MDD	Maximum Dry Density
LL	Liquid Limit	OMC	Optimum Moisture Content
PL	Plastic Limit	PSD	Particle Size Distribution
PI	Plasticity Index	UU	Undrained Unconsolidated
LS	Linear Shrinkage	CU	Consolidated Undrained
ρ_p	Particle Density	CD	Consolidated Drained
ρ_b	Bulk Density	$I_{s(50)}$	Point Load Index
ρ_d	Dry Density	UCS	Uniaxial Compressive Strength

Boundary classifications – Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.

* effervesces with H_2O_2

DESCRIPTION OF A SOIL

i. Colour
ii. Plasticity or particle characteristics of soil
iii. Secondary components name
iv. Estimated proportion
v. Secondary component plasticity or particle characteristics
vi. Other minor soil components
vii. Structure of soil, geological origin
viii. Consistency / density
ix. Moisture condition

Term		Grain Size	Shape and Texture	Field Guide
CLAY		< 2 µm	Shiny	Not visible under 10x
SILT		7 – 75 µm	Dull	Visible under 10x
SAND	Fine	0.075 – 0.2 mm	Angular / sub - angular / sub - rounded / rounded	Visible by eye
	Medium	0.2 – 0.6 mm		Visible at < 1 mm
	Course	0.6 – 2.36 mm		Visible at < 3 mm
GRAVEL	Fine	2.36 – 6 mm		Visible at < 5 mm
	Medium	6 – 20 mm		Road Gravel
	Course	20 – 63 mm		Rail ballast
COBBLES		63 – 200 mm		Beaching
BOULDERS		> 200 mm		

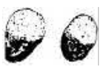
COLOUR

The colour of a soil should be described using simple terns, such as black, white, grey, red, brown, orange, yellow green or blue. These may be modified as necessary by 'pale', 'dark' or 'mottled'. Borderline colours may be described as a combination of these colours (e.g. orange brown). Where a soil consists of a primary colour with a secondary mottling it should be described as (primary colour) mottled (first colour) and (secondary colour). Where a soil consists of two colours presented in roughly equal proportions the colour description should be mottled (first colour) and (secondary).

PARTICLE CHARACTERISTICS – COARSE GRAINED SOILS

Term	Description
Well Graded	Having good representation of all particle sizes
Poorly graded	With one or more intermediate size poorly represented
Gap graded	With one or more intermediate sizes absent
Uniform	Essentially of one size

ANGULARITY – COARSE GRAINED SOILS


Rounded


Sub-rounded


Sub-angular


Angular

PLASTICITY

Liquid limit (%)	Description
≤ 35	Low plasticity
>35 to ≤ 50	Medium plasticity
> 50	High plasticity

DESCRIPTIVE TERMS FOR SECONDARY AND MINOR COMPONENTS

Coarse Grained Soils		Fine grained soils	
% Fines	Modifier	% Coarse	Modifier
≤ 5	Omit or use 'trace'	≤ 15	Omit, or use 'trace'
>5 to ≤12	Describe as 'with clay/ silt' as applicable	>15 to ≤ 30	Describe as 'with sand/ gravel' as applicable
> 12	Prefix soil type as 'clayey/silt' as applicable	> 30	Prefix soil type as 'sandy/ gravelly' as applicable

CONSISTENCY TERMS – COHESIVE SOILS

Term	Undrained shear strength	SPT (N) Blow Count	Field Guide to consistency
Very Soft (VS)	<12	0 – 2	Easily penetrated several centimetres by fist, exudes between fingers when squeezed in fist
Soft (S)	12 – 25	2 – 4	Easily penetrated several centimetres by thumb, easily moulded by light finger pressure
Firm (F)	25 – 50	4 – 8	Can be penetrated several centimetres by thumb with moderate effort, and moulded between the fingers by strong pressure
Stiff (St)	50 – 100	8 – 15	Readily indented by thumb but penetrated only with difficultly. Cannot be moulded by fingers
Very Stiff (VSt)	100 – 200	15 –30	Readily intended by thumb nail, still very tough
Hard (H)	>200	>30	Indented with difficulty by thumb nail, brittle

CONSISTENCY TERMS – NON COHESIVE SOILS

Term	Density Index (%)	SPT (N) Blow Count	Field Guide to Density
Very Loose (VL)	< 15	0 – 4	Ravels
Loose (L)	15 – 35	4 – 10	Shovels easily
Medium Dense (MD)	35 – 65	10 – 30	Shovelling very difficult
Dense (D)	65 – 85	30 – 50	Pick required
Very Dense (VD)	> 85	50 -100	Pick difficult

MOISTURE

Term (Symbol)	Description
Dry / <Wp (D)	Hard and friable or powdery, moisture content well below plastic limit
Moist / Wp (M)	Soil feels cool, darkened in colour, can be moulded, near plastic limit
Wet / >Wp (W)	Soil feels cool, dark, usually weakened, free water, moisture content well above plastic limit

STRUCTURE

Term	Description
Zoning	Soils may consist of separate zones different in colour, grain size or other properties. The thickness, orientation and any distinguishing features of the zone should be described i.e. gradational or distinct boundaries. The patterns of these zones may be described using layer (zone is continuous), lens (a discontinuous layer of different material, with lenticular shape) or pocket (irregular inclusion of different materials).
Defects	The dimensions, orientation and spacing of the defects should be given. The surface of the defects should be described in terms of texture (rough, polished) and coating. Defects may be re-cemented and may be stronger than the parent soils. Defects may include fissures, cracks, roots, roots and tube holes, infill tubes, in-filled seams, dykes.
Cementing	Soils or defects within soils may be cemented together by various agencies. The nature of the cementing agent should be identified if possible, strength, reaction to acid and the like. Weakly cemented – If the cementing agent allows the particle aggregation to be easily fractured by hand when the soil is saturated. Strongly cemented – If the cementing agent prevents fracturing by hand of the particle when the soil is saturated (use strength classification as per rock)

ADDITIONAL OBSERVATIONS

Geological origin

Term	Description
Weathered in place soils	Extremely weathered soil - Structure and fabric of parent rock visible
	Residual soil - Structure and fabric of parent rock not visible
Transported soils	Aeolian soil - Deposited by wind
	Alluvial soil - Deposited by streams and rivers
	Colluvial soil -Deposited on slopes (transported down slope)
	Lacustrine soil - Deposited by lakes
	Marine soil - Deposited in ocean, bays, beaches and estuaries
Fill materials	Soil Fill - Describe soil type, UCS symbol and add 'FILL'
	Rock Fill - Rock type, degree of weathering, and word 'FILL'
	Domestic Fill - Percent soil or rock, whether pretrucible or not
	Industrial Fill - Percent soil, whether contaminated, particle size & type of waste product, i.e. – brick, concrete, metal

Any scour should be noted.

ORGANIC OR ARTIFICIAL MATERIALS

Preferred Terms	Secondary Description
Organic matter	Fibrous peat, charcoal, wood fragments, roots (greater than 2 mm diameter), root fibres (less than 2 mm diameter)
Waste fill	Domestic refuse, oil, bitumen, brickbats, concrete rubble, fibrous plaster, wood pieces, wood shavings, saw dust, iron filings, drums, steel bars, steel scrap, bottles, broken glass, leather.

Rock Description

ROCK TYPE

Composition of the rock material i.e. colour, grain size, structure, texture, fabric, mineral composition, hardness alteration, cementation etc. as applicable. Condition of the material i.e. estimated strength, weathering and moisture condition. Rock mass properties i.e. structure of rock, defects – type, orientation spacing, roughness, waviness and continuity and weathering (of the rock mass).

GRAIN SIZE

Particle size scales depends on rock type. For sedimentary rocks, the following descriptors can be used:

- Sand terms for sandstone
- Gravel terms for conglomerates and breccias
- No description of grainsize is required for claystone, siltstone, shale and mudstone etc.

For metamorphic and igneous rocks, record the typical grain size in millimetres

COLOUR

The colour of a rock should be described using simple terms, such as black, white, grey, red, brown, orange, yellow, green or blue. These may be modified as necessary by 'pale', 'dark' or 'mottled'. Borderline colours may be described as a combination of these colours (e.g. grey green).

STRUCTURE

Terms typically used to describe the structure of a rock mass where possible include:

- Sedimentary rocks – bedded, laminated
- Metamorphic – foliated, banded, cleaved
- Igneous rocks – massive, flow banded.

The spacing or thickness of these structural features should be given as described in the table below:

Thickness	Bedding Term
< 6 mm	Very thinly laminated
6 – 20 mm	Thinly laminated
20 – 60 mm	Laminated
60 – 200 mm	Thinly Bedded
0.2 – 0.6 m	Medium bedding
0.6 – 2 m	Thickly bedded
> 2 m	Very thickly bedded

TEXTURE

Type	Definition
Massive	Effectively Homogeneous and isotropic. Bulky or equidimensional and elongated or tabular grains uniformly distributed.
Distinct	Bedded, foliated, cleaved – effectively homogeneous with planar anisotropy. Elongated or tabular grains or pores in a layered arrangement. The arrangement of grains, referred to as the rock fabric, may show a preferred orientation.

STRENGTH

Term	Code	$I_{s(50)}$ (MPa)	Field Guide to Strength
Extremely Low	EL	≤ 0.30	Easily remoulded by hand to a material with soil properties.
Very Low	VL	> 0.03 to ≤0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 3 cm thick can be broken by finger pressure.
Low	L	> 0.1 to ≤ 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blow of the pick point; has dull sound under hammer. A piece of core 150 mm long 50 mm in diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	> 0.3 to ≤ 1.0	Readily scored with a knife; a piece of core 150 mm long by 50 mm in diameter can be broken by hand with difficulty.
High	H	> 1 to ≤ 3	A piece of core 150 mm long by 50 mm in diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	VH	> 3 to ≤ 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High	EH	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

1. These terms refer to the strength of the rock material and not to the strength of the rock mass which may be considered weaker due to the effect of rock defects.
2. The field guide visual assessment of rock strength may be used for preliminary assessment or when point load testing is not available.
3. Anisotropy of rock material samples may affect the field assessment of strength

WEATHERING CLASSIFICATION

Degree of weathering		Definition
Residual soil (RS)		Soil developed from weathering of rock in-situ. The mass structure and substance fabric are no longer evident.
Extremely weathered rock (XW)		Rock is weathered to such an extent that it has soil properties. It disintegrates or can be remoulded in water. It shows a rock fabric but is described as a soil.
Highly weathered rock (HW)	Distinctly weathered (DW)*	Secondary minerals often weathered to clay. Staining of most grain boundaries and some disintegration due to weakening of grain bonds. Often significant loss of strength. However cementing of joints can occasionally lead to strengthening.
Moderately weathered rock (MW)		Staining and pitting of most secondary minerals and other grain boundaries. The loss of strength depends on the weathering and extent of secondary minerals in the rock matrix. The rock substance may be highly discoloured, usually by iron staining.
Slightly weathered rock (SW)		Secondary minerals are stained but not pitted, slight staining at some grain boundaries. Little or no change of strength indicated by amount of colour change.
Fresh rock (F)		Rock shows no sign of decomposition or staining. Relatively strong.

*Distinctly Weathered indicates a distinct change in colour, hardness and/or friability and not distinguishable into HW or MW

DESCRIPTION OF A DISCONTINUITY

- Depth
- Dip
- Infill material
- Aperture observation
- Planarity
- Small scale roughness
- Aperture measurement (mm)
- Remark
- Roughness Class

INFILL MATERIAL

Code	Description
CA	Calcite
CH	Clay
CG	Clayey gravel
GM/ GP/ GW	Gravel
Fe	Iron oxide
Fe Clay	Iron oxide clay
Qz	Quartz
X	Carbonaceous

APERTURE OBSERVATION

Term	Code	Description
Clean	CN	No visible coating or infill
Stain	Sn	No visible coating or infill but surfaces are discoloured by mineral staining
Veneer <1 mm	VR	A visible coating or soil or mineral substance but usually unable to be measured. If discontinuous over the plane, patchy veneer.
Coating >1 mm to <10mm	CT	A visible coating or infilling of soil or mineral substance. Describe composition and thickness.
Filling (Filled) >10 m	Filled	A visible filling of soil or mineral substance. Describe composition and thickness.

PLANARITY

Code	Description
CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped

SMALL SCALE ROUGHNESS

Code	Description
POL	Polished
RF	Rough
S	Smooth
SL	Slickensided
VR	Very rough

ROUGHNESS CLASS

Code	Description
I	Rough or irregular, stepped
II	Smooth, stepped
III	Slickensided, stepped
IV	Rough or irregular, undulating
IX	Slickensided, planar
V	Smooth, undulating
VI	Slickensided, undulating
VII	Rough or irregular, planar

TYPE OF DISCONTINUITY

<table>
<tr><th>Term</th><th>Code</th><th colspan="2">Description</th></tr>
<tr><td>Bedding</td><td>BP</td><td>Generally no micro fractures</td><td rowspan="4">Arrangement in layers, of mineral grains of similar sizes or composition, and/or arrangement of elongated to tabular minerals near parallel to one another, and/ or to the layers.</td></tr>
<tr><td>Foliation</td><td>FL</td><td rowspan="3">Discontinuous micro fractures may be present, near parallel to the layering</td></tr>
<tr><td>Cleavage</td><td>CL</td></tr>
<tr><td>Schistosity</td><td>SH</td></tr>
<tr><td>Contact</td><td>CO</td><td colspan="2">A contact is the surface along which one rock touches another.</td></tr>
<tr><td>Joint</td><td>JT</td><td colspan="2">A discontinuity or crack, planar, curved, irregular, across which the rock usually has little tensile strength.
The joint may be open (filled with air or water) or filled by soil substance or by rock substance or rock substance which acts as a cement, joint surface may be rough, smooth or slickensided</td></tr>
<tr><td>Shear seam/ zone</td><td>SS/ SZ</td><td colspan="2">Zone, with roughly parallel planar boundaries of rock material intersected by closely spaced (generally <50 mm) joints and/ or microscopic fractures (cleavage) planes.
The joints are at small angles to the zone boundaries. They are usually slightly curved and divide the mass into blocks of lenticular or wedge space.</td></tr>
<tr><td>Crushed seam/ zone</td><td>CS/ CZ</td><td colspan="2">Zone with roughly parallel planar boundaries, composed of disoriented, usually angular fragments of the host rock substance. The fragments may be of clay, silt, sand or gravel size, or mixtures of any of these.
Some minerals maybe altered or decomposed but this is not necessarily so.</td></tr>
<tr><td>Decomposed seam / zone</td><td>DS/ DZ</td><td colspan="2">Seam or zone of any shape, but commonly with roughly parallel boundaries in which the rock material is discoloured and usually weakened.
The boundaries with fresh rock are usually gradational.
Geological structures in the fresh rock are usually preserved in the decomposed rock.</td></tr>
<tr><td>Infill seam/ zone</td><td>IS</td><td colspan="2">Seam or zone of any shape, but commonly with roughly parallel boundaries composed of soil substance.
The infill is caused by migration of soil and into open joints.
May show layering roughly parallel to the zone boundaries.
Geological structures in the adjacent rock do not continue into the infill substance.</td></tr>
<tr><td>Vein</td><td>VN</td><td colspan="2">vein is a distinct sheet like body of crystallized minerals within a rock</td></tr>
<tr><td>Dyke</td><td>DK</td><td colspan="2">Dykes are sheet-like bodies of igneous rock that cut across sedimentary bedding or foliations in rocks. They may be single or multiple in nature.</td></tr>
<tr><td>Sill</td><td>SI</td><td colspan="2">A sill is an intrusion of magma that spreads underground between the layers of another kind of rock</td></tr>
<tr><td>Void</td><td>VO</td><td colspan="2">A completely empty space.</td></tr>
</table>

Refer to Table A10 in AS1726-1993

Drilling

DRILLING / EXCAVATION METHOD

Code	Description
AD/V	Auger drilling V-bit
AD/T	Auger drilling with TC-bit
AT	Air track
B	Bulldozer
BD	Backhoe bucket
BH	Washbore drag pit
CA	Casing advancer
E	Excavator
EH	Excavator with hammer
HA	Hand auger
NMLC	NMLC core barrel
HMLC	HMLC core barrel
NQ3	Wire line NQ core barrel
HQ3	Wire line HQ core barrel
PQ3	Wire line PQ core barrel
PT	Push tube
RR	Rock roller
WB	Washbore
X	Existing excavation
N	Natural exposure

WATER/ DRILLING FLUID

Symbol	Description
	Water loss: partial
	Water loss: complete
	Water inflow
	Water outflow
	Water level: drilling
	Water level: standing

DRILLING PENETRATION

Ease of penetration in non-core drilling

Code	Description
VE	Very easy
E	Easy
F	Firm
H	Hard
VH	Very hard

SAMPLES AND FIELD TEST

Code	Description
B	Bulk disturbed sample
BLK	Block sample
DS	Small disturbed sample
ES	Soil sample for environmental testing
EW	Water sample for environmental testing
LB	Large bulk disturbed sample
P	Piston sample
SPT	Standard Penetration Test
VS	Vane shear test
HP	Hand penetrometer test
U	Undisturbed push in sample

BACKFILL / WELL DETAIL

Symbol	Description
	Cement seal
	Grout backfill
	Blank pipe
	Slotted pipe
	Filter pack: sand filter
	Bentonite seal
	Backfill – excavated material

JACOBS

NON-CORE DRILL HOLE - GEOLOGICAL LOG

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH1
FILE / JOB NO : IA157700
SHEET : 1 OF 3

POSITION : E: 333321.8, N: 6248324.6 (MGA94 Zone 56) | SURFACE ELEVATION : 25.90 (AHD) | ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC | MOUNTING : Track | CONTRACTOR : Terratest | DRILLER : BM

DATE STARTED : 20/11/2017 | DATE COMPLETED : 20/11/2017 | DATE LOGGED : 20/11/2017 | LOGGED BY : MG | CHECKED BY :

DRILLING & CASING (PROGRESS)	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION (Soil Type, Colour, Plasticity or Particle Characteristic, Secondary and Minor Components)	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
NDD (0.0–1.5m)	E	Not Observed	ES 0.00m–0.10m	0.0		0.10m FILL: Gravelly CLAY: Brown, medium plasticity, gravel is fine to coarse, subangular to angular, with a trace of root fibres.	M		FILL
			ES 0.30m–0.40m			0.50m FILL: Silty SAND: Brown, fine to medium grained, with a trace of clay and gravel.			0.30: Plastic bottle and plastic debris recovered.
			ES 0.60m–0.70m			FILL: Gravelly CLAY: Orange-brown, high plasticity, gravel is fine to coarse, subangular to subrounded.			
			ES 1.00m–1.10m	1.0		From 0.9m, reducing in gravel amount.			
CASING / AD/T (1.5–3.8m)	F (1.8–2.0m)					From 1.5m, colour change to red-brown.			
	E (2.0–2.7m)		SPT 2.00m–2.45m 6,6,7 N=13	2.0		2.30m			2.00: Sandstone gravel recovered in SPT.
					CH	Silty CLAY: Red-brown and pale grey, high plasticity.	D	VSt	RESIDUAL SOIL
	F (2.7–3.5m)			3.0					2.70: Increased drilling resistance.
	H (3.5–3.8m)		D 3.50m–3.70m			3.80m		H	
				4.0		Continued as Cored Drill Hole			3.80: TC-bit refusal at 3.8m.
				5.0					
				6.0					
				7.0					
				8.0					

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS

CORED DRILL HOLE LOG

HOLE NO : BH1
FILE / JOB NO : IA157700
SHEET : 2 OF 3

CLIENT : Transport for NSW
PROJECT : Redfern Station Investigation Works
LOCATION : Redfern, NSW

POSITION : E: 333321.8, N: 6248324.6 (MGA94 Zone 56) | SURFACE ELEVATION : 25.90 (AHD) | ANGLE FROM HORIZONTAL : 90°
RIG TYPE : XC | MOUNTING : Track | CONTRACTOR : Terratest | DRILLER : BM
DATE STARTED : 20/11/2017 | DATE COMPLETED : 20/11/2017 | DATE LOGGED : 20/11/2017 | LOGGED BY : MG | CHECKED BY :
CASING DIAMETER : HQ | BARREL (Length) : | BIT : | BIT CONDITION :

DRILLING & CASING	WATER	PROGRESS (CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION: ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	NATURAL FRACTURE (mm) (20 40 100 300 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0 – 3.80		3.80m START CORING AT 3.80m					
NMLC	0% LOSS	0% LOSS; 4.65		3.80 – 4.70		Silty CLAY: Pale grey with some red-brown ironstone gravel, high plasticity, dry, hard, gravel is medium to coarse, subangular to angular.					
	5% LOSS	24% LOSS		4.70 – 4.81		CORE LOSS 0.11m (4.70-4.81)					
				4.81 – 5.24		Silty CLAY: Pale grey with some red-brown ironstone gravel, high plasticity, dry, hard, gravel is medium to coarse, subangular to angular.					
				5.24 – 5.49		CORE LOSS 0.25m (5.24-5.49)					
		6.15		5.49 – 6.15		Silty CLAY: Pale grey with some red-brown ironstone laminae, high plasticity, dry, hard.					
	5% LOSS	17% LOSS		6.15 – 6.40		CORE LOSS 0.25m (6.15-6.40)					
				6.40 – 6.50		Silty CLAY: Pale grey with some red-brown ironstone laminae, high plasticity, dry, hard.					
		7.65	Is(50) a=0.05 d=0.12 MPa	6.50 – 7.65		INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Grey and pale grey, sandstone is fine grained, distinctly laminated at 0-5°, some iron staining along defects. From 6.80m, becoming dark grey and pale grey. From 7.29 to 7.46m, clay seam, grey and pale grey.	HW				ALL DEFECTS ARE SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5°) 6.6; 6.65 to 6.74: VN, Cu, 80-90°, Fe.; 6.74 to 6.83: Highly fractured.; 6.91 to 6.97: Clay SM, 60mm.; 7.06 to 7.10: FZ, 40mm.; 7.13; 7.23; 7.29 to 7.46: Clay SM, 170mm.; 7.48; 7.57
	5% LOSS	11% LOSS		7.65 – 7.81		CORE LOSS 0.16m (7.65-7.81)					
			Is(50) a=0.01 d=0.07 MPa	7.81 – 8.0			HW				7.81; 7.83

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH1
FILE / JOB NO : IA157700
SHEET : 3 OF 3

POSITION : E: 333321.8, N: 6248324.6 (MGA94 Zone 56) SURFACE ELEVATION : 25.90 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : BM

DATE STARTED : 20/11/2017 DATE COMPLETED : 20/11/2017 DATE LOGGED : 20/11/2017 LOGGED BY : MG CHECKED BY :

CASING DIAMETER : HQ BARREL (Length) : BIT : BIT CONDITION :

DRILLING & CASING	WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH)	NATURAL FRACTURE (mm) (20 40 100 300 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	5% LOSS	11% LOSS		8.0		INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Grey and pale grey, sandstone is fine grained, distinctly laminated at 0-5°. *(continued)*	HW				7.88 7.95: Sandstone SM. 8.06 8.14 8.24 8.27 8.31 8.38 8.41 8.5 8.53 8.62 8.64 8.69 8.75 8.78 8.82 8.91: Fe. 8.97: Fe. 9.11 9.13
			Is(50) a=0.03 d=0.09 MPa								
				9.0		From 8.90m, becoming grey-brown, increasing strength.					
		9.15	Is(50) a=0.04 d=0.08 MPa		9.15m	Hole Terminated at 9.15 m Target depth					
				10.0							
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

PointID : BH1 Depth Range: 3.80 - 9.15 m

JACOBS	CLIENT: Transport for NSW			
	PROJECT: Redfern Station Investigation			
	DRAWN: MG	DRAWING CHECK: MF	REVIEWED	APPROVED
	DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE: Core Photo - BH1		
SCALE: Not To Scale	DRAWING No: 1/1	REV

NON-CORE DRILL HOLE - GEOLOGICAL LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH2
FILE / JOB NO : IA157700
SHEET : 1 OF 3

POSITION : E: 333351.6, N: 6248322.8 (MGA94 Zone 56) | SURFACE ELEVATION : 26.37 (AHD) | ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC | MOUNTING : Track | CONTRACTOR : Terratest | DRILLER : PB

DATE STARTED : 18/11/2017 | DATE COMPLETED : 18/11/2017 | DATE LOGGED : 18/11/2017 | LOGGED BY : MG | CHECKED BY :

DRILLING & CASING	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION (Soil Type, Colour, Plasticity or Particle Characteristic, Secondary and Minor Components)	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
NDD (0.0–1.1)	E (0.0–3.5)	Not Observed		0.0–0.05		Asphaltic CONCRETE.			FILL
				0.05–0.45		FILL: Gravelly SAND: Brown, fine to coarse grained, gravel is fine to coarse, subangular to angular.	D		
			0.80m ES 0.90m; 1.00m ES 1.10m	0.45–1.50		FILL: Clayey SAND: Brown, fine to medium grained with some medium to coarse, subangular to subrounded gravel. At 1.0m, with some red-brown and grey clay.	M		0.40: Buried Asphalt pavement, 50mm thick.
AD/T, CASING (1.1–5.0)			1.50m SPT 4,1,2 N=3. 1.95m	1.50–2.00		FILL: Gravelly CLAY: Brown, low plasticity, gravel is fine to coarse, subangular to angular.	D		
	E / F (from 3.5)		3.00m SPT 5,10,15 N=25. 3.45m; 4.50m SPT 11,16,5/20mm HB, N=R. 4.82m	2.00–5.00	CH	Silty CLAY: Grey mottled red-brown, high plasticity with trace of ironstone gravel.	D	VSt (to 4.0), H	RESIDUAL SOIL
				5.00		Continued as Cored Drill Hole			

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS 3.01.2 LIB.GLB Log IS AU BOREHOLE 2 IA157700.GPJ <<DrawingFile>> 18/12/2017 09:32 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: Jacobs 3.01.2 2017-03-09 Prj: Jacobs 3.00.0 2016-07-17

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH2
FILE / JOB NO : IA157700
SHEET : 2 OF 3

POSITION : E: 333351.6, N: 6248322.8 (MGA94 Zone 56) SURFACE ELEVATION : 26.37 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : PB

DATE STARTED : 18/11/2017 DATE COMPLETED : 18/11/2017 DATE LOGGED : 18/11/2017 LOGGED BY : MG CHECKED BY :

CASING DIAMETER : HQ BARREL (Length) : 1.50 m BIT : BIT CONDITION :

DRILLING & CASING	WATER	CORE LOSS (CORE RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	DESCRIPTION	Weathering	ESTIMATED STRENGTH Is(50) (● - Axial, ○ - Diametral)	ADDITIONAL DATA
				5.00	START CORING AT 5.00m			
NMLC	0% LOSS	0% LOSS		5.00–6.00	Silty CLAY: Pale grey, with some red-brown ironstone gravel, high plasticity, dry, hard.			
		5.50 / 0% LOSS			From 5.5m, ironstone gravel is absent.			
				6.00–6.60	SHALE: Grey, red-brown laminated.	XW		ALL DEFECTS ARE SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5°). 6.10: Clay SM 50mm. 6.15 6.30: Clay SM 50mm. 6.36 6.40
				6.60–8.00	INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Grey and pale grey, sandstone is fine grained, distinctly laminated at 0-5°, some iron staining along defects.	HW		6.44: JT, 90 degrees, Cu, Infilled. 6.48 6.57 to 6.6: Clay SM 30mm. 6.67: Fe. 6.73: Fe. 6.89: Fe, JT, 70 to 90 degrees, St, Infilled.
		7.00 / 0% LOSS	Is(50) d=0.05 a=0.05 MPa				●	7.10 7.14 7.15 7.17: Clay SM. 7.21: Clay SM. 7.25 7.28
			Is(50) d=0.01 a=0.1 MPa		From 7.59 to 7.68, pale grey clay seam.		○ ●	7.35: Clay, SM. 7.37

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH2
FILE / JOB NO : IA157700

POSITION : E: 333351.6, N: 6248322.8 (MGA94 Zone 56) | SURFACE ELEVATION : 26.37 (AHD) | ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC | MOUNTING : Track | CONTRACTOR : Terratest | DRILLER : PB

DATE STARTED : 18/11/2017 | DATE COMPLETED : 18/11/2017 | DATE LOGGED : 18/11/2017 | LOGGED BY : MG | CHECKED BY :

CASING DIAMETER : HQ | BARREL (Length) : 1.50 m | BIT : | BIT CONDITION :

DRILLING & CASING	WATER	CORE LOSS (CORE RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH)	NATURAL FRACTURE (mm) (20 40 100 300 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	0% LOSS	0% LOSS		8.0		INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Grey and pale grey, sandstone is fine grained, distinctly laminated at 0-5°, some iron staining along defects. *(continued)*	HW				7.38 7.42, Clay SM 10mm. 7.47 7.52 7.55 7.59-7.63: Clay SM 40mm. 7.68 7.71 7.74 7.82 7.93 7.98 to 8.06: Fz. 8.06 8.10: Clay SM 40mm. 8.17 to 8.22: Clay SM 50mm. 8.22 8.27: Fe. 8.28: Fe. 8.33: Fe. 8.35 8.40: Fe.
		8.50	Is(50) d=0.04 a=0.09 MPa		8.50m	Hole Terminated at 8.50 m Target depth					
				9.0							
				10.0							
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

PointID : BH2 Depth Range: 5.00 - 8.50 m

JACOBS	CLIENT: Transport for NSW			
	PROJECT: Redfern Station Investigation			
	DRAWN: MG	DRAWING CHECK: MF	REVIEWED	APPROVED
	DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE: Core Photo - BH2		
SCALE: Not To Scale	DRAWING No: 1/1	REV

NON-CORE DRILL HOLE - GEOLOGICAL LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH3
FILE / JOB NO : IA157700
SHEET : 1 OF 3

POSITION : E: 333359.7, N: 6248314.2 (MGA94 Zone 56) SURFACE ELEVATION : 26.48 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : PF

DATE STARTED : 19/11/2017 DATE COMPLETED : 19/11/2017 DATE LOGGED : 19/11/2017 LOGGED BY : MG CHECKED BY :

DRILLING & CASING	WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION (Soil Type, Colour, Plasticity or Particle Characteristic, Secondary and Minor Components)	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
NDD (0.0–1.2m)		E	Not Observed	0.05m ES 0.15m; 0.30m ES 0.40m	0.0–0.05		Asphaltic CONCRETE.			FILL
					0.05–0.40		FILL: Gravelly SAND: Brown and grey, fine to coarse grained sand gravel is fine to coarse, subangular to angular.	D		
				0.60m ES 0.70m; 1.10m ES 1.20m	0.40–1.50		FILL: Silty CLAY: Orange-brown and red-brown, high plasticity with trace of sand and fine subangular gravel. At 0.6m, buried pavement, approximately 100mm thick, including asphalt over bricks.	M		0.80: Terracotta pipe at 0.8m depth, hole moved 0.5m.
AD/T, CASING (1.2–4.8m)				1.50m SPT 3,7,9 N=16. 1.95m; 3.00m SPT 9,16,10/50mm HB, N=R. 3.35m	1.50–4.80	CH	Silty CLAY: Red-brown and pale-grey, high plasticity with a trace of ironstone gravel.	M (to 2.5m); D	VSt (to 2.5m); H	RESIDUAL SOIL
					4.80		Continued as Cored Drill Hole			

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS 3.01.2 LIB.GLB Log IS AU BOREHOLE 2 IA157700.GPJ <<DrawingFile>> 18/12/2017 09:32 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: Jacobs 3.01.2 2017-03-09 Prj: Jacobs 3.00.0 2016-07-17

CORED DRILL HOLE LOG

JACOBS

HOLE NO : BH3
FILE / JOB NO : IA157700
SHEET : 2 OF 3

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333359.7, N: 6248314.2 (MGA94 Zone 56) SURFACE ELEVATION : 26.48 (AHD) ANGLE FROM HORIZONTAL : 90°
RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : PF
DATE STARTED : 19/11/2017 DATE COMPLETED : 19/11/2017 DATE LOGGED : 19/11/2017 LOGGED BY : MG CHECKED BY :
CASING DIAMETER : HQ BARREL (Length) : 1.50 m BIT : BIT CONDITION :

DRILLING & CASING	WATER	CORE LOSS (CORE RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	NATURAL FRACTURE (mm) (20 40 100 300 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0–4.80		4.80m START CORING AT 4.80m					
NMLC	0% LOSS	0% LOSS		4.80–6.35		Silty CLAY: Pale grey with a trace of red-brown staining, high plasticity, dry, hard.					ALL DEFECTS ARE SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5 degrees).
		6.20 / 0% LOSS		6.35		Silty CLAY: Grey-brown, with red-brown ironstone laminae, high plasticity, dry, hard.					
	0% LOSS			6.80		SHALE: Dark grey and pale grey, thinly laminated to laminated.	XW				6.8 to 7.15: Highly fractured, with iron staining in defects.
			Is(50) d=0 a=0.01 MPa					●			7.15 7.25 7.32 7.45 7.5
		7.55 / 0% LOSS		7.55		SHALE: Pale grey with iron staining. From 7.70m, colour is brown.					7.55 to 8.00: Clay SM.
	0% LOSS			8.00							

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH3
FILE / JOB NO : IA157700
SHEET : 3 OF 3

POSITION : E: 333359.7, N: 6248314.2 (MGA94 Zone 56) SURFACE ELEVATION : 26.48 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : PF

DATE STARTED : 19/11/2017 DATE COMPLETED : 19/11/2017 DATE LOGGED : 19/11/2017 LOGGED BY : MG CHECKED BY :

CASING DIAMETER : HQ BARREL (Length) : 1.50 m BIT : BIT CONDITION :

DRILLING & CASING	WATER	(CORE LOSS RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH)	NATURAL FRACTURE (mm) (20 40 100 300 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	0% LOSS	0% LOSS		8.0		SHALE: Dark grey and brown, thinly laminated to laminated.	HW				8.15 to 8.25: Clay SM. 8.25 to 8.30: Clay SM, orange brown. 8.3 to 8.54: Highly fractured. 8.64 8.84
		9.00	Is(50) d=0 a=0.04 MPa			9.00m		●			
				9.0		Hole Terminated at 9.00 m Target depth					
				10.0							
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

PointID : BH3 Depth Range: 4.80 - 9.00 m

JACOBS	CLIENT Transport for NSW			
	PROJECT Redfern Station Investigation			
	DRAWN MG	DRAWING CHECK MF	REVIEWED	APPROVED
	DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE Core Photo - BH3		
SCALE Not To Scale	DRAWING No 1/1	REV

NON-CORE DRILL HOLE - GEOLOGICAL LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH4
FILE / JOB NO : IA157700
SHEET : 1 OF 3

POSITION : E: 333412.4, N: 6248312.4 (MGA94 Zone 56) SURFACE ELEVATION : 26.34 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : BM/PF

DATE STARTED : 11/11/2017 DATE COMPLETED : 12/11/2017 DATE LOGGED : 11/11/2017 LOGGED BY : MG CHECKED BY : MF

DRILLING & CASING	WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
AD/T		E	Not Observed		0.0			Asphaltic CONCRETE (to 0.20m)			FILL
NDD				0.40m ES 0.50m				FILL: Gravelly CLAY: Brown, medium plasticity, gravel is fine to coarse, subangular to angular. (0.20m–0.50m)	D		
				0.80m ES 0.90m				FILL: Silty CLAY: Grey mottled red-brown, medium to high plasticity. (0.50m–1.50m)			
					1.0						1.00: Possibly Residual Soil.
											1.30: Platform height is 1.3m above rail ballast.
CASING / AD/T				1.50m SPT 8,11,25 N=36 1.95m			CH	Silty CLAY: Grey and red-brown, high plasticity with ironstone gravel (1.50m–4.40m)	D	H	RESIDUAL SOIL
											1.80: SPT hammer bouncing from 1.8m
					2.0						
				2.50m D 2.70m							
		F		2.70m SPT 2,5,17 N=22 3.15m						VSt	2.70: Nearing TC-bit refusal on ironstone cobble
					3.0						
				3.30m D 3.50m							3.50: SPT unable to be performed due to hole cave-in
					4.0						
		H						4.40m From 4.30m, becoming grey to dark grey		H	4.30: TC-bit refusal
								Continued as Cored Drill Hole			
					5.0						
					6.0						
					7.0						
					8.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH4
FILE / JOB NO : IA157700
SHEET : 2 OF 3

POSITION : E: 333412.4, N: 6248312.4 (MGA94 Zone 56) SURFACE ELEVATION : 26.34 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC MOUNTING : Track CONTRACTOR : Terratest DRILLER : BM/PF

DATE STARTED : 11/11/2017 DATE COMPLETED : 12/11/2017 DATE LOGGED : 11/11/2017 LOGGED BY : MG CHECKED BY : MF

CASING DIAMETER : HQ BARREL (Length) : 0.80 m BIT : BIT CONDITION :

DRILLING | MATERIAL | FRACTURES

Columns: PROGRESS (DRILLING & CASING; WATER); (CORE LOSS / RUN %) DRILL DEPTH; SAMPLES & FIELD TESTS; DEPTH (m); GRAPHIC LOG; DESCRIPTION – ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable); Weathering; ESTIMATED STRENGTH Is(50) (● - Axial, ○ - Diametral; EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH); NATURAL FRACTURE (mm) (20, 40, 100, 300, 1000); VISUAL; ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other

Depth (m)	Core loss / run	Samples & field tests	Description	Weathering
4.40m			START CORING AT 4.40m	
4.40–4.55m	0% LOSS (run to 5.20)		Silty CLAY: Grey, high plasticity, dry, very stiff.	
4.55–5.00m		Is(50) d=0.1 a=0.07 MPa	SHALE: Dark grey, thinly laminated.	MW
5.00–5.20m	5.20		SHALE: Brown and grey, thinly laminated.	XW - HW
5.20–6.40m	0% LOSS (run to 6.00); 6.00	Is(50) d=0.13 a=0.06 MPa	SHALE: Dark grey, laminated with iron staining in defects.	MW
6.40–8.00m	0% LOSS (run to 6.80); 6.80; 0% LOSS (run to 7.60); 7.60; 0% LOSS	Is(50) d=0 a=0.08 MPa; Is(50) d=0 a=0.11 MPa	INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Dark grey and grey sandstone is fine grained, distinctly laminated at 0-5°.	XW - HW (6.80); MW; XW (7.60); HW

Drilling & casing: NMLC. Water: 0% LOSS (4.40–5.20), 0% LOSS (5.20–6.00), 10% LOSS (6.00–6.80), 10% LOSS (6.80–7.60), 10% LOSS (7.60–8.00).

Additional data:

~~ALL DEFECTS ARE~~ SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5°)
- 4.40 to 4.55: Clay SM, 150mm
- 4.70: JT, 90°, Pl, R
- 4.77
- 5.00
- 5.04: Clay SM, 30mm
- 5.07 to 5.12: FZ.
- 5.13: Clay SM, 20mm
- 5.17: Clay SM, 60mm
- 5.36: JT, 80°, Pl, Sr
- 5.40: Fe
- 5.54: JT, 70-80°, Pl, Sr
- 5.65
- 5.80 to 6.00: JT, 60-80°, Cu, R, Fe
- 5.90
- 6.13: Clay infill
- 6.17: JT, 20-30°, Pl, R, Fe
- 6.23
- 6.40: JT, 70°, Pl, R, Fe
- 6.45: Clay SM, 20mm
- 6.49: Fe
- 6.65 to 6.80: FZ.
- 6.82
- 6.86
- 6.89
- 6.95 to 7.09: Highly fractured.
- 7.38: Clay SM, 10mm
- 7.42: Clay SM, 40mm
- 7.52
- 7.55
- 7.60 to 7.72: Clay SM.
- 7.83: Clay infill
- 7.87: Clay infill

Depth scale: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0

See Explanatory Notes for details of abbreviations & basis of descriptions.

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH4
FILE / JOB NO : IA157700
SHEET : 3 OF 3

POSITION : E: 333412.4, N: 6248312.4 (MGA94 Zone 56) | SURFACE ELEVATION : 26.34 (AHD) | ANGLE FROM HORIZONTAL : 90°

RIG TYPE : XC | MOUNTING : Track | CONTRACTOR : Terratest | DRILLER : BM/PF

DATE STARTED : 11/11/2017 | DATE COMPLETED : 12/11/2017 | DATE LOGGED : 11/11/2017 | LOGGED BY : MG | CHECKED BY : MF

CASING DIAMETER : HQ | BARREL (Length) : 0.80 m | BIT : | BIT CONDITION :

DRILLING					MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	WATER	(CORE LOSS RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	10% LOSS	0% LOSS 8.40		8.0		INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Dark grey and grey sandstone is fine grained, distinctly laminated at 0-5°. *(continued)*	HW				7.92; 7.96; 8.07; 8.14: JT, 70°, Pl, Sr, Fe; 8.27: Clay infill; 8.34: Clay SM, 10mm
	10% LOSS	0% LOSS 9.20	Is(50) d=0.11 a=0.19 MPa	9.0							8.54: Clay infill; 8.57; 8.64: Clay SM, 15mm; 8.76; 8.82: Clay SM, 20mm; 8.88: Clay SM, 10mm; 8.93: Clay SM, 10mm; 8.98; 9.08: Clay SM, 30mm; 9.17: JT, 80-90°, Pl, R
	10% LOSS	0% LOSS 10.00	Is(50) d=0.2 a=0.05 MPa			10.00m					9.25: Clay SM, 10mm; 9.29; 9.34: Clay SM, 20mm; 9.43: Clay SM, 10mm; 9.49: Clay SM, 10mm; 9.54; 9.75: Clay SM, 10mm; 9.77: Clay SM, 10mm; 9.88: Clay SM, 10mm; 9.95
				10.0		Hole Terminated at 10.00 m Target depth					
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

PointID : BH4 Depth Range: 4.40 - 10.00 m

JACOBS	CLIENT Transport for NSW			
	PROJECT Redfern Station Investigation			
	DRAWN MG	DRAWING CHECK MF	REVIEWED	APPROVED
	DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE Core Photo - BH4		
SCALE Not To Scale	DRAWING No 1/1	REV

JACOBS

NON-CORE DRILL HOLE - GEOLOGICAL LOG

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH5
FILE / JOB NO : IA157700
SHEET : 1 OF 3

POSITION : E: 333481.4, N: 6248345.8 (MGA94 Zone 56) SURFACE ELEVATION : 24.03 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Commachio 205 MOUNTING : Track CONTRACTOR : Terratest DRILLER : AZ

DATE STARTED : 28/11/2017 DATE COMPLETED : 28/11/2017 DATE LOGGED : 28/11/2017 LOGGED BY : MG CHECKED BY :

DRILLING: Drilling & Casing	Water	Drilling Penetration	Ground Water Levels	Samples & Field Tests	Depth (m)	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION: Soil Type, Colour, Plasticity or Particle Characteristic, Secondary and Minor Components	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T CASING		E		ES 0.10m	0.0			FILL: Sandy Gravelly CLAY: Brown and red-brown, low to medium plasticity, gravel is fine to medium.			FILL
				0.50m SPT 3,2,3 N=5	0.60m			From 0.5m, coal layer (100mm).			
				0.95m				FILL: Silty Sandy CLAY: Brown and red-brown, medium to high plasticity, sand is fine to coarse grained, with a trace of siltstone lenses.			
				1.30m D 1.50m	1.30m		CH	Silty CLAY: Grey and orange-brown, high plasticity, with some siltstone lenses.	M	St - VSt	RESIDUAL SOIL
				SPT 4,2,7 N=9 1.95m							
		F		2.80m D 3.00m SPT 10/50mm, HB N=R 3.05m	2.60m			SHALE: Grey, highly weathered, very low strength.			BEDROCK
			Not Observed		3.20m			Continued as Cored Drill Hole			

Depth scale: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS

CORED DRILL HOLE LOG

HOLE NO : BH5
FILE / JOB NO : IA157700
SHEET : 2 OF 3

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333481.4, N: 6248345.8 (MGA94 Zone 56) SURFACE ELEVATION : 24.03 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Commachio 205 MOUNTING : Track CONTRACTOR : Terratest DRILLER : AZ

DATE STARTED : 28/11/2017 DATE COMPLETED : 28/11/2017 DATE LOGGED : 28/11/2017 LOGGED BY : MG CHECKED BY :

CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : BIT CONDITION :

Drilling & Casing	Water	Core Loss (Run %) / Drill Depth	Samples & Field Tests	Depth (m)	Description (Rock type: Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable))	Weathering	Additional Data (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0–3.20	3.20m START CORING AT 3.20m		
NMLC	0% LOSS	0% LOSS		3.20	INTERLAMINATED SILTSTONE & SANDSTONE (65% siltstone 35% sandstone): Dark grey, sandstone is pale grey and fine grained, with some iron staining in defects, distinctly laminated at 0-5°.	MW	ALL DEFECTS ARE SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5°); 3.20 to 3.28: Clay SM; 3.30; 3.35; 3.41; 3.48 to 3.84: Highly fractured with iron.; 3.93
			Is(50) d=0.01 a=0.23 MPa	4.0			4.10
		4.40					4.22 to 4.52: Highly fractured.
	10% LOSS	0% LOSS		4.40		MW - SW	4.59 to 4.84: Highly fractured.; 4.89
				5.0			5.13; 5.23 to 5.50: Highly fractured.
				5.50	From 5.50m, increasing in sandstone, 40-50%.		5.54; 5.67; 5.70 to 5.77: Pale grey.; 5.88; 5.95
			Is(50) d=0.31 a=1.02 MPa	6.0			6.08; 6.13; 6.17 to 7.61: St, 80°, Pl, R, Fe (No Fe from 6.86m).
			Is(50) d=0.02 a=0.26 MPa				6.33; 6.42; 6.44; 6.53; 6.58; 6.68; 6.69; 6.72; 6.76
				6.86	From 6.86m, iron absent in defects.	SW	6.84; 6.87: St.; 6.91, St.; 6.93; 6.96
		7.40		7.0			7.10: St.; 7.16; 7.23
	90% LOSS	0% LOSS	Is(50) d=0.08 a=0.19 MPa	8.0	8.00m		7.31; 7.5; 7.54; 7.61

Estimated Strength Is(50): ● - Axial ○ - Diametral; EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH

Natural Fracture (mm): 20, 40, 100, 300, 1000

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS 3.01.2 LIB.GLB Log IS AU CORED BOREHOLE 2 IA157700.GPJ <<DrawingFile>> 18/12/2017 09:34 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: Jacobs 3.01.2 2017-03-09 Prj: Jacobs 3.00.0 2016-07-17

CORED DRILL HOLE LOG

JACOBS

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

HOLE NO : BH5
FILE / JOB NO : IA157700
SHEET : 3 OF 3

POSITION : E: 333481.4, N: 6248345.8 (MGA94 Zone 56) SURFACE ELEVATION : 24.03 (AHD) ANGLE FROM HORIZONTAL : 90°
RIG TYPE : Commachio 205 MOUNTING : Track CONTRACTOR : Terratest DRILLER : AZ
DATE STARTED : 28/11/2017 DATE COMPLETED : 28/11/2017 DATE LOGGED : 28/11/2017 LOGGED BY : MG CHECKED BY :
CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : BIT CONDITION :

Drilling & Casing	Water	Core Loss (Core Run %) / Drill Depth	Samples & Field Tests	Depth (m)	Description (Rock type: Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable))	Weathering	Additional Data (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	90% LOSS	0% LOSS		8.0	INTERLAMINATED SILTSTONE & SANDSTONE (55% siltstone 45% sandstone): Dark grey, sandstone is pale grey and fine grained, distinctly laminated at 0-5°.	SW	7.65 7.75 7.84 to 7.92: JT, Pl, 80°, SR. 8.03 8.11 8.23: Clay SM 5mm. 8.25: Clay SM 5mm. 8.37 8.50 8.61: Clay SM 10mm. 8.82 8.87
			Is(50) d=0.26 a=2.09 MPa	9.0	From 9.10m, decreasing in sandstone (30%).	SW - FR	9.04 9.10 9.16 9.28
			Is(50) d=0.26 a=2.24 MPa				
		10.40	Is(50) d=0.25 a=1 MPa	10.0	10.40m		
					Hole Terminated at 10.40 m Target depth		

Depth scale: 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0

Estimated Strength Is(50): ● - Axial ○ - Diametral; EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Natural Fracture (mm): 20 40 100 300 1000

See Explanatory Notes for details of abbreviations & basis of descriptions.

PointID : BH5 Depth Range: 3.20 - 10.40 m

JACOBS

CLIENT			
Transport for NSW			
PROJECT: Redfern Station Investigation			
DRAWN: MG	DRAWING CHECK: MF	REVIEWED	APPROVED
DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE		
Core Photo - BH5		
SCALE: Not To Scale	DRAWING No: 1/1	REV

JACOBS

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BH6
FILE / JOB NO : IA157700
SHEET : 1 OF 3

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333452.6, N: 6248279.5 (MGA94 Zone 56) | SURFACE ELEVATION : 25.14 (AHD) | ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hanjin DB8 | MOUNTING : Track | CONTRACTOR : Terratest | DRILLER : BM

DATE STARTED : 07/11/2017 | DATE COMPLETED : 07/11/2017 | DATE LOGGED : 07/11/2017 | LOGGED BY : MG | CHECKED BY : MF

DRILLING: PROGRESS – DRILLING & CASING	WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	MATERIAL DESCRIPTION (Soil Type, Colour, Plasticity or Particle Characteristic, Secondary and Minor Components)	CLASSIFICATION SYMBOL	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
NDD (0.0–1.0m)		E (0.0–3.7m)	Not Observed		0.0–0.20m	Asphaltic CONCRETE				FILL
				0.20m ES 0.30m; 0.60m ES 0.70m	0.20–1.00m	FILL: Sandy Clayey GRAVEL: Dark grey and brown, fine to coarse, subanagular to subrounded. At 0.4m, some broken bricks. At 0.6m, some shale cobbles and boulders up to 300mm.		D		
AD/V – CASING (1.0–5.5m)				1.00m SPT 3,6,7 N=13 1.45m; 2.50m SPT 8,21,11/90mm HB, N=R 2.89m; 3.80m D 4.00m	1.00–4.50m	Silty CLAY: Grey mottled red-brown, high plasticity. At 2.5m, as above, with some orange-brown mottling.	CH	D	St (1.0–2.0m); VSt (2.0–4.5m)	RESIDUAL SOIL 1.20: Hole collapse prior to SPT. 2.50: Hole collapse prior to SPT. 2.80: SPT bouncing on lense of dark grey shale. 3.70: Increased drilling resistance. 4.00: SPT unable to be performed due to hole cave-in.
		F (3.7–5.5m)		5.30m D 5.50m	4.50–5.50m	SHALE: Dark grey, extremely weathered, extremely low strength, remoulds to silty clay.				WEATHERED ROCK
					5.50m	Continued as Cored Drill Hole				5.50: SPT bouncing when attempted.

Depth scale: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS

CORED DRILL HOLE LOG

HOLE NO : BH6
FILE / JOB NO : IA157700
SHEET : 2 OF 3

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333452.6, N: 6248279.5 (MGA94 Zone 56) SURFACE ELEVATION : 25.14 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hanjin DB8 MOUNTING : Track CONTRACTOR : Terratest DRILLER : BM

DATE STARTED : 07/11/2017 DATE COMPLETED : 07/11/2017 DATE LOGGED : 07/11/2017 LOGGED BY : MG CHECKED BY : MF

CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : BIT CONDITION :

DRILLING: PROGRESS – DRILLING & CASING	WATER	(CORE LOSS RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	MATERIAL: GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	FRACTURES: NATURAL FRACTURE (mm) (20, 40, 100, 300, 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0 – 5.5		5.50m START CORING AT 5.50m					
NMLC	5% Water LOSS	20% LOSS		5.50 – 5.80		CORE LOSS 0.30m (5.50-5.80) 5.80m					ALL DEFECTS ARE SUB-HORIZONTAL BEDDING PARTINGS UNLESS NOTED OTHERWISE (0-5°)
			Is(50) d=0.27 a=0.36 MPa	5.80 – 7.00		INTERLAMINATED SILTSTONE & SANDSTONE (70% siltstone 30% sandstone): Dark grey and pale grey, sandstone is fine grained, distinctly laminated at 0-10°, some iron staining along defects.	SW				5.80 5.95 6.05 6.25: JT, 70°, Fe, Pl, R 6.36 6.63: Fe 6.75: Fe 6.83: SM, 10mm, Fe, Pl, R 6.85: SM, 5mm, Fe, Pl, R 6.9: 15°
		7.00	Is(50) d=0.45 a=0.55 MPa	7.0							
	5% Water LOSS	0% LOSS	Is(50) d=0.16 a=0.43 MPa	7.00 – 8.00		At 7.75m, sandstone section 100mm, grey, high strength. 8.00m					7.26 7.27 7.28: SM, 10mm, Fe 7.36 7.58

See Explanatory Notes for details of abbreviations & basis of descriptions.

JACOBS

CORED DRILL HOLE LOG

CLIENT : Transport for NSW
LOCATION : Redfern, NSW
PROJECT : Redfern Station Investigation Works

POSITION : E: 333452.6, N: 6248279.5 (MGA94 Zone 56) SURFACE ELEVATION : 25.14 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hanjin DB8 MOUNTING : Track CONTRACTOR : Terratest DRILLER : BM

DATE STARTED : 07/11/2017 DATE COMPLETED : 07/11/2017 DATE LOGGED : 07/11/2017 LOGGED BY : MG CHECKED BY : MF

CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : BIT CONDITION :

DRILLING & CASING	WATER	(CORE LOSS RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	5% Water LOSS	0% LOSS		8.0	INTERLAMINATED SILTSTONE & SANDSTONE (60% siltstone 40% sandstone): Dark grey and pale grey, sandstone is fine grained, distinctly laminated at 0-10°, some iron staining along defects.	SW	8.08: SM, 10mm 8.22 8.25 8.33: JT, 30-40°, ST, R 8.47: JT, 80-90°, Wa, R 8.57 8.7 8.75 8.76 8.93: SM, 10mm, Pl, R
			Is(50) d=0.6 a=0.12 MPa	9.0			9.12 9.45 9.61: SM, 5mm, Pl, R 9.82: St.
		9.90	Is(50) d=0.13 a=0.99 MPa		9.90m		
				10.0	Hole Terminated at 9.90 m Target depth		
				11.0			
				12.0			
				13.0			
				14.0			
				15.0			
				16.0			

ESTIMATED STRENGTH Is(50): ● - Axial ○ - Diametral; EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH

NATURAL FRACTURE (mm): 20 40 100 300 1000

VISUAL

See Explanatory Notes for details of abbreviations & basis of descriptions.

PointID : BH6 Depth Range: 5.50 - 9.90 m

JACOBS

CLIENT Transport for NSW			
PROJECT Redfern Station Investigation			
DRAWN MG	DRAWING CHECK MF	REVIEWED	APPROVED
DESIGNED	DESIGN REVIEW	DATE	DATE

TITLE

Core Photo - BH6

SCALE	DRAWING No	REV
Not To Scale	1/1	

Appendix D. Laboratory testing certificates

MOISTURE CONTENT TEST REPORT

Client:	Jacobs	**Job No:**	S17470
Address:	100 Christie Street, St Leonards NSW 2065	**Report No:**	S29263-MC
Project:	Redfern Station Investigation (IA157700)		

Test Procedure:

- ☑ AS 1289 2.1.1 Soil moisture content tests - Determination of the moisture content of a soil - Oven drying method (Standard method).
- ☐ AS4133 1.1.1 Rock moisture content tests - Determination of the moisture content of rock - Oven drying method (standard method)
- ☐ RMS T120 Moisture content of road construction materials (Standard method)
- ☐ RMS T262 Determination of moisture content of aggregates (Standard method)

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample No.	Source	Sample Description	Moisture Content %
S29263	BH1 3.5-3.7m	Silty CLAY	**19.1**
S29264	BH1 4.1-4.3m	Gravelly Silty CLAY	**18.3**
S29269	BH2 4.5-4.8m	Silty CLAY	**16.9**
S29273	BH3 3.0-3.45m	Silty CLAY	**16.4**

Notes:

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Authorised Signatory:

Chris Lloyd

28/11/2017

Date:

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Macquarie Geotechnical
U8 10 Bradford Street
Alexandria NSW 2015

MOISTURE CONTENT TEST REPORT

Client:	Jacobs	**Job No:**	S17470
Address:	100 Christie Street, St Leonards NSW 2065	**Report No:**	S29378-MC
Project:	Redfern Station Investigation (IA157700)		

Test Procedure:

- ☑ AS 1289 2.1.1 Soil moisture content tests - Determination of the moisture content of a soil - Oven drying method (Standard method).
- ☐ AS4133 1.1.1 Rock moisture content tests - Determination of the moisture content of rock - Oven drying method (standard method)
- ☐ RMS T120 Moisture content of road construction materials (Standard method)
- ☐ RMS T262 Determination of moisture content of aggregates (Standard method)

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample No.	Source	Sample Description	Moisture Content %
S29378	BH5 1.3-1.5m	Sandy Silty CLAY with Gravel	**11.1**
S29379	BH5 2.8-3m	Sandy Silty CLAY	**10.3**

Notes:

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MOISTURE CONTENT TEST REPORT

Client:	Jacobs	**Job No:**	S17470
Address:	100 Christie Street, St Leonards NSW 2065	**Report No:**	S29111-MC
Project:	Redfern Station Investigation (IA157700)		

Test Procedure:

- ☑ AS 1289 2.1.1 Soil moisture content tests - Determination of the moisture content of a soil - Oven drying method (Standard method).
- ☐ AS4133 1.1.1 Rock moisture content tests - Determination of the moisture content of rock - Oven drying method (standard method)
- ☐ RMS T120 Moisture content of road construction materials (Standard method)
- ☐ RMS T262 Determination of moisture content of aggregates (Standard method)

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample No.	Source	Sample Description	Moisture Content %
S29111	BH6 2.50-2.95m	Silty CLAY with Gravel and Sand	**13.2**
S29112	BH6 3.80-4.00m	Silty CLAY	**12.2**
S29118	BH4 2.50-2.70m	Silty CLAY	**17.0**
S29119	BH4 2.70-3.15m	Silty CLAY trace of Sand	**15.8**

Notes:

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Authorised Signatory:

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22/11/2017

Date:

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SOIL CLASSIFICATION REPORT

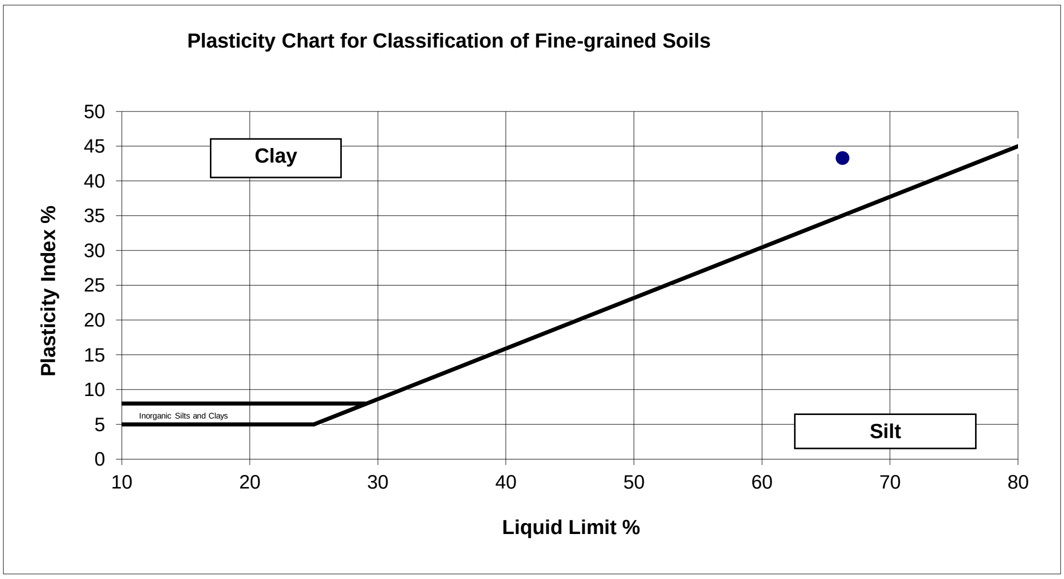
Client:	Jacobs	**Source:**	BH1 3.5-3.7m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	Silty CLAY
Project:	Redfern Station Investigation (IA157700)	**Report No:**	S29263-PI
Job No:	S17470	**Lab No:**	S29263

Test Procedure:

- ☑ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Liquid Limit (%):	66	**Linear Shrinkage (%):**	12.5
Plastic Limit (%):	23	**Plastic Index:**	43



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

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SOIL CLASSIFICATION REPORT

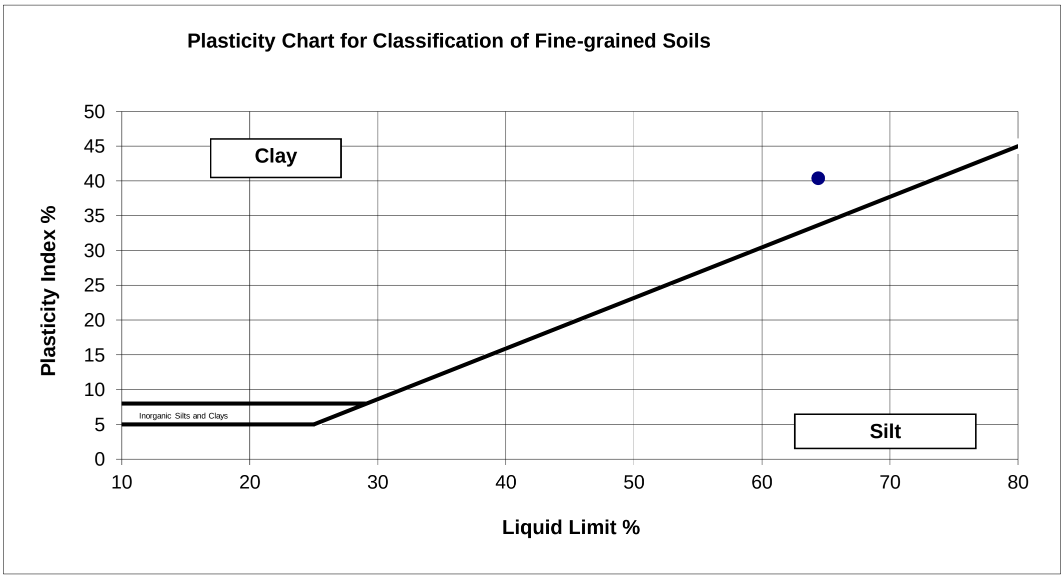
Client:	Jacobs	**Source:**	BH2 4.5-4.8m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	Silty CLAY
Project:	Redfern Station Investigation (IA157700)	**Report No:**	S29269-PI
Job No:	S17470	**Lab No:**	S29269

Test Procedure:

- ☑ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Liquid Limit (%):	64	**Linear Shrinkage (%):**	10.0
Plastic Limit (%):	24	**Plastic Index:**	40



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

29/11/2017
Date:

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SOIL CLASSIFICATION REPORT

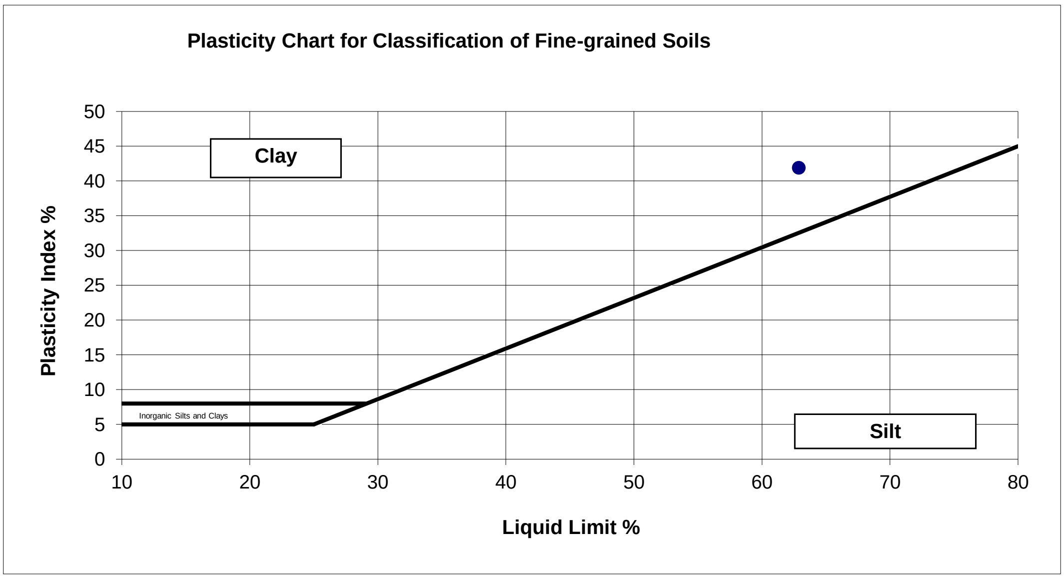
Client:	Jacobs	**Source:**	BH3 3.0-3.45m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	Silty CLAY
Project:	Redfern Station Investigation (IA157700)	**Report No:**	S29273-PI
Job No:	S17470	**Lab No:**	S29273

Test Procedure:

- ☑ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☐ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☑ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Liquid Limit (%):	63	**Linear Shrinkage (%):**	13.0
Plastic Limit (%):	21	**Plastic Index:**	42



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

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SOIL CLASSIFICATION REPORT

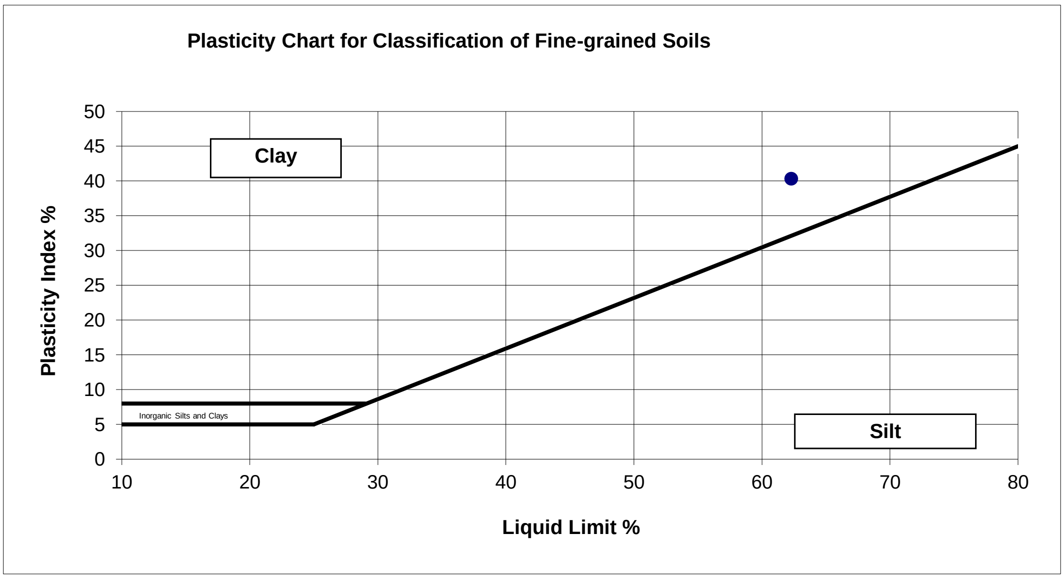
Client:	Jacobs	**Source:**	BH4 2.50-2.70m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	
Project:	Redfern Station Investigation (IA157700)	**Report No:**	S29118-PI
Job No:	S17470	**Lab No:**	S29118

Test Procedure:

- ☑ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Liquid Limit (%):	62	**Linear Shrinkage (%):**	10.5
Plastic Limit (%):	22	**Plastic Index:**	40



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

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SOIL CLASSIFICATION REPORT

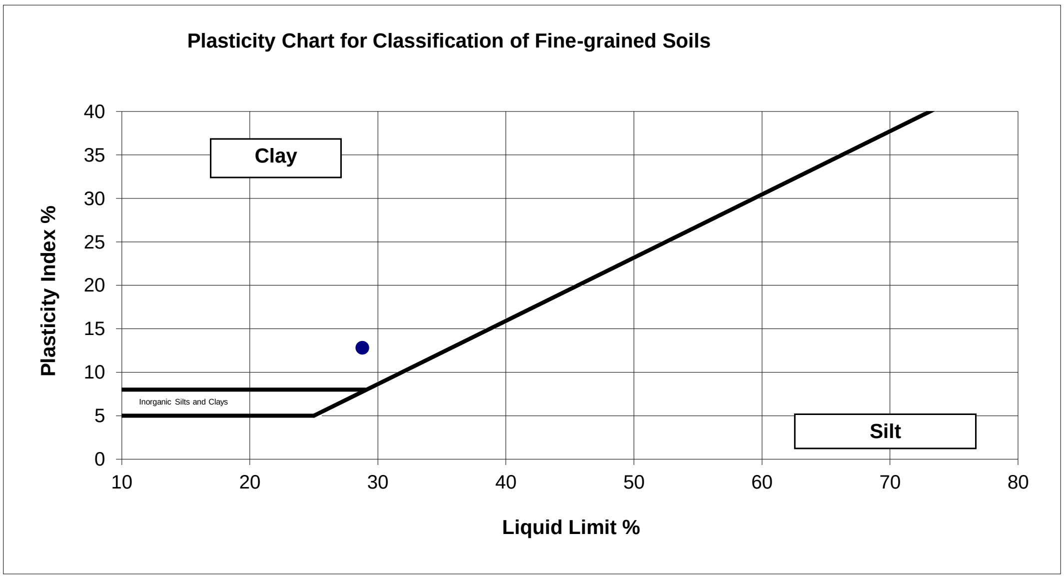
Client:	Jacobs	**Source:**	BH5 1.3-1.5m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	Sandy Silty CLAY with Gravel
Project:	Redfern Station Investigation (IA157700)	**Report No:**	S29378-PI
Job No:	S17470	**Lab No:**	S29378

Test Procedure:

- ☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Liquid Limit (%):	29	**Linear Shrinkage (%):**	5.5
Plastic Limit (%):	16	**Plastic Index:**	13



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

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SOIL CLASSIFICATION REPORT

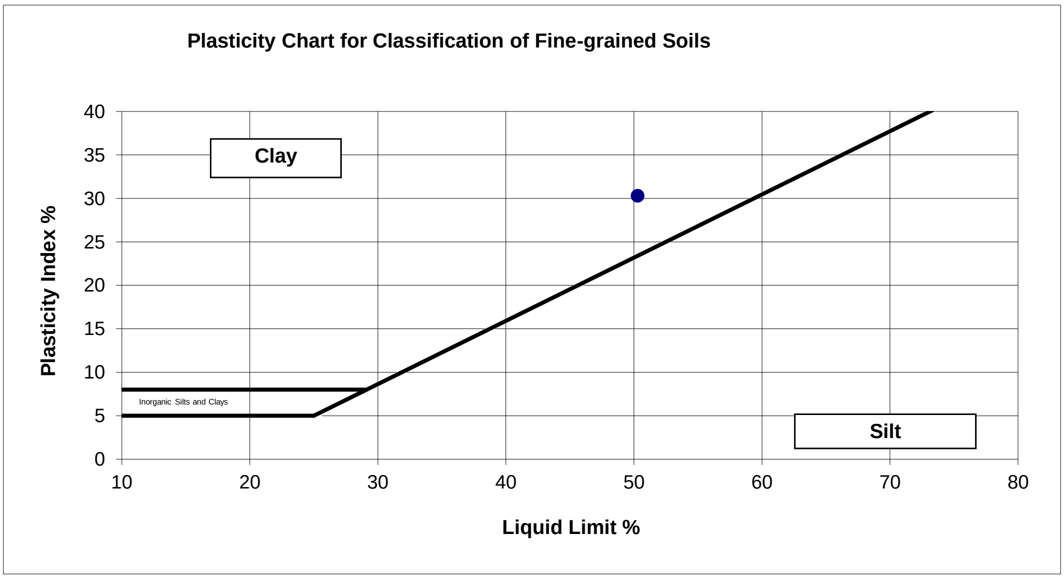
Client:	Jacobs	**Source:**	BH6 3.80-4.00m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	
Project:	Redfern Station Investigation (IA157700)	**Report No:**	S29112-PI
Job No:	S17470	**Lab No:**	S29112

Test Procedure:

- ☑ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Liquid Limit (%):	50	**Linear Shrinkage (%):**	10.0
Plastic Limit (%):	20	**Plastic Index:**	30



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

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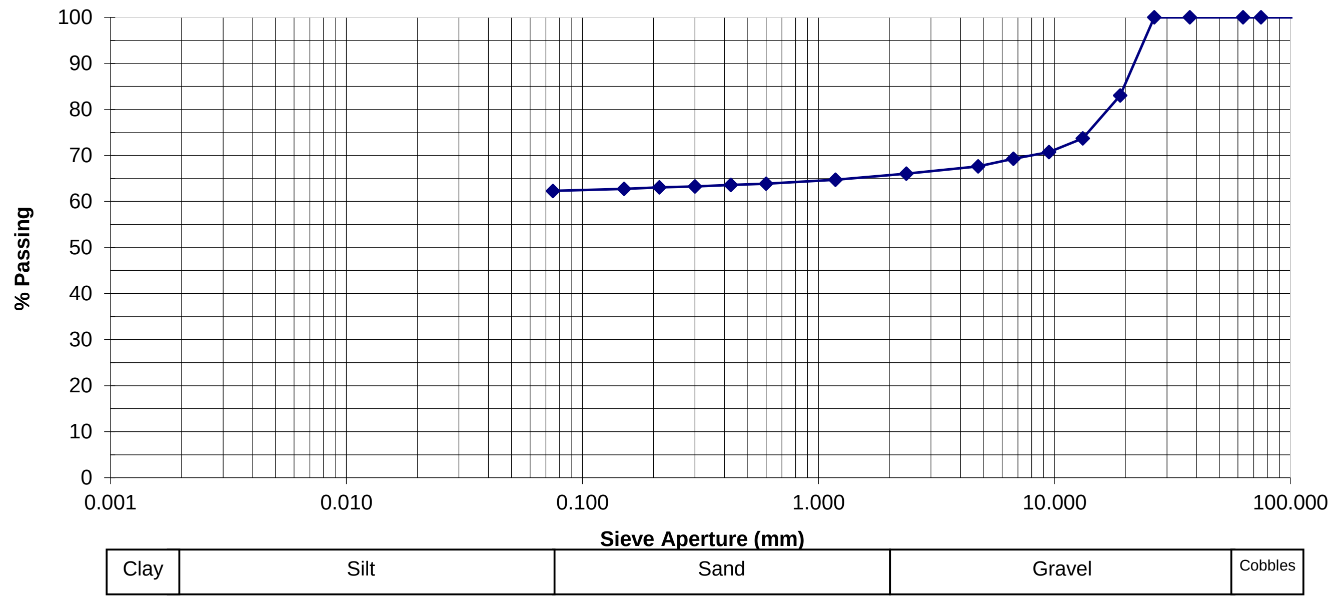
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Jacobs	**Source:**	BH1 4.1-4.3m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	Gravelly Silty CLAY
Project:	Redfern Station Investigation (IA157700)	**Report No.:**	S29264-PSD
Job No.:	S17470	**Lab No.:**	S29264

Test Procedure: ☑ AS1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling: Sampled by Client | Date Sampled: Unknown

Preparation: Prepared in accordance with the test method



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75	100		2.36	66	
63	100		1.18	65	
37.5	100		0.600	64	
26.5	100		0.425	64	
19	83		0.300	63	
13.2	74		0.212	63	
9.5	71		0.150	63	
6.7	69		0.075	62	

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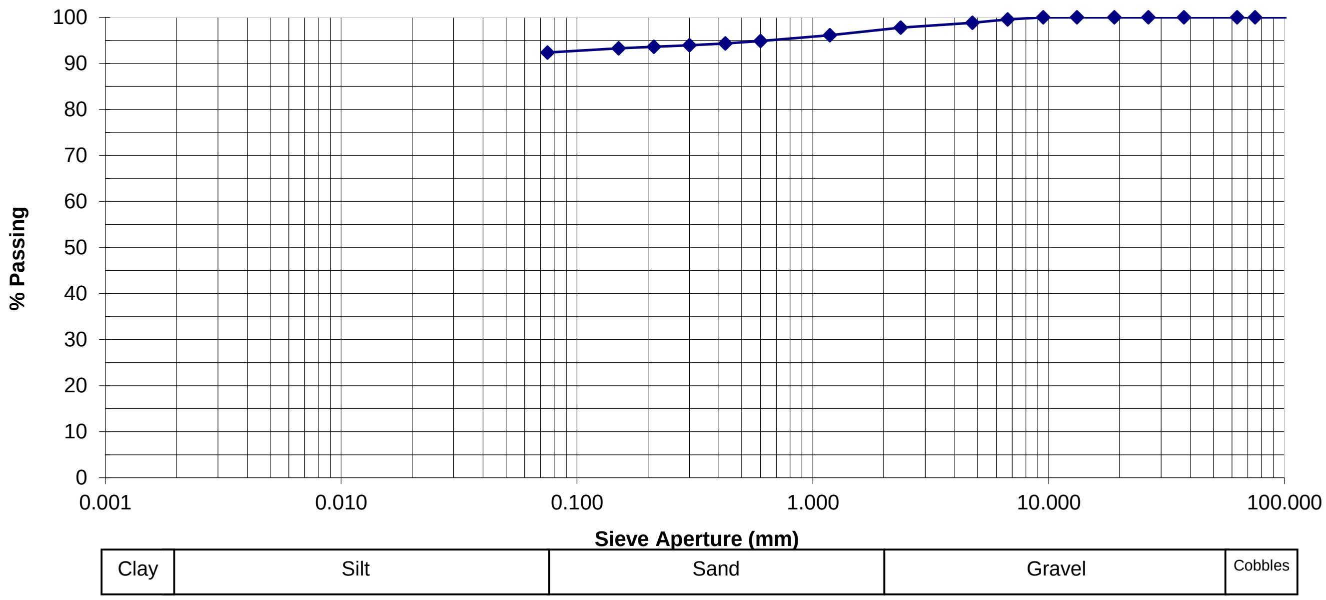
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Jacobs	**Source:**	BH2 4.5-4.8m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	Silty CLAY
Project:	Redfern Station Investigation (IA157700)	**Report No.:**	S29269-PSD
Job No.:	S17470	**Lab No.:**	S29269

Test Procedure: ☑ AS1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling: Sampled by Client | Date Sampled: Unknown

Preparation: Prepared in accordance with the test method



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75	100		2.36	98	
63	100		1.18	96	
37.5	100		0.600	95	
26.5	100		0.425	94	
19	100		0.300	94	
13.2	100		0.212	94	
9.5	100		0.150	93	
6.7	100		0.075	92	

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Authorised Signatory:

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28/11/2017

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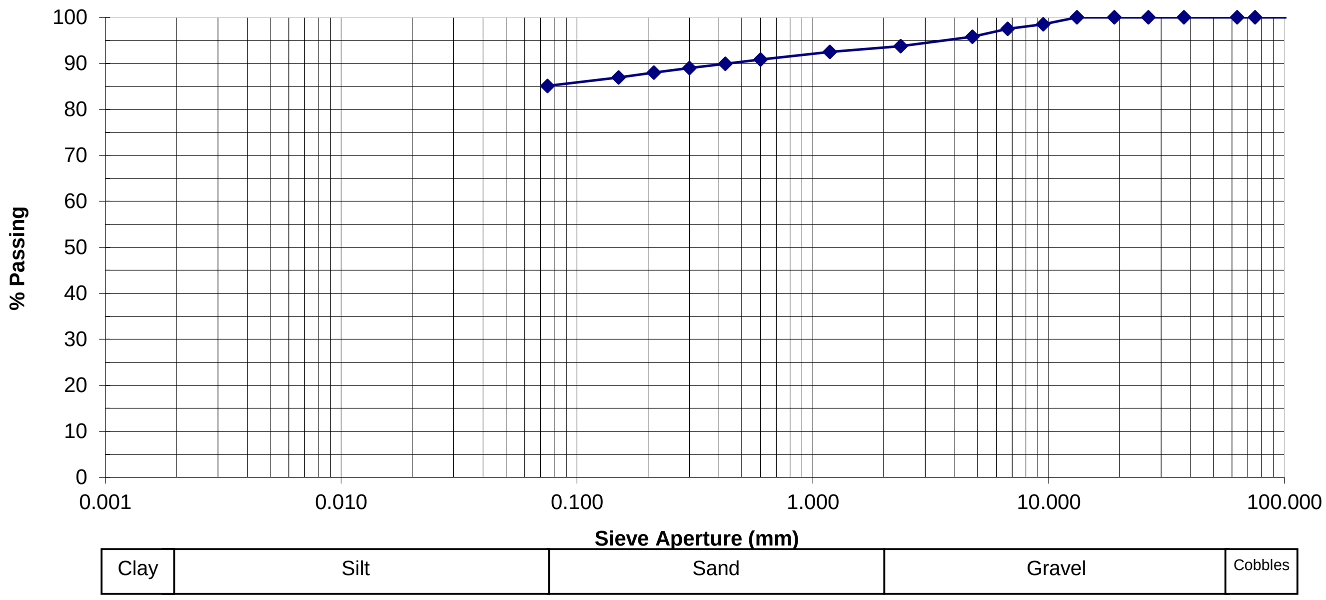
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Jacobs	**Source:**	BH3 3.0-3.45m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	Silty CLAY
Project:	Redfern Station Investigation (IA157700)	**Report No.:**	S29273-PSD
Job No.:	S17470	**Lab No.:**	S29273

Test Procedure: ☑ AS1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling: Sampled by Client | Date Sampled: Unknown

Preparation: Prepared in accordance with the test method



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200	100		4.75	96	
75	100		2.36	94	
63	100		1.18	92	
37.5	100		0.600	91	
26.5	100		0.425	90	
19	100		0.300	89	
13.2	100		0.212	88	
9.5	98		0.150	87	
6.7	98		0.075	85	

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Date: 28/11/2017

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Alexandria NSW 2015

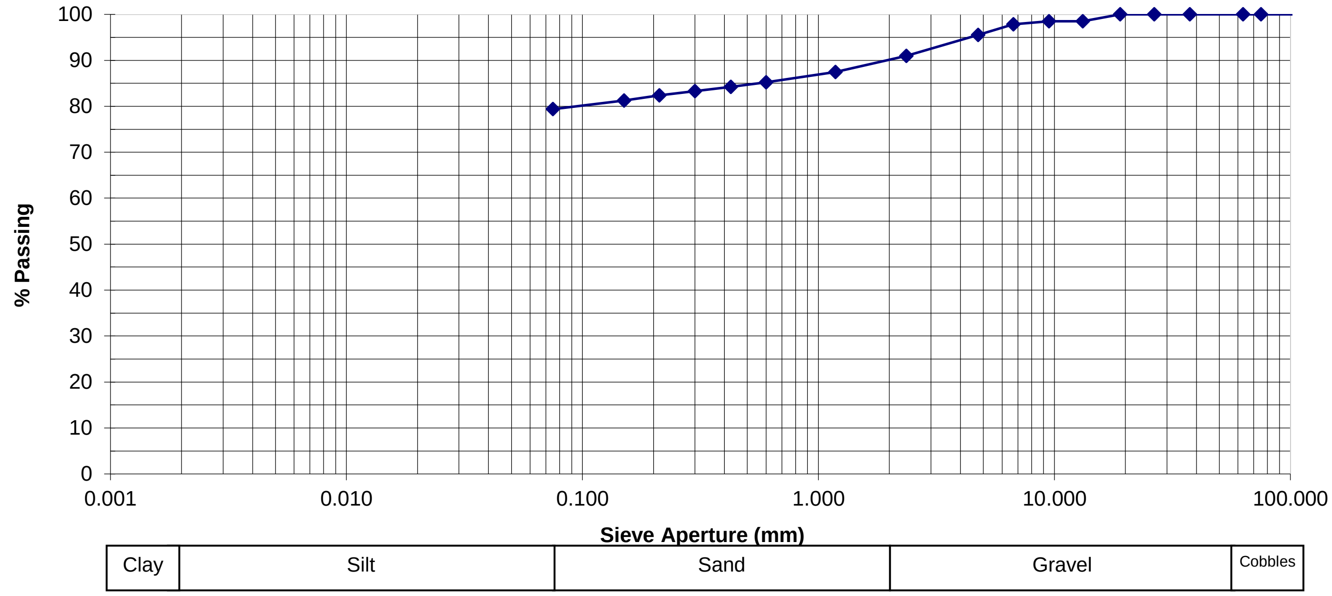
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Jacobs	**Source:**	BH4 2.70-3.15m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	Silty CLAY trace of Sand
Project:	Redfern Station Investigation (IA157700)	**Report No.:**	S29119-PSD
Job No.:	S17470	**Lab No.:**	S29119

Test Procedure: ☑ AS1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling: Sampled by Client | Date Sampled: Unknown

Preparation: Prepared in accordance with the test method



Sieve Apperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
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75	100		2.36	91	
63	100		1.18	87	
37.5	100		0.600	85	
26.5	100		0.425	84	
19	100		0.300	83	
13.2	98		0.212	82	
9.5	98		0.150	81	
6.7	98		0.075	79	

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Alexandria NSW 2015

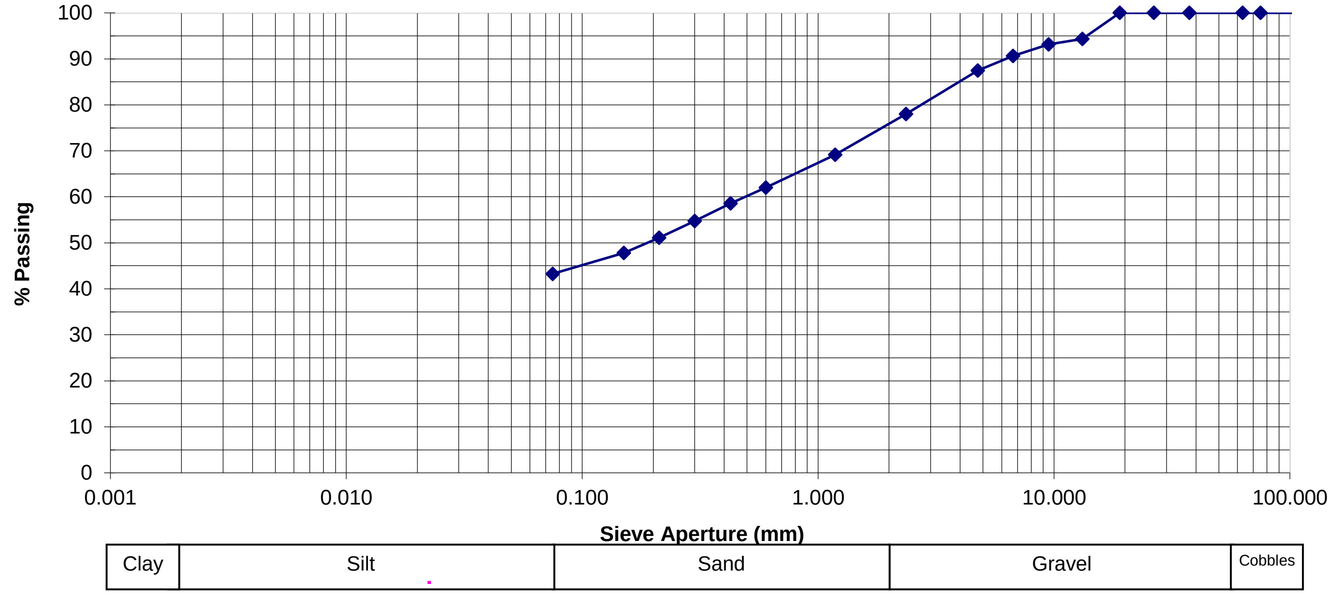
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Jacobs	**Source:**	BH5 1.3-1.5m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	Sandy Silty CLAY with Gravel
Project:	Redfern Station Investigation (IA157700)	**Report No.:**	S29378-PSD
Job No.:	S17470	**Lab No.:**	S29378

Test Procedure: ☑ AS1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling: Sampled by Client | Date Sampled: Unknown

Preparation: Prepared in accordance with the test method



Sieve Apperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
200	100		4.75	87	
75	100		2.36	78	
63	100		1.18	69	
37.5	100		0.600	62	
26.5	100		0.425	59	
19	100		0.300	55	
13.2	94		0.212	51	
9.5	93		0.150	48	
6.7	91		0.075	43	

NATA

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

6/12/2017

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
U8 10 Bradford Street
Alexandria NSW 2015

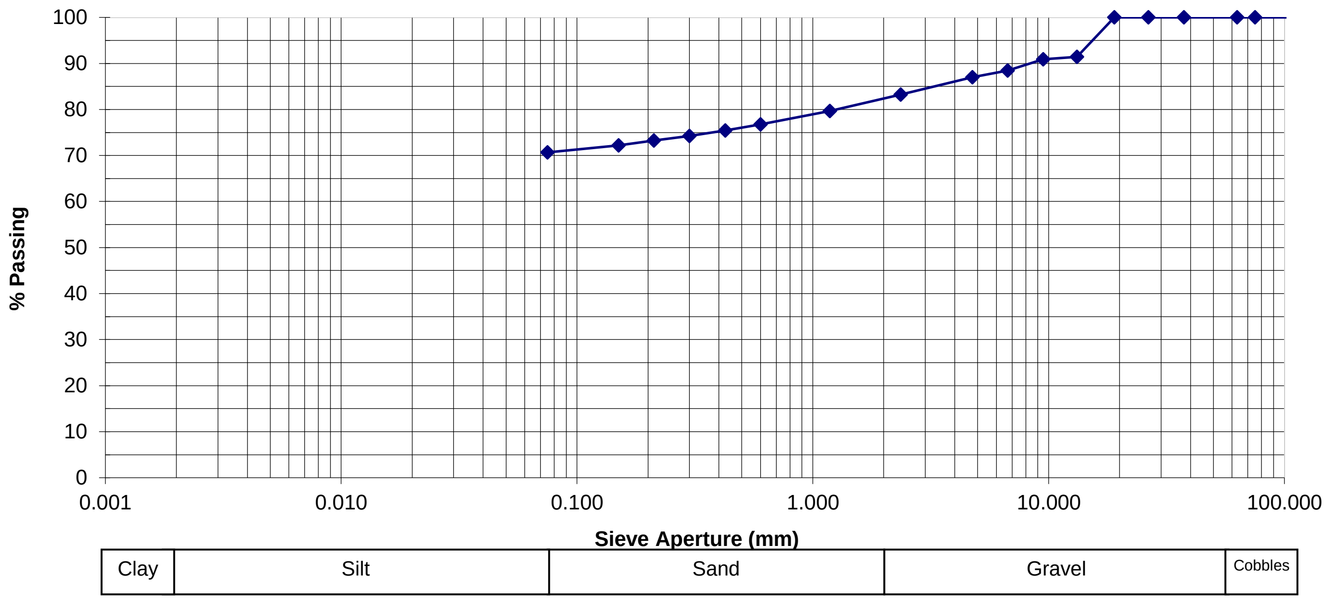
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Jacobs	**Source:**	BH6 2.50-2.95m
Address:	100 Christie Street, St Leonards NSW 2065	**Sample Description:**	Silty CLAY with Gravel and Sand
Project:	Redfern Station Investigation (IA157700)	**Report No.:**	S29111-PSD
Job No.:	S17470	**Lab No.:**	S29111

Test Procedure: ☑ AS1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving

Sampling: Sampled by Client | Date Sampled: Unknown

Preparation: Prepared in accordance with the test method



Sieve Apperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
200	100		4.75	87	
75	100		2.36	83	
63	100		1.18	80	
37.5	100		0.600	77	
26.5	100		0.425	75	
19	100		0.300	74	
13.2	91		0.212	73	
9.5	91		0.150	72	
6.7	88		0.075	71	

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Authorised Signatory:

Chris Lloyd

22/11/2017

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
U8 10 Bradford Street
Alexandria NSW 2015

POINT LOAD STRENGTH INDEX REPORT

Client:	Jacobs	**Moisture Content Condition:**	As received
Address:	100 Christie Street, St Leonards NSW 2065	**Storage History:**	Core box
Project:	Redfern Station Investigation (IA157700)	**Report No:**	S29265-PL
Job No:	S17470	**Date Tested:**	23/11/2017

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S29265	BH1 6.50-6.58m	Sandstone	Diametral	-	46.0	0.12	0.06	0.05	1
			Axial	48.8	17.0	0.16	0.15	0.12	1
S29266	BH1 7.94-7.99m	Sandstone	Diametral	-	47.0	0.03	0.01	0.01	1
			Axial	50.4	17.0	0.10	0.09	0.07	1
S29267	BH1 8.52-8.60m	Sandstone	Diametral	-	47.0	0.07	0.03	0.03	1
			Axial	50.4	19.0	0.13	0.10	0.09	1
S29268	BH1 9.00-9.07m	Sandstone	Diametral	-	48.0	0.10	0.04	0.04	1
			Axial	50.3	25.0	0.15	0.09	0.08	1
S29270	BH2 6.92-6.98m	Sandstone	Diametral	-	47.0	0.11	0.05	0.05	1
			Axial	51.3	21.0	0.09	0.06	0.05	1
S29271	BH2 7.92-7.98m	Sandstone	Diametral	-	46.0	0.03	0.01	0.01	1
			Axial	51.1	13.0	0.11	0.12	0.10	1
S29272	BH2 8.42-8.49m	Sandstone	Diametral	-	49.0	0.09	0.04	0.04	1
			Axial	51.3	23.0	0.16	0.11	0.09	1
S29274	BH3 7.33-7.39m	Sandstone	Diametral	-	46.0	0.01	0.00	0.00	1
			Axial	54.0	27.0	0.03	0.01	0.01	1
S29275	BH3 8.87-8.94m	Sandstone	Diametral	-	48.0	0.01	0.00	0.00	1
			Axial	53.2	23.0	0.08	0.05	0.04	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

NATA

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Authorised Signatory:

Chris Lloyd

23/11/2017

Date

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Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	Jacobs	**Moisture Content Condition:**	As received
Address:	100 Christie Street, St Leonards NSW 2065	**Storage History:**	Core boxes
Project:	Redfern Station Investigation (IA157700)	**Report No:**	S29380-PL
Job No:	S17470	**Date Tested:**	30/11/2017

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S29380	BH5 3.92-3.99m	Siltstone	Diametral	-	47.0	0.02	0.01	0.01	1
			Axial	49.8	25.0	0.40	0.25	0.23	1
S29381	BH5 5.87-5.93m	Siltstone	Diametral	-	49.0	0.76	0.32	0.31	1
			Axial	51.4	19.0	1.49	1.20	1.02	1
S29382	BH5 6.32-6.36m	Siltstone	Diametral	-	48.0	0.04	0.02	0.02	1
			Axial	51.2	9.0	0.22	0.37	0.26	1
S29383	BH5 7.90-7.98m	Siltstone	Diametral	-	49.0	0.19	0.08	0.08	1
			Axial	51.5	13.0	0.21	0.24	0.19	1
S29384	BH5 8.93-8.99m	Siltstone	Diametral	-	49.0	0.64	0.27	0.26	1
			Axial	51.4	20.0	3.16	2.41	2.09	1
S29385	BH5 9.48-9.56m	Siltstone	Diametral	-	49.0	0.63	0.26	0.26	1
			Axial	51.5	26.0	4.17	2.45	2.24	1
S29386	BH5 10.31-10.39m	Siltstone	Diametral	-	49.0	0.62	0.26	0.25	1
			Axial	51.6	24.0	1.76	1.11	1.00	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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Authorised Signatory:

Chris Lloyd

30/11/2017

Date

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Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	Jacobs	**Moisture Content Condition:**	As Received
Address:	100 Christie Street, St Leonards NSW 2065	**Storage History:**	Core Boxes
Project:	Redfern Station Investigation (IA157700)	**Report No:**	S29113-PL
Job No:	S17470	**Date Tested:**	17/11/2017

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S29113	BH6 5.88-5.96m	Siltstone	Diametral	-	48.0	0.63	0.27	0.27	1
			Axial	52.0	40.0	0.93	0.35	0.36	4
S29114	BH6 6.9-7m	Siltstone	Diametral	-	48.0	1.05	0.46	0.45	1
			Axial	52.0	30.0	1.16	0.58	0.55	1
S29115	BH6 7.86-7.94m	Siltstone	Diametral	-	50.0	0.41	0.16	0.16	1
			Axial	52.0	40.0	1.13	0.43	0.43	4
S29116	BH6 8.92-9m	Siltstone	Diametral	-	50.0	1.50	0.60	0.60	1
			Axial	52.0	35.0	0.29	0.13	0.12	4
S29117	BH6 9.82-9.9m	Siltstone	Diametral	-	50.0	0.33	0.13	0.13	1
			Axial	52.0	31.0	2.12	1.03	0.99	1
S29120	BH4 4.9-4.98m	Siltstone	Diametral	-	48.0	0.23	0.10	0.10	1
			Axial	52.0	45.0	0.20	0.07	0.07	4
S29121	BH4 5.9-6m	Siltstone	Diametral	-	48.0	0.31	0.13	0.13	1
			Axial	52.0	42.0	0.17	0.06	0.06	4
S29122	BH4 6.9-7m	Siltstone	Diametral	-	51.0	0.01	0.00	0.00	1
			Axial	52.0	42.0	0.21	0.08	0.08	1
S29123	BH4 7.71-7.82m	Siltstone	Diametral	-	50.0	0.01	0.00	0.00	1
			Axial	52.0	48.0	0.34	0.11	0.11	4
S29124	BH4 8.68-8.77m	Siltstone	Diametral	-	50.0	0.27	0.11	0.11	1
			Axial	52.0	42.0	0.51	0.18	0.19	4

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/11/2017

Date

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Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	Jacobs	**Moisture Content Condition:**	As Received
Address:	100 Christie Street, St Leonards NSW 2065	**Storage History:**	Core Boxes
Project:	Redfern Station Investigation (IA157700)	**Report No:**	S29125-PL
Job No:	S17470	**Date Tested:**	17/11/2017

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S29125	BH4 9.83-9.95m	Siltstone	Diametral	-	50.0	0.51	0.20	0.20	1
			Axial	52.0	43.0	0.13	0.05	0.05	4
			Diametral						
			Axial						
			Diametral						
			Axial						
			Diametral						
			Axial						
			Diametral						
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			Axial						
			Diametral						
			Axial						
			Diametral						
			Axial						

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/11/2017

Date

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ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 179707-A

Client Details

Client	Jacobs Group (Australia) Pty Ltd
Attention	Michael Grasso, Scott Raynsford, Michael Stacey
Address	Level 7, 177 Pacific Highway, North Sydney, NSW, 2060

Sample Details

Your Reference	IA157700
Number of Samples	5 Soil
Date samples received	13/11/2017
Date completed instructions received	21/11/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	28/11/2017
Date of Issue	24/11/2017

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Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

David Springer, General Manager

Misc Inorg - Soil		
Our Reference		179707-A-3
Your Reference	UNITS	BH4 - 1.5
Date Sampled		11/11/2017
Type of sample		Soil
Date prepared	-	23/11/2017
Date analysed	-	23/11/2017
pH 1:5 soil:water	pH Units	5.3
Chloride, Cl 1:5 soil:water	mg/kg	10
Sulphate, SO4 1:5 soil:water	mg/kg	90
Resistivity in soil*	ohm m	130

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			23/11/2017	[NT]	[NT]	[NT]	[NT]	23/11/2017	[NT]
Date analysed	-			23/11/2017	[NT]	[NT]	[NT]	[NT]	23/11/2017	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	99	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	94	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	97	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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www.envirolab.com.au

CERTIFICATE OF ANALYSIS 180317

Client Details

Client	Jacobs Group (Australia) Pty Ltd
Attention	Michael Stacey
Address	Level 7, 177 Pacific Highway, North Sydney, NSW, 2060

Sample Details

Your Reference	**IA157700**
Number of Samples	13 Soil
Date samples received	21/11/2017
Date completed instructions received	21/11/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	28/11/2017
Date of Issue	28/11/2017

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Asbestos Approved By
Analysed by Asbestos Approved Identifier: Matt Tang
Authorised by Asbestos Approved Signatory: Paul Ching

Results Approved By
Dragana Tomas, Senior Chemist
Long Pham, Team Leader, Metals
Nick Sarlamis, Inorganics Supervisor
Paul Ching, Senior Analyst
Priya Samarawickrama, Senior Chemist
Steven Luong, Senior Chemist

Authorised By

David Springer, General Manager

Misc Inorg - Soil			
Our Reference		180317-9	180317-11
Your Reference	UNITS	BH3	BH2_STP
Depth		0.6-0.7	3.0
Date Sampled		18/11/2017	18/11/2017
Type of sample		Soil	Soil
Date prepared	-	24/11/2017	24/11/2017
Date analysed	-	24/11/2017	24/11/2017
pH 1:5 soil:water	pH Units	7.8	5.0
Chloride, Cl 1:5 soil:water	mg/kg	<10	20
Sulphate, SO4 1:5 soil:water	mg/kg	52	39
Resistivity	ohm m	110	240

Method ID	Methodology Summary
AS1289.3.6.3	Determination Particle Size Analysis using AS1289.3.6.3 and AS1289.3.6.1 and in house method INORG-107. Clay fraction at <2µm reported.
ASB-001	Asbestos ID - Qualitative identification of asbestos in bulk samples using Polarised Light Microscopy and Dispersion Staining Techniques including Synthetic Mineral Fibre and Organic Fibre as per Australian Standard 4964-2004.
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Inorg-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.
Metals-009	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's. Note, the Total +ve reported DDD+DDE+DDT PQL is reflective of the lowest individual PQL and is therefore simply a sum of the positive individually report DDD+DDE+DDT.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD. Note, the Total +ve PCBs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PCBs" is simply a sum of the positive individual PCBs.

Method ID	Methodology Summary
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013. For soil results:- 1. 'EQ PQL'values are assuming all contributing PAHs reported as <PQL are actually at the PQL. This is the most conservative approach and can give false positive TEQs given that PAHs that contribute to the TEQ calculation may not be present. 2. 'EQ zero'values are assuming all contributing PAHs reported as <PQL are zero. This is the least conservative approach and is more susceptible to false negative TEQs when PAHs that contribute to the TEQ calculation are present but below PQL. 3. 'EQ half PQL'values are assuming all contributing PAHs reported as <PQL are half the stipulated PQL. Hence a mid-point between the most and least conservative approaches above. Note, the Total +ve PAHs PQL is reflective of the lowest individual PQL and is therefore "Total +ve PAHs" is simply a sum of the positive individual PAHs.
Org-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date prepared	-			24/11/2017	[NT]	[NT]	[NT]	[NT]	24/11/2017	[NT]
Date analysed	-			24/11/2017	[NT]	[NT]	[NT]	[NT]	24/11/2017	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	99	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	107	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	109	[NT]
Resistivity	ohm m	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

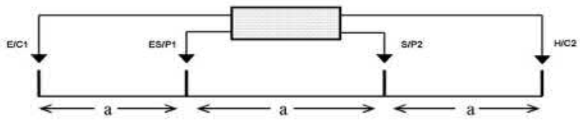
Appendix E. Soil resistivity information

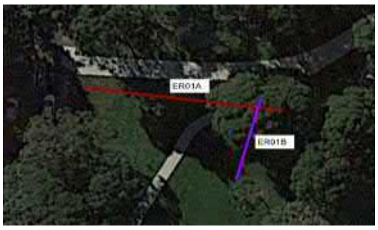
Project:	Redfern Station Investigation	Project Number:	IA157700
Location:	Gibbons Street Reserve	GPS Coordinates:	333450.00 m E
Method:	Wenner 4 Electrode Method		6248245.00 m S
Test personnel:	1. Michael Grasso		
	2. Owen Cooke		

Test date: 9/11/17

Test Equipment: 1 Megger DET4TCR2 — Calibration Exp: 2018

Calculations: Apparent Resistivity r (Ω.m) = 2 * π * a (m) * R(Ω)



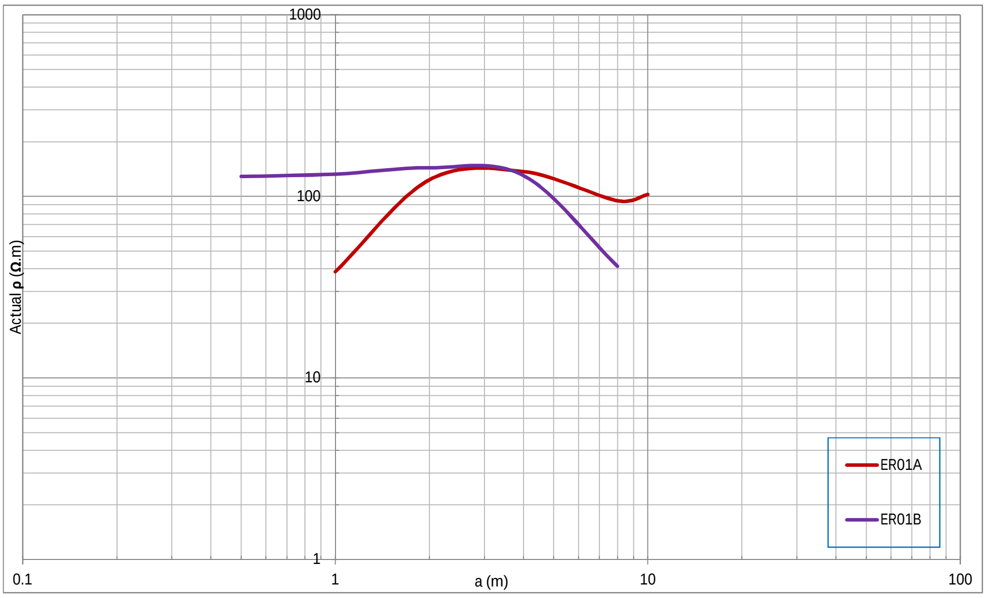


Test results:

a(m)	2πa (m)	Target Probe Depth (cm)	ER01A		ER01B	
			Measured R(Ω)	Actual ρ (Ω.m)	Measured R(Ω)	Actual ρ (Ω.m)
20	126	50	-	-	-	-
10	63	50	1.63	102	-	-
8	50	40	1.88	94	0.82	41
4	25	20	5.45	137	5.18	130
2	13	10	9.81	123	11.44	144
1	6	5	6.11	38	21.1	133
0.5	3	5	Error	-	40.9	128

Site conditions:

		Details
Temperature		21 °C deg
Weather on day		Sunny Clear
Weather week		Clear/ Showers
Grid diagonal (m)		

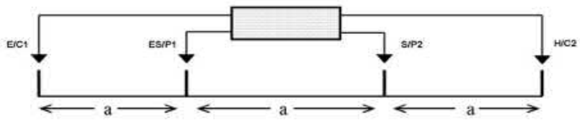


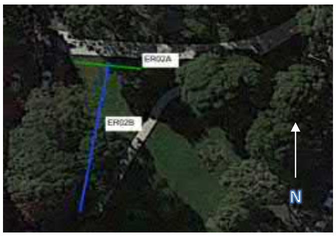
Project:	Redfern Station Investigation	Project Number:	IA157700
Location:	Gibbons Street Reserve	GPS Coordinates:	333430.00 m E
Method:	Wenner 4 Electrode Method		6248248.00 m S
Test personnel:	1. Michael Grasso		
	2. Owen Cooke		

Test date: 9/11/17

Test Equipment: 1 Megger DET4TCR2 — Calibration Exp: 2018

Calculations: Apparent Resistivity r (Ω.m) = 2 * π * a (m) * R(Ω)





Test results:

a(m)	2πa (m)	Target Probe Depth (cm)	ER02A		ER02B	
			Measured R(Ω)	Actual ρ (Ω.m)	Measured R(Ω)	Actual ρ (Ω.m)
20	126	50	-	-	-	-
10	63	50	-	-	2.66	167
8	50	40	-	-	4.14	208
4	25	20	9	226	10.17	256
2	13	10	10	126	16	201
1	6	5	12	75	26	163
0.5	3	5	43.4	136	45.8	144

Site conditions:

		Details
Temperature		21 °C deg
Weather on day		Sunny Clear
Weather week		Clear/ Showers
Grid diagonal (m)