



REPORT

Proposed Gran Central Development

Geotechnical and Hydrogeological Investigation Report

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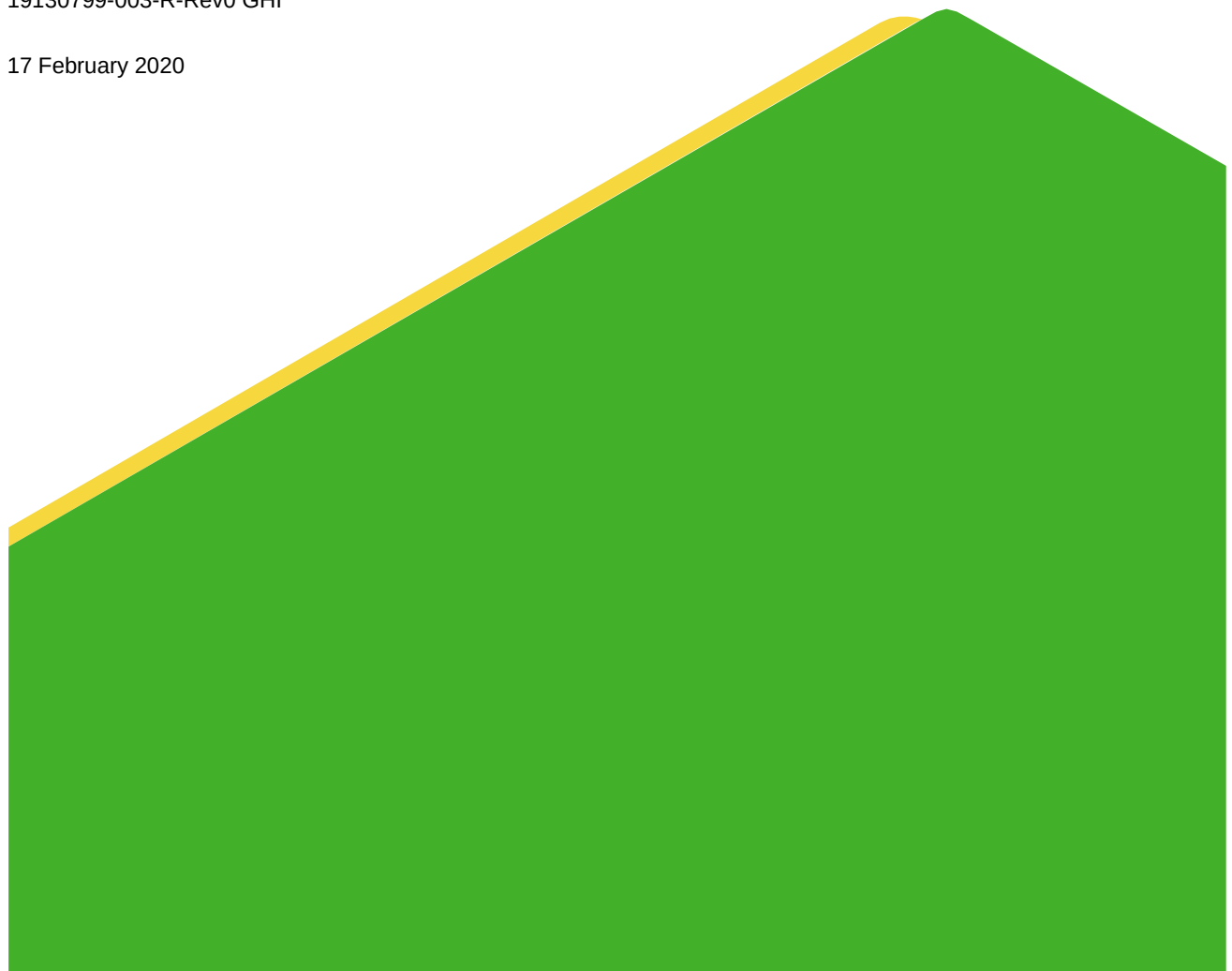
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1.0 INTRODUCTION

This report presents the results of geotechnical investigations conducted by Golder Associates Pty Ltd (Golder) for the proposed Gran Central building development. The project is located at 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.

The work was authorised by Property Development Solutions Pty Ltd (PDS Group), on behalf of Starryland NSW Pty Ltd (Starryland).

The works were carried out in two stages to develop a progressive understanding of ground and groundwater conditions across the site and to provide sufficient information to allow design to develop. The two stages were carried out as follows:

- Stage 1 (preliminary geotechnical investigations) were conducted in accordance with our proposal P19122955-001-P-Rev0, dated 8 May 2019. The email authorisation to proceed was received on 28 June 2019 and the fieldworks were carried out between 29th July 2019 and 2nd August 2019.

A Preliminary Geotechnical Investigation (PGI) report (19122955-001-R-Rev1 PGI, dated 1 November 2019) was issued. The PGI report provided a general understanding of the site conditions, ground engineering risks and preliminary parameters for design development.

A meeting between Starryland, PDS, Meinhardt (the structural engineers) and Golder was held on 10 September 2019 to discuss the findings of the PGI and to develop a plan for targeted future investigations.

- Stage 2 (Geotechnical and Hydrogeological Investigation, GHI) works were proposed based on the outcomes of the meeting discussed above and were presented in our proposal P19122955-004-P-Rev0, dated 23 September 2019. The email authorisation to proceed was received on 23 October 2019.

The main objectives of the Stage 2 works were to:

- Better understanding of the in-situ properties of the bedrock and the material near the proposed bulk excavation level to refine the footing design;
- Better understanding of the groundwater inflow volumes, existing groundwater flow direction, water quality for potential trade waste agreements;
- Further defining the extent of contamination on the site and providing information which can be incorporated into a Phase 2 investigation and a waste classification assessment for accessible areas of the site.

This current GHI report presents the outcomes of both Stages of work and as such, is an updated revision of the PGI.

Coincident with the PGI, soil, rock and water samples were collected and tests performed to develop an understanding of the risks associated with the potential presence of contaminated soil and groundwater across the site. A preliminary environmental investigation report (19122955-002-R, dated 1 November 2019) was separately issued.

Additional samples were retrieved during the Stage 2 works to inform the contaminated soil and groundwater assessment. A preliminary waste classification report and a soil vapour technical memorandum will be prepared separately to this GHI report.

1.1 Project Understanding

The following documents have been supplied by PDS Group and were used to assist with the preparation of this GHI report:

- Architectural drawings prepared by PDB Architects – Project No 1838, Issue A, dated 29 October 2019; and
- Detailed Survey Plan by LTS Lockley – Drawing No 50705 001DT, Sheet 1&2 of 2, dated 14 June 2019. The datum is in Australian Height Datum (AHD).

Based on the architectural drawings listed above, Golder understands that the proposed development involves the demolition of existing site structures and construction of a multi-tower mixed-used building up to 24 levels high and over a common single-level basement car park. The proposed walls of the basement are setback from the site boundaries and infrastructure, as follows:

- 6.0 m to the northern site boundary (bounded by Parramatta Road).
- 6.5 m to the eastern site boundary (bounded by Good Street).
- 7.5 m to the eastern portion of the southern site boundary (bounded Cowper Street).
- 0 - 1 m to the western portion of the southern site boundary (bounded by Cowper Street).
- 7.5 m to the southern portion of the western site boundary (bounded by an existing multi-storey mixed-use development with a single level basement).
- 0 m to the northern portion of the western site boundary (bounded by an existing service station, which has a number of underground storage tanks).

The proposed single basement has a Finished Floor Level (FFL) of RL 8.0 m AHD. To achieve this, a Bulk Excavation Level (BEL) of RL 7.8 m is assumed, which will allow for the construction of the basement floor slabs. This will require excavations to depths ranging from 3.0 m to 5.0 m Below Existing Ground Levels (BEGL). Locally deeper excavations may be required for footings, lift shafts, crane pads and service trenches.

However, based on the email correspondence between Mr Sean Gilchrist of PDS and Mr Ben Caruana of Golder, we understand that a two level basement is also being considered. This report also provides preliminary advice if the second basement level is adopted. A FFL of RL 4.0 m has been assumed for the second basement level with a BEL of RL 3.8 m. This will require excavations to depths ranging from 7.0 m to 9.0 m BEGL. Locally deeper excavations may be required for footings, lift shafts, crane pads and service trenches.

1.2 Aim and Scope of Work

The primary aim of this report is to provide an assessment of geotechnical conditions across the site to inform design for the mixed-use development.

The report includes the following:

- A summary of expected ground conditions, including thickness and composition of fill, soils and rock.
- Assessment of foundation and retention wall options for both drained and tanked basement options.
- Advice on geotechnical design parameters, including piles and shallow footings, retention design parameters, pavement subgrade parameters and footing settlement characteristics.
- Advice and recommendations on possible groundwater inflows, both during and following construction. This includes an assessment of groundwater quality and comments in relation to disposal options.

- Comment on possible constructability issues such as excavation stability, groundwater management and site trafficability.
- Assessment and recommendations for further testing and/or monitoring (i.e. movement and groundwater) requirements.

2.0 DESKTOP STUDY

The following documents and information were used for the desktop study:

- Department of Mineral Resources Geological Map Sydney 1:100,000 Geological Series Sheet 9130 (DMR 1983); and
- Groundwater monitoring state overview¹ (Water NSW)
- Soil Landscape Maps from eSPADE² (NSW Office of Environment and Heritage)
- Six maps³ (NSW)
- Detailed Survey Plan by LTS Lockley – Drawing No 50705 001DT, Sheet 1&2 of 2, dated 14 June 2019. The datum is in Australian Height Datum (AHD).

2.1 Site Terrain

The site is approximately 5,150 m² based on the provided survey map. The site is located on the southern side of Parramatta Road across gently (about 0 – 5 degrees) declining topography to the north based on the six maps and the provided survey plan. The site levels range from about RL 13m, towards the south-western corner to RL 10.3 m, towards the north-eastern corner of the site.

2.2 Regional Geology

Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Sydney 1:100,000 Geological Series Sheet 9130 (DMR 1983) indicates the site is underlain by Ashfield Shale (Rwa). The Ashfield Shale is Triassic aged and from the Wianamatta Group of rocks and forms the ridge capping over Hawkesbury Sandstone bedrock within this part of Sydney. The Ashfield Shale geological unit generally comprises an interbedded sequence of shale and laminite which are prone to deep weathering at the surface to clays of medium to high plasticity.

The Geological Map indicates the presence of a known dyke, located to the south-west of the site. The dyke is shown to project in a south-west to north-east orientation and feasibly crosses the site. Dykes in Sydney are typically doleritic, dip steeply and can comprise of materials of variable strength, weathering and fracturing, often presenting as clayey soils near ground surface and improving to high to very high strength rock with depth. The dykes are usually only a few meters wide, however can act as a barrier to groundwater flow (i.e. an aquitard).

2.3 Rainfall

The climate of Sydney is humid subtropical. Rainfall is fairly evenly spread through the year, with moderate to low variability. Precipitation is slightly higher during the first half of the year and lower in the second half. Due to the unpredictability of rain, the wettest and driest months would change in a yearly basis. Based on the Bureau of Meteorology, the selected rainfall station is Parramatta North (Masons Drive) (about 4.4 km away from the site). The rainfall data is available from 1965 until present. A summary of the rainfall data is summarized in Figure 1

¹ <https://realtimedata.watarnsw.com.au/water.stm>

² <https://www.environment.nsw.gov.au/eSpade2WebApp>

³ <https://maps.six.nsw.gov.au/>

Based on recorded data, we note that 2019 was particularly dry compared with historical averages, especially at the time of the investigation, July – August (Stage 1) and November – December (Stage 2).

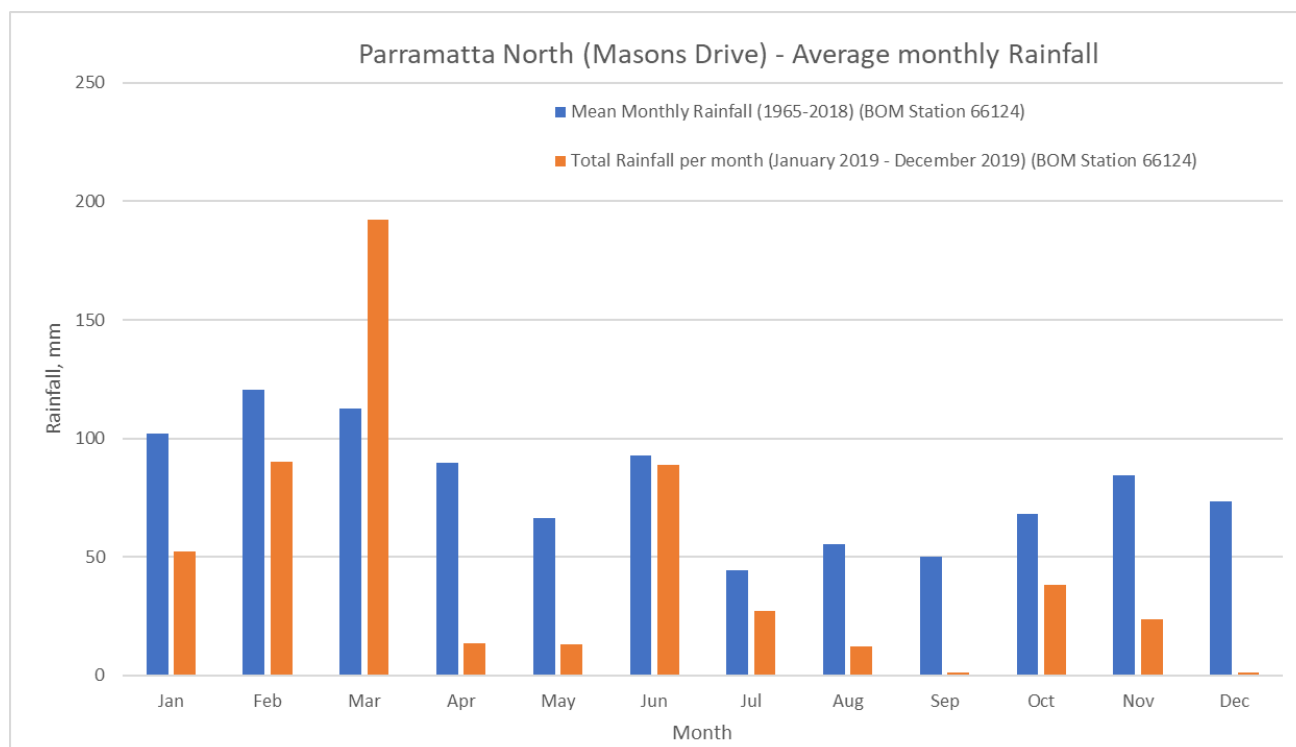


Figure 1: Rainfall Data from BOM at Parramatta North (Masons Drive) (1965-2019)

2.4 Groundwater

There is no published groundwater monitoring data in the vicinity of the site. The nearest creeks, A'becketts Creek and Duck Creek are located more than 380 m away to the north and east from the site respectively.

3.0 SCOPE OF WORKS AND METHODOLOGY

The scope of works for both Stages 1 and 2 of the Geotechnical and Hydrogeological Investigation includes:

- Preparation of a Health and Safety Environment Plan (HaSEP).
- Review of relevant geological maps for the project area.
- Electro-magnetic scanning of proposed borehole locations for buried conductive services using a licensed service locator with reference to Dial Before You Dig (DBYD) plans.
- Non-destructive drilling using hand augers at all borehole locations (four borehole locations during Stage 1 and eight borehole locations during Stage 2 investigations). The existing ground surface levels shown on the borehole logs were approximated from the spot levels shown on the supplied survey plans. Approximate borehole locations are shown on the attached Map (**APPENDIX A**).
- Auger drilling of ten boreholes (four boreholes during Stage 1 and six boreholes during Stage 2 investigations) with a track-mounted drill rig using solid flight augers equipped with a 'Tungsten-Carbide' (T-C) bit
 - Standard Penetration Testing (SPT) was carried out (as per AS1289.6.3.1 – 2004) during auger drilling of the boreholes to assess soil in-situ strength. Soil samples were sent to Macquarie Geotech Pty Ltd and SGS Sydney Pty Ltd, which are the National Australian Testing Authority (NATA) accredited laboratories, for testing and storage.
 - The strength of the weathered rock in the augered sections of the boreholes was assessed by observation of the penetration resistance, examination of the recovered rock cuttings and the SPT readings.
- Continuation of seven of the boreholes (four boreholes during Stage 1 and three boreholes during Stage 2 investigations) using NMLC diamond coring techniques to the target depths.
 - Rock cores recovered from the boreholes were boxed, logged, photographed. Borehole logs and core photographs are provided in **APPENDIX B**. Rock core samples were sent to Macquarie Geotech Pty Ltd for testing and storage.
 - Point Load Strength Index testing (PLT) was carried out (as per AS4133.4.1 - 2007) by a Golder engineer, to assess the intact strength of the recovered rock. The test results are presented on the borehole logs in **APPENDIX B**.
 - Pressuremeter Testing (PMT) was carried out (as per ASTM 4719 – 00) after completion of coring of the Stage 2 boreholes to assess the in-situ stiffness of the clay/bedrock. The test results are presented in **APPENDIX C**.
- Following the completion of the boreholes:
 - Five of the cored boreholes (one borehole during Stage 1 and four boreholes during Stage 2 investigations) were converted to groundwater monitoring wells, the construction details for the wells are provided in **APPENDIX B**.
 - Two shallow boreholes were converted to soil vapour wells during Stage 2 investigations.
 - The remaining boreholes were backfilled with grout to existing ground surface level.

- All boreholes were monitored for possible groundwater seepage during and shortly after completion of auger drilling. Four data loggers were installed within the BH01M, BH101, BH102 and BH102a to provide groundwater level fluctuations.
- Four slug tests within monitoring wells were carried out about two weeks after the installation of the wells.
 - Permeability tests (hydraulic 'slug' tests) were carried out in all four monitoring wells to estimate the hydraulic conductivity of the formation.
- Laboratory geotechnical testing was conducted on selected soil/rock samples. This consisted of the following tests:
 - Two (2) Moisture Content (MC) tests on selected soil samples and twenty-two (22) tests on selected rock samples.
 - Two (2) Atterberg Limit tests.
 - Three (3) Aggressivity Suites of tests (i.e. pH, sulfate, chlorides and Electrical Conductivity).
 - One (1) Shrink Swell Index test on an undisturbed soil sample.
 - One (1) California Bearing Ratio (CBR) and Standard Maximum Dry Density (SMDD) test.
 - Eight (8) Uniaxial Compressive Strength (UCS) tests on selected rock samples.
 - Four (4) deformability tests were carried out during the uniaxial compression.

4.0 RESULTS OF THE SITE INVESTIGATIONS

4.1 Site Description

The area of the site is 5,147 m² based on the survey plan which was provided by PDS.

A site walkover was conducted prior to commencement of the intrusive works and the following observations were made:

- 26-30 Good Street: A single-storey commercial brick building with no basement occupied the eastern portion of the DP.
- 32 Good Street: The lot consists a single storey commercial rendered building (Holy Shop) located at the south eastern corner of the lot and a two-storey brick building (old fire station) without basement, located at the north-eastern corner of the lot. The buildings abutted each other.
- 59 Cowper Street: A single-storey weatherboard residential dwelling without basement occupied at the southern portion of the lot.
- 61 Cowper Street: Vacant yard with grass.
- 134 Parramatta Road and 38-44 Good street): Gravel paved car storage yard with a metal awning was located at the south-western corner of the site.
- 138 Parramatta Road: A one to two storey brick building without a basement (office furniture shop) occupied the northern portion of the lot. The façade of the building was classified as the heritage based on the provided information and there was a concrete paved car park located at the rear of the address. There were a few medium to large size trees located at the north-eastern corner of the lot.
- 142 Parramatta Road: The lot was paved with concrete and a metal demountable shed was located at the south-western corner of the lot.

4.1.1 Local Land Use

The site is situated within an area of mixed-use. Current uses on surrounding land at the time of our presence on-site are described in **Table 1** below.

Table 1: Summary of Local Land Use

Direction Relative to Site	Land Use Description
North	Parramatta Road (RMS Asset): A four-lane asphaltic-concrete road followed by few commercial brick/rendered developments. The minimum setback between the road kerb and site boundary is about 3 m, which is the approx. width of the footpath.
East	Good Street: A four-lane asphaltic-concrete road followed by few commercial brick/rendered developments. The minimum setback between the road kerb and site boundary is about 3 m, which is the approx. width of the footpath.
South	Cowper Street: A four-lane asphaltic-concrete road with kerb-side car parking, followed by a few commercial brick/rendered developments. The minimum setback between the road kerb and site boundary is about 3m, which is the approx. width of the footpath.
West	A multi-storey mixed-use development and a service station abutted the western site boundary: We understand that the multi-storey mixed-use building has a single level basement. A service station: the main building has a minimum setback of about 15m from the western site boundary. Underground storage tanks (OSD) was constructed adjacent to the northern portion of the western site boundary. The approx. depth of the OSD is assumed to be 3m below the existing ground level. A single-lane asphaltic-concrete road (runs in west-east direction) located to the west of the site, to provide access to the basement of the multi-storey building at the rear of the lot 12, DP 575064 (142 Parramatta Road).

4.2 Subsurface Investigation Results

A summary of the boreholes completed for the both preliminary and detailed investigation is provided in **Table 2**.

Table 2: Summary of Boreholes

Investigation Location		Coordinates ¹ (MGA56)		Surface Elevation ² (RL m)	Termination Depth (m BGL)	Termination Reason	Completion
		Easting	Northing				
Stage 1	BH01M	315964	6254865	10.8	10.1	Target Depth	Monitoring well
	BH02	315950	6254816	12.5	8.75		Backfilled
	BH03	315992	6254806	12.3	8.34		Backfilled
	BH04	316032	6254826	11.0	7.80		Backfilled
Stage 2	BH101	315995	6254810	12.5	13.52	Target Depth	Monitoring well
	BH101a	315994	6254810	12.5	3.29		Monitoring well
	BH102	316002	6254851	10.9	12.38		Monitoring well
	BH102a	316002	6254848	11.0	5.4		Monitoring well
	BH103	315965	6254811	12.5	13.6		Backfilled
	BH104	315965	6254854	10.75	1.65		Soil vapour wells
	BH105	315967	6254878	11.0	1.47		Soil vapour wells
	BH106	315952	6254812	12.8	1.49		Backfilled

¹ – Handheld GPS to Map Grid of Australia (MGA94 56), accuracy ± 5 m.

² – From spot levels shown on the supplied survey plan referenced in **Section 1.1**, accuracy ± 0.5 m.

Golder geotechnical engineers were present on-site to set out the borehole locations, direct the testing and sampling, log the subsurface conditions and record the groundwater levels.

The five cored boreholes (one borehole during Stage 1 and four boreholes during Stage 2 investigations) were converted to groundwater monitoring wells, the construction details for the wells are summarised in **Table 3** and provided in **APPENDIX B**. The monitoring wells were developed dry or a minimum of three times the well volume using a bailer after installation of the well.

Table 3: Summary of the Monitoring Well Constructions

Monitoring Well Nos.	Monitoring Well Depth / RL (m) / (mAHD)	Screen Depths (m)
BH01M	5.02 / 5.08	2.0 – 5.0
BH101	11.0 / 1.5	5.0 - 11.0
BH101a	3.0 / 9.5	0.7 - 3.0
BH102	12.38 / -1.48	7.38 - 12.38
BH102a	5.4 / 5.6	1.0 - 5.4

4.3 Groundwater

4.3.1 Groundwater Levels

Groundwater levels at the site were monitored between 20th November 2019 and 9th December 2019 using water-pressure transducers and electronic data loggers installed in the following groundwater monitoring wells:

- BH01 – a shallow monitoring well screened at the base of the weathered profile and top of relatively fresh Ashfield Shale
- BH101 – a deep monitoring well screened in extremely weathered to fresh Ashfield Shale
- BH102 – a deep monitoring well screened in moderately weathered to fresh Ashfield Shale, and
- BH102a - a shallow monitoring well screened across residual soil and into the top of the Ashfield Shale.

Attempts were made to install a logger in monitoring well BH101a (3 m deep well screened mostly in the weathered profile) both at the end of November 2019 and middle of December 2019 however this well was essentially dry; groundwater was observed in the sump of this well on both occasions however was thought to be remnant water from the drilling and well-installation process.

Groundwater levels at the site during the monitoring period are shown on Figure 2. Rainfall recorded at the nearby Bureau of Meteorology weather station at the Sydney Olympic Park (station No. 66212) during this period was as follows:

- 23 November 2019 – 3.8 mm
- 24 November 2019 – 1.6 mm
- 4 December 2019 – 0.2 mm

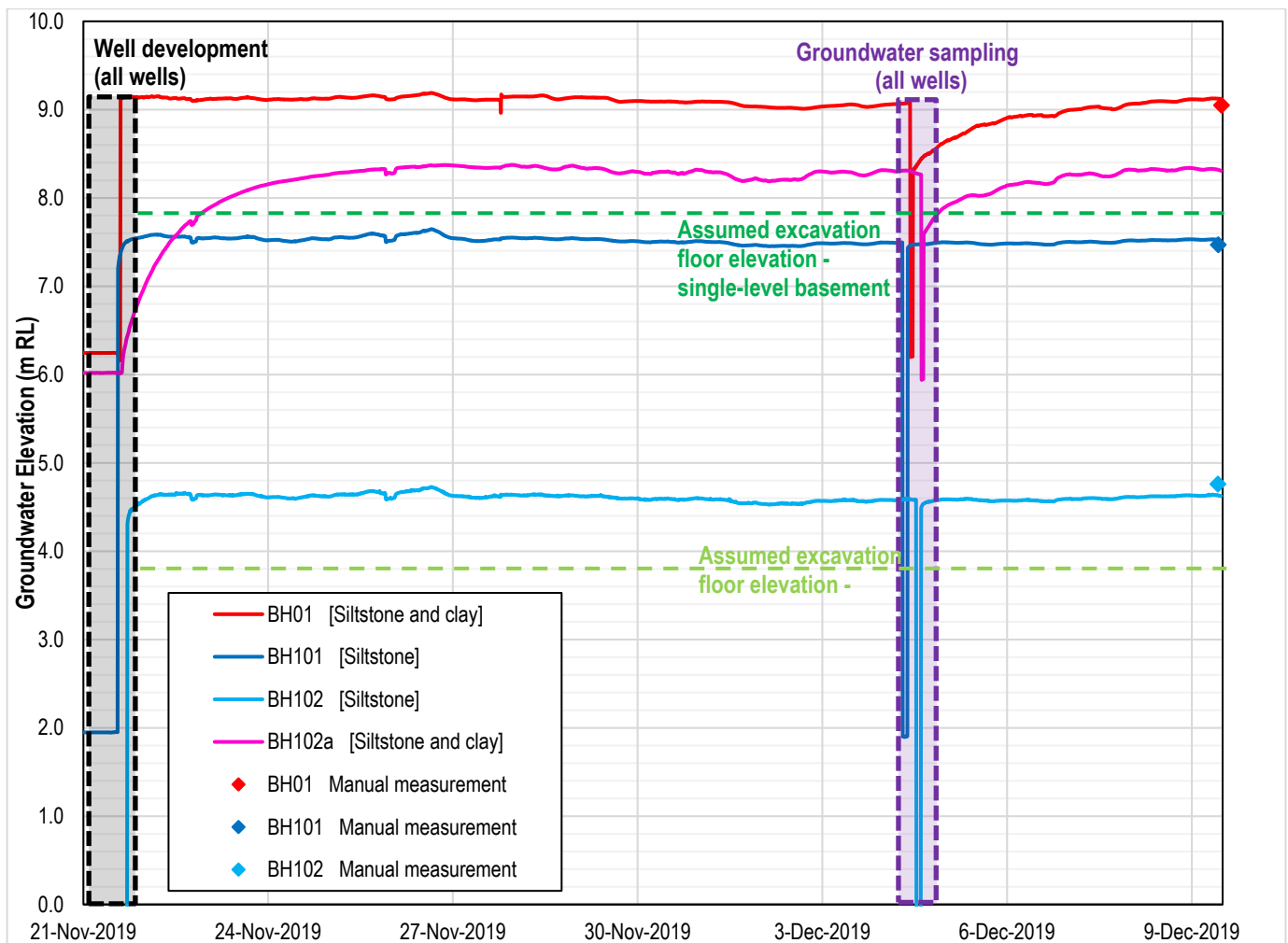


Figure 2: Groundwater levels (m RL) at the site between 20 November and 9 December 2019.

Groundwater levels shown in Figure 2 indicate:

- There are likely to be two water-bearing units at the site, namely:
 - i) the weathered profile of the Ashfield Shale, which forms either a shallow unconfined aquifer or a perched aquifer, and
 - ii) slightly-weathered to fresh (and fractured) Ashfield Shale, which forms an unconfined to semi-confined fractured-rock aquifer.
- Groundwater (including rainfall recharge) moves downward from and through the weathered profile into fresh Ashfield Shale beneath (i.e. downward hydraulic gradient).
- Groundwater in the Ashfield Shale is inferred to broadly flow in a general 'northerly' direction.

4.3.2 Permeability

Rising-head and falling-head ('slug') tests were carried out in each of the groundwater monitoring wells at the site to estimate the horizontal hydraulic conductivity (K_h) of the water-bearing units at the site.

Rising-head and falling-head tests were generally carried out as outlined below:

- An electronic water-pressure transducer and data logger was set to record groundwater levels (measured as water pressure above the reference point of these instruments) at five-second intervals or

less; higher logging frequencies were used for tests in those wells which recovered faster following development.

- The standing water level in the well was measured using an electronic water-level 'dipper' tape.
- The water-pressure transducer and data logger were installed inside the monitoring well on new stainless-steel cable and set two or more metres below the groundwater level in the well.
- Hydraulic testing using a weighted and close bailer (i.e. a 'slug') was then carried out:
 - For falling-head tests, the slug was quickly lowered into the well and below the initial elevation of the groundwater table. The test-induced head change in the well was then typically allowed to return (in this case 'fall') to about 90% or more of its pre-test elevation, with changes in the elevation of the test head monitored over time using the water-pressure transducer and data logger in the well.
 - For rising-head tests, which were carried out immediately following a falling-head test, the slug was quickly removed from the well and the induced head change typically allowed to return (in this case 'rise') to about 90% or more its pre-test elevation. Changes in the elevation of the test head were again monitored over time using the water-pressure transducer and data logger in the well.
- On completion of testing in each well the water-pressure transducer and data loggers were retrieved from the well and the data downloaded.

The permeability (in this case horizontal hydraulic conductivity) was estimated for the screened interval in each of the tested groundwater monitoring wells from the hydraulic 'slug' tests field data using the Bouwer and Rice (1976) method in the software *Aqtesolv™*. Estimates of hydraulic conductivity are presented in **Table 4** whilst copies of the *Aqtesolv™* output for each test are presented in APPENDIX D.

Table 4: Summary of In-situ Horizontal Hydraulic Conductivity Estimates

Monitoring Well	Test Interval Top (m bgl†)	Test Interval Base (m bgl)	Test Interval Thickness (m)	Test Interval Geology	Data Type	Horizontal Hydraulic Conductivity (m/sec‡)
BH01	1.5	5.0	3.5	Siltstone + Silty Clay	Recovery of groundwater post-sampling	3.2×10^{-9}
					Falling-head test 1	4.3×10^{-9}
BH101	4.8	11.0	6.2	Siltstone + Silty Clay	Falling-head test 1	3.1×10^{-6}
					Rising-head test 1	3.1×10^{-6}
					Falling-head test 2	4.2×10^{-6}
					Rising-head test 2	1.8×10^{-6}
BH102	6.1	12.4	6.3	Siltstone	Falling-head test 1	7.5×10^{-7}
					Rising-head test 1	8.0×10^{-7}
					Falling-head test 2	4.7×10^{-7}
BH102a	0.5	5.4	4.9	Siltstone + Silty Clay	Recovery of groundwater post-well development	2.1×10^{-8}
					Falling-head test 1	$<1 \times 10^{-9}$ §

Notes: † metres below ground level

‡ metres per second

^s recovery insufficient for estimation of hydraulic conductivity

The horizontal hydraulic conductivity values for those tests carried out in groundwater monitoring wells BH101 and BH102 are typically one to two-orders of magnitude higher than those guideline rock-mass hydraulic conductivity values for the Ashfield Shale presented in Table 8 of Pells et al. (2019). This highlights atypical groundwater conditions are likely to prevail at the site and result in higher-than-normal groundwater inflows to any free-draining excavations both during project construction and into any long-term drained basements (refer to Section 6.2 below for further discussion).

4.4 Results of In-situ Pressuremeter Testing

Pressuremeter tests were completed in each of the investigation boreholes drilled as part of the Stage 2 geotechnical investigations. The results of these tests are summarised in **Table 5**. The initial Young's modulus for each test, assessed from the initial portion of the pressure expansion, is plotted against elevation in **Figure 3**.

The results of the in situ pressuremeter testing are:

- Four tests were carried out at the approximate single level basement excavation level (RL 8m), the elastic loading modulus ranging from 60 MPa (test carried out in Silty Clay) to about 1,700 MPa (test carried out in very low strength Siltstone);
- Four tests were carried out at the approximate two-level basement excavation level (RL 4m), the test results ranging from 1,700 MPa (low strength Siltstone) to about 2,000 MPa (medium strength Siltstone).

The lower test results (i.e. 60 MPa) could be influenced by a number of factors including disturbance of the test zone during drilling, the presence of localised clay seams or more weathered materials. We consider the lower test result, whilst relevant, is unlikely to be representative of the modulus of the majority of proposed founding materials and the potential for weaker materials in footings can be mitigated with assessments following footing excavation.

The maximum applied pressure during the in situ pressuremeter testing provides an indication as to the strength and quality of the rock mass being tested. The maximum applied pressure in tests completed in the weathered Siltstone unit was between 7.9 MPa to 11.8 MPa, except:

- 5.5 MPa at 6.5m BGL at BH101, which is the residual soil (extremely weathered Siltstone)
- 1.4 MPa at 4.6m BGL at BH103, which is the residual soil (extremely weathered Siltstone)
- 14.8 MPa at 12.5m BGL at BH103, which is the high strength Siltstone

Table 5: Summary of in situ pressuremeter test results

Test No.	Borehole No.	Test Depth (m)	Elevation (RL m AHD)	Tested Material	Maximum pressure (P _{max}) (MPa):	Elastic Modulus, E' (Loading) (MPa)
1	BH101	4.5	8	Highly weathered Siltstone	9.6	600
2		6.5	6	Highly weathered to moderately weathered Siltstone	5.5	130
3		8.5	4	Fresh Siltstone	11.8	2000
4		10.5	2	Fresh Siltstone	11.8	2000

Test No.	Borehole No.	Test Depth (m)	Elevation (RL m AHD)	Tested Material	Maximum pressure (P _{max}) (MPa):	Elastic Modulus, E' (Loading) (MPa)
5		12.5	0	Fresh Siltstone	11.7	2000
6	BH102	3.4	7.5	Highly weathered Siltstone	9	230
7		5.4	5.5	Extremely weathered to highly weathered Siltstone	7.9	350
8		7.4	3.5	Moderately weathered to slightly weathered Siltstone	11.5	1700
9		9.4	1.5	slightly weathered Siltstone	11.6	2000
10		11.4	-0.5	Fresh Siltstone	11.6	2000
11	BH103	2.5	10	Highly weathered Siltstone	11.7	1900
12		4.5	8	Silty Clay with Ironstone / Extremely weathered Siltstone	1.4	60
13		5	7.5	Extremely weathered to highly weathered Siltstone	8.7	1700
14		6.5	6	Moderately weathered to slightly weathered Siltstone	11.6	2000
15		8.5	4	Fresh Siltstone	11.8	2000
16		10.5	2	Fresh Siltstone	11.8	2000
17		12.5	0	Fresh Siltstone	14.8	2000

Notes:* The test depths and elevations are the approximate mid-point of the test section

E_i – Youngs modulus, initial loading assuming a Poissons ratio of 0.25, P_{max} – maximum pressure applied during the test

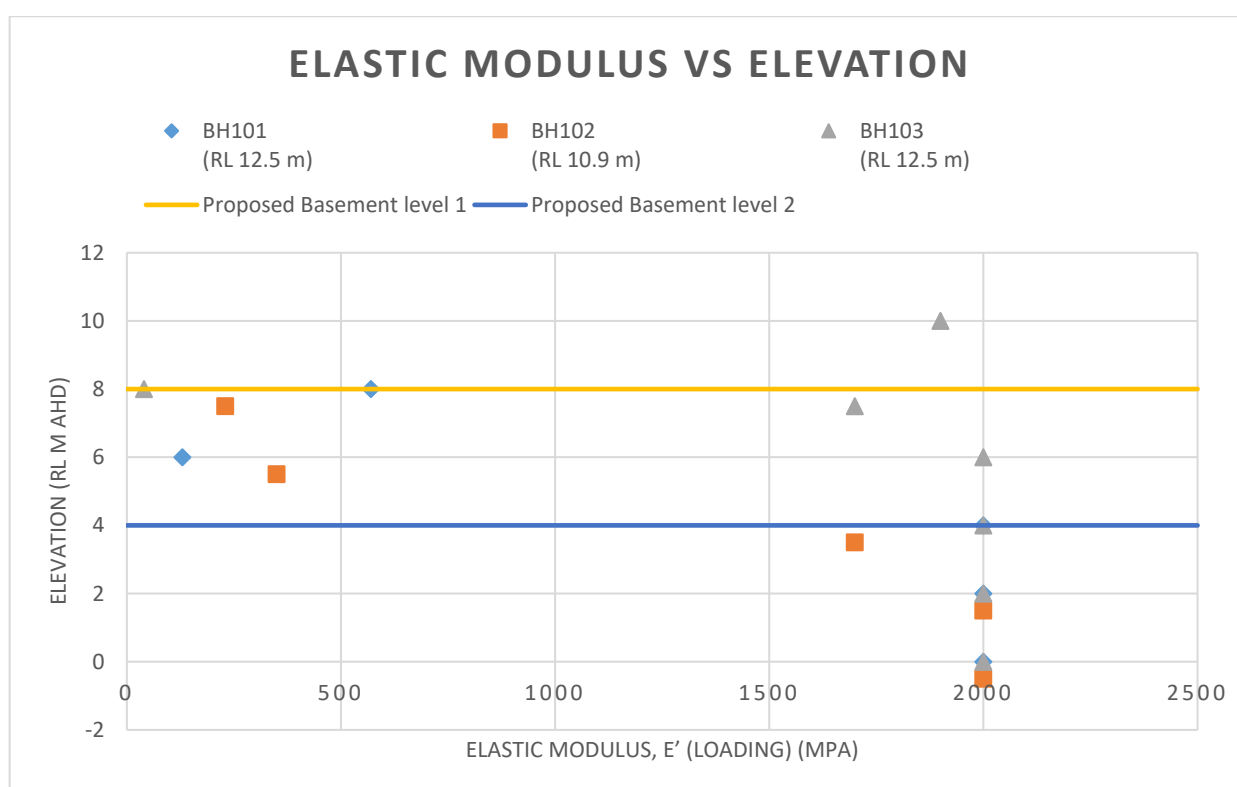


Figure 3: Elastic modulus (PMT) Vs elevation

4.5 Results of Laboratory Testing

Laboratory testing of selected samples recovered from the boreholes was carried out to assess soil/rock characterisation and likely behaviours. The tests on the soil/rock samples were carried out in accordance with relevant Australian Standard AS1289 “Methods of testing soils for engineering purposes”.

Table 6 to Table 10 summarises the laboratory test results, and the associated laboratory test certificates are attached in **APPENDIX C**.

Table 6: Summary of Laboratory CBR Test Result

Investigation Location	Sample Depth (m BGL)	Material Description ¹	MDD (t/m ³)	OMC (%)	CBR (%) at penetration of 2.5mm	CBR Swell (%)
BH106	0.3-1.49	Silty Clay	1.573	24.8	8	0.6

¹For a detailed descriptions of the subsurface conditions at each borehole location refer to the borehole logs presented in **APPENDIX B**.

Table 7: Summary of Laboratory Moisture Content Test Results

Material Description ¹	Average Moisture Content (%)	Mean Moisture Content (%)	Standard Deviation (%)
Silty Clay	20.3	18.4	9.2
Very low and low strength Siltstone	13.2	12.8	3.1
Medium strength Siltstone	2.9	2.9	0.5

¹For a detailed descriptions of the subsurface conditions at each borehole location refer to the borehole logs presented in **APPENDIX B**.

Table 8: Summary of Laboratory Characterisation Test Results

Investigation Location	Sample Depth (m)	Material Description ¹	Moisture Content (%)	Atterberg Limits			Shrink Swell Index
				Liquid Limit (%)	Plasticity Limit (%)	Plastic Index (%)	
BH01M	0.53-0.60	Silty Clay	37.5	90	20	70	-
BH03	0.50-0.60	Silty Clay	30.8	108	32	76	-
BH04	2.00-2.35	Silty Clay	-	-	-	-	1.7

¹For a detailed description of the subsurface conditions at each borehole location refer to the borehole logs presented in **APPENDIX B**.

Table 9: Summary of Laboratory Characterisation Test Results (Chemical)

Investigation Location	Sample Depth (m)	Material Description ¹	Moisture Content (%)	Aggressivity				
				pH	Electrical Conductivity (µS/cm)	Electrical Resistivity (ohm.cm)	Sulfate SO ₄ (ppm)	Chloride Cl (ppm)
BH02	1.8-1.85	Silty Clay	8.9	5.4	94	11000	60	1.9
BH04	0.55-0.65	Silty Clay	24.8	5.0	150	6600	87	42

¹For a detailed description of the subsurface conditions at each borehole location refer to the borehole logs presented in **APPENDIX B**.

Table 10: Summary of Laboratory Characterisation Test Results (UCS)

Investigation Location	Sample Depth (m BGL)	Material Description ¹	UCS (MPa)	Young's Modulus (MPa)	Poisson's Ratio
BH101	10.5	Medium strength Siltstone	11	800	0.26
BH101	12.3	Medium strength Siltstone	13	-	-
BH102	3.38	Residual clay (Grading into extremely weathered Siltstone)	0.14	-	-
BH102	9.34	Medium strength Siltstone	9.5	-	-
BH102	11.3	Medium strength Siltstone	11	1900	0.13
BH103	4.76	Residual clay	0.19	-	-

Investigation Location	Sample Depth (m BGL)	Material Description ¹	UCS (MPa)	Young's Modulus (MPa)	Poisson's Ratio
		(Grading into extremely weathered Siltstone)			
BH103	8.57	Medium strength Siltstone	11	700	0.26
BH103	10.8	High strength Siltstone	21	1700	0.29

¹For a detailed description of the subsurface conditions at each borehole location refer to the borehole logs presented in **APPENDIX B**.

Rock core samples were tested by a Golder Engineer (as per AS1289.6.3.1 – 2004) to estimate the Point Load Strength Index (IS₅₀) values to assist with rock strength assessment. A total of eighty-two (82) tests were carried out and the results of the testing are summarised on the borehole logs provided in **APPENDIX B** and in Figure 4. The point load strength index tests correlated reasonably well with our field assessments of rock strength and the UCS results.

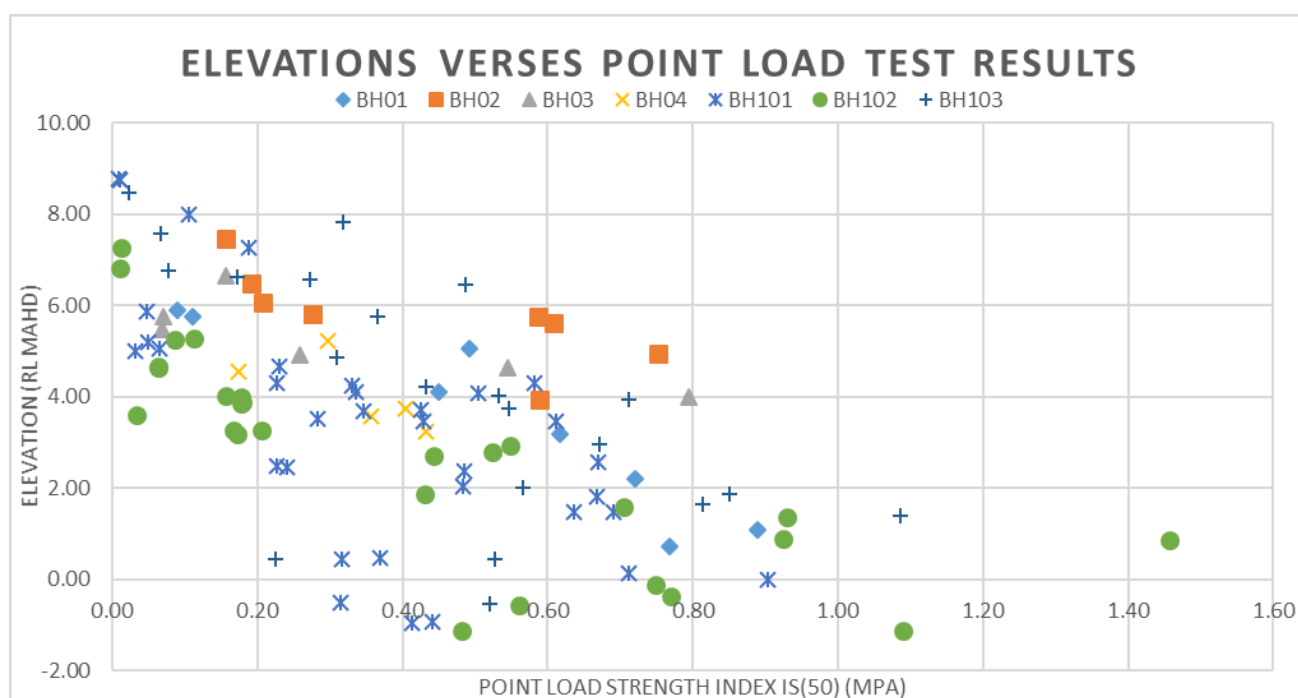


Figure 4: Elevations Verses Point Load Test Results

Based on the UCS test results, the approximate correlation between the UCS and PLT is approximate 17 (refer to Figure 5). Based on the adopted ratio, the approximate Unconfined Compressive Strength (UCS) of the rock core, estimated from correlations with the point load strength index test results, varied from less than 1 MPa to 15.1 MPa.

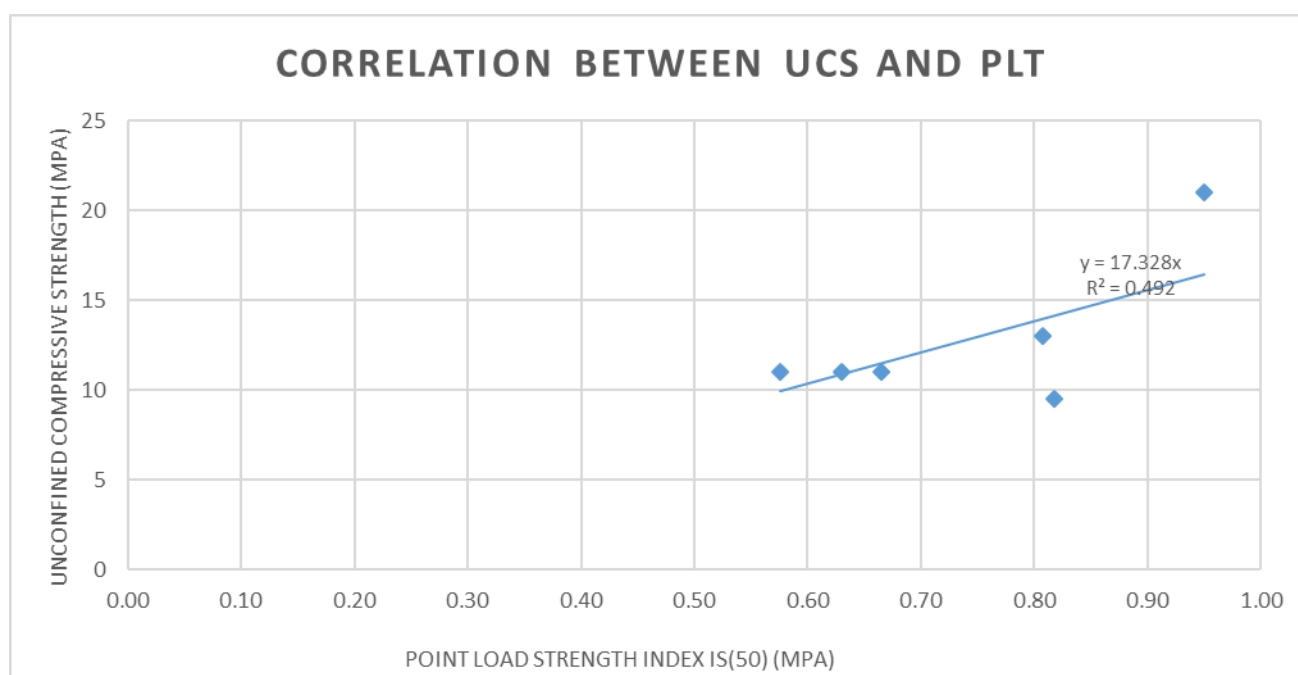


Figure 5: Correlation between UCS and PLT

Five selected groundwater samples were sent to SGS for groundwater testing. The test results were summarized in **Table 11**.

Table 11: Groundwater quality results

Analyte	Units	Borehole				
		BH01	BH101	BH101a	BH102	BH102a
Groundwater quality indicators						
pH	pH units	6.4	4.9	6.0	5.8	5.0
Total dissolved solids	mg/L [†]	2,700	1,900	-- [#]	3,800	2,500
Total suspended solids	mg/L	84	6	--	28	46
Acidity to pH 8.3	mg/CaCO3/L ^a	120	110	--	110	50
Major anions and cations						
Calcium	mg/L	27	2.0	26	8.4	14
Magnesium	mg/L	46	20	4.1	69	27
Sodium	mg/L	770	550	58	1,200	680
Potassium	mg/L	6.0	4.0	1.6	9.3	7.4
Chloride	mg/L	720	580	--	1600	630
Sulfate	mg/L	710	490	--	610	780
Total alkalinity	mg/L	370	15	--	150	--
Fluoride	mg/L	0.44	0.43	--	2.40	0.26
Nutrients						
Nitrate (as N [§])	mg/L	<0.025	<0.025	--	<0.050	0.072
Nitrite (as N)	mg/L	0.006	<0.005	--	<0.005	0.009
Ammonia (as N)	mg/L	0.21	0.11	--	0.19	0.12
Total Kjeldahl nitrogen (as N)	mg/L	0.77	0.24	1.50	0.32	0.43

Analyte	Units	Borehole				
		BH01	BH101	BH101a	BH102	BH102a
Total nitrogen (as N)	mg/L	0.78	0.24	--	0.32	0.52
Total phosphorus (as P ^ψ)	mg/L	0.10	0.04	0.59	0.24	0.02
Reactive phosphorus (as P)	µg/L [‡]	<5	8	--	180	7
Heavy metals and metalloids						
Arsenic	µg/L [‡]	3.0	<1.0	<1.0	<1.0	<1.0
Cadmium	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	µg/L	2	<1.0	2	<1.0	3.0
Copper	µg/L	<1.0	2	12	<1.0	280
Lead	µg/L	<1.0	<1.0	4	<1.0	<1.0
Nickel	µg/L	32	11	3	27	130
Zinc	µg/L	<5	54	100	98	73
Aluminium – dissolved	µg/L	21	510	1,300	380	180
Aluminium - total	µg/L	990	540	--	730	1,100
Iron – dissolved	µg/L	13,000	1,300	1,200	2,500	170
Iron – total	µg/L	14,000	1,300	--	2,800	1,800
Manganese	µg/L	580	520	200	2,700	240
Mercury	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Organic contaminants						
Volatile TPH ^{††}	µg/L	ND	ND	ND	ND	ND
Semi-volatile TPH ^{‡‡}	µg/L	ND	ND	--	ND	ND
PAH [*]	µg/L	ND	ND	ND	ND	ND
Chloroform	µg/L	4.7	ND	2.8	ND	1.2
Total VOC ^Ω	µg/L	4.7	ND	2.8	ND	1.2

Notes: † milligrams per litre

‡ micrograms per litre

^α milligrams of calcium carbonate per litre

[§] nitrogen

^ψ phosphorus

insufficient sample volume for analysis (well purged dry during groundwater sampling and did not recover post-sampling)

†† volatile total petroleum hydrocarbons (for full suite refer to laboratory certificates in Appendix E)

‡‡ semi-volatile total petroleum hydrocarbons (for full suite refer to laboratory certificates in Appendix E)

* polycyclic aromatic hydrocarbons

Ω volatile organic contaminants (for full suite refer to laboratory certificates in Appendix E)

5.0 GROUND MODEL

5.1 Stratigraphy

Based on the results of the geotechnical investigation and associated testing, we have developed ground units to summarise the typical subsurface profile encountered across the site. **Table 12** presents the ground model. The rock classification (Unit 3 to Unit 6) is based on the most recent literature of Pells et al (2019)⁴.

Table 12: Stratigraphic units

Ground Unit	Inferred Subsurface Conditions
Unit 1 Fill / Topsoil	- Concrete pavement was present at all borehole locations, except BH03 and BH104, and is between 80mm and 150mm thick. - Topsoil of medium to high plasticity Silty Clay was encountered at BH03, about 230 mm thick, trace rootlets and wood fibre; - Gravel pavement, 20mm thick was encountered in BH04; Beneath the surface materials was fill, which was encountered at all borehole locations except BH03. The fill is generally mixed, comprising different proportions of sand/gravel/silt and clay. The fill varies in thickness between about 40 mm and 450 mm. The deeper fill material was encountered at BH101(450mm), BH101a (400mm) and BH103 due to close proximity to the existing underground services/storage tank.
Unit 2 Residual Clay	Silty Clay, high plasticity, or clayey Silt, brown to red-brown, becoming pale grey with depth, generally very stiff to hard. The thickness is expected to vary between about 1.2m and 3.4m, likely to increase towards the northern and eastern parts of the site.
Unit 3 Class V Siltstone	Generally very low to low strength, highly fractured, pale grey, iron stained Siltstone. The defects were assessed to be very closely spaced (20-60mm) or less. However extensive zones (i.e. 1m to 2m) of extremely weathered Siltstone are expected with some zones of clay (ie up to 0.5m thick in places) also present. This is a highly variable and weathered material that is expected to deteriorate further if exposed to groundwater or stormwater runoff and trafficked with construction vehicles.
Unit 4 Class IV Siltstone	Generally very low or low strength, highly weathered to moderately weathered, grey and red-brown, iron stained Siltstone. The defects were assessed to be very closely spaced (10-100 mm) sub-horizontal beddings, some extremely weathered seams and sub-vertical joints.
Unit 5 Class III Siltstone	Generally low or low to medium strength, moderately to slightly weathered, dark grey, iron stained Siltstone.

⁴ Pells, P J , et al. "classification of sandstones and shales in the Sydney region: a forty year review " (2019).

Ground Unit	Inferred Subsurface Conditions
	The defects were assessed to be closely spaced (30-300 mm) sub-horizontal beddings, some extremely weathered seams and sub-vertical joints.
Unit 6 Class II Siltstone	Generally medium strength, fresh, dark grey, Siltstone The defects were assessed to be moderately spaced to widely spaced (300-1000 mm) sub-horizontal beddings, some extremely weathered seams and sub-vertical joints.

The ground conditions encountered in each of the boreholes are summarised in Table 13.

Table 13: Ground conditions in boreholes

Ground Unit	BH01M	BH02	BH03	BH04	BH101	BH102	BH103
	Depth to top of Unit / RL (m BEGL) / (mAHD)						
Unit 1 Fill/Topsoil	0 / 10.8	0 / 12.5	0 / 12.3	0 / 11	0 / 12.5	0 / 10.9	0 / 12.5
Unit 2 Residual Clay	0.2 / 10.6	0.3 / 12.2	0.2 / 12.1	0.3 / 10.8	0.6 / 11.9	0.3 / 10.6	0.5 / 12
Unit 3 Class V Siltstone	1.7 / 9.1	1.5 / 11	1.8 / 10.5	2.8 / 8.2	4 / 8.5	2.2 / 8.7	1.7 / 10.8
Unit 4 Class IV Siltstone	4.7 / 6.1	5.2 / 7.3	5.6 / 6.7	5.5 / 5.6	6.0 / 6.6	5.7 / 5.2	5.1 / 7.4
Unit 5 Class III Siltstone	5.7 / 5.1	7.0 / 5.5	6.8 / 5.5	5.8 / 5.2	7.9 / 4.5	7.2 / 3.7	6.8 / 5.7
Unit 6 Class II Siltstone	6.3 / 4.5	8.2 / 4.3	7.7 / 4.4	7.0 / 4.0	10.3 / 2.3	8.1 / 2.8	8.1 / 4.4

BEGL – Below existing ground level

¹Level is based on approximation from site survey plan and GPS locations, accuracy is ± 0.5 m.

Although the boreholes drilled did not encounter a dyke, the published geological maps indicate the presence of a known dyke to the south-west of the site. The orientation of the dyke is such that it could potentially project across the site if it is laterally continuous. The presence of the dyke could locally affect ground and groundwater conditions. Dykes can also have localised faulting associated with them, leading to poorer (i.e. deeper weathering, lower strength and more highly fractured) ground in its vicinity.

The Geotechnical Cross Sections (which will be provided in APPENDIX B in the next revision of this report) indicate increasing thicknesses of Units 2 to 4 towards the eastern and south parts of the site. Additionally, borehole BH102 indicates deeper weathering towards the central parts of the northern site boundary.

At this stage, it's unclear if a dyke is present and what's its orientation is so some contingency planning should be considered should a dyke be exposed during excavation.

If present, the dyke itself is likely to be limited in width (i.e. possibly to a few meters) and dip steeply. The material will likely vary in strength with depth but depending on fracturing within the material, it may act as:

- A barrier to lateral groundwater flow; or
- A localised “drain”,

in both instances resulting in higher groundwater level on one side of the dyke relative to the other.

6.0 DISCUSSION AND RECOMMENDATIONS

The proposed building is to consist of multi-level towers (i.e. to 24 levels) with a single level basement. Excavations for the basement are expected to be 3m to 5 m deep and will be at an approximate RL of 8 m AHD. The foundation system may consist of shallow or deep footings. Based on our understanding of the project and the inferred ground conditions, the following geotechnical considerations have been addressed in this report:

- Basement excavation and retention to limit lateral deflections and ground loss as a result of excavations. This includes consideration of excavations adjacent to RMS Assets and other assets such as the existing multi-story building and service station to the west.
- Groundwater inflows and management of groundwater.
- Foundation design for building loads and ancillary structures.
- Pavement considerations for driveways.
- Trafficability at the bulk excavation level and other construction issues.

Additionally, we understand there is a concept that allows for a second level basement. We have provided preliminary comment on some of the geotechnical risks and benefits associated with a second level basement, which if adopted, we have assumed would extend to about RL 4 m AHD.

6.1 Geotechnical Design Parameters

Geotechnical parameters for the design of permanent and temporary components of the proposed development are provided in **Table 14**. The geotechnical parameters have been developed based on the site conditions and testing carried out across both Stage 1 and Stage 2 works.

We note that the inferred consistency of the residual soils indicated in the borehole logs are those that are relevant for the moisture conditions at the time of testing. The consistencies are based on the results of SPTs and tactile observations, which have some uncertainty. In addition, the consistency of top 1.5 m clay was unable to be assessed from in-situ testing due to non-destructive drilling using hand augers. Consistency assessment of this upper material was made based on judgement of hand auger resistance.

The parameters provided in **Table 14** are intended to reflect those that the soils and rocks will potentially see across the life of the proposed development. The design parameters are derived from results of in-situ testing, laboratory testing and engineering judgement.

Table 14: Recommended geotechnical design parameters

Design Parameter	Unit 1 Fill	Unit 2 Residual Clay	Unit 3 Class V Siltstone	Unit 4 Class IV Siltstone	Unit 5 Class III Siltstone	Unit 6 Class II Siltstone
Bulk Unit Weight, γ (kN/m ³)	18	20	22	22	23	24
Undrained Shear Strength ¹ , S_u (kPa)	40	150	-	-	-	-
Poisson's Ratio (ν)	0.35	0.3	0.3	0.2	0.2	0.15
Drained Cohesion, c' (kPa)	1	5	20	50	100	300
Drained Friction Angle, ϕ' (deg)	25	28	30	32	35	42
Elastic Modulus, E' (Loading) (MPa)	10	40	100	400	900	1800
Vertical Modulus of Subgrade (MPa/m) ²	5/B	22/B	60/B	200/B	500/B	1000/B
Susceptibility to Liquefaction During an Earthquake ³	Low					

¹Undrained cohesion & friction angle applies to short-term.

²Modulus derived based on Mayne & Poulos (1999); B = Width of structural element

³Susceptibility to liquefaction during an earthquake is based on the following definition:

Low – Medium to very dense sands, stiff to hard clays, and rock

Medium – Loose to medium dense sands, soft to firm clays, or uncontrolled fill below the water table

High – Very loose sands or very soft clays below the water table.

Due to the inherent complexity of soil behaviour, subgrade in soil foundation interaction problems is often simplified as Winkler springs, which require input of subgrade reaction coefficient/modulus of subgrade reaction. The foundation designer should note that the provided modulus of subgrade reaction is not a fundamental soil property, but it is a specific to the geometry of the foundation and loading condition (Terzaghi, 1955).

6.2 Groundwater Consideration

6.2.1 Groundwater Inflow Estimates

Groundwater inflows have been estimated for the following scenarios:

- Single level basement – construction phase inflows to a free-draining excavations (Scenario 1 – this Scenario is still being developed and details will be provided in the next revision of this report);
- Two level basement:

- Construction-phase inflows to a free-draining excavation (Scenario 2)
- Construction-phase inflows to a secant-piled supported excavation (Scenario 3), and
- Long-term (i.e. post-construction) inflows to a free-draining two-level underground (car-park) basement (Scenario 4).

6.2.1.1 *Scenario 1 – Single-level, free-draining excavation during construction*

Estimates of groundwater inflow to a single-level excavation assuming no groundwater control will be used during excavation and construction were made using the Dupuit-Forchheimer equation for steady-state radial flow in an unconfined aquifer. In using this method, a number of simplifications (most notably regarding aquifer homogeneity and the likely shape of the excavation and accompanying radius-of-influence) and assumptions have been made as outlined below.

- The perched aquifer is continuous around the perimeter of the planned development and laterally extensive.
- Excavation for the (single-storey) basement will be carried out to +7.8 m RL.
- Excavation to full depth is instantaneous (i.e. groundwater inflow estimates do not consider temporary inflows during the excavation of the basement which may result in partial dewatering of the water-bearing units at the site).
- The elevation of the perched groundwater table in the residual soils and weathered Ashfield Shale surrounding the excavation is +9.65 m AHD (in this case the average groundwater level in these units during December 2019 plus 0.5 m to account for possible seasonal variations).
- The single-level basement of the mixed-use development immediately to the west of the site will prevent groundwater from this direction draining to the planned single-storey basement.

There are no other drained subterranean features in the area which would prevent or influence groundwater flow towards and ultimately into the planned excavation.

- Estimates of rock-mass horizontal hydraulic conductivity (K_h) for the silty clay and weathered siltstone (i.e. ground units 2 and 3) throughout the area are as derived from the hydraulic testing carried out in boreholes BH01 and BH102a and from the monitoring of groundwater levels during the development of these wells.
- Groundwater recharge has not been considered, nor any increase in groundwater inflow associated with groundwater levels higher than those used in this estimate.
- Inflow estimates do not consider any additional water which may drain to the sumps due to rainfall events or from construction water.
- Groundwater in the footprint of the excavation will be removed with the excavation spoil during the excavation of the basement.

Given the demonstrated variation in the hydraulic conductivity of the silty clay and underlying weathered siltstone and uncertainty regarding the radius-of-influence of the excavation, estimates of groundwater inflows were made for a number of scenarios both during construction and for a long-term drained (single-storey) basement to obtain a better understanding of the range of likely groundwater inflows that could be expected. Modelled parameters are summarised in Table 15.

Table 15: Modelled parameters – Scenario 1

Parameter	Value(s)	Source
Hydraulic conductivity	3.2×10^{-9} m/sec [†] 9.5×10^{-9} m/sec 2.1×10^{-8} m/sec	Minimum, average and maximum estimates of horizontal hydraulic conductivity from hydraulic ('slug') testing and well development monitoring within the silty clay and weathered siltstone (i.e. those tests carried out in groundwater monitoring wells BH01 and BH102a).
Pre-excavation groundwater elevation	+9.65 m RL [‡]	Average groundwater elevation in the Ashfield Shale as measured in groundwater monitoring wells BH01 and BH102a in December 2019 plus 0.5 m to account for any seasonal variations of groundwater levels.
Base of excavation (and post-excavation groundwater level)	+7.80 m RL	Assumes a single-storey basement; refer to Section 1.1.
Base of aquifer	0 m RL	Assumption only.
Effective (equivalent) excavation radius	42 m 37 m	Equation 6.10 of Powers et. al. (2007) coupled with information presented in Section 1.1 including likely basement setbacks from the property boundaries. Equation 6.11 of Powers et. al. (2007) coupled with information presented in Section 1.1 including likely basement setbacks from the property boundaries.
Radius of influence – <i>during construction</i>	Varying between 3 m and 10 m	Values selected in light of the geological and topographic setting, likely duration of excavation and experienced-based professional judgement.
Radius of influence – <i>post construction (i.e. long-term drained basement)</i>	Varying between 10 m and 30 m	Values selected in light of the geological and topographic setting, likely duration of excavation and experienced-based professional judgement.

Notes: [†] metres per second

[‡] metres relative level

Predicted groundwater inflows (percentiles) to the planned single-storey excavation during construction are as follows.

25th percentile predicted inflow – 275 kL/day

50th percentile predicted inflow – 375 kL/day

75th percentile predicted inflow – 800 kL/day

90th percentile predicted inflow – 1,200 kL/day

Average groundwater inflow rate into the excavation may be about 600 L/day.

Predicted long-term groundwater inflows to the planned single-storey basement should it not be tanked are as follows.

25th percentile predicted inflow – 100 L/day

50th percentile predicted inflow – 150 L/day

75th percentile predicted inflow – 300 L/day

90th percentile predicted inflow – 450 L/day

Average groundwater inflow rate into the single-storey basement may be about 225 L/day.

Should a secant-piled wall (or similar no-flow barrier) will be installed around the perimeter of the excavation or property and keyed into bedrock then groundwater inflow is not envisaged. There will be water within those materials below the perched water table and removed during excavation, however this water is likely to be of low volume and could be:

- removed with the excavated soils and rock, and/or
- collected in sumps and removed from the site.

6.2.1.2 Scenario 2 – Two-level free-draining excavation during construction

Estimates of groundwater inflow to a two-level excavation, assuming no groundwater control will be used during excavation and construction, were made using the Dupuit-Forchheimer equation for steady-state radial flow in an unconfined aquifer. In using this method, a number of simplifications (most notably regarding aquifer homogeneity and the likely shape of the excavation and accompanying radius-of-influence) and assumptions have been made in addition to those used in Scenario 1 as outlined below:

- Excavation for the two-level basement-level car park will be carried out to +3.8 m RL (i.e. the development will include a two-level underground car-parking facility).
- Excavation to full depth is instantaneous.
- The excavation will not encounter any significant fracture zones (such as faults and shear zones) which may have a hydraulic conductivity greater than the bulk hydraulic conductivity used in the analytical assessment.

Similarly the permeability of the dyke shown on the 1:100,000 scale geological map – and that may pass through the site – does not vary from that of the surrounding Ashfield Shale.

- Estimates of rock-mass horizontal hydraulic conductivity (K_h) for the Ashfield Shale throughout the area (i.e. not just the site) are as derived from the hydraulic testing carried out in boreholes BH101 and BH102.
- The Ashfield Shale is homogenous and isotropic; vertical hydraulic conductivity (K_v) has been assumed to be the same as K_h .
- The elevation of the groundwater table in the Ashfield Shale surrounding the excavation is +6.7 m AHD (in this case the average groundwater level in the Ashfield Shale during December 2019 plus 0.5 m to account for possible seasonal variations).
- The single-level basement of the mixed-use development immediately to the west of the site will not prevent groundwater from this direction draining to the planned basement. Similarly, there are no other drained subterranean features in the area which would prevent or influence groundwater flow towards and ultimately into the planned excavation.
- Groundwater recharge has not been considered, nor any increase in groundwater inflow associated with groundwater levels higher than those used in this estimate.

- Inflow estimates do not consider any additional water which may drain to the sumps due to rainfall events or from construction water.
- Groundwater in the footprint of the excavation will be removed with the excavation spoil during the excavation of the basement.

Given the demonstrated variation in the hydraulic conductivity of the Ashfield Shale and uncertainty regarding the radius-of-influence of the excavation, estimates of groundwater inflows were made for a number of scenarios to obtain a better understanding of the range of likely groundwater inflows that could be expected. Modelled parameters are summarised in Table 16.

Table 16: Modelled parameters – Scenario 2

Parameter	Value(s)	Source
Hydraulic conductivity	4.6×10^{-7} m/sec [†] 1.8×10^{-6} m/sec 4.2×10^{-6} m/sec	Minimum, average and maximum estimates of horizontal hydraulic conductivity from hydraulic ('slug') testing within the Ashfield Shale (i.e. those tests carried out in groundwater monitoring wells BH101 and BH102).
Pre-excavation groundwater elevation	6.7 m RL [‡]	Average groundwater elevation in the Ashfield Shale as measured in groundwater monitoring wells BH101 and BH102 in December 2019 plus 0.5 m to account for any seasonal variations of groundwater levels.
Base of excavation (and post-excavation groundwater level)	3.8 m RL	Assumes a two-level basement will be adopted; refer to Section 1.1.
Effective excavation radius	42 m RL	Equation 6.11 of Powers et. al. (2007) coupled with information presented in Section 1.1 including likely basement setbacks from the property boundaries.
Radius of influence	Varying between 5 and 15 m	Values selected in light of the geological and topographic setting, likely duration of excavation and experienced-based professional judgement (a lower number provides a greater rate).

Notes: [†] metres per second

[‡] metres relative level

Predicted inflows (percentiles) to the planned excavation during construction are as follows.

25th percentile predicted inflow – 35 kL/day

50th percentile predicted inflow – 80 kL/day

75th percentile predicted inflow – 150 kL/day

90th percentile predicted inflow – 180 kL/day

Average groundwater inflow rate into the excavation may be about 100 kL/day (about 1.2 L/sec).

It should be recognised that rock mass fracturing is heterogeneous and the interconnections between permeable fractures and zones of more permeable fractures are not understood. Whilst some uncertainty in the predicted inflows calculated (in this case represented by the various percentile estimates presented above) have been allowed for, it is recognised that groundwater inflows could be as higher, particularly as groundwater is removed from storage in the water-bearing units at the start of excavation.

6.2.1.3 **Scenario 3 – Two-level basement excavation with a fully-enclosed secant-pile wall during construction**

Given the design of the development has not been finalised and changes to the dimensions of the basement are possible, estimates of groundwater inflows (underflow) to two-level excavation during construction have been made assuming a secant-piled wall (or similar no-flow barrier) will be installed around the perimeter of:

- the basement excavation, and
- the property.

Estimates of groundwater inflows were made using the analytical method proposed by Kavvas et al (1992) and presented in Cashman and Preece (2012). This method allows preliminary estimates to be made of groundwater inflows per unit length of linear excavations below the groundwater table which are supported by cut-off walls at the sides of the excavation.

When applying the method described by Kavvas et al (1992) the following additional assumptions have been made to those used in Scenarios 1 and 2:

- The toe of each secant-piled wall will extend 1 m below the base of the excavation.
- Drawdown (including depressurisation) will not occur outside of the excavation.
- Groundwater flow will only occur through the floor of the excavation; i.e. the secant-piled wall (or similar no-flow barrier) is impermeable.
- An impermeable stratum is present at the depth.
- Groundwater recharge was not considered in these estimates. In stating this though it has been assumed drawdown and depressurisation will not occur outside of the secant-piled wall (i.e. constant-head conditions are assumed in all hydrostratigraphic units), with this forming a de-facto substitute for groundwater recharge.

Predicted inflows on completion of excavation, assuming a secant-piled wall (or similar no-flow barrier) will be installed around the *perimeter* of a two-level basement excavation and the base of the aquifer is at 0 m RL, are between about 10 and 60 kL/day (between 0.1 and 0.7 L/sec), with an average inflow estimate of about 30 kL/day (about 0.4 L/sec).

Should the base of the aquifer be at – 5 m RL predicted inflows to the excavation are between about 20 and 150 kL/day (between about 0.25 and 1.7 L/sec).

Estimates suggest no significant change in groundwater inflows are likely should a secant-piled wall be installed just within the property boundary (i.e. should the planned setback from the property boundaries be reduced).

6.2.1.4 **Scenario 4 – Long-term groundwater inflows to a free-draining two-level basement**

Estimates of groundwater inflow to a two-level basement should (i) it not be tanked, and (ii) long-term groundwater external control not be adopted, was also estimated using the Dupuit-Forchheimer equation for steady-state radial flow in an unconfined aquifer. Those parameters and values listed in **Table 16** were again used for this scenario, however values of radius of influence were changed to more appropriately represent the impacts of the planned basement on the groundwater profile in the long-term; values of radius of influence for this scenario was set to vary between 50 and 100 m.

Predicted long-term groundwater inflows (percentiles) to a two-level basement should groundwater control not be adopted in the design are as follows.

25th percentile predicted inflow – 5 kL/day

50th percentile predicted inflow – 15 kL/day

75th percentile predicted inflow – 30 kL/day

95th percentile predicted inflow – 35 kL/day

The average groundwater inflow rate into the excavation was estimated to be about 20 kL/day (about 0.2 L/sec).

6.2.2 Groundwater Quality

Groundwater samples were collected from groundwater monitoring wells BH01, BH101, BH101a, BH102 and BH102a at the beginning of December 2019. They were collected by Golder personnel using the low-flow sampling techniques and submitted to SGS Australia Pty Ltd (SGS) for laboratory analysis; SGS is accredited by the National Association of Testing Authorities (NATA) for the analysis carried out and those methods listed in the laboratory certificates in APPENDIX E.

A summary of the analytical results is presented in **Table 11**. Reference should be made to the analytical laboratory certificates in APPENDIX E for a full listing of each analyte within each organic contaminant analytical group presented in this table.

6.2.2.1 Groundwater corrosivity and aggressivity to buried structures

Groundwater analytical data presented in **Table 11** has been compared to those exposure classifications for the surface of buried steel piles and concrete structures in Australian Standard AS 2159-2009 '*Piling-design and installation*'; this document provides the range of exposure classifications for the surface of steel piles and concrete piles based on the range of hydrogeochemical conditions and the possibility of changes in groundwater levels.

No corrosive or aggressive groundwater conditions to either steel or concrete piles or structures are inferred from the groundwater samples collected from the site.

In stating the above the following should be noted:

- groundwater at the site is acidic and has a low buffering capacity hence could be vulnerable to further acidification
- groundwater sample results can only provide an insight to the corrosivity and aggressivity at those locations tested, hence the potential remains (albeit a low potential) that corrosive and aggressive groundwater may exist at other locations at the site, and
- the geochemistry (and therefore corrosivity and/or aggressivity potential) of groundwater flowing towards and possibly discharging to the planned basement may change in response to changes in landuse surrounding the planned development.

6.2.2.2 Disposal of collected groundwater

In order to provide comment regarding disposal options for collected groundwater both during and post-construction (the latter should a drained basement be included in the design), groundwater analytical results for the samples collected from groundwater monitoring wells BH101 and BH102 have been compared against the respective trigger levels for the 95% level of protection (LOP) of species in fresh waters presented in Table 3.4.1 of the Australia and New Zealand Environment and Conservation Council publication titled '*The*

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000); these trigger levels have been used to provide a preliminary assessment of the suitability of likely disposal of groundwater to the local stormwater system and thereby ultimately to A'Becketts Creek to the north or Duck Creek to the east.

Comparison of these analytical results with the abovementioned LOPs indicates any collected groundwater would need to be treated for heavy metals and nutrients prior to disposal to the local stormwater system.

Should Starryland wish to approach Sydney Water to assess whether disposal of site groundwater to sewer is feasible under the conditions of a *Trade Waste Agreement* then it is recommended additional groundwater samples be collected from the monitoring wells at the site and the samples be analysed for additional groundwater quality indicators and potential contaminants listed in Table 1 and Table 2 of Sydney Water's *Trade Waste Industrial Customers – Acceptance Standards (2017 – 18)*. This would include (above those analytes already tested and documented in **Table 11**):

- additional heavy metals and metalloids including barium, cobalt, molybdenum, selenium, silver, tin and uranium
- sulphur species including sulphide, sulphite and thiosulfate
- boron
- cyanide
- bromine
- chlorine
- biological oxygen demand
- grease, and
- other volatile and semi-volatile organic compounds including acetaldehyde, chlorinated phenolics, formaldehyde, herbicides and defoliants, mercaptans, organoarsenic compounds and volatile halocarbons.

6.2.3 Considerations for the adoption of a drained basement design

As stated in Golder's preliminary geotechnical investigation report for the site (report No. 19122955-001-R-Rev1 PGI dated 1 November 2019), should the planned basement not be tanked then a drainage system would need to be installed:

- behind all basement walls
- around the perimeter of the slab, and
- below the basement slab.

Groundwater at the site though in both the residual soils and Ashfield Shale is acidic, oxygen-poor and has high concentrations of dissolved iron and manganese, all of which present complications for the long-term viability and effectiveness of groundwater drainage systems. Under such conditions, ferrous iron (Fe^{2+}) – which is the dominant form of iron – is highly mobile. When Fe^{2+} -rich groundwater is exposed to oxygen-rich environments such as in basements and other draining subterranean infrastructure, ferrous iron is oxidised to ferric iron (Fe^{3+}), with the oxidation of ferric-iron oxyhydroxides ensuing; these oxyhydroxides form the orange, brown and ochre staining evident on the walls of free-draining excavations and similar exposures throughout Sydney.

Once ferric-iron oxyhydroxides form at groundwater discharge points they cannot be easily removed by chemical processes and if left unaddressed will inevitably block drainage systems. They are rather usually removed by physical processes such as cleaning coupled with chlorination, with the long-term collection of iron-rich groundwater ingress in subfloor drainage systems typically not viable at the small-scale. As such the risk for clogging of any sub-soil drain system(s) which need to be considered in the design to allow access for ongoing maintenance.

6.3 Excavation Retention

6.3.1 Retention Systems

Retention systems will be required to provide support of the walls of the basement both during construction and permanently. Excavations and retention systems will also need to take into consideration their allowable movement so as not to have any adverse effects on the buildings/structures and infrastructure adjoining the excavation. The retention system will also need to consider the requirements for a tanked or drained basement.

Based on the provided documents, Golder understands that the proposed development involves the demolition of the existing site structures, including the existing heritage building on site, and the construction of two multi-storey mixed-use towers over a common single-level (or two-level) basement car park.

Considering the excavation depth and setbacks to the site boundary (which were outlined in Section 1.1), where site allows, we consider that temporary batters of 1H: 1V may be feasible if the setbacks are greater than the excavation depth. However, temporary excavation batters made during construction may need to be backfilled to achieve final levels. This is likely to involve the use of engineered fill and suitable earthwork compaction methods.

Where the recommended temporary batters are not feasible or not desirable, a suitable retention system will be required. The adopted retaining wall system will likely be dependent on the tolerable movement adjacent to the retaining wall to limit impacts on neighbouring infrastructure and the requirements for a tanked or drained basement. Consideration should also be made for the potential undermining of adjacent building footings in the adoption of the retention system. Additional investigation of the adjacent building may be required to better understand limitations. Further design considerations and parameters for retaining wall systems are provided in Section 6.3.2.

Some potential retention systems include:

- Drained:
 - Anchored soldier pile walls with concrete infill panels.
 - Contiguous retaining wall or semi-contiguous retaining wall with shotcrete infill
 - Soil Nail Wall (for single level basement only)
- Tanked:
 - Diaphragm wall
 - Secant pile wall

Piles must be installed below bulk excavation level (including footings, service trenches and lift overrun pits) with a suitable socket length for lateral resistance. The presence of neighbouring basements (including anchor systems from these basements if any), footings or services and their levels should be considered as part of anchor or soil nail design. Where anchors or soil nails are not suitable, internal propping may be required or an alternative retention system adopted. For tanked basements, there may still be leakage of water through the

wall, the amount will vary depending on quality control during construction and details adopted for joints and membranes.

Bored or CFA piles may be used for this site. However, larger capacity piling rigs may be required for drilling through the medium strength Siltstone encountered in Unit 6 (Class II Siltstone) and in zones of Unit 4&5 (Class IV / III Siltstone) to achieve required socket lengths. We recommend further advice be sought from piling contractors to assess rig type and excavatability.

Working platforms for the pile rigs are also likely to be required.

Due to the presence of Siltstone bedrock at the depths of excavations for the basement, it is assumed that driven piles will not be able to achieve suitable embedment depths and have not been considered further.

6.3.2 Retaining Walls Design Parameters

Retaining structures should be designed in accordance with AS 4678-2002 "Earth-retaining structures". Retaining walls should be designed to limit lateral movement when in close proximity to existing buildings/ structures, basements, services, pavements and transformers. For preliminary design of temporary and permanent support we recommend the following:

- For flexible walls such as cantilever walls a triangular earth pressure distribution can be used. Assuming that there are no significant constraints on tolerable ground movements, relatively flexible shoring systems may be used in the design, based on active (K_a) pressures.
- For rigid or propped walls, a rectangular earth pressure distribution should be used with a maximum pressure of 4H or 6H (kPa), depending on the amount of movement that can be tolerated, where 'H' is the effective vertical height of the wall in metres.
- All surcharge loading affecting the walls (including from construction equipment, construction loads, adjacent high-level footings, etc.) should be adopted in the retaining wall design as an additional surcharge;
- For a drained basement, measures are to be taken to provide complete and permanent drainage behind the walls. Strip drains protected with a non-woven geotextile fabric should be used behind the shotcrete infill panels for soldier pile walls or inserted between gaps in contiguous piles. Alternatively, for the contiguous pile walls, weepholes comprising 20mm diameter PVC pipes grouted into holes or gaps between adjacent piles may be used. The embedded end of the pipes must, however, be wrapped with a non-woven geotextile fabric (such as Bidim A34) to act as a filter against subsoil erosion;
- For tanked basements and retaining wall design, hydrostatic pressures should be included. We recommend that the active triangular distribution of the hydrostatic pressure be taken as zero from the finished ground surface level to take into account possible groundwater fluctuations that may occur at the site.
- For piles embedded beneath bulk excavation level the BEL, assessment of the , consideration should be given for the potential presence ultimate lateral toe resistance needs to consider the potential presence of rock that contain adverse defects. in the rock mass, etc. At least the upper 0.5m depth below bulk excavation level should not be taken into account to allow for tolerance and disturbance effects during excavation.
- If anchors or soil nails extend beyond the site boundaries, then permission from the neighbouring properties would need to be obtained prior to installation. Also, the presence of neighbouring basements or services and their levels must be confirmed prior to finalising anchor design. If permission from the neighbouring properties cannot be obtained, then internal props or alternative retention systems may be required.

- Anchors should have their bond length within Siltstone. For the design of anchors bonded into Siltstone, the ultimate bond stress values outlined in **Table 17** below may be used, subject to the following conditions:
 - Anchor bond lengths of at least 3m behind the 'active' zone of the excavation (taken as a 45° zone above the base of the excavation) is provided.
 - Overall stability, including anchor group interaction, is satisfied;
 - All anchors should be proof loaded to at least 1.10 times (for temporary anchor with service life less than 6 month) the design working load before locked off at working load. Such proof loading is to be witnessed by an engineer independent of the anchoring contractor. We recommend that only experienced contractors be considered for anchor installation.
 - Permanent anchors must have appropriate corrosion provisions for longevity.

Furthermore, any existing buried services which extend below the site will require diversion prior to the commencement of excavation or alternatively be temporarily supported during excavation, subject to permission or other instructions from the relevant service authorities. Enquiries should also be made for further information and details, such as invert levels, on the buried services.

Table 17 provides recommended geotechnical design parameters to be used for the design of retention systems. For soldier pile retaining walls where the walls are free to deflect (e.g. unpropped, laterally unrestrained or cantilever type walls), the design should be based upon "active" (K_a) earth pressure coefficients. For soil nail walls, ground movements would likely already have occurred prior to installation of a permanent lateral restraint system. Therefore, "active" (K_a) earth pressure coefficients could be applied.

These parameters are applicable for long term (permanent) structures and assume horizontal ground behind the wall. If an inclined slope is proposed behind the wall, or additional surcharge loads from traffic or structures are imposed during or after construction, then these additional loadings should be allowed for in the design.

For particularly movement sensitive walls, we recommend the use of foundation – structure interaction analysis during detailed design to further consider likely deformations and to better model the earth pressures and influence of the excavation on adjacent structures and services. Such analysis can often result in significant cost savings associated with the construction of the wall compared to conventional analysis using parameters set out below. We can assist with this analysis during design if requested.

Table 17: Recommended retaining wall design parameters

Design Parameter		Unit 1 Fill	Unit 2 Residual Clay	Unit 3 Class V Siltstone	Unit 4 Class IV Siltstone	Unit 5 Class III Siltstone	Unit 6 Class II Siltstone
Earth Pressure Coefficients	At rest K_o ¹	0.57	1.0	1.0	1.2	-	-
	Active K_a ¹	0.41	0.3	0.25	0.2	-	-
	Passive K_p ¹	-	2.8	3.5	4.0	-	-
Ultimate Bond Stress (kPa)		-	-	100	150	500	1,000

¹ – Earth pressures are provided on the assumption that the ground behind the retaining walls is horizontal.

6.4 Footings

We understand that the preferred foundation option involves founding columns on shallow pad or strip footings at the base of the proposed bulk excavation. Alternatively, piled footings could be used to support the column loads.

6.4.1 Pad Footings

Provided that under slab drainage is provided at basement level, shallow footings may be considered to support structures with relatively low loads. Following bulk excavations for the basement footprint to:

- an RL about 7.8 m for single level basement, we expect the majority of the site will have Unit 3 (Class V Siltstone) exposed. Some parts of the site may have Unit 2 Residual Soils or Unit 4 Class IV Siltstone.
- an RL about 3.8 m for a two level basement, we expect the exposed foundation may comprise Unit 6 Class II Siltstone and Unit 5 Class III Siltstone, however some zones of Unit 4 Class IV Siltstone may also be present.

Cast-in-place concrete pad or strip footings and surface precast footings for lightly loaded ancillary structures may be founded in the Unit 2 Residual Soil / Class V Siltstone material.

6.4.1.1 General

For a single level basement, the Class V Siltstones have the potential to deteriorate further under construction traffic and exposure to water. Therefore, given the potentially clayey and silty soil conditions at the depth of footings, the bearing pressures provided in Table 18 are to be considered upper limits for shallow footings due to the potential for groundwater inflows and elevated groundwater pressures and the likely difficulty with preventing disturbance and softening of the soil/weathered rock in the footing excavation.

This assumes that individual pad footings are embedded a minimum of 0.6 m depth below final basement level. The assessment has assumed that the recommended site preparation outlined in Section 6.6 and groundwater depressurisation has been carried out. Footings carrying significant eccentric loading will need to be assessed separately.

Settlement of an individual isolated footing will be less than the settlement of the same footing located within a group of footings due to interaction between footings. For typical footing arrangements, we anticipate that settlements at the centre of a group of footings could be about 25% higher than the settlement at the perimeter of the group.

Given the variable ground conditions at footing level across the site (for a single level basement), it's likely that pad footings will be predominantly founded on:

- Class IV siltstone towards the south and southwestern parts of the site; and
- Class V siltstone elsewhere.

If weaker materials than assumed for the design are encountered at the base of the footing excavations, they should be excavated and replaced with a suitable backfill with similar strength and stiffness to the surrounding ground.

Footing excavations should be inspected by a suitably qualified and experienced engineer. An inspection regime should be developed if shallow footings are adopted, in particular for the main structure.

Excavations may require management of health and safety hazards and potential control measures such as benching and battering, shoring, water removal, ground support for adjacent structures, fall prevention barriers and access/egress considerations.

For further construction considerations refer to **Section 6.7**.

6.4.1.2 Bearing Pressures

Table 18 summarises the serviceability bearing pressures for shallow footings. Discrete footings designed using these values should result in settlements of less than 1 % of the least footing dimension.

The proposed parameters assume the construction of the foundation is clean and debris free. They should be excavated in dry condition to prevent softening of the materials in the base of the excavation. This may require active drainage around the footing locations to locally reduce or transfer groundwater from the footing excavations.

Table 18: Summary of serviceability bearing pressure for shallow footing

Ground Unit	Serviceability Bearing Pressure (kPa)
Unit 1 Fill/Topsoil	-
Unit 2 Residual Clay	-
Unit 3 Class V Siltstone	800
Unit 4 Class IV Siltstone	1,500
Unit 5 III Siltstone	3,500
Unit 6 Class II Siltstone	6,000

Assuming column spacings in the order of 5m x 5m and loads of up to 5MN, 2m x 2m size pad footings could be expected to settle in the order of:

- 5-10mm for pads in Class IV siltstone (Unit 4); and
- 20-25mm for pads founded in Class V siltstone (Unit 3).

Pad footings founded across weathered rocks of Units 3 and 4 should also be checked against Ultimate Limit State loads.

6.4.1.3 Soil Reactivity to Shallow Footings

Selection of footing types and founding depth will need to consider the risk of adverse movements due to shrink-swell of reactive clay soils, both within and between proposed lightly loaded structures.

The results of shrink-swell testing and Atterberg Limit results across the site are presented in **Table 6**.

Once the locations of lightly loaded structures have been confirmed, additional site investigations could be completed to assess the shrink-swell index (Iss) for the moisture change depth range. We recommend that the design of such structures be based on a site classification of H1 (AS2870).

The level of site reactivity experienced by structures will depend on the prevailing weather conditions at the time of construction. For example, if construction occurs during drought, the structures may experience the full range of swell following prolonged periods of rainfall. Careful consideration should also be given to site drainage, and the proximity of trees and shrubs in the vicinity of the shallow footings.

Methods to mitigate the impact of expansive soils include the use of a raft slab (larger footings), founding the entire footing deeper into the soil profile, founding structures on pier foundations that resist the soil movements due to moisture change, or by facilitating differential movements through flexible connections to services and other infrastructure.

6.4.2 Pile Footings

The structure could be fully or partially supported on piles. Piles would need to extend into the underlying siltstones beneath the base of the proposed excavation. Bored or CFA piles would likely be appropriate to support building loads for this site.

6.4.2.1 General

The designer of the piles should make an independent assessment of the appropriate parameters for the particular pile construction method adopted. The designer should select a geotechnical strength reduction factor (ϕ_g) in accordance with AS 2159 2009 and apply appropriate testing and QA/QC regime that is consistent with the selected value of ϕ_g .

Indicative design parameters for piles are provided in **Table 19** for the purpose of preliminary sizing.

Depending on the retention system adopted, pile footings may be installed from near existing surface level or following bulk excavations for the basement footprint.

This section relates to cast-in-place or CFA concrete pile footings.

6.4.2.2 Pile Design Parameters

Table 19 provided above presents a summary of indicative geotechnical design parameters recommended for pile footings. The geotechnical reduction factor ϕ_g to be applied to the ultimate capacities will depend on the foundation type, structural redundancy and level of testing, in accordance with Australian Standard AS2159 (2009). Trial piles and/or pile testing may be necessary to justify the adoption of high ϕ_g factors and/or higher design parameters than suggested in **Table 19**.

Table 19: Summary of ultimate and serviceability bearing pressure for pile foundation

Ground Unit	³ Ultimate End Bearing (kPa)	Ultimate Shaft Adhesion ¹ (kPa)		Serviceability End Bearing ² (kPa)
		Tension	Compression	
Unit 3 Class V Siltstone	3,000	35	50	850
Unit 4 Class IV Siltstone	4,000	105	150	1,500
Unit 5 III Siltstone	6,000	280	400	3,500
Unit 6 Class II Siltstone	35,000	560	800	6,000

¹ – Shaft adhesion values given assume there is intimate contact between the pile and foundation material and should achieve a clean socket roughness category R2 or better. For uplift, design engineer to check both 'piston pull-out' and 'cone lift out' mechanics in accordance with AS4678-2002 Earth Retaining Structures.

² – The serviceability bearing pressures given above are based on serviceability criteria of settlements at the pile toe of less than or equal to 1% of the minimum pile diameter.

³ – Ultimate bearing pressures occur at large settlements, greater than 5% of minimum footing dimension

The parameters in **Table 19** are provided on the basis of the following assumptions:

- Piles have a nominal socket of at least 0.5m, into the relevant founding material;

- For piles, there is intimate contact between the pile and foundation material (a clean socket roughness category of R2 or better);
- The pile should be drilled in the presence of a Geotechnical Engineer prior to pile construction to verify that ground conditions meet design assumptions. Where groundwater ingress is encountered during pile excavation, concrete is to be placed as soon as possible upon completion of pile excavation. Pile excavations should be pumped dry of water prior to pouring concrete, or alternatively a tremie system could be used;
- The bases of all pile excavations are cleaned of loose and softened material and water is pumped out prior to placement of concrete;
- The concrete is poured on the same day as drilling, inspection and cleaning
- Geotechnical strength reduction factor ϕ_g is discussed in Section 6.4.2.3

6.4.2.3 Advice on Site Risk Factor

We suggest the use of the following site individual risk rating (IRR) factors to allow an assessment of the geotechnical strength reduction factor ϕ_g as per Table 4.3.2 (A) in AS 2159:

- Geological complexity of site: IRR = 2 (Low risk) as it is relatively horizontal, well-defined soil characteristics, some variability over the site but without observed abrupt changes in stratigraphy.
- The extent of ground investigation: IRR = 2 (Low risk) based on extent of investigations that have been carried out to adequate depth.
- Amount and quality of geotechnical data: IRR = 2 (Low risk) as only both field and laboratory tests were carried out for a site of this size.
- Method of assessment of geotechnical parameters: IRR = 2 (Low risk) as based laboratory and in-situ tests.

6.4.3 Ground Aggressivity

The results of groundwater aggressivity tests from Stage 1 works (refer to PGI, Report No 19122955-001-R-Rev1, dated 1 November 2019) are provided in **Table 9**. Groundwater analytical data collected during stage 2 are presented in **Table 11**.

The intrusive investigation indicated a low permeability soil is present above and below the groundwater table. In accordance with Tables 6.4.2(C) and 6.5.2(C) of AS 2159:2009 'Piling – Design and Installation', the results of the pH, chloride and sulfate content and electrical conductivity/resistivity of the soil and groundwater provided the following exposure classifications:

- 'Mild' for buried concrete structural elements; and
- 'Non-Aggressive' for buried steel structural elements.

In accordance with Table 4.8.1 of AS3600-2018 'Concrete Structures' these soils would be classified as exposure classification 'A2' for concrete in sulfate soils.

6.5 Earthquake Risk Classification

The methods of assessing the earthquake risk classification are outlined in the Australian Standard AS1170.4 (2007) *Structural Design Actions, Part 4: Earthquake Actions in Australia*. The standard uses a number of factors in assessing an earthquake design category for a particular structure at a given site.

The hazard factor (Z) depends on the geographic location of the proposed structure. For the proposed site, AS1170.4 indicates a hazard factor of 0.07.

The governing condition for the site subsoil class is the thickness and consistency of the subsurface materials beneath the building footings. Based on observed ground conditions we recommend that a site Subsoil Class of 'C_e – Shallow soil' is appropriate for the site, in accordance with Section 4.2 of AS1170.4 (2007).

6.6 Earthworks and Subgrade Preparation

Following excavation to subgrade level, the floor of the excavation is expected to comprise clayey and very low to low strength siltstone, that has the potential to deteriorate when exposed to water and traffic. Depending on the equipment used in the base of the excavation and the effectiveness of the adopted dewatering methods, it may be necessary to install a working platform across the base of the excavation to assist with trafficability.

Following bulk excavations, the floor should be inspected, parts may need to be proof rolled and remove any areas of wet or softened material and backfill with an imported granular material in no thicker than 300 mm layers. Proof-roll the surface in the presence of a geotechnical engineer.

The working platform could comprise 300 mm thick of imported free draining clean gravel. A layer of separation geofabric should be placed across the floor of the excavation prior to placement of the working platform. The material in the working platform should be compacted with at least eight passes of a 12 tonne vibratory smooth drum roller or equivalent.

Following completion of the basement excavation, additional localised depressurisation may be required around shallow footings to mitigate against the impacts of groundwater inflow and softening of footing bases.

The localised depressurisation may take the form of trenches or spear points around footings and installed prior to footing excavations. Once footing bases have been assessed and approved by a geotechnical engineer, the localised excavations will need to have blinding concrete placed across their bases immediately.

Imported fill should comply with the material requirements as outlined in AS 3798-2007 "Guidelines on Earthworks for Commercial and Residential Developments". Structural fill material should be clean granular material containing less than 5% fines (material less than 75 micron).

Where material from site excavations is intended for reuse onsite, it must be inspected and confirmed by a suitably qualified geotechnical engineer or engineering geologist prior to reuse. Additional laboratory testing may be required to confirm material properties depending on where the fill is intended to be used. Compaction characteristics (density, moisture) should be checked during construction using in situ density testing.

Reference should be made to AS 3798 for details in relation to earthworks procedures as well as geotechnical supervision and testing requirements.

6.6.1 Pavement Subgrades

A single laboratory CBR test was carried out at the proposed driveway entrance and indicated a soaked CBR value of 8%. Based on our experiences with Ashfield Shale residual clay subgrades elsewhere around Sydney, this CBR value is high and may not be entirely representative of subgrade conditions throughout the pavement life. Therefore, given the limited extent of the driveway works, Golder suggest pavements be designed on a lower subgrade CBR value, in the order 3 % would be more appropriate.

The design of new pavements will depend on subgrade preparation, subgrade drainage, the nature and composition of imported fill, as well as vehicle loadings and use. We recommend that in situ density tests be completed on the proof rolled and prepared subgrade to confirm that at least 98% Standard Maximum Dry Density (SMDD) has been achieved. If the existing fill is removed and replaced with imported fill, the CBR of the imported material may be taken into account.

Attention to details to the subsurface and surface drainage is required in view of the effect of moisture on the clayey soils. Pavement levels will need to be graded to promote rapid removal of surface water so ponding does not occur on the surface of pavements. The drainage trenches should be excavated with a uniform longitudinal fall to appropriate discharge points so as to reduce the risk of water ponding. The capacity of the stormwater collection system from the pavement should be checked and upgraded if necessary. In order to protect the pavement edge, subsoil drains should be provided along the perimeter of all proposed new external pavement areas, particularly in those areas of cut, with invert levels of at least 200mm below subgrade level.

The long-term successful performance of the pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance programme should not be limited to routine

compaction density testing only. Other important factors associated with the earthworks include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc.

6.7 Construction Considerations

The following sections provide some guidance on potential ground related construction issues that should be taken into consideration for the design and construction of the proposed development.

Potentially poor subgrade conditions may be expected at bulk excavation level for a single basement level and will require careful consideration, such as localised dewatering and construction of a working platform.

6.7.1 Dilapidation Surveys

Prior to excavation and construction, we recommend that detailed dilapidation surveys be carried out on all structures and infrastructures surrounding the site that falls within the zone of influence of the excavation. The zone of influence of the excavation is defined by a distance back from the excavation perimeter of twice the total depth of the excavation. The zone of influence should also consider the potential groundwater drawdown profile which may extend beyond the excavation zone of influence, should a drained basement be adopted.

6.7.2 Excavation Assessment

Prior to any excavation commencing, we recommend that reference be made to the WorkCover Excavation Work Code of Practice – October 2018.

We understand that:

- The proposed single level basement has a Finished Floor Level (FFL) of Reduced Level (RL) of 8.0 m AHD. To achieve this latter, a Bulk Excavation Level (BEL) of RL 7.8 m is assumed, which will allow for the construction of the basement floor slabs.
- The assumed two-level basement has a Finished Floor Level (FFL) of Reduced Level (RL) of 4.0 m AHD. To achieve this latter, a Bulk Excavation Level (BEL) of RL 3.8 m is assumed, which will allow for the construction of the basement floor slabs.
- Locally deeper excavations may be required for footings, lift shafts, crane pads and service trenches.

Based on the borehole logs, the proposed basement excavation is expected to extend through:

- Unit 1 to Unit 4 for single level basement;
- Unit 1 to Unit 6 for two-level basement;

Units 1, 2, 3 and 4 at the site should be able to be excavated with medium or large sized hydraulic excavators, fitted with 'Tiger Teeth'. We note that the low to medium strength Siltstone bands were encountered at all borehole locations through the Unit 2 Siltstone. These may require some moderate to hard ripping to excavate through, depending on the fracture spacing of this material insitu. Smaller size excavator may result in lower productivity.

Should excavation in Unit 5 or better be required, a high capacity and heavy bulldozer of at least D9 or equivalent. Excavation of Unit 6 bedrock or better is expected to present hard or heavy ripping, or "hard rock" excavation conditions. Ripping would require a high capacity and heavy bulldozer of at least D10 or similar for effective production. Considering the size of the site, we believe that a D10 bulldozer may not be feasible for this site. Alternatively, hydraulic breakers, rock saws, ripping hooks or rotary grinders could be used, though productivity would be lower and equipment wear increased, and this should be allowed for. Such equipment would also be required for detailed excavation, such as footings or services on the rock, and for trimming of faces. Final trimming of faces may also be completed using a grinder attachment rather than a rock breaker in

order to assist in limiting vibrations. The use of rotary grinders generally generates dust and this may be suppressed by spraying with water.

Excavation using rock hammers should commence away from the adjoining structures and the transmitted vibrations monitored to assess how close the hammer can operate to the adjoining structures while maintaining transmitted vibrations within acceptable limits. Alternatively, vibration monitors may be set up on the adjoining buildings to monitor vibrations at all times during rock excavation. Such monitors should be attached to flashing lights to warn the operator when acceptable limits have been reached.

We recommend the excavation contractors make their own assessment of the excavability based on their experiences with the equipment they have access to. Where the transmitted vibrations are excessive, alternate excavation equipment would need to be used, such as a small rock hammer, ripping hooks, rotary grinders or rock saws. If an alternate rock hammer is to be used, the transmitted vibrations from that hammer should be measured to determine how close each individual hammer can operate to the adjoining buildings. To assist in reducing vibrations and over-break of the shale, we recommend that initial saw cuts through the bedrock may be provided using rock saw attachments fitted to the excavator. However, the effectiveness of such approach must be confirmed by the results of vibration monitoring.

The impacts on neighbouring infrastructure of vibration from excavations and other construction activities should be considered during the selection of construction methods and construction plant. Reference should be made to German Standard DIN 4150 – Part 3: 1999 for a guide to acceptable limits of transmitted vibrations. The use of rock saws may help to reduce the risk of vibration.

Groundwater seepage monitoring should be carried out during bulk excavation prior to finalising the design of a pump out facility. Outlets into the stormwater system will require Council approval.

6.7.3 Site Trafficability

Units 2, 3 and 4 have the potential to deteriorate to clayey siltssilts/silty claysupper upon wetting, which may impact the performance of the basement floor and results in trafficability issues. Imported granular materials may need to be brought to site to improve trafficability for construction vehicles, in particular during or following periods of rainfall and if groundwater inflows are experienced.

6.7.4 Monitoring

6.7.4.1 Ground Displacement

Consideration should be made to the impact of the proposed development upon neighbouring structures, roadways and services. Basement excavation retention systems should be designed so as to limit lateral deflections.

Monitoring of deflections of retaining structures and surface settlements should be carried out by a registered surveyor at agreed points along the excavation boundaries and along existing building foundations / services / pavements and other structures located within or near the zone of influence of the excavation. Owners of existing services adjacent to the site should be consulted to assess appropriate deflection limits for their infrastructures.

We understand that the Parramatta road is an RMS Asset. The RMS Technical Direction Excavation adjacent to RMS Infrastructure (Ref. GTD 2012/001 dated 27 April 2012) provides a technical direction for all proposed excavations and or any temporary structures by private and commercial developments which have a zone of influence that extends onto the road reserve and RMS easements.

6.7.4.2 *Monitoring Regime*

Prior to and during excavation works, a monitoring regime should be in operation. This monitoring should include movement trigger levels, based on predicted movement of retention systems, which allow unexpected behaviour to be identified and addressed.

We anticipate that monitoring during excavation for the site could include the following:

- Three dimensional survey targets / monitoring points.
- Settlement monitoring points on adjacent buildings and roads.
- Groundwater monitoring wells.
- Vibration monitoring.

7.0 FURTHER GEOTECHNICAL INPUTS

Based on the results of the geotechnical investigation, we recommend that the following items be considered for further investigation:

- Deeper excavations: should localised deeper excavations such as lift wells or onsite detention systems be required, we recommended completing additional boreholes targeted at these locations.
- Investigations into adjacent building footings (type, levels, dimension and founding material) as part of the detailed investigation and design.

In addition to further geotechnical investigation, the following geotechnical items should also be considered as the design and construction specifications are progressed:

- Design of working platforms for construction plant should be in accordance with Building Research Establishment (BRE) guidelines.
- Requirements for witnessing installation and proof-testing of anchors and soil nails. In particular adjacent to Parramatta Road, where RMS may require any soil nail wall to be designed and constructed in accordance with their soil nail specification (RMS R64).;
- Geotechnical inspections of footings should be carried out by an experienced geotechnical professional before concrete or steel are placed to verify their bearing capacity and the in-situ nature of the founding strata.

8.0 REFERENCES

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Powers, J. P., A. B. Cowan, P. C. Schmall and W. E. Kaeck (2007). *Construction dewatering and groundwater control: new methods and applications*. John Wiley and Sons, Inc. Third edition.

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9.0 ABBREVIATIONS

AHD Australian Height Datum

AS Australian Standard

B EGL Below Existing Ground Level

BH Borehole

DBYD Dial Before You Dig

DP Deposited Plan

NATA National Association of Testing Authorities, Australia

RL Reduced Level

SPT Standard Penetration Test

T-C Tungsten-Carbide

UCS Unconfined Compressive Strength

Signature Page

Golder Associates Pty Ltd



Guoyue(Frank) Yu
Geotechnical Engineer



Bernie Francis
Principal Geotechnical Engineer

FY/BF/fy:bc

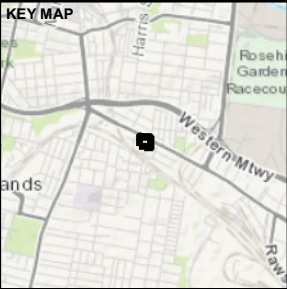
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APPENDIX A

Investigation Location Plan



- LEGEND**
- Cross section
 - ▭ Site boundary
- Investigation locations**
- Stage 1**
- ◆ Borehole, backfilled
 - ⊕ Borehole, monitoring well installed
- Stage 2**
- ⊕ Borehole, backfilled
 - ⊕ Borehole, shallow and deep monitoring well installed
 - ⊕ Borehole, vapour well installed



NOTE(S)
1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 56

REFERENCE(S)
1. AERIAL PHOTO (C) NEARMAP
2. KEYMAP SOURCED FROM ESRI ONLINE BASEMAPS

CLIENT
STARRYLAND NSW PTY LTD C/O PDS GROUP

PROJECT
GRAN CENTRAL DEVELOPMENT

TITLE
BOREHOLE LOCATION PLAN

	CONSULTANT	DD-MM-YYYY	14-02-2020
		DESIGNED	EAA
		PREPARED	EAA
		REVIEWED	BC
		APPROVED	BC

APPENDIX B

**Borehole Log, Explanatory Notes
and Cross-Sectional Drawings**



GOLDER

DRAFT REPORT OF BOREHOLE: BH01M

SHEET: 1 OF 3

CLIENT: PDS and Starrylands

COORDS: 315964 m E 6254865 m N MGA94 56 (hhGPS)

DRILL RIG: Komatsu 05

PROJECT: Proposed Gran Central

SURFACE RL: 10.8 m DATUM: AHD (MAP)

CONTRACTOR: Nealings

LOCATION: Cnr Parramatta Rd and Good Street, Granville

INCLINATION: -90°

LOGGED: FY DATE: 31/7/19

JOB NO: 19122955

HOLE DEPTH: 10.10 m

CHECKED: BJF DATE: 20/8/19

Drilling				Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	
DTC	-	90-100% Water	0	0.14				-	CONCRETE average 140mm thick igneous aggregate	-	-	ROAD SURFACE	
	HA		M	10.62	DS 0.14-0.18 m PID = 0.1 ppm DS 0.35-0.45 m PID = 0.1 ppm DS 0.53-0.60 m PID = 0 ppm DS 0.80-0.90 m PID = 1 ppm			CL-CH	FILL: Sandy CLAY low plasticity, dark grey, find to medium grained sand, with fine to coarse, sub angular to sub rounded gravel	w > PL	-	FILL RESIDUAL SOIL	
H			10.10	DS 1.10-1.20 m PID = 2.1 ppm DS 1.30-1.40 m PID = 0.5 ppm SPT 1.45-1.90 m 5, 15, 25 N=40 PID = 0.3 ppm				Silty CLAY medium - high plasticity, brown mottled orange brown, trace fine to coarse, sub angular to sub rounded gravel					
			9.70	DS 1.10-1.20 m PID = 2.1 ppm DS 1.30-1.40 m PID = 0.5 ppm SPT 1.45-1.90 m 5, 15, 25 N=40 PID = 0.3 ppm				red-brown mottled pale grey, with fine to coarse, sub angular to sub rounded gravel					
L			1.70	DS 1.10-1.20 m PID = 2.1 ppm DS 1.30-1.40 m PID = 0.5 ppm SPT 1.45-1.90 m 5, 15, 25 N=40 PID = 0.3 ppm				pale grey mottled pale brown, trace fine to coarse, sub angular to sub rounded gravel, with iron indurate band	H		@ 1.45 m, Hand Auger refusal		
ADT	M		9.10	DS 1.10-1.20 m PID = 2.1 ppm DS 1.30-1.40 m PID = 0.5 ppm SPT 1.45-1.90 m 5, 15, 25 N=40 PID = 0.3 ppm					-	SILTSTONE pale grey, inferred low strength, with medium strength layer, extremely weathered, with clay seams, trace iron staining	-	-	
	M-H		3	3.00 7.80	SPT 3.00-3.45 m 10, 16, 22 N=38 PID = 0.1 ppm DS 3.40-3.50 m PID = 0.4 ppm			CL-CH	Silty CLAY medium - high plasticity, pale grey mottled red-brown, with iron indurate bands	w > PL	H		
			4	DS 3.90-4.00 m PID = 0.1 ppm									
			4.65	DS 4.40-4.50 m PID = 0.2 ppm SPT 4.50-4.75 m 6, 21/100mm HB N>21					-		SILTSTONE grey to dark grey and grey brown, very low to low strength	-	-
WB	-												

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F01a
RL3



SHEET: 2 OF 3

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: FY DATE: 31/7/19

CHECKED: BJF DATE: 20/8/19

NMLC	
90-100% Water RETURN	
100	60 (95)
100	80 (90)
100	90 (95)
100	85 (100)

GAP gINT FN. F02a
RL3



GOLDER

DRAFT REPORT OF BOREHOLE: BH01M

SHEET: 3 OF 3

CLIENT: PDS and Starrylands

COORDS: 315964 m E 6254865 m N MGA94 56 (hhGPS)

DRILL RIG: Komatsu 05

PROJECT: Proposed Gran Central

SURFACE RL: 10.8 m DATUM: AHD (MAP)

CONTRACTOR: Nealings

LOCATION: Cnr Parramatta Rd and Good Street, Granville INCLINATION: -90°

LOGGED: FY DATE: 31/7/19

JOB NO: 19122955

HOLE DEPTH: 10.10 m

CHECKED: BJF DATE: 20/8/19

Drilling						Field Material Description						Defect Information			
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)		DEFECT DESCRIPTION & Additional Observations		AVERAGE DEFECT SPACING (mm)	
				10	10.10		END OF BOREHOLE @ 10.10 m TARGET DEPTH PIEZOMETER INSTALLED BH01M was redrilled on 2-8-19 using HQ size shoe, to install monitoring well				PLI(D)=0.74 PLI(A)=0.77				
				11											
				12											
				13											
				14											
				15											
				16											
				17											
				18											
				19											
				20											

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

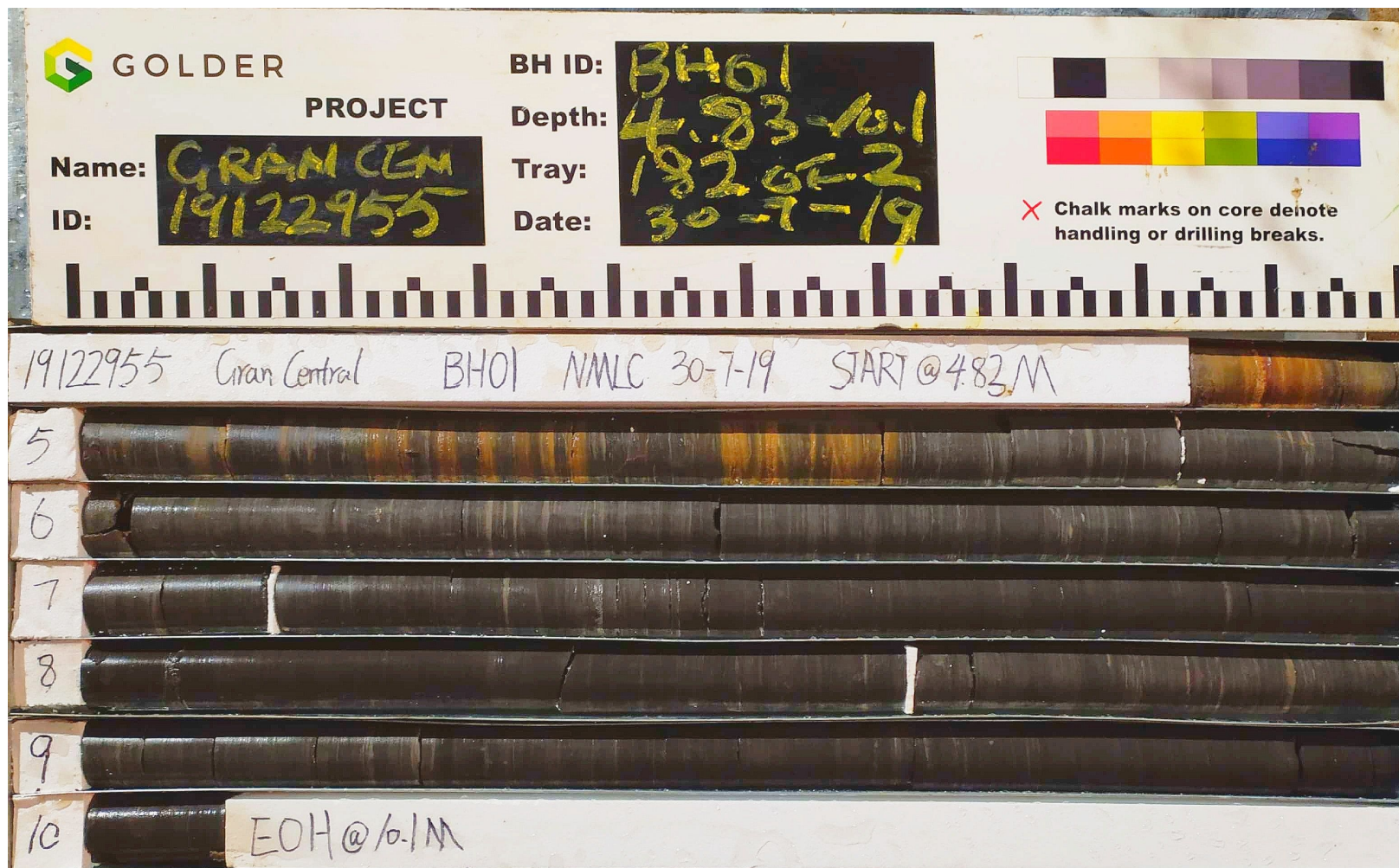
GAP gINT FN. F02a
RL3

CLIENT: PDS and Starrylands
 PROJECT: Proposed Gran Central
 LOCATION: Cnr Parramatta Rd and Good Street, Granville
 JOB NO: 19122955

COORDS: 315964 m E 6254865 m N MGA94 56 (hhGPS)
 SURFACE RL: 10.8 m DATUM: AHD (MAP)
 INCLINATION: -90°
 HOLE DEPTH: 10.10 m

SHEET: 1 OF 1
 DRILL RIG: Komatsu 05
 CONTRACTOR: Nealings
 LOGGED: FY
 CHECKED: BJF

DATE: 31/7/19
 DATE: 20/8/19



This report of core photographs must be read in conjunction with accompanying notes and abbreviations.



GOLDER

DRAFT REPORT OF BOREHOLE: BH01M

SHEET: 1 OF 2

CLIENT: PDS and Starrylands

COORDS: 315964 m E 6254865 m N MGA94 56 (hhGPS)

DRILL RIG: Komatsu 05

PROJECT: Proposed Gran Central

SURFACE RL: 10.8 m DATUM: AHD (MAP)

CONTRACTOR: Nealings

LOCATION: Cnr Parramatta Rd and Good Street, Granville

INCLINATION: -90°

LOGGED: FY DATE: 31/7/19

JOB NO: 19122955

HOLE DEPTH: 10.10 m

CHECKED: BJF DATE: 20/8/19

Drilling				Sampling	Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION ID Static Water Level BH01M Reference Point gl 10.73 m AHD
DTC		0	0.14	DS 0.14-0.18 m PID = 0.1 ppm		CONCRETE average 140mm thick igneous aggregate		Grout
		10.62		DS 0.35-0.45 m PID = 0.1 ppm		FILL: Sandy CLAY low plasticity, dark grey, fine to medium grained sand, with fine to coarse, sub angular to sub rounded gravel, Moist, wet of plastic limit.		Bentonite
HA		0.70		DS 0.53-0.60 m PID = 0 ppm		Silty CLAY medium - high plasticity, brown mottled orange brown, trace fine to coarse, sub angular to sub rounded gravel, Moist, wet of plastic limit., hard		
		10.10		DS 0.80-0.90 m PID = 1 ppm		red-brown mottled pale grey, with fine to coarse, sub angular to sub rounded gravel		Sand
		1.10		DS 1.10-1.20 m PID = 2.1 ppm		pale grey mottled pale brown, trace fine to coarse, sub angular to sub rounded gravel, with iron indurate band		50mm Casing
		9.70		DS 1.30-1.40 m PID = 0.5 ppm		SILTSTONE pale grey, inferred low strength, with medium strength layer, extremely weathered, with clay seams, trace iron staining		
		1.70		SPT 1.45-1.90 m 5, 15, 25 N=40 PID = 0.3 ppm				
		9.10						
ADT		3	3.00	SPT 3.00-3.45 m 10, 16, 22 N=38 PID = 0.1 ppm		Silty CLAY medium - high plasticity, pale grey mottled red-brown, with iron indurate bands, Moist, wet of plastic limit., hard		50mm Screen
		7.80		DS 3.40-3.50 m PID = 0.4 ppm				
		4		DS 3.90-4.00 m PID = 0.1 ppm				
WB		4.65		DS 4.40-4.50 m PID = 0.2 ppm		SILTSTONE grey to dark grey and grey brown, very low to low strength		Bentonite
		4.83		SPT 4.50-4.75 m 6, 21/100mm HB N>21		SILTSTONE grey to dark grey and grey brown, with pale grey sandstone lamination, bedded at 0-5°, with iron staining, very low to medium strength, highly weathered to fresh		
		5.97		C 4.83-5.82 m		no iron staining		
		5.60						
		5.20		C 5.82-7.13 m				
NMLC		7		C 7.13-8.61 m				
		8						
		9		C 8.61-10.10 m				
		10						

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F05
RL3



GOLDER

DRAFT REPORT OF BOREHOLE: BH01M

SHEET: 2 OF 2

CLIENT: PDS and Starrylands

COORDS: 315964 m E 6254865 m N MGA94 56 (hhGPS)

DRILL RIG: Komatsu 05

PROJECT: Proposed Gran Central

SURFACE RL: 10.8 m DATUM: AHD (MAP)

CONTRACTOR: Nealings

LOCATION: Cnr Parramatta Rd and Good Street, Granville

INCLINATION: -90°

LOGGED: FY DATE: 31/7/19

JOB NO: 19122955

HOLE DEPTH: 10.10 m

CHECKED: BJF DATE: 20/8/19

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	ID Static Water Level BH01M	CONSTRUCTION Reference Point gl 10.73 m AHD
		10	10.10 0.70			END OF BOREHOLE @ 10.10 m TARGET DEPTH PIEZOMETER INSTALLED BH01M was redrilled on 2-8-19 using HQ size shoe, to install monitoring well			
		11							
		12							
		13							
		14							
		15							
		16							
		17							
		18							
		19							
		20							

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F05
RL3



GOLDER

DRAFT REPORT OF BOREHOLE: BH02

SHEET: 1 OF 2

CLIENT: PDS and Starrylands

COORDS: 315954 m E 6254814 m N MGA94 56 (hhGPS)

DRILL RIG: Komatsu 05

PROJECT: Proposed Gran Central

SURFACE RL: 12.5 m DATUM: AHD (MAP)

CONTRACTOR: Nealings

LOCATION: Cnr Parramatta Rd and Good Street, Granville

INCLINATION: -90°

LOGGED: FY

DATE: 1/8/19

JOB NO: 19122955

HOLE DEPTH: 8.75 m

CHECKED: BJF

DATE: 20/8/19

Drilling					Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	
DTC	-	H	GWNE	0	PID = 0 ppm				CONCRETE average 120mm thick igneous aggregate	-	-	-	ROAD SURFACE	
				0.12	DS 0.15-0.20 m									FILL
				0.30	DS 0.20-0.30 m									
				12.20	PID = 0 ppm									
				0.60	DS 0.30-0.40 m									
				11.90	PID = 0 ppm									
					DS 0.60-0.70 m									
				1.00	PID = 0 ppm									
				11.50	DS 1.10-1.20 m									
					PID = 0 ppm									
ADT	H	H	GWNE	1.55	DS 1.40-1.50 m				pale grey mottled red-brown and pale brown, fine to coarse, sub rounded ironstone				@ 1.50 m, NDD Target Reached	
				10.95	SPT 1.50-1.65 m									
					23/150mm, 8/0mm HB N>8									
					PID = 0 ppm									
					DS 1.80-1.85 m									
												</		

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F01a
RL3



GOLDER

DRAFT REPORT OF BOREHOLE: BH02

SHEET: 2 OF 2

CLIENT: PDS and Starrylands

COORDS: 315954 m E 6254814 m N MGA94 56 (hhGPS)

DRILL RIG: Komatsu 05

PROJECT: Proposed Gran Central

SURFACE RL: 12.5 m DATUM: AHD (MAP)

CONTRACTOR: Nealings

LOCATION: Cnr Parramatta Rd and Good Street, Granville

INCLINATION: -90°

LOGGED: FY

DATE: 1/8/19

JOB NO: 19122955

HOLE DEPTH: 8.75 m

CHECKED: BJF

DATE: 20/8/19

Drilling					Field Material Description							Defect Information				
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)		DEFECT DESCRIPTION & Additional Observations		AVERAGE DEFECT SPACING (mm)		
				0												
				1												
				1.86												
				10.64			Continuation of Sheet 1									
			100 0 (20)	2			SILTSTONE pale grey, with ironstone band, bedded at 0-20°, trace iron staining	XW				1.86-1.99 m: EWS, 0°, 130 mm, Recovered as fractured core 2.06-2.09 m: EWS, 0°, 30 mm, weathered siltstone 2.16-2.23 m: J, 80-90°, 70 mm, Healed 2.16 m: P, 0°, Pl, Sm, Cn 2.16-2.23 m: J, 80-90°, 70 mm, Healed 2.29-2.36 m: JX2, 70-90°, sp = 5 mm, Pl, Sm, Cn, 70 mm 2.30 m: P, 0°, Pl, Sm, Cn 2.35-2.40 m: PX2, 0-5°, sp = 5-40 mm, St, Sm, Cn 2.46 m: PX3, 0°, sp = 10 mm, Pl, Sm, Cn 2.51 m: PX2, 0°, sp = 3 mm, Pl, Sm, Cn 2.53 m: Px2, 0°, sp = 20 mm, Pl, Sm, Cn 2.62 m: P, 0°, Pl, Sm, Fe Sn 2.77 m: P, 0°, Pl, Sm, Cn 2.85 m: EWS, 0°, 30 mm 3.00-3.02 m: J, 90°, Pl, Sm, Fe Sn, 20 mm 3.02 m: P, 0°, Pl, Sm, Fe Sn 3.05 m: P, 0°, Pl, Sm, Fe Sn				
			100 0 (0)	3			Silty CLAY (CI-CH) medium - high plasticity, pale grey, with ironstone gravel/layers, inferred to be at least very stiff	RS								
			100 0 (0)	4												
			100 0 (40)	5			SILTSTONE dark grey and orange brown, with pale grey lamination, bedded at 0-5°, trace iron staining	MW				4.94 m: P, 0-45°, Cv, Sm, Fe Sn 5.05-5.51 m: Px6, 0-5°, sp = 60-200 mm, Pl-St, Sm, Fe Sn 5.10 m: J, 0-45°, Ir, Sm, Fe Sn 5.18 m: J, 0-20°, Ir, Sm, Fe Sn 5.23-5.26 m: J, 70°, Pl, Sm, Fe Sn, 30 mm 5.26 m: EWS, 0°, Fe Sn, 15 mm, weathered siltstone 5.37 m: EWS, 0°, clay, 5 mm 5.57-5.84 m: Jx 14, 5-10°, sp = 10-30 mm, Pl, Sm, Fe Sn 5.72-5.86 m: J, 70°, Pl, Sm, Fe Sn, 140 mm 5.85 m: EWS, 0°, clay Sn, 15 mm 5.91-6.00 m: Px4, 0°, sp = 20-30 mm, Pl, Sm, Fe Sn 6.11-6.47 m: EWSx2, 0°, sp = 30-200 mm, Fe Sn, 60 mm 6.71-8.56 m: Px13, 0°, sp = 30-250 mm, Pl, Sm, Cn 7.03 m: EWS, 0°, 15 mm, weathered siltstone				
			100 75 (90)	6				SW				PLI(A)=0.16 PLI(A)=0.19				
			100 85 (100)	7			no iron staining	FR				PLI(D)=0.03 PLI(A)=0.21 PLI(D)=0.17 PLI(A)=0.28 PLI(A)=0.59 PLI(A)=0.61 PLI(D)=0.73 PLI(A)=0.75				
				8												
				8.75			END OF BOREHOLE @ 8.75 m TARGET DEPTH GROUTED					PLI(D)=0.55 PLI(A)=0.59				
				9												
				10												

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

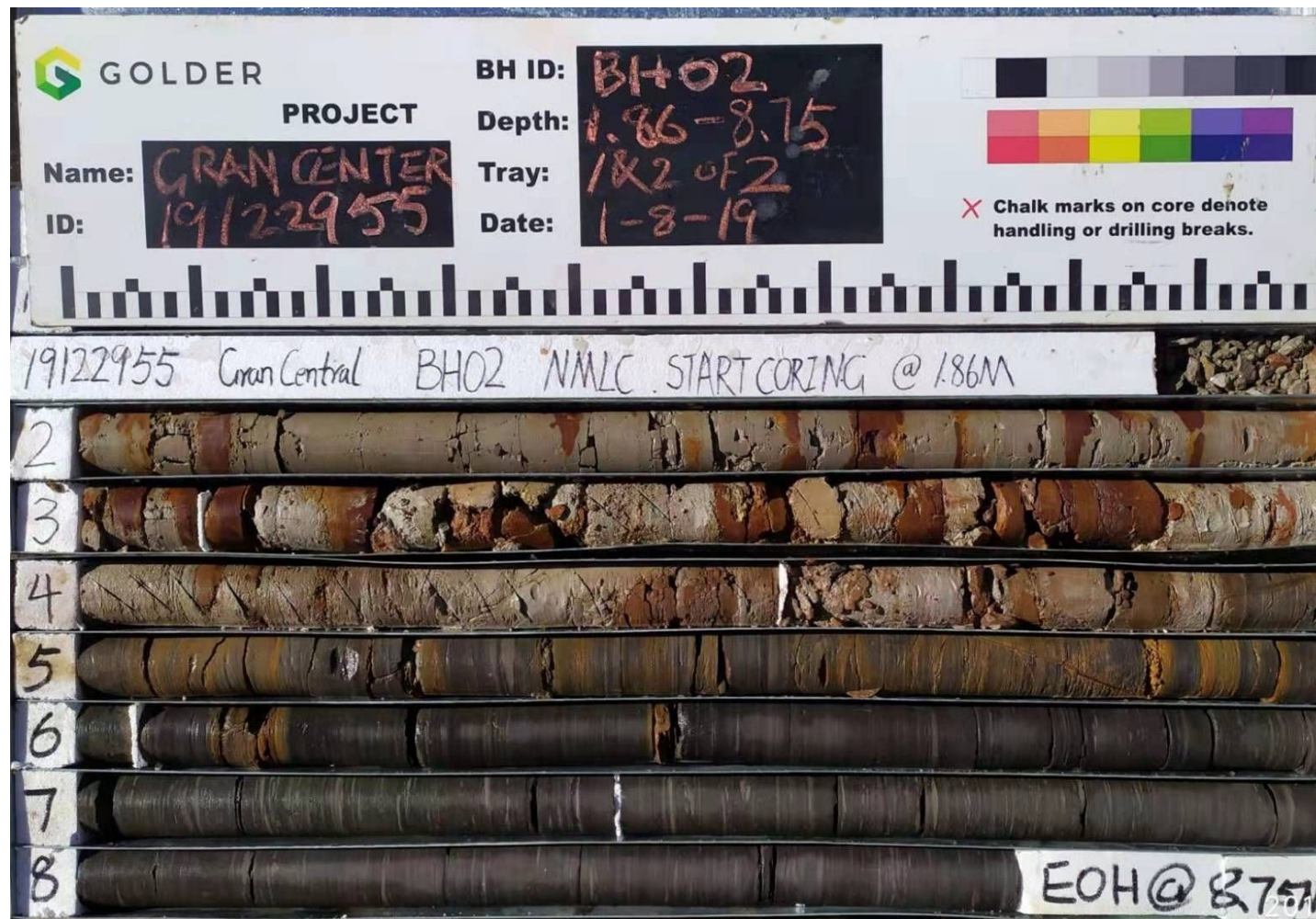
GAP gINT FN. F02a
RL3

CLIENT: PDS and Starrylands
 PROJECT: Proposed Gran Central
 LOCATION: Cnr Parramatta Rd and Good Street, Granville
 JOB NO: 19122955

COORDS: 315954 m E 6254814 m N MGA94 56 (hhGPS)
 SURFACE RL: 12.5 m DATUM: AHD (MAP)
 INCLINATION: -90°
 HOLE DEPTH: 8.75 m

SHEET: 1 OF 1
 DRILL RIG: Komatsu 05
 CONTRACTOR: Nealings
 LOGGED: FY
 CHECKED: BJF

DATE: 1/8/19
 DATE: 20/8/19



This report of core photographs must be read in conjunction with accompanying notes and abbreviations.



GOLDER

DRAFT REPORT OF BOREHOLE: BH03

SHEET: 1 OF 2

CLIENT: PDS and Starrylands

COORDS: 315991 m E 6254810 m N MGA94 56 (hhGPS)

DRILL RIG: Komatsu 05

PROJECT: Proposed Gran Central

SURFACE RL: 12.3 m DATUM: AHD (MAP)

CONTRACTOR: Nealings

LOCATION: Cnr Parramatta Rd and Good Street, Granville

INCLINATION: -90°

LOGGED: FY DATE: 1/8/19

JOB NO: 19122955

HOLE DEPTH: 8.34 m

CHECKED: BJF DATE: 20/8/19

Drilling				Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	M	GWNE	0	12.30	PID = 0 ppm			-	TOPSOIL: Silty CLAY medium to high plasticity, dark brown, trace rootlets and wood fibre	w > PL	-	TOPSOIL
			0.23	DS 0.10-0.20 m	CL-CH			Silty CLAY medium to high plasticity, pale brown to brown mottled red-brown	w > PL	-	RESIDUAL SOIL	
			12.07	PID = 0.1 ppm								
			0.75	DS 0.40-0.50 m								
			10.95	PID = 0 ppm								
			0.95	DS 0.50-0.60 m								
			11.40	DS 0.80-0.90 m								
			1.80	PID = 0 ppm								
			10.50	DS 1.30-1.40 m								
			1.80	PID = 0 ppm								
10.50	DS 1.40-1.50 m											
2	10.50	PID = 0 ppm			-	SILTSTONE pale grey, low to medium strength, extremely weathered	-	-	@ 1.50 m, NDD Target Reached			
2	10.50	SPT 1.50-1.95 m			-	For Continuation Refer to Sheet 2	-	-				
7, 16, 36												
N=52												
PID = 0 ppm												
SPT 2.00-2.12 m												
21/120mm HB												
N=R												
PID = 0 ppm												

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F01a
RL3



SHEET: 2 OF 2

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: FY DATE: 1/8/19

CHECKED: BJB DATE: 20/8/19

NMLC

GAP gINT FN. F02a
RL3

CLIENT: PDS and Starrylands
 PROJECT: Proposed Gran Central
 LOCATION: Cnr Parramatta Rd and Good Street, Granville
 JOB NO: 19122955

COORDS: 315991 m E 6254810 m N MGA94 56 (hhGPS)
 SURFACE RL: 12.3 m DATUM: AHD (MAP)
 INCLINATION: -90°
 HOLE DEPTH: 8.34 m

SHEET: 1 OF 1
 DRILL RIG: Komatsu 05
 CONTRACTOR: Nealings
 LOGGED: FY
 CHECKED: BJF

DATE: 1/8/19
 DATE: 20/8/19



This report of core photographs must be read in conjunction with accompanying notes and abbreviations.



GOLDER

DRAFT REPORT OF BOREHOLE: BH04

SHEET: 1 OF 2

CLIENT: PDS and Starrylands

COORDS: 316031 m E 6254831 m N MGA94 56 (hhGPS)

DRILL RIG: Komatsu 05

PROJECT: Proposed Gran Central

SURFACE RL: 11.0 m DATUM: AHD (MAP)

CONTRACTOR: Nealings

LOCATION: Cnr Parramatta Rd and Good Street, Granville

INCLINATION: -90°

LOGGED: FY

DATE: 29/7/19

JOB NO: 19122955

HOLE DIA: 90 mm HOLE DEPTH: 7.80 m

CHECKED: BJF

DATE: 20/8/19

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	H	GWNE	0	10.98 0.25 10.75	DS 0.10-0.20 m PID = 0.8 ppm DS 0.25-0.35 m PID = 0.7 ppm DS 0.55-0.65 m PID = 1.8 ppm		-	FILL: GRAVEL medium to coarse grained, poorly graded, sub-angular, blue metal	-	FILL
			1		DS 1.05-1.15 m PID = 6.9 ppm DS 1.30-1.35 m PID = 2.4 ppm DS 1.40-1.50 m PID = 3.7 ppm SPT 1.50-1.95 m 6, 12, 17 N=29 U75 2.00-2.35 m		CL-CH	FILL: Gravelly SAND fine to medium grained, fine to coarse, sub rounded to sub angular gravel, trace glass. Silty CLAY medium to high plasticity, brown mottled red-brown	-	RESIDUAL SOIL
			2						w > PL	@ 1.50 m, NDD Target Reached
ADT	M		3	2.80 8.20	DS 2.80-3.00 m SPT 3.00-3.15 m 13 HB N>30		-	SILTSTONE pale grey, low to medium strength, extremely weathered, trace iron staining	w < PL	H
	H		4					For Continuation Refer to Sheet 2		
			5							
			6							
			7							
			8							
			9							
			10							

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F01a
RL3



SHEET: 2 OF 2

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: FY DATE: 29/7/19

CHECKED: BJB DATE: 20/8/19

NMLC

GAP gINT FN. F02a
RL3

CLIENT: PDS and Starrylands
 PROJECT: Proposed Gran Central
 LOCATION: Cnr Parramatta Rd and Good Street, Granville
 JOB NO: 19122955

COORDS: 316031 m E 6254831 m N MGA94 56 (hhGPS)
 SURFACE RL: 11.0 m DATUM: AHD (MAP)
 INCLINATION: -90°
 HOLE DIA: 90 mm HOLE DEPTH: 7.80 m

SHEET: 1 OF 1
 DRILL RIG: Komatsu 05
 CONTRACTOR: Nealings
 LOGGED: FY
 CHECKED: BJF

DATE: 29/7/19
 DATE: 20/8/19



This report of core photographs must be read in conjunction with accompanying notes and abbreviations.



GOLDER

REPORT OF BOREHOLE: BH101

SHEET: 1 OF 3

CLIENT: Starryland
PROJECT: Starrylands - Gran Central
LOCATION: 134-142 Parramatta Road, Granville
JOB NO: 19130799

COORDS: 316004 m 6254801 m (hhGPS)
SURFACE RL: 12.5 m DATUM: AHD (MAP)
INCLINATION: -90°
HOLE DEPTH: 13.52 m

DRILL RIG: Komatsu 05
CONTRACTOR: Nealings
LOGGED: CW DATE: 15/11/19
CHECKED: BC DATE: 18/11/19

Drilling				Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
DTC	-	M	0	0.15	DS 0.15-0.17 m PID = 1.1 ppm			-	CONCRETE: pale grey with purple red and dark grey, rounded to angular aggregate, up to 25mm diameter, 8mm reinforcing bar at 75mm spacing at 100mm cover	-	-	-	ROAD SURFACE
				12.33					FILL: Gravelly SAND fine to coarse grained, dark brown, with silt	D	-	-	FILL
HA	M-H	GWNE during and immediately after auger drilling	1	0.60	DS 0.45-0.50 m PID = 1.1 ppm			CH	FILL: Clayey SILT low liquid limit, dark grey, with fine grained, angular gravel, remnants of earthen ware pipe from 0.20-0.30m	-	-	-	RESIDUAL SOIL
				11.90					Silty CLAY high plasticity, red brown, trace fine to coarse, sub-rounded to sub-angular ironstone gravel				
ADT	L	GWNE during and immediately after auger drilling	2	1.10	DS 1.05-1.15 m PID = 1.2 ppm			-	trace fine sand	w ~ PL	-	-	RESIDUAL SOIL
				11.35					becoming mottled grey, no sand				
WB	L	GWNE during and immediately after auger drilling	3	3.00	DS 1.55-2.00 m SPT 1.55-2.00 m 6, 11, 15 N=26 PID = 1 ppm			H	pale grey with iron indurated bands and gravels grading into extremely weathered siltstone	-	-	-	EXTREMELY WEATHERED MATERIAL
				9.50					DS 2.80-3.25 m SPT 2.80-3.25 m 8, 17, 24 N=41 HB 50mm into second interval PID = 1.1 ppm				
For Continuation Refer to Sheet 2													

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F01a
RL3



GOLDER

REPORT OF BOREHOLE: BH101

SHEET: 2 OF 3

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: CW DATE: 15/11/19

CHECKED: BC DATE: 18/11/19

CLIENT: Starryland

COORDS: 316004 m 6254801 m (hhGPS)

PROJECT: Starrylands - Gran Central

SURFACE RL: 12.5 m DATUM: AHD (MAP)

LOCATION: 134-142 Parramatta Road, Granville

INCLINATION: -90°

JOB NO: 19130799

HOLE DEPTH: 13.52 m

Drilling					Field Material Description					Defect Information				
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)		
				0										
				1										
				2										
				3										
				3.35			Continuation of Sheet 1							
				9.15			Silty CLAY: high plasticity, pale grey, extremely weathered siltstone with iron indurated bands and gravels	RS - XW						
				3.87										
				4.00			CORE LOSS: 130mm							
				8.50			SILTSTONE pale grey	HW						
				4.66										
				7.84			Silty CLAY: high plasticity, pale to dark grey, extremely weathered siltstone, very stiff to hard, with medium strength iron indurated bands and gravels	RS - XW						
				5										
				6										
				6.40										
				6.10			SILTSTONE dark grey, with pale grey sandstone laminations, average bedding dipping at 0-5 degrees, average lamination spacing 10-20mm, average 1-2mm thick	MW - SW						
				7										
				7.70										
				4.72			CORE LOSS: 20mm							
				8			SILTSTONE: as above							
							CORE LOSS: 20mm							
							SILTSTONE: as above	FR						
				9										
				10										

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F02a
RL3



CHECKED: BC DATE: 18/11/19

HOLE DEPTH: 13.52 m

GAP gINT FN. F02a
RL3

CLIENT: Starryland
 PROJECT: Starrylands - Gran Central
 LOCATION: 134-142 Parramatta Road, Granville
 JOB NO: 19130799

COORDS: 316004 m 6254801 m (hhGPS)
 SURFACE RL: 12.5 m DATUM: AHD (MAP)
 INCLINATION: -90°
 HOLE DEPTH: 13.52 m

SHEET: 1 OF 3
 DRILL RIG: Komatsu 05
 CONTRACTOR: Nealings
 LOGGED: CW DATE: 15/11/19
 CHECKED: BC DATE: 18/11/19



This report of core photographs must be read in conjunction with accompanying notes and abbreviations.

CLIENT: Starryland
 PROJECT: Starrylands - Gran Central
 LOCATION: 134-142 Parramatta Road, Granville
 JOB NO: 19130799

COORDS: 316004 m 6254801 m (hhGPS)
 SURFACE RL: 12.5 m DATUM: AHD (MAP)
 INCLINATION: -90°
 HOLE DEPTH: 13.52 m

SHEET: 2 OF 3
 DRILL RIG: Komatsu 05
 CONTRACTOR: Nealings
 LOGGED: CW
 CHECKED: BC

DATE: 15/11/19
 DATE: 18/11/19



This report of core photographs must be read in conjunction with accompanying notes and abbreviations.

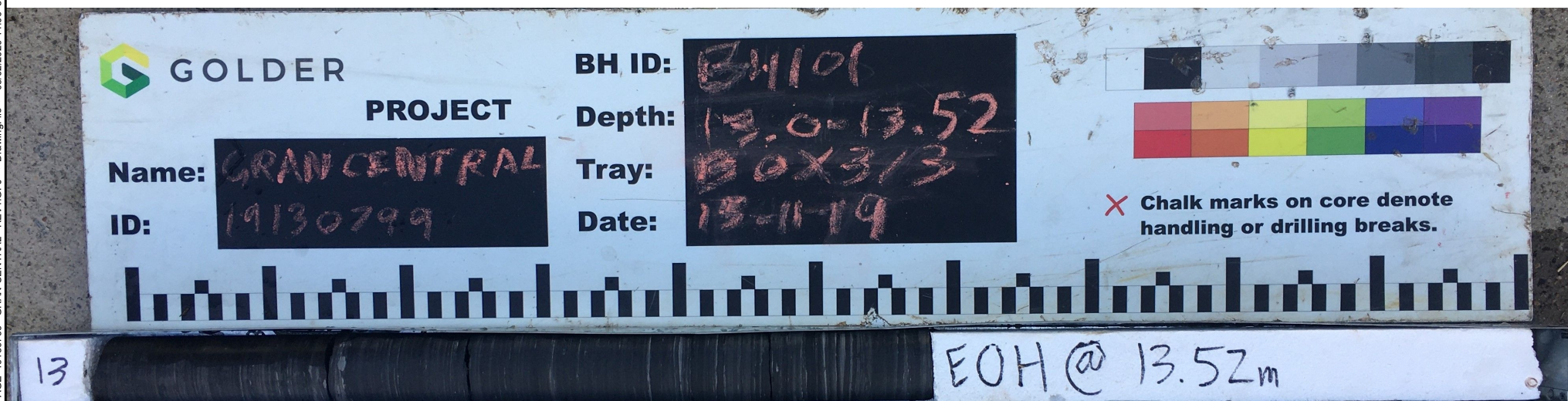
CLIENT: Starryland
 PROJECT: Starrylands - Gran Central
 LOCATION: 134-142 Parramatta Road, Granville
 JOB NO: 19130799

COORDS: 316004 m 6254801 m (hhGPS)
 SURFACE RL: 12.5 m DATUM: AHD (MAP)
 INCLINATION: -90°
 HOLE DEPTH: 13.52 m

SHEET: 3 OF 3
 DRILL RIG: Komatsu 05
 CONTRACTOR: Nealings
 LOGGED: CW
 CHECKED: BC

DATE: 15/11/19
 DATE: 18/11/19

GAP 8_16.8 LIB.GLB GrtTtl GAP CORE PHOTO 1 PER PAGE 19130799 - GRAN CENTRAL - REV4.GPJ <DrawingFiles> 05/02/2020 14:00 8.30.004 Datagel Tools





GOLDER

REPORT OF BOREHOLE: BH101

SHEET: 1 OF 2

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: CW DATE: 15/11/19

CHECKED: BC DATE: 18/11/19

CLIENT: Starryland

PROJECT: Starrylands - Gran Central

LOCATION: 134-142 Parramatta Road, Granville

JOB NO: 19130799

COORDS: 316004 m 6254801 m (hhGPS)

SURFACE RL: 12.5 m DATUM: AHD (MAP)

INCLINATION: -90°

HOLE DEPTH: 13.52 m

Drilling			Sampling	Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)
DTC							ID Static Water Level BH101M
HA							CONSTRUCTION Reference Point gl 12.42 m AHD
ADT							
WB							
NMLC							
GWNE during and immediately after auger drilling							
90-100% Water RETURN							
0		0.15		DS 0.15-0.17 m PID = 1.1 ppm		CONCRETE: pale grey with purple red and dark grey, rounded to angular aggregate, up to 25mm diameter, 8mm reinforcing bar at 75mm spacing at 100mm cover	
12.33		0.60		DS 0.45-0.50 m PID = 1.1 ppm		FILL: Gravelly SAND fine to coarse grained, dark brown, with silt, dry	
11.90		1.10		DS 1.05-1.15 m PID = 1.2 ppm		FILL: Clayey SILT low liquid limit, dark grey, with fine grained, angular gravel, remnants of earthen ware pipe from 0.20-0.30m, Moist, near plastic limit	
11.35		1.45		SPT 1.55-2.00 m 6, 11, 15 N=26 DS 1.55-2.00 m PID = 1 ppm		Silty CLAY high plasticity, red brown, trace fine to coarse, sub-rounded to sub-angular ironstone gravel, Moist, near plastic limit, hard	
2		3.00		SPT 2.80-3.25 m 8, 17, 24 N=41 HB 50mm into second interval		trace fine sand becoming mottled grey, no sand	
9.50		3.35		DS 2.80-3.25 m PID = 1.1 ppm C 3.35-4.66 m		pale grey with iron indurated bands and gravels grading into extremely weathered siltstone	
9.15		3.87				Silty CLAY: high plasticity, pale grey, extremely weathered siltstone with iron indurated bands and gravels	
4		4.00				CORE LOSS: 130mm	
8.50		4.66		C 4.66-5.43 m		SILTSTONE pale grey, low strength, highly weathered	
7.84		5		C 5.43-6.17 m		Silty CLAY: high plasticity, pale to dark grey, extremely weathered siltstone, very stiff to hard, with medium strength iron indurated bands and gravels	
6		6.40		C 6.17-7.66 m			
6.10		7				SILTSTONE dark grey, with pale grey sandstone laminations, average bedding dipping at 0-5 degrees, average lamination spacing 10-20mm, average 1-2mm thick, very low strength, moderately weathered to slightly weathered	
7.70		8		C 7.66-9.20 m		CORE LOSS: 20mm SILTSTONE: as above CORE LOSS: 20mm SILTSTONE: as above	
4.72		9		C 9.20-10.73 m			
10							

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F05
RL3



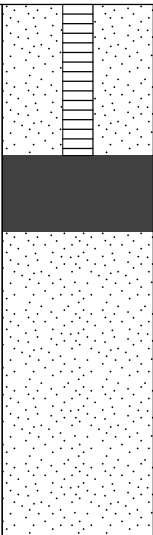
GOLDER

REPORT OF BOREHOLE: BH101

CLIENT: Starryland
PROJECT: Starrylands - Gran Central
LOCATION: 134-142 Parramatta Road, Granville
JOB NO: 19130799

COORDS: 316004 m 6254801 m (hhGPS)
SURFACE RL: 12.5 m DATUM: AHD (MAP)
INCLINATION: -90°
HOLE DEPTH: 13.52 m

SHEET: 2 OF 2
DRILL RIG: Komatsu 05
CONTRACTOR: Nealings
LOGGED: CW DATE: 15/11/19
CHECKED: BC DATE: 18/11/19

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION	Reference Point gl 12.42 m AHD
NMLC	90-100% Water RETURN	10		C 9.20-10.73 m		SILTSTONE: as above			
		11		C 10.73-12.14 m					
		12		C 12.14-13.52 m					
		13							
		13.52	-1.02			END OF BOREHOLE @ 13.52 m TARGET DEPTH STANDPIPE INSTALLED			
		14							
		15							
		16							
		17							
		18							
		19							
		20							

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F05
RL3



GOLDER

REPORT OF BOREHOLE: BH101a

SHEET: 1 OF 1

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: CW DATE: 13/11/19

CHECKED: BC DATE: 18/11/19

CLIENT: Starryland

COORDS: 316003 m 6254803 m (hhGPS)

PROJECT: Starrylands - Gran Central

SURFACE RL: 12.5 m DATUM: AHD (MAP)

LOCATION: 134-142 Parramatta Road, Granville

INCLINATION: -90°

JOB NO: 19130799

HOLE DEPTH: 3.29 m

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	STRUCTURE AND ADDITIONAL OBSERVATIONS
DTC	-		0	0.15				CONCRETE: pale grey with purple red and dark grey, rounded to angular aggregate, up to 25mm diameter, 8mm reinforcing bar at 75mm spacing at 100mm cover	-	ROAD SURFACE
	M			0.25					D	FILL
				0.35				FILL: Sandy GRAVEL	w ~ PL	
				12.15				fine to coarse grained, angular, dark brown, trace silt		
				0.55				FILL: Gravelly SAND		RESIDUAL SOIL
				11.95				fine to coarse grained, angular, pale grey		
HA	M-H		1					FILL: Sandy CLAY		
								high plasticity, dark brown, fine to coarse sand, with silt		
								Silty CLAY		
								high plasticity, red mottled brown and grey, trace fine to coarse, sub-rounded to sub-angular ironstone gravel		
ADT	L		2		SPT 1.65-2.10 m 4, 8, 15 N=23				w ~ PL	
									H	
	M		3	3.00	SPT 3.00-3.29 m 15, 30/140mm HB N>30			pale grey with iron indurated bands and gravels grading into extremely weathered siltstone		EXTREMELY WEATHERED MATERIAL
				9.50						
				9.21						
			4					END OF BOREHOLE @ 3.29 m TARGET DEPTH STANDPIPE INSTALLED		
			5							
			6							
			7							
			8							
			9							
			10							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for hydrogeological purposes only, without attempt to assess geotechnical properties or possible contamination. Any reference to geotechnical properties or potential contamination are for information only and do not necessarily indicate the presence or absence of the properties stated.

GAP gINT FN. F01a
RL3



GOLDER

REPORT OF BOREHOLE: BH101a

SHEET: 1 OF 1

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: CW DATE: 13/11/19

CHECKED: BC DATE: 18/11/19

CLIENT: Starryland

PROJECT: Starrylands - Gran Central

LOCATION: 134-142 Parramatta Road, Granville

JOB NO: 19130799

COORDS: 316003 m 6254803 m (hhGPS)

SURFACE RL: 12.5 m DATUM: AHD (MAP)

INCLINATION: -90°

HOLE DEPTH: 3.29 m

Drilling				Sampling				Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	ID Static Water Level BH101aM	CONSTRUCTION Reference Point gl 12.41 m AHD	
DTC		0	0.15				CONCRETE: pale grey with purple red and dark grey, rounded to angular aggregate, up to 25mm diameter, 8mm reinforcing bar at 75mm spacing at 100mm cover				Grout
		0.25	0.35				FILL: Sandy GRAVEL fine to coarse grained, angular, dark brown, trace silt, dry				Bentonite
		12.15	0.55				FILL: Gravelly SAND fine to coarse grained, angular, pale grey, dry to Moist, near plastic limit				Sand
		11.95					FILL: Sandy CLAY high plasticity, dark brown, fine to coarse sand, with silt, Moist, near plastic limit				50mm PVC
		1					Silty CLAY high plasticity, red mottled brown and grey, trace fine to coarse, sub-rounded to sub-angular ironstone gravel, Moist, near plastic limit, hard				50mm PVC Screen
		2		SPT 1.65-2.10 m 4, 8, 15 N=23							
		3	3.00								
		9.50		SPT 3.00-3.29 m 15, 30/140mm HB N>30			pale grey with iron indurated bands and gravels grading into extremely weathered siltstone				Bentonite
		3.29					END OF BOREHOLE @ 3.29 m TARGET DEPTH STANDPIPE INSTALLED				
		9.21									
		4									
		5									
		6									
		7									
		8									
		9									
		10									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for hydrogeological purposes only, without attempt to assess geotechnical properties or possible contamination. Any reference to geotechnical properties or potential contamination are for information only and do not necessarily indicate the presence or absence of the properties stated.

GAP gINT FN. F05
RL3



GOLDER

REPORT OF BOREHOLE: BH102

SHEET: 1 OF 3

CLIENT: Starryland
PROJECT: Starrylands - Gran Central
LOCATION: 134-142 Parramatta Road, Granville
JOB NO: 19130799

COORDS: 316002 m 6254851 m (hhGPS)
SURFACE RL: 10.9 m DATUM: AHD (MAP)
INCLINATION: -90°
HOLE DEPTH: 12.38 m

DRILL RIG: Komatsu 05
CONTRACTOR: Nealings
LOGGED: CW DATE: 19/11/19
CHECKED: BC DATE: 29/11/19

Drilling				Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
DTC	H	GWNE during and immediately after auger drilling	0	0.11	DS 0.11-0.16 m 2A PID = 1.7 ppm DS 0.45-0.60 m 1A PID = 1.9 ppm DS 1.15-1.20 m 1A PID = 1.9 ppm SPT 1.50-1.95 m 2, 4, 8 N=12 PID = 2.1 ppm							

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F01a
RL3



GOLDER

REPORT OF BOREHOLE: BH102

CLIENT: Starryland
PROJECT: Starrylands - Gran Central
LOCATION: 134-142 Parramatta Road, Granville
JOB NO: 19130799

COORDS: 316002 m 6254851 m (hhGPS)
SURFACE RL: 10.9 m DATUM: AHD (MAP)
INCLINATION: -90°
HOLE DEPTH: 12.38 m

SHEET: 2 OF 3
DRILL RIG: Komatsu 05
CONTRACTOR: Nealings
LOGGED: CW DATE: 19/11/19
CHECKED: BC DATE: 29/11/19

Drilling					Field Material Description					Defect Information				
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)		
				0										
				1										
				2										
				3	3.08		Continuation of Sheet 1							
				3.21			SILTSTONE	HW			3.14-3.21 m: EWS, 0°, recovered as fractured rock			
				7.62			pale grey	RS						
							CORE LOSS: 70mm	XW		UCS=0.140				
							Silty CLAY: high plasticity, pale grey, extremely weathered siltstone, very stiff to hard, with low to medium strength iron indurated bands and gravels			PLI(D)=0.02 PLI(A)=0.01				
				4						PLI(A)=0.01				
					4.52									
					4.62		CORE LOSS: 100mm							
				6.28			Silty CLAY: high plasticity, pale grey, extremely weathered siltstone, very stiff to hard, with low to medium strength iron indurated bands and gravels							
				5										
					5.48									
					5.42		SILTSTONE	HW			5.50 m: P, 0-10°, Un, Sm, fe Ve 5.53 m: EWS, 0-10°, clay, 5mm 5.70-5.75 m: EWS, 0°, clay, 50mm 5.84-5.90 m: EWS, 0°, clay, 60mm			
					5.90		dark grey, with pale grey sandstone laminations, average bedding dipping at 0-5 degrees, average lamination spacing 10-20mm, average 1-2mm thick, ironstained			PLI(A)=0.11 PLI(D)=0.05 PLI(A)=0.09				
				6	4.96		CORE LOSS: 40mm	MW			6.05 m: P, 5°, Pl, Sm, fe Sn 6.13 m: P, 0°, Pl, Sm, Cn 6.25 m: P, 0°, Pl, Sm, Cn 6.37-6.41 m: PX2, 0°, Pl, Sm, fe Ve 6.50-6.54 m: EWS, 0°, clay, 40mm			
					6.54		SILTSTONE: as above	SW		PLI(A)=0.06 PLI(A)=0.06				
					4.26		CORE LOSS: 100mm				6.83 m: P, 0-10°, Pl, Sm, fe Ve 6.88 m: P, 0°, Pl, Sm, Cn 6.93 m: EWS, 0°, recovered as fractured rock, 5mm 6.94 m: P, 0°, Pl, Sm, fe Ve 6.97-6.99 m: J, 40-50°, Pl, Sm 6.99-7.00 m: EWS, 0°, recovered as fractured rock, 5mm			
				7			SILTSTONE: as above			PLI(A)=0.16 PLI(D)=0.16 PLI(A)=0.18 PLI(A)=0.18 PLI(A)=0.18 PLI(A)=0.03				
					7.59		no ironstaining	FR		PLI(A)=0.17 PLI(D)=0.17 PLI(A)=0.21 PLI(A)=0.17 PLI(A)=0.55 PLI(A)=0.52 PLI(A)=0.44 PLI(D)=0.03				
					3.31						7.04-7.09 m: PX5, 0°, Pl, Sm, fe Ve 7.26 m: J, 0-10°, Un, Sm, fe Ve 7.27-7.47 m: EWSX5, 0°, fe Sn, weathered siltstone, 55mm 7.51-7.55 m: PX2, 0°, Pl, Sm, fe Ve 7.79-7.80 m: EWS, 0-10°, clay, 10mm 8.27 m: P, 0°, St, Sm, Cn 8.48 m: J, 5-10°, Pl, Sm, Cn 8.50 m: P, 0°, Pl, Sm, Cn 8.81 m: P, 0°, Pl, Sm, Cn			
				8										
				9						PLI(A)=0.43 PLI(D)=0.30				
											9.52 m: P, 0°, Pl, Sm, Cn			
				10										

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F02a
RL3



GOLDER

REPORT OF BOREHOLE: BH102

SHEET: 3 OF 3

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: CW DATE: 19/11/19

CHECKED: BC DATE: 29/11/19

CLIENT: Starryland

COORDS: 316002 m 6254851 m (hhGPS)

PROJECT: Starrylands - Gran Central

SURFACE RL: 10.9 m DATUM: AHD (MAP)

LOCATION: 134-142 Parramatta Road, Granville

INCLINATION: -90°

JOB NO: 19130799

HOLE DEPTH: 12.38 m

Drilling						Field Material Description						Defect Information										
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa					LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)						
									VL 0.5	L 20	M 60	H 20	VH 80	EH 200			10	30	100	300	1000	3000
NMLC	90-100% Water RETURN		100	100 (100)	10			FR					PLI(A)=0.92 PLI(D)=0.72 PLI(A)=1.46	10.23 m: P, 0-5°, Pl, Sm, Cn 10.56 m: P, 0°, Pl, Sm, Cn								
		100	125 (100)	11																		

CLIENT: Starryland
 PROJECT: Starrylands - Gran Central
 LOCATION: 134-142 Parramatta Road, Granville
 JOB NO: 19130799

COORDS: 316002 m 6254851 m (hhGPS)
 SURFACE RL: 10.9 m DATUM: AHD (MAP)
 INCLINATION: -90°
 HOLE DEPTH: 12.38 m

SHEET: 1 OF 2
 DRILL RIG: Komatsu 05
 CONTRACTOR: Nealings
 LOGGED: CW
 CHECKED: BC

DATE: 19/11/19
 DATE: 29/11/19



This report of core photographs must be read in conjunction with accompanying notes and abbreviations.

CLIENT: Starryland
 PROJECT: Starrylands - Gran Central
 LOCATION: 134-142 Parramatta Road, Granville
 JOB NO: 19130799

COORDS: 316002 m 6254851 m (hhGPS)
 SURFACE RL: 10.9 m DATUM: AHD (MAP)
 INCLINATION: -90°
 HOLE DEPTH: 12.38 m

SHEET: 2 OF 2
 DRILL RIG: Komatsu 05
 CONTRACTOR: Nealings
 LOGGED: CW DATE: 19/11/19
 CHECKED: BC DATE: 29/11/19



This report of core photographs must be read in conjunction with accompanying notes and abbreviations.



GOLDER

REPORT OF BOREHOLE: BH102

SHEET: 1 OF 2

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: CW DATE: 19/11/19

CHECKED: BC DATE: 29/11/19

CLIENT: Starryland

PROJECT: Starrylands - Gran Central

LOCATION: 134-142 Parramatta Road, Granville

JOB NO: 19130799

COORDS: 316002 m 6254851 m (hhGPS)

SURFACE RL: 10.9 m DATUM: AHD (MAP)

INCLINATION: -90°

HOLE DEPTH: 12.38 m

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	ID Static Water Level BH102M	CONSTRUCTION Reference Point gl
DTC		0	0.11	DS 0.11-0.16 m 2A		CONCRETE: pale grey with red and dark grey, sub-angular to angular aggregate, up to 25mm diameter, 8mm reinforcing bar at 100mm spacing at 100mm cover			Grout
		0.30	10.60	PID = 1.7 ppm DS 0.45-0.60 m 1A		FILL: Gravelly SAND fine to coarse grained, dark grey, fine grained, sub-angular to angular gravel, trace silt, moist			Bentonite
		0.80	10.10	PID = 1.9 ppm		FILL: Silty CLAY medium plasticity, brown mottled red, Moist, near plastic limit			
HA		1		DS 1.15-1.20 m 1A		Silty CLAY high plasticity, red, Moist, near plastic limit, firm to hard mottled grey			
		1.80	9.10	PID = 1.9 ppm SPT 1.50-1.95 m 2, 4, 8					
		2.20	8.70	N=12 1A		pale grey with iron indurated bands and gravels grading into extremely weathered siltstone			
ADT				PID = 2.1 ppm		SILTSTONE: pale grey, inferred very low strength and highly weathered			
		3	3.08	SPT 3.00-3.10 m 22/100mm HB					
		3.21		N=R 1A		SILTSTONE pale grey, very low strength, highly weathered			
		7.62		PID = 2 ppm C 3.08-4.52 m		CORE LOSS: 70mm Silty CLAY: high plasticity, pale grey, extremely weathered siltstone, very stiff to hard, with low to medium strength iron indurated bands and gravels			50mm PVC Casing
		4							
		4.52							
		4.62							
		6.28							
		5							
		5.48							
		5.42							
		6	5.90			SILTSTONE dark grey, with pale grey sandstone laminations, average bedding dipping at 0-5 degrees, average lamination spacing 10-20mm, average 1-2mm thick, ironstained, very low strength, highly weathered			
		4.96				CORE LOSS: 40mm SILTSTONE: as above			Sand
		6.54				CORE LOSS: 100mm SILTSTONE: as above			
		4.26							
		7							
		7.59							
		3.31				no ironstaining			
		8							
		9							
		10							50mm PVC Screen

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F05
RL3



GOLDER

REPORT OF BOREHOLE: BH102

SHEET: 2 OF 2

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: CW DATE: 19/11/19

CHECKED: BC DATE: 29/11/19

CLIENT: Starryland

COORDS: 316002 m 6254851 m (hhGPS)

PROJECT: Starrylands - Gran Central

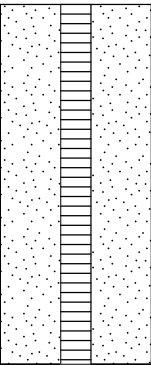
SURFACE RL: 10.9 m DATUM: AHD (MAP)

LOCATION: 134-142 Parramatta Road, Granville

INCLINATION: -90°

JOB NO: 19130799

HOLE DEPTH: 12.38 m

Drilling				Sampling		Field Material Description and Instrumentation				
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION	
									ID Static Water Level BH102M	Reference Point gl
NMLC	90-100% Water RETURN	10		C 9.01-10.40 m						
			C 10.40-11.99 m							
		11								
		12	C 11.99-12.38 m							
		12.38 -1.48					END OF BOREHOLE @ 12.38 m TARGET DEPTH STANDPIPE INSTALLED			
		13								
		14								
		15								
		16								
		17								
		18								
		19								
		20								

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F05
RL3



GOLDER

REPORT OF BOREHOLE: BH102a

SHEET: 1 OF 1

CLIENT: Starryland
PROJECT: Starrylands - Gran Central
LOCATION: 134-142 Parramatta Road, Granville
JOB NO: 19130799

COORDS: 316002 m 6254848 m (hhGPS)
SURFACE RL: 11.0 m DATUM: AHD (MAP)
INCLINATION: -90°
HOLE DEPTH: 5.40 m

DRILL RIG: Komatsu 05
CONTRACTOR: Nealings
LOGGED: CW DATE: 19/11/19
CHECKED: BC DATE: 29/11/19

Drilling				Sampling		Field Material Description																							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS																	
DTC	-	-	0	0.12	SPT 1.50-1.95 m 3, 5, 5 N=10		0.12 0.80 1.30 1.40 9.60	CH	CONCRETE: pale grey with red and dark grey, sub-angular to angular aggregate, up to 25mm diameter, 8mm reinforcing bar at 100mm spacing at 100mm cover	-	-	ROAD SURFACE																	
			10.81	FILL																									
HA	M-H	0.80	10.20	SPT 1.50-1.95 m 3, 5, 5 N=10						0.12 0.80 1.30 1.40 9.60	CH	FILL: Gravelly SAND fine to coarse grained, well graded, dark grey, fine grained, sub-anguar to angular gravel	-	-	FILL														
		1	FILL: Silty CLAY medium plasticity, dark brown mottled red									-	-	RESIDUAL SOIL															
ADT	L	1.30	1.40									SPT 1.50-1.95 m 3, 5, 5 N=10		0.12 0.80 1.30 1.40 9.60	CH	Silty CLAY high plasticity, red mottled grey	-	-	EXTREMELY WEATHERED MATERIAL										
		2	grey mottled red with trace root													-	-												
ADT	M	2.80	8.20													SPT 3.00-3.45 m 13, 15, 19 N=34 HB 100mm into first interval		0.12 0.80 1.30 1.40 9.60		CH	pale grey, inferred extremely weathered siltstone, with low to medium strength iron indurated bands and gravels	-	-						
		3																			-	-							
ADT	M	4																			SPT 3.00-3.45 m 13, 15, 19 N=34 HB 100mm into first interval		0.12 0.80 1.30 1.40 9.60	CH		-	-	WEATHERED ROCK	
		5																							-	-			
ADT	M	5.60			SPT 4.50-4.59 m 10/90mm HB N=R		0.12 0.80 1.30 1.40 9.60	CH																	END OF BOREHOLE @ 5.40 m TARGET DEPTH STANDPIPE INSTALLED	-	-		
		6																							-	-			
ADT	M	7		SPT 4.50-4.59 m 10/90mm HB N=R						0.12 0.80 1.30 1.40 9.60	CH															-	-		
		8																							-	-			
ADT	M	9										SPT 4.50-4.59 m 10/90mm HB N=R		0.12 0.80 1.30 1.40 9.60	CH										-	-			
		10																	-						-				

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GAP gINT FN. F01a
RL3



SHEET: 1 OF 1

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: CW DATE: 19/11/19

CHECKED: BC DATE: 29/11/19

CLIENT: Starrvland

PROJECT: Starrylands - Gran Central

LOCATION: 134-142 Parramatta Road, Granville

JOB NO: 19130799

COORDS: 316002 m 6254848 m (hhGPS)

SURFACE RL: 11.0 m DATUM: AHD (MAP)

INCLINATION: -90°

HOLE DEPTH: 5.40 m

Geotechnical Log Data:

Depth (m)	DT (min)	HA (mm)	ADT (min)	Soil Description	Test Results
0.00 - 0.12	0.12	10.81		CONCRETE: pale grey with red and dark grey, sub-angular to angular aggregate, up to 25mm diameter, 8mm reinforcing bar at 100mm spacing at 100mm cover, dry	
0.12 - 0.80	0.80	10.20		FILL: Gravelly SAND fine to coarse grained, well graded, dark grey, fine grained, sub-angular to angular gravel, dry to Moist, near plastic limit	
0.80 - 1.30	1.30			FILL: Silty CLAY medium plasticity, dark brown mottled red, Moist, near plastic limit	
1.30 - 1.40	1.40			Silty CLAY high plasticity, red mottled grey, Moist, near plastic limit, stiff to very stiff	
1.40 - 1.95	9.60			grey mottled red with trace root	SPT 1.50-1.95 m 3, 5, 5 N=10
1.95 - 2.80				pale grey, inferred extremely weathered siltstone, with low to medium strength iron indurated bands and gravels	
2.80 - 3.00	2.80	8.20		SILTSTONE: pale grey, highly weathered, inferred very low strength with low to medium strength iron indurated bands and gravels	
3.00 - 3.45					SPT 3.00-3.45 m 13, 15, 19 N=34 HB 100mm into first interval
3.45 - 4.50					
4.50 - 4.59					SPT 4.50-4.59 m 10/90mm HB N=R
4.59 - 5.40					

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for hydrogeological purposes only, without attempt to assess geotechnical properties or possible contamination. Any reference to geotechnical properties or potential contamination are for information only and do not necessarily indicate the presence or absence of the properties stated.

GAP gINT FN. F05
RI.3



GOLDER

REPORT OF BOREHOLE: BH103

SHEET: 1 OF 3

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: CW DATE: 12/11/19

CHECKED: BC DATE: 18/11/19

CLIENT: Starryland

COORDS: 315967 m 6254815 m (hhGPS)

PROJECT: Starrylands - Gran Central

SURFACE RL: 12.5 m DATUM: AHD (MAP)

LOCATION: 134-142 Parramatta Road, Granville

INCLINATION: -90°

JOB NO: 19130799

HOLE DEPTH: 13.60 m

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
DTC	-	L	0	12.42	DS 0.08-0.10 m PID = 1.3 ppm			-	CONCRETE: pale grey with purple red and dark grey, rounded to angular aggregate, up to 25mm diameter	-	-	ROAD SURFACE
	0.49			DS 0.10-0.15 m PID = 1.4 ppm	FILL: Silty SAND fine to coarse grained, dark brown, low plasticity silt, with fine grained, angular gravel				D	-	FILL	
HA	M-H	GWNE during and immediately after auger drilling	1	12.01	DS 0.58-0.60 m PID = 1.1 ppm			CH	Silty CLAY high plasticity, dark brown and red and grey	w ~ PL	F	RESIDUAL SOIL
				1.20	DS 0.60-0.65 m PID = 1.6 ppm				grey			
				11.30	DS 1.10-1.25 m PID = 0.9 ppm				increased ironstaining, grading to extremely weathered siltstone.			
				1.53	SPT 1.43-1.68 m 20, 30/100mm HB N>30				For Continuation Refer to Sheet 2			
			2		Hammer bounce starting from 100mm into first interval. PID = 1.3 ppm							EXTREMELY WEATHERED MATERIAL
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F01a
RL3



SHEET: 2 OF 3

DRILL RIG: Komatsu 05
CONTRACTOR: Nealings
LOGGED: CW DATE: 12/11/19
CHECKED: BC DATE: 18/11/19

NMLC	90-100% Water RETURN
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GAP gINT FN. F02a
RL3



GOLDER

REPORT OF BOREHOLE: BH103

SHEET: 3 OF 3

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings

LOGGED: CW DATE: 12/11/19

CHECKED: BC DATE: 18/11/19

CLIENT: Starryland

COORDS: 315967 m 6254815 m (hhGPS)

PROJECT: Starrylands - Gran Central

SURFACE RL: 12.5 m DATUM: AHD (MAP)

LOCATION: 134-142 Parramatta Road, Granville

INCLINATION: -90°

JOB NO: 19130799

HOLE DEPTH: 13.60 m

Drilling						Field Material Description						Defect Information										
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa					LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)						
									VL 0.5	L 20	M 60	H 20	VH 80	EH 200			10	30	100	300	1000	3000
NMLC	90-100% Water RETURN		100 (100)	10			SILTSTONE dark grey, with pale grey sandstone laminations, average bedding dipping at 0-5 degrees, average lamination spacing 10-20mm, average thickness 1-2mm	FR					PLI(D)=0.26 PLI(A)=0.57 PLI(D)=0.37 PLI(A)=0.85 PLI(A)=0.81 PLI(A)=1.09	9.66 m: P, 0°, Pl, Sm, Cn 9.70 m: P, 0°, Pl, Sm, Cn 9.72 m: DB 9.87 m: P, 0°, Pl, Sm, clay Ve 10.07 m: P, 0°, Un, Sm, Cn 10.19 m: DB 10.42-10.51 m: DBX3 10.69 m: P, 0°, Pl, Sm, Cn 10.88 m: P, 0°, Pl, Sm, Cn 11.01 m: HB	11.52-12.68 m: DBX7	12.50 m: P, 5°, Pl, Sm, Cn	13.25 m: P, 0°, Pl, Sm, Cn 13.43 m: P, 0°, Pl, Sm, clay Ve					
				11																		
				12																		
				13																		
				13.60																		
				-1.10																		
				14																		
				15																		
				16																		
				17																		
				18																		
				19																		
				15																		
				16																		
				17																		
				18																		
				19																		
				20																		

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F02a
RL3

CLIENT: Starryland
 PROJECT: Starrylands - Gran Central
 LOCATION: 134-142 Parramatta Road, Granville
 JOB NO: 19130799

COORDS: 315967 m 6254815 m (hhGPS)
 SURFACE RL: 12.5 m DATUM: AHD (MAP)
 INCLINATION: -90°
 HOLE DEPTH: 13.60 m

SHEET: 1 OF 3
 DRILL RIG: Komatsu 05
 CONTRACTOR: Nealings
 LOGGED: CW DATE: 12/11/19
 CHECKED: BC DATE: 18/11/19



This report of core photographs must be read in conjunction with accompanying notes and abbreviations.



REPORT OF CORE PHOTOGRAPHS: BH103

CLIENT: Starryland
PROJECT: Starrylands - Gran Central
LOCATION: 134-142 Parramatta Road, Granville
JOB NO: 19130799

COORDS: 315967 m 6254815 m (hhGPS)
SURFACE RL: 12.5 m DATUM: AHD (MAP)
INCLINATION: -90°
HOLE DEPTH: 13.60 m

SHEET: 2 OF 3
DRILL RIG: Komatsu 05
CONTRACTOR: Nealings
LOGGED: CW DATE: 12/11/19
CHECKED: BC DATE: 18/11/19



This report of core photographs must be read in conjunction with accompanying notes and abbreviations.

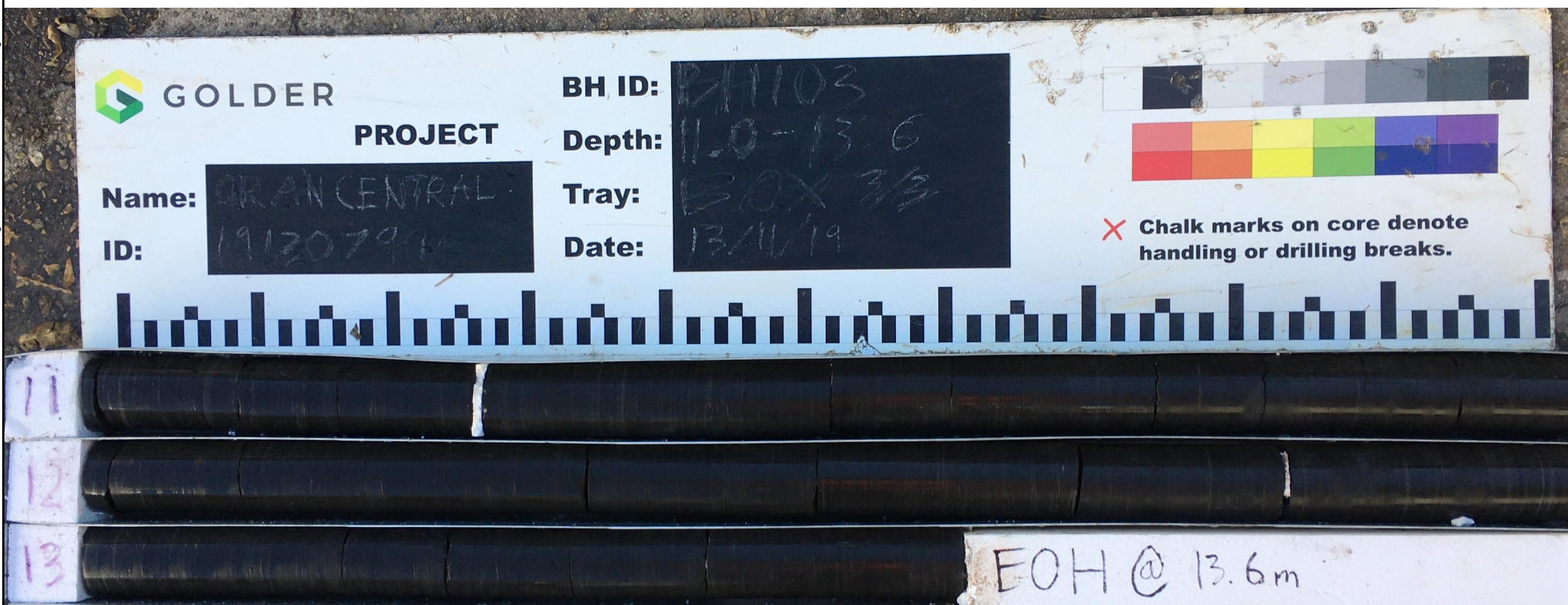
GAP gINT FN. F31
RL1

CLIENT: Starryland
 PROJECT: Starrylands - Gran Central
 LOCATION: 134-142 Parramatta Road, Granville
 JOB NO: 19130799

COORDS: 315967 m 6254815 m (hhGPS)
 SURFACE RL: 12.5 m DATUM: AHD (MAP)
 INCLINATION: -90°
 HOLE DEPTH: 13.60 m

SHEET: 3 OF 3
 DRILL RIG: Komatsu 05
 CONTRACTOR: Nealings
 LOGGED: CW
 CHECKED: BC

DATE: 12/11/19
 DATE: 18/11/19





GOLDER

REPORT OF BOREHOLE: BH104

SHEET: 1 OF 1

CLIENT: Starryland
PROJECT: Starrylands - Gran Central
LOCATION: 134-142 Parramatta Road, Granville
JOB NO: 19130799

COORDS: 315966 m 6254859 m (hhGPS)
SURFACE RL: 10.8 m DATUM: AHD (MAP)
INCLINATION: -90°
HOLE DEPTH: 1.65 m

DRILL RIG: Komatsu 05
CONTRACTOR: Nealings
LOGGED: CW DATE: 15/11/19
CHECKED: BC DATE: 29/11/19

Drilling				Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	STRUCTURE AND ADDITIONAL OBSERVATIONS
DTC	-	-	0	0.15	DS 0.50-0.58 m			-	CONCRETE: pale grey with red and dark grey aggregates	-	ROAD SURFACE
				0.30				-	FILL: Clayey GRAVEL	M	FILL
				10.45				CH	sub-angular to angular, brown, medium plasticity clay	-	
				0.55					Gravelly CLAY		RESIDUAL SOIL
				0.65					medium to high plasticity, grey mottled brown, sub-rounded to sub-angular gravel		
				10.10				CH	red mottled grey, trace gravel		
				10.03	DS 1.45-1.50 m				Silty CLAY		
				1.00					high plasticity, red mottled brown		
				9.75					with fine, sub-rounded to sub-angular gravel		
				9.60					trace gravel		
HA	M-H	GWNE during and immediately after auger drilling	1	1.45					no gravel, red mottled grey		
				9.30					trace fine, sub-angular gravel		
			2						END OF BOREHOLE @ 1.65 m		
									TARGET DEPTH		
									PRODUCTION WELL		
			3								
			4								
			5								
			6								
			7								
			8								
			9								
			10								

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

GAP gINT FN. F01a
RL3



GOLDER

REPORT OF BOREHOLE: BH105

CLIENT: Starryland
PROJECT: Starrylands - Gran Central
LOCATION: 134-142 Parramatta Road, Granville
JOB NO: 19130799

COORDS: 315961 m 6254851 m (hhGPS)
SURFACE RL: 11.0 m DATUM: AHD (MAP)
INCLINATION: -90°
HOLE DEPTH: 1.47 m

SHEET: 1 OF 1
DRILL RIG: Komatsu 05
CONTRACTOR: Nealings
LOGGED: CW DATE: 15/11/19
CHECKED: BC DATE: 29/11/19

Drilling				Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
DTC	-	-	0	0.15	DS 0.42-0.49 m			-	CONCRETE: pale grey with red and dark grey aggregates	-	-	ROAD SURFACE
			0.25				-		-			
0.75			CH	FILL: Gravelly CLAY low to medium plasticity, grey mottled brown, sub-rounded to sub-angular gravel				FILL				
0.45				Silty CLAY high plasticity, red-brown, trace fine, sub-angular gravel				RESIDUAL SOIL				
10.55				no gravel, red mottled grey and brown								
1				grey mottled red								
HA	M-H	Immediately after auger drilling	1.15	9.85	DS 1.30-1.32 m							
		GWNE during and	9.53						END OF BOREHOLE @ 1.47 m REFUSAL ON WEATHERED ROCK PRODUCTION WELL			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

GAP gINT FN. F01a
RL3



GOLDER

REPORT OF BOREHOLE: BH106 (CBR)

SHEET: 1 OF 1

CLIENT: Starryland
PROJECT: Starrylands - Gran Central
LOCATION: 134-142 Parramatta Road, Granville
JOB NO: 19130799

COORDS: 315949 m 6254810 m (hhGPS)
SURFACE RL: 12.8 m DATUM: AHD (MAP)
INCLINATION: -90°
HOLE DEPTH: 1.49 m

DRILL RIG: Komatsu 05
CONTRACTOR: Nealings
LOGGED: CW DATE: 15/11/19
CHECKED: BC DATE: 29/11/19

Drilling				Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
DTC	-	-	0	0.13	BDS 0.30-1.49 m	</						

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F01a
RL3



DRILLING/EXCAVATION METHOD

ADH	Hollow auger drilling	EX	Excavator	PQ3	Diamond core - 83 mm
ADT	Auger drilling with tc-bit	HA	Hand auger	PT	Push tube sampling
ADV	Auger drilling with v-bit	HAND	Excavated by hand methods	RAB	Rotary air blast
AIRCORE	Aircore	HMLC	Diamond core - 63 mm	RC	Reverse circulation
AT	Air track	HQ3	Diamond core - 61 mm	RT	Rock roller
BH	Backhoe bucket	JET	Jetting	SONIC	Sonic drilling
CT	Cable tool rig	MZ	Mazier tube sampling	SPT	Standard penetration testing
DTC	Diatube coring	NDD	Non-destructive digging	U	Undisturbed tube sampling
EE	Existing excavation	NMLC	Diamond core - 52 mm	WB	Washbore drilling
EPT	Extruded push tube	NQ3	Diamond core - 45 mm		

PENETRATION/EXCAVATION RESISTANCE

L	Low resistance. Rapid penetration possible with little effort from the equipment used.
M	Medium resistance. Excavation/possible at an acceptable rate with moderate effort from the equipment used.
H	High resistance to penetration/excavation. Further penetration is possible at a slow rate and requires significant effort from the equipment.
R	Refusal or Practical Refusal. No further progress possible without the risk of damage or unacceptable wear to the digging implement or machine.
These assessments are subjective and are dependent on many factors including the equipment power, weight, condition of excavation or drilling tools, and the experience of the operator.	

WATER

	Water level at date shown		Partial water loss
	Water inflow		Complete water loss
GROUNDWATER NOT OBSERVED	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.		
GROUNDWATER NOT ENCOUNTERED	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.		

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating
30/80 mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed sample
BDS	Bulk disturbed sample
G	Gas Sample
W	Water Sample
FP	Field permeability test over section noted
FV	Field vane shear test expressed as uncorrected shear strength (sv = peak value, sr = residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket penetrometer test expressed as instrument reading in kPa
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
WPT	Water pressure test
DCP	Dynamic cone penetration test
CPT	Cone penetration test
CPTu	Cone penetration test with pore pressure (u) measurement

RANKING OF VISUALLY OBSERVABLE CONTAMINATION AND ODOUR (for specific soil contamination assessment projects)

R = 0	No visible evidence of contamination	R = A	No non-natural odours identified
R = 1	Slight evidence of visible contamination	R = B	Slight non-natural odours identified
R = 2	Visible contamination	R = C	Moderate non-natural odours identified
R = 3	Significant visible contamination	R = D	Strong non-natural odours identified

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)	RQD = Rock Quality Designation (%)	SCR = Solid Core Recovery (%)	F = Fracture Frequency
$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$	$= \frac{\sum \text{Axial lengths of core} > 100 \text{ mm}}{\text{Length of core run}} \times 100$	$= \frac{\sum \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100$	$= \frac{\text{No. of defects}}{\text{Length of zone (m)}}$



SYMBOLS

	FILL		CLAY (CL, CI or CH)
	GRAVEL (GW, GP, GM or GC)		ORGANIC SOILS (OL, OH or Pt)
	SAND (SW, SP, SM or SC)		COBBLES or BOULDERS
	SILT (ML or MH)		

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay.

CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and Rock is classified and described in Reports of Boreholes and Test Pits using the preferred method given in AS1726-2017. The material properties are assessed in the field by visual/tactile methods.

Particle Size			Plasticity Properties
Soil Group	Sub Division	Particle Size	
BOULDERS		> 200 mm	
COBBLES		63 to 200 mm	
GRAVEL	Coarse	19 to 63 mm	
	Medium	6.7 to 19 mm	
	Fine	2.36 to 6.7 mm	
SAND	Coarse	0.6 to 2.36 mm	
	Medium	0.21 to 0.6 mm	
	Fine	0.075 to 0.21 mm	
SILT		0.002 to 0.075 mm	
CLAY		< 0.002 mm	

MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sand and gravels tend to cohere.

Moisture condition for fine grained soils is described relative to the plastic limit or liquid limit as specified in AS1726-2017.

CONSISTENCY AND DENSITY

Fine Grained Soils			Coarse Grained Soils		
Symbol	Term	Undrained Shear Strength	Symbol	Term	Density Index (%)
VS	Very Soft	0 to 12 kPa	VL	Very Loose	Less than 15
S	Soft	12 to 25 kPa	L	Loose	15 to 35
F	Firm	25 to 50 kPa	MD	Medium Dense	35 to 65
St	Stiff	50 to 100 kPa	D	Dense	65 to 85
VSt	Very Stiff	100 to 200 kPa	VD	Very Dense	Above 85
H	Hard	Above 200 kPa			
Fr	Friable	-			

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

* SPT correlations are not stated in AS1726-2017, and may be subject to corrections for overburden pressure and equipment type.

CEMENTATION

Weakly Cemented	The soil may be easily disaggregated by hand in air or water.
Moderately Cemented	Effort is required to disaggregate the soil by hand in air or water.



GOLDER

TERMS FOR ROCK MATERIAL STRENGTH & WEATHERING AND ABBREVIATIONS FOR DEFECT DESCRIPTIONS

STRENGTH

Symbol	Term	UCS (MPa)	Field Guide
VL	Very Low	0.6 to 2	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 30 mm can be broken by finger pressure.
L	Low	2 to 6	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	6 to 20	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	20 to 60	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	60 to 200	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>200	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Material with strength less than 'Very Low' shall be described using soil characteristics. The presence of an original rock structure, fabric or texture should be noted, if relevant.

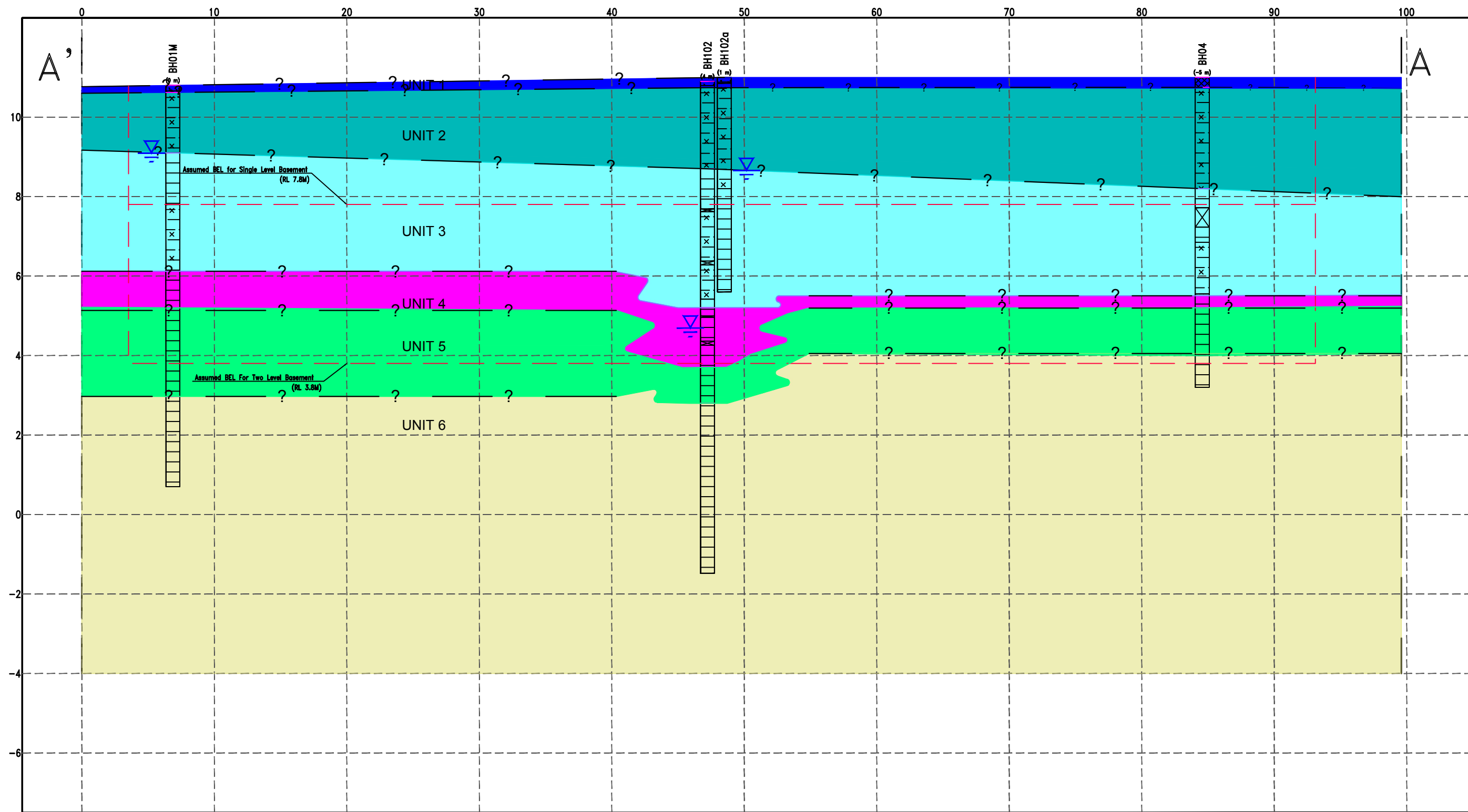
ROCK MATERIAL WEATHERING

ROCK MATERIAL WEATHERING			Field Guide
Symbol	Term		
RS	Residual Soil		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
XW	Extremely Weathered		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.
DW	HW	Highly Weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
	MW	Moderately Weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable, but shows little or no change of strength from fresh rock.
SW	Slightly Weathered		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
FR	Fresh		Rock shows no sign of decomposition of individual minerals or colour changes.

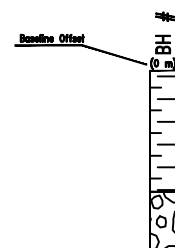
ABBREVIATIONS FOR DEFECT TYPES AND DESCRIPTIONS

Defect Type	Coating or Infilling	Roughness
P Parting	Cn Clean	VRo Very Rough
X Foliation	Sn Stain	Ro Rough
L Cleavage	Ve Veneer	Sm Smooth
C Contact	Ct Coating	Po Polished
J Joint	In Infill	Sl Slickensided
SSu Sheared Surface	Planarity Pl Planar Cv Curved Un Undulating St Stepped Ir Irregular	Vertical Boreholes – The dip (inclination from horizontal) of the defect is given. Inclined Boreholes – The inclination is measured as the acute angle between the core axis and the vertical direction.
SS Sheared Seam		
SZ Sheared Zone		
CS Crushed Seam		
IS Infilled Seam		
EWS Extremely Weathered Seam		
V Vein		

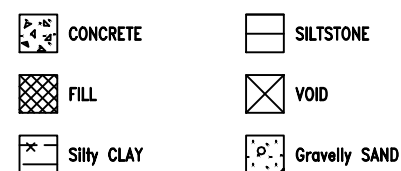
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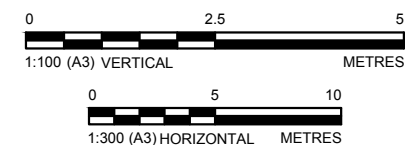
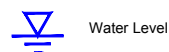
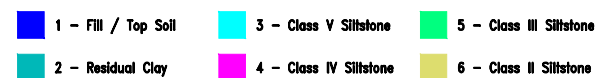
POST LEGEND



MATERIAL GRAPHIC



Ground Units



REV. YYYY-MM-DD DESCRIPTION

FY FY BJF BJF
DESIGNED PREPARED REVIEWED APPROVED

CLIENT
STARRYLAND

CONSULTANT



SYDNEY OFFICE
LEVEL 8, 40 MOUNT STREET
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www.golder.com

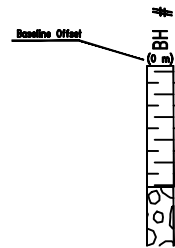
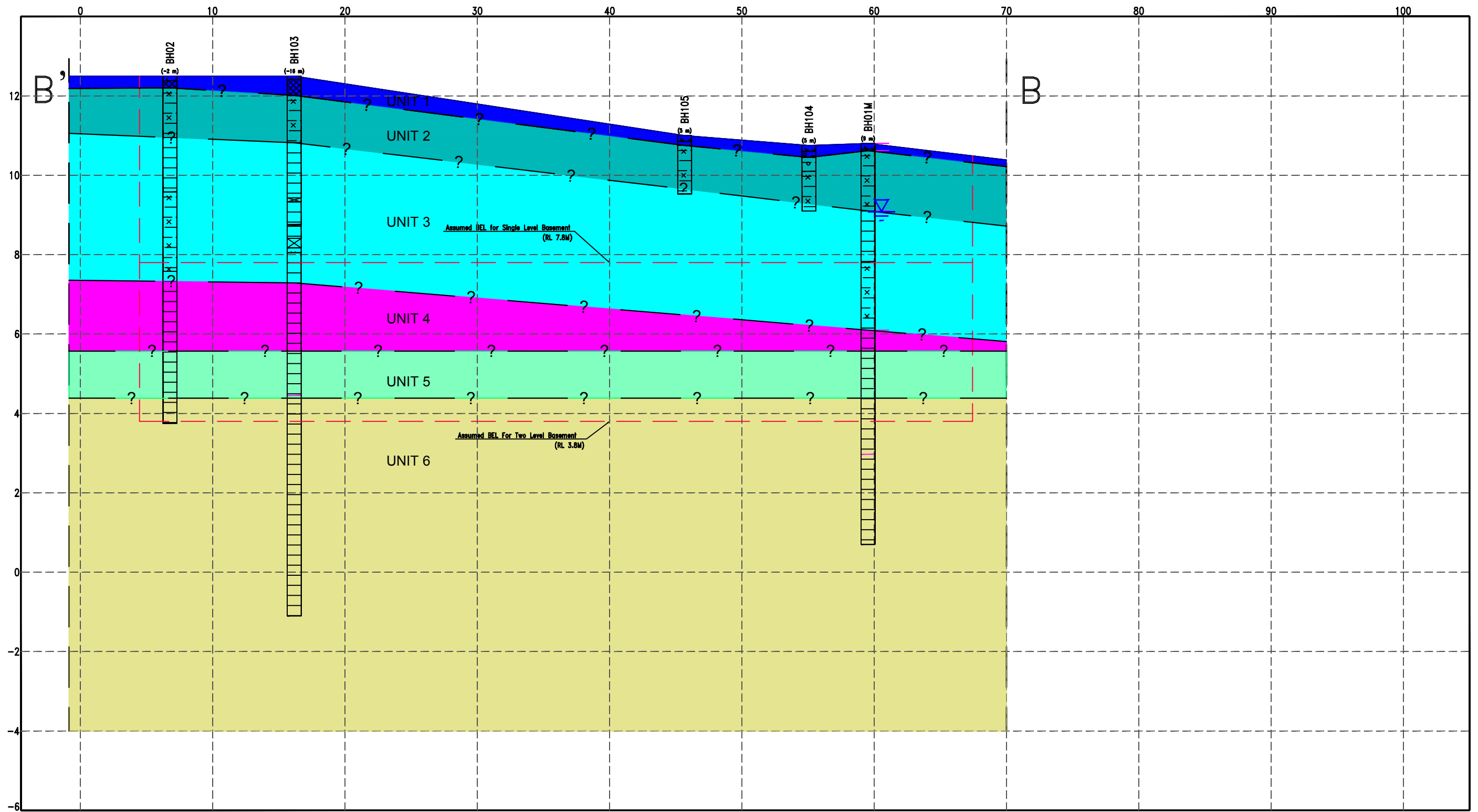
PROJECT
STARRYLANDS - GRAN CENTRAL
134 - 142 PARRAMATTA ROAD, GRANVILLE

TITLE
INFERRED SURFACE SECTION A - A

PROJECT NO. 19130799 CONTROL 003 REV. 0 of FIGURE 7

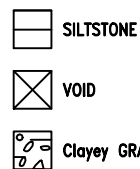
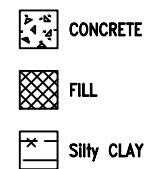
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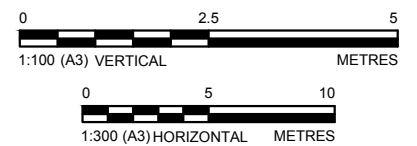
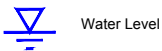
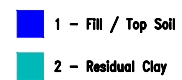


POST LEGEND

MATERIAL GRAPHIC



Ground Units



REV.	YYYY-MM-DD	DESCRIPTION	FY	FY	BJF	BJF
			DESIGNED	PREPARED	REVIEWED	APPROVED

CLIENT
STARRYLAND

CONSULTANT



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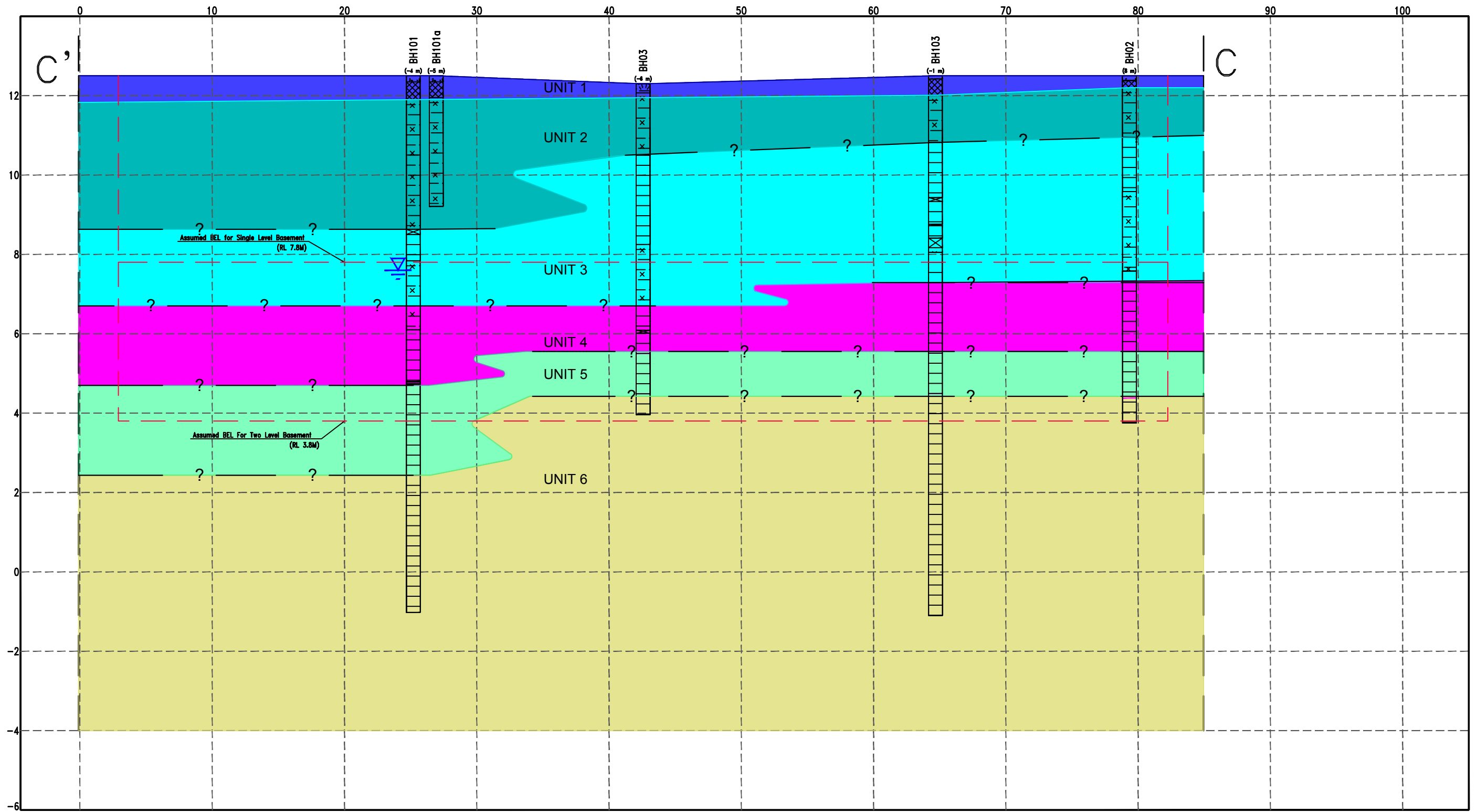
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134 - 142 PARRAMATTA ROAD, GRANVILLE

TITLE
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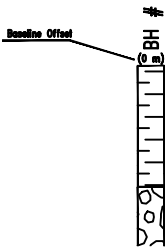
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19130799	003	0		8

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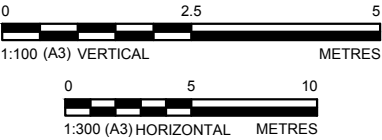


MATERIAL GRAPHIC

- | | |
|------------|-----------|
| CONCRETE | SILTSTONE |
| FILL | TOPSOIL |
| Silty CLAY | VOID |

Ground Units

- | | | |
|---------------------|------------------------|-------------------------|
| 1 - Fill / Top Soil | 3 - Class V Siltstone | 5 - Class III Siltstone |
| 2 - Residual Clay | 4 - Class IV Siltstone | 6 - Class II Siltstone |
- Water Level



REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED

CLIENT
STARRYLAND

CONSULTANT



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PROJECT
STARRYLANDS - GRAN CENTRAL
134 - 142 PARRAMATTA ROAD, GRANVILLE

TITLE
INFERRED SURFACE SECTION C - C

PROJECT NO.	CONTROL	REV.	of	FIGURE
19130799	003	0		9

25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

APPENDIX C

Pressure Meter Test Results

Pressuremeter testing

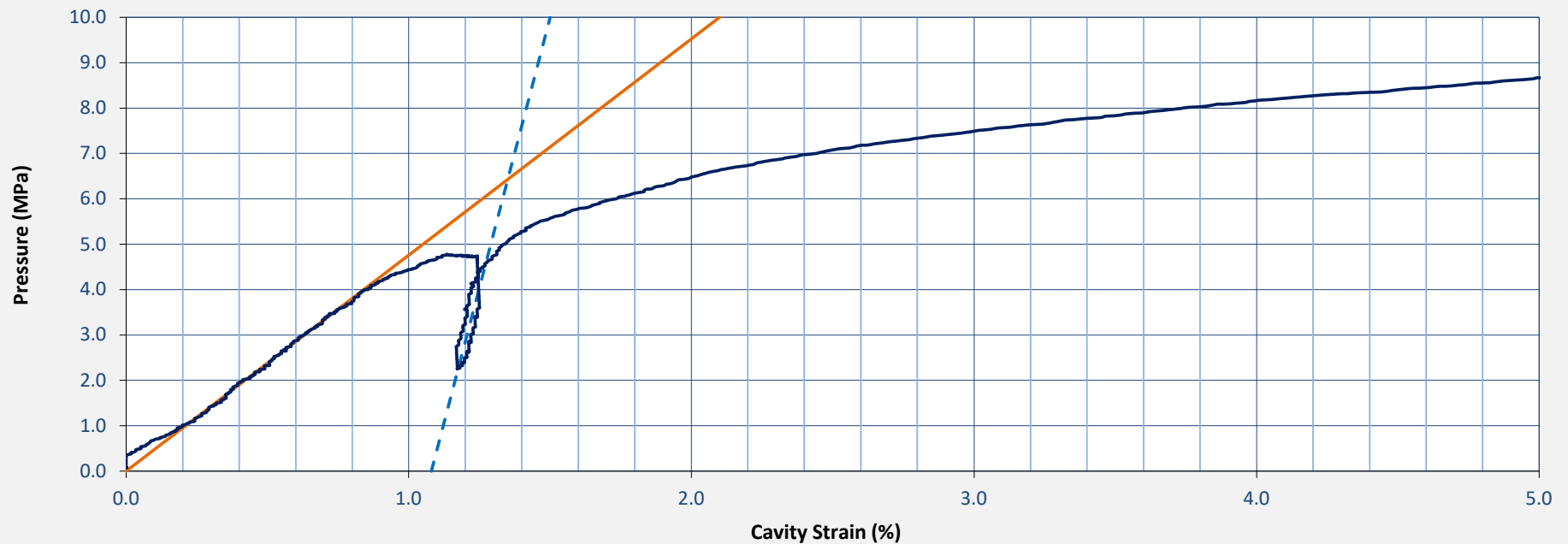
GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS



Pressuremeter Analysis

Project ID:	19130799	Borehole ID:	BH101	Test No:	1	Tested date:	15/11/2019	Golder Associates Pty Ltd Building 7, Botanicca Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Client:	Starryland NSW Pty Ltd c/o PDS Group									
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.									
Material description:	SILTSTONE; pale grey, low strenth, highly weathered.							Depth to test:	4.5	m
								Test RL:	8	m



Legend: — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

Results:	Initial Young's Modulus (E_i) (MPa):	600	Maximum pressure (P_{max}) (MPa):	9.6	Unloading/Reloading Modulus (E_{ur}) (MPa):	3000
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Cert. ref.: PMA_19130799_BH101_1_4.5m

Tests performed by: CW 15/11/2019

Date reported: 31/01/2020

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Results reviewed by: KMM 20/01/2020

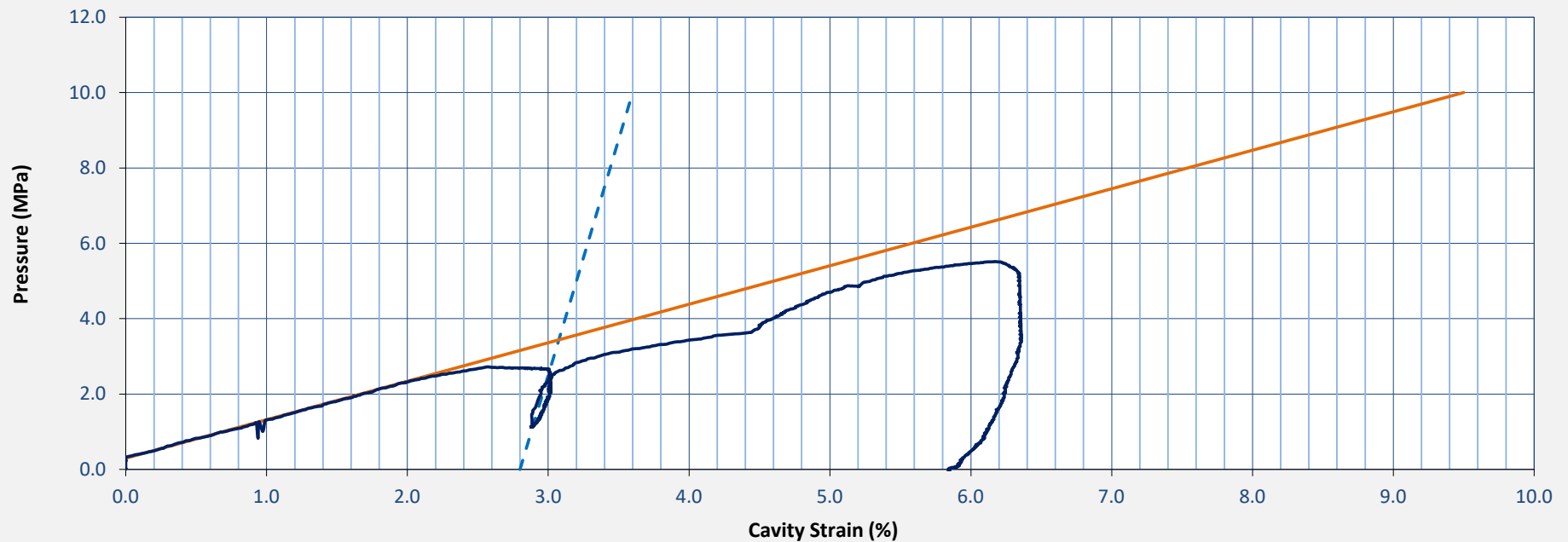
FINAL ISSUE

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH101	Test No:	2	Tested date:	15/11/2019	Golder Associates Pty Ltd
Client:	Starryland NSW Pty Ltd c/o PDS Group							Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.							
Material description:	SILTSTONE; dark grey, very low to low strength, highly weathered to moderately weathered, with pale grey sandstone laminations, bedded at 0							Depth to test: 6.5 m
								Test RL: 6 m



Legend: — Pressure-strain curve — Tangent used to determine initial Young's modulus - - - Tangent used to determine initial Unloading/Reloading Modulus

Results: Initial Young's Modulus (E_i) (MPa): **130** Maximum pressure (P_{max}) (MPa): **5.5** Unloading/Reloading Modulus (E_{ur}) (MPa): **1600**

Cert. ref.: PMA_19130799_BH101_2_6.5m

Tests performed by: CW 15/11/2019

Date reported: 31/01/2020

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Results reviewed by: KMM 20/01/2020

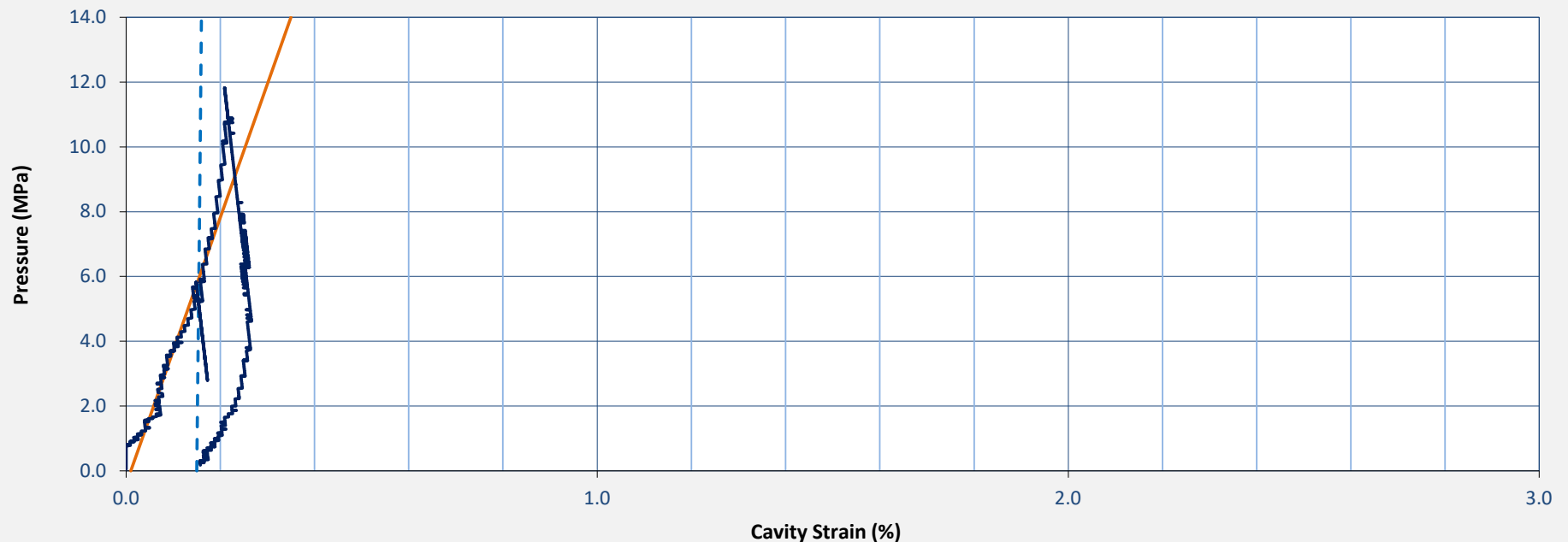
FINAL ISSUE

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH101	Test No:	3	Tested date:	15/11/2019	Golder Associates Pty Ltd Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121
Client:	Starryland NSW Pty Ltd c/o PDS Group							
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.							
Material description:	SILTSTONE; dark grey, medium strength, fresh, with pale grey sandstone laminations, bedded at 0-5 degrees.							Depth to test: 8.5 m Test RL: 4 m

**Legend:** — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

Results:	Initial Young's Modulus (E_i) (MPa):	5200	Maximum pressure (P_{max}) (MPa):	11.8	Unloading/Reloading Modulus (E_{ur}) (MPa):	>10 000
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Cert. ref.: PMA_19130799_BH101_3_8.5m

Tests performed by: CW 15/11/2019

Date reported: 31/01/2020

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Results reviewed by: KMM 20/01/2020

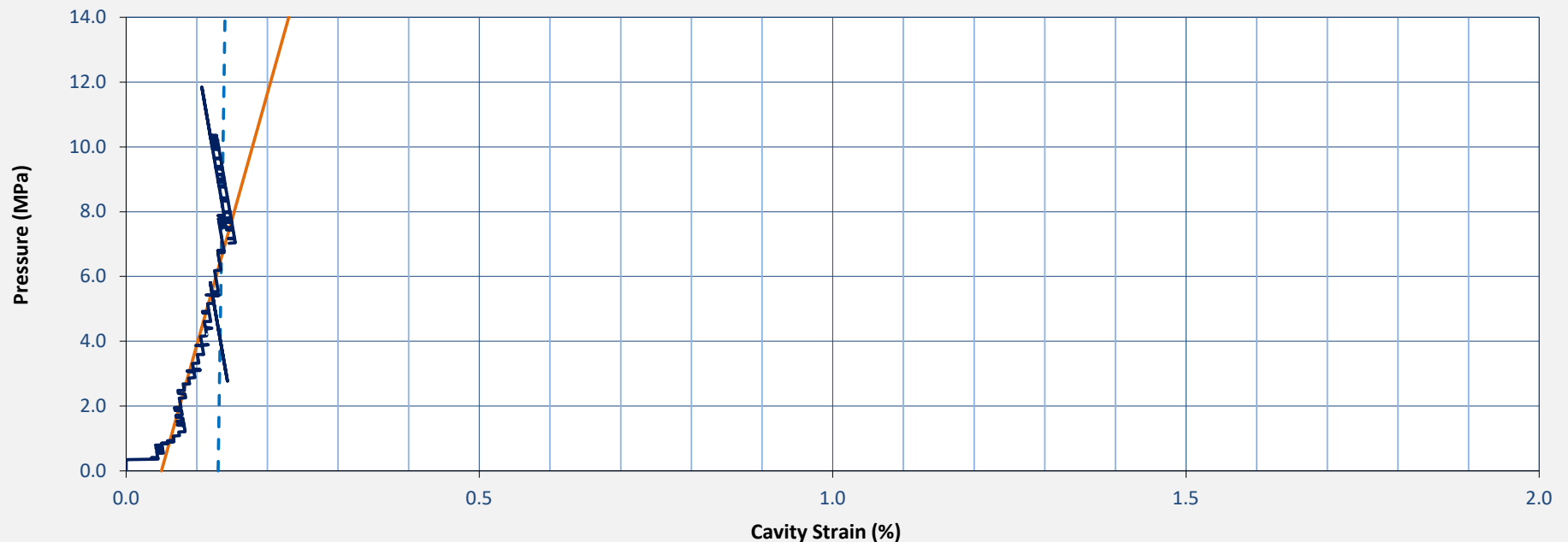
FINAL ISSUE

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH101	Test No:	5	Tested date:	15/11/2019	Golder Associates Pty Ltd Building 7, Botanicca Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121
Client:	Starryland NSW Pty Ltd c/o PDS Group							
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.							
Material description:	SILTSTONE; dark grey, medium strenth, fresh, with pale grey sandstone laminations, bedded at 0-5 degrees.							Depth to test: 10.5 m Test RL: 2 m

**Legend:** — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

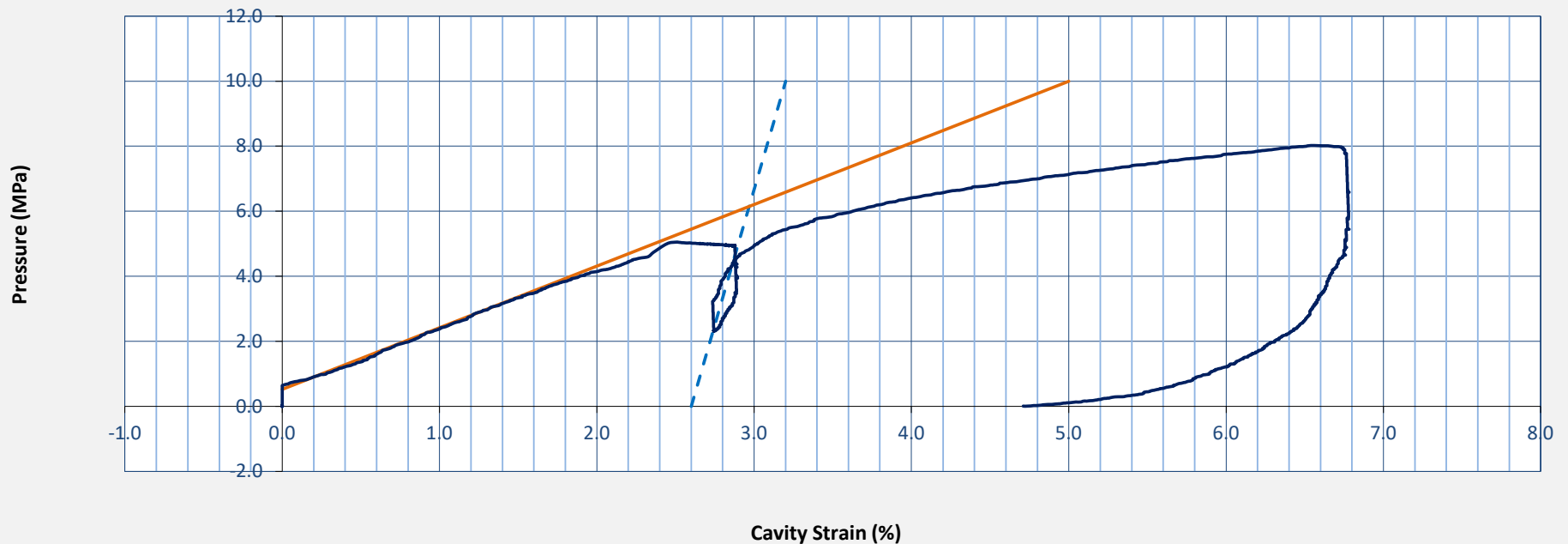
Results:		Initial Young's Modulus (E_i) (MPa):	9900	Maximum pressure (P_{max}) (MPa):	11.8	Unloading/Reloading Modulus (E_{ur}) (MPa):	>10 000	
Cert. ref.:	PMA_19130799_BH101_5_10.5m			Tests performed by:	CW	15/11/2019	Date reported:	31/01/2020
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL				Results reviewed by:	KMM	20/01/2020	FINAL ISSUE	

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH102	Test No:	1	Tested date:	19/11/2019	Golder Associates Pty Ltd Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Client:	Starryland NSW Pty Ltd c/o PDS Group									
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.									
Material description:	SILTSTONE; grey to pale grey, low to medium strength, highly weathered, with pale grey sandstone laminations, bedded at 0-5 degrees.							Depth to test:	3.4	m
								Test RL:	7.5	m

**Legend:** — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

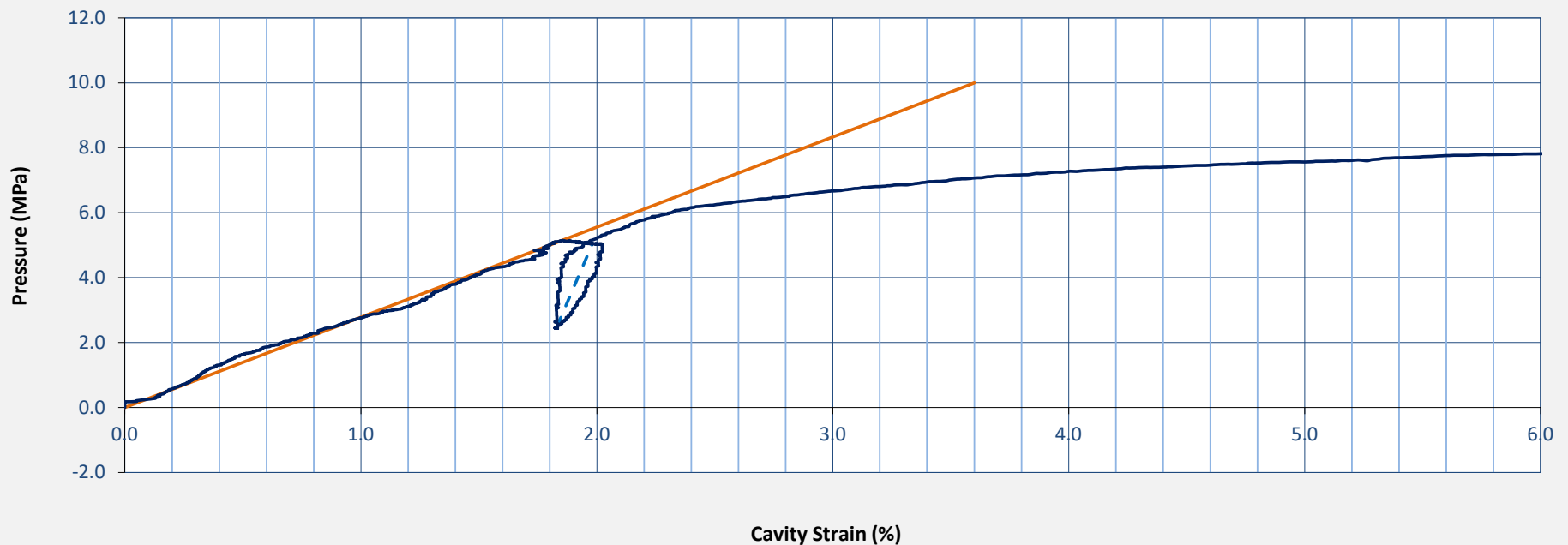
Results:		Initial Young's Modulus (E_i) (MPa):	240	Maximum pressure (P_{max}) (MPa):	8.0	Unloading/Reloading Modulus (E_{ur}) (MPa):	2100	
Cert. ref.:	PMA_19130799_BH102_1_3.4m			Tests performed by:	CW	19/11/2019	Date reported:	31/01/2020
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL				Results reviewed by:	KMM	20/01/2020	FINAL ISSUE	

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH102	Test No:	2	Tested date:	19/11/2019	Golder Associates Pty Ltd Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Client:	Starryland NSW Pty Ltd c/o PDS Group									
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.									
Material description:	SILTSTONE; pale grey, very low strength, extremely weathered to highly weathered, with pale grey sandstone laminations, bedded at 0-5 degree							Depth to test:	5.4	m
								Test RL:	5.5	m

**Legend:** — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

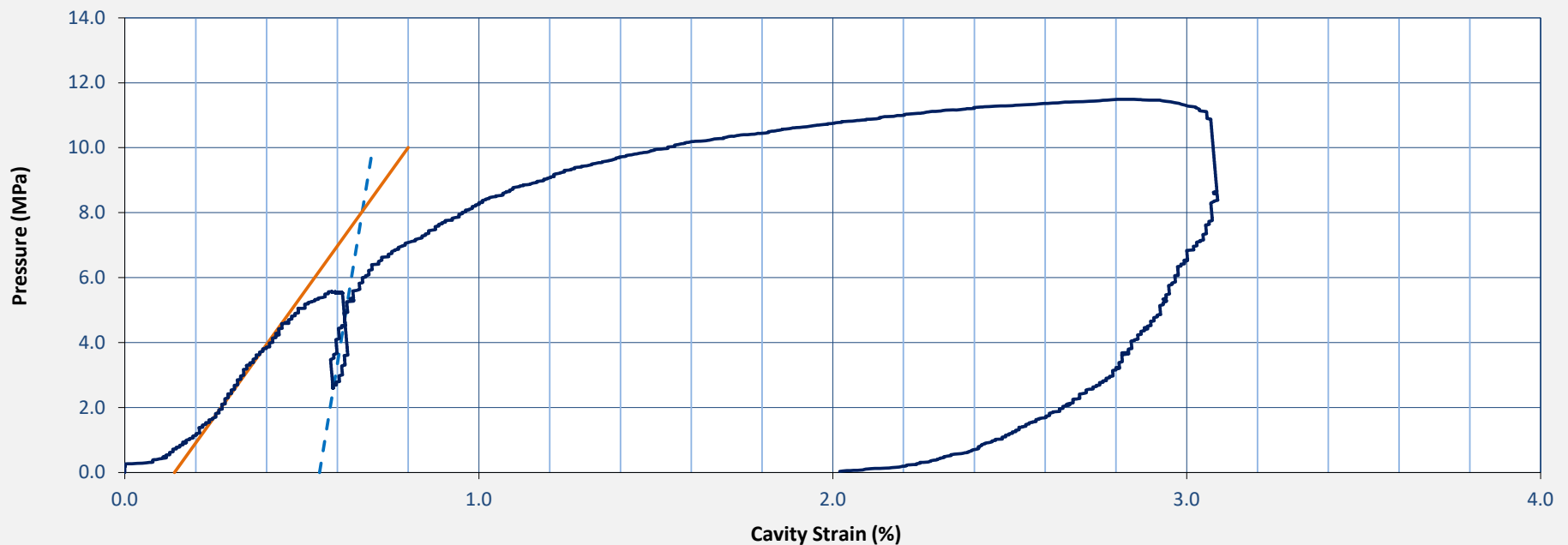
Results:		Initial Young's Modulus (E_i) (MPa):	350	Maximum pressure (P_{max}) (MPa):	7.9	Unloading/Reloading Modulus (E_{ur}) (MPa):	2200	
Cert. ref.:	PMA_19130799_BH102_2_5.4m			Tests performed by:	CW	19/11/2019	Date reported:	31/01/2020
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL				Results reviewed by:	KMM	20/01/2020	FINAL ISSUE	

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH102	Test No:	3	Tested date:	19/11/2019	Golder Associates Pty Ltd Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Client:	Starryland NSW Pty Ltd c/o PDS Group									
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.									
Material description:	SILTSTONE; dark grey, very low to low strenth, slightly weathered, with pale grey sandstone laminations, bedded at 0-5 degrees, trace ironstain							Depth to test:	9.4	m
								Test RL:	1.5	m

**Legend:** — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

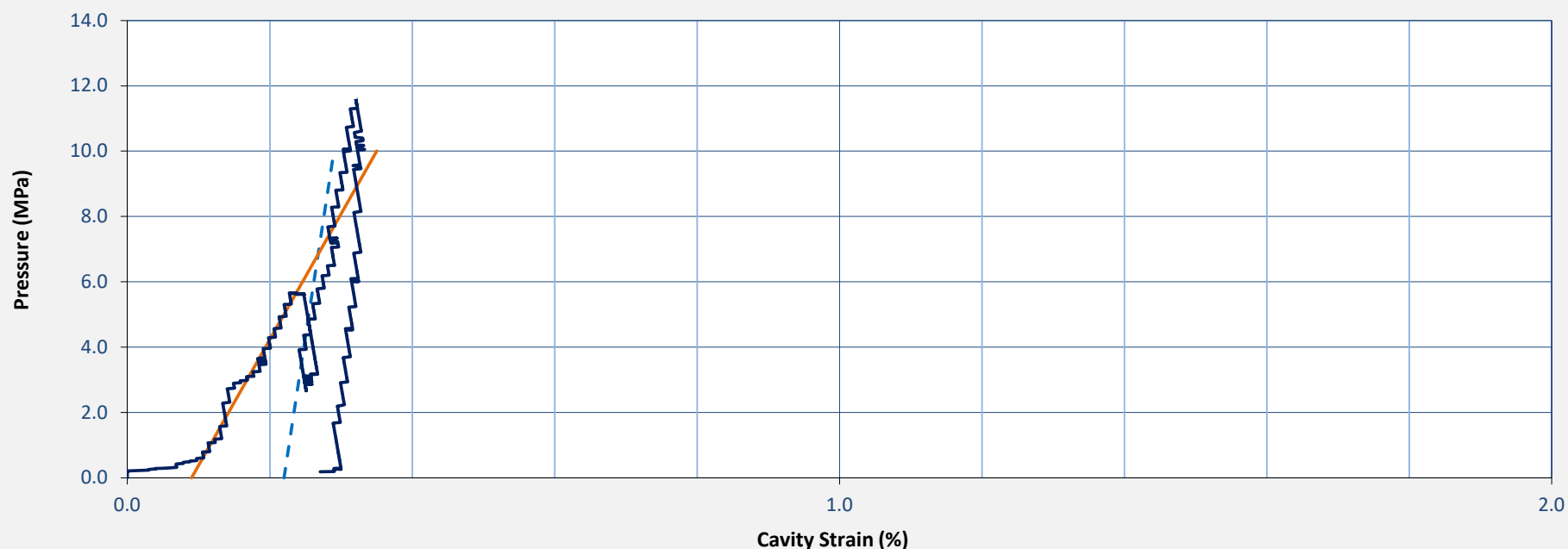
Results:		Initial Young's Modulus (E_i) (MPa):	1900	Maximum pressure (P_{max}) (MPa):	11.5	Unloading/Reloading Modulus (E_{ur}) (MPa):	8500	
Cert. ref.:	PMA_19130799_BH102_3_9.4m			Tests performed by:	CW	19/11/2019	Date reported:	31/01/2020
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL				Results reviewed by:	KMM	20/01/2020	FINAL ISSUE	

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH102	Test No:	4	Tested date:	19/11/2019	Golder Associates Pty Ltd Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121
Client:	Starryland NSW Pty Ltd c/o PDS Group							
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.							
Material description:	SILTSTONE; dark grey, medium strenth, fresh, with pale grey sandstone laminations, bedded at 0-5 degrees.							Depth to test: 9.4 m
								Test RL: 1.5 m

**Legend:** — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

Results:	Initial Young's Modulus (E_i) (MPa):	4900	Maximum pressure (P_{max}) (MPa):	11.6	Unloading/Reloading Modulus (E_{ur}) (MPa):	>10 000
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Cert. ref.: PMA_19130799_BH102_4_9.4m

Tests performed by: CW 19/11/2019

Date reported: 31/01/2020

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Results reviewed by: KMM 20/01/2020

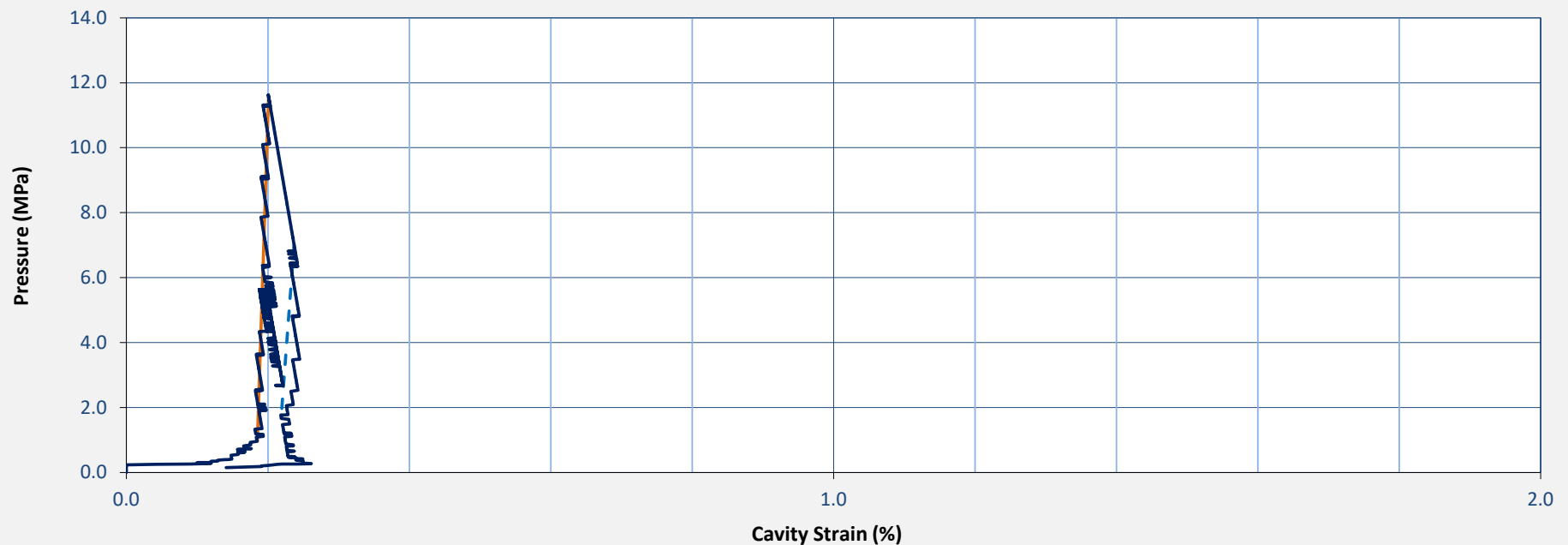
FINAL ISSUE

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH102	Test No:	5	Tested date:	19/11/2019	Golder Associates Pty Ltd Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121
Client:	Starryland NSW Pty Ltd c/o PDS Group							
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.							
Material description:	SILTSTONE; dark grey, medium strenth, fresh, with pale grey sandstone laminations, bedded at 0-5 degrees.							Depth to test: 11.4 m Test RL: -0.5 m

**Legend:** — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

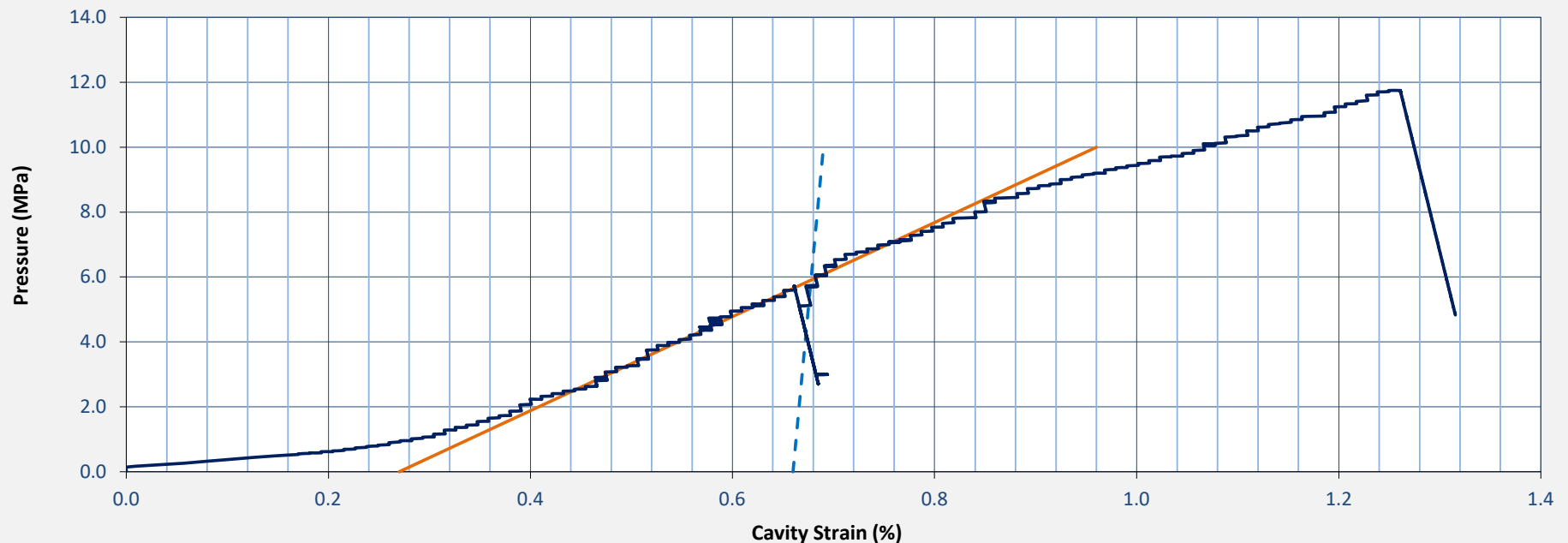
Results:	Initial Young's Modulus (E_i) (MPa):	>10 000	Maximum pressure (P_{max}) (MPa):	11.6	Unloading/Reloading Modulus (E_{ur}) (MPa):	>10 000	
Cert. ref.:	PMA_19130799_BH102_5_11.4m		Tests performed by:	CW	19/11/2019	Date reported:	31/01/2020
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL			Results reviewed by:	KMM	20/01/2019	FINAL ISSUE	

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH103	Test No:	1	Tested date:	12/11/2019	Golder Associates Pty Ltd Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Client:	Starryland NSW Pty Ltd c/o PDS Group									
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.									
Material description:	SILTSTONE: pale grey, medium strength, highly weathered, fractured.							Depth to test:	2.5	m
								Test RL:	10	m

**Legend:** — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

Results:	Initial Young's Modulus (E_i) (MPa):	1800	Maximum pressure (P_{max}) (MPa):	11.7	Unloading/Reloading Modulus (E_{ur}) (MPa):	>10 000
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Cert. ref.: PMA_19130799_BH103_1_2.5m

Tests performed by: CW/RM/FY 12/11/2019

Date reported: 31/01/2020

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Results reviewed by: KMM 20/01/2020

FINAL ISSUE

Pressuremeter testing

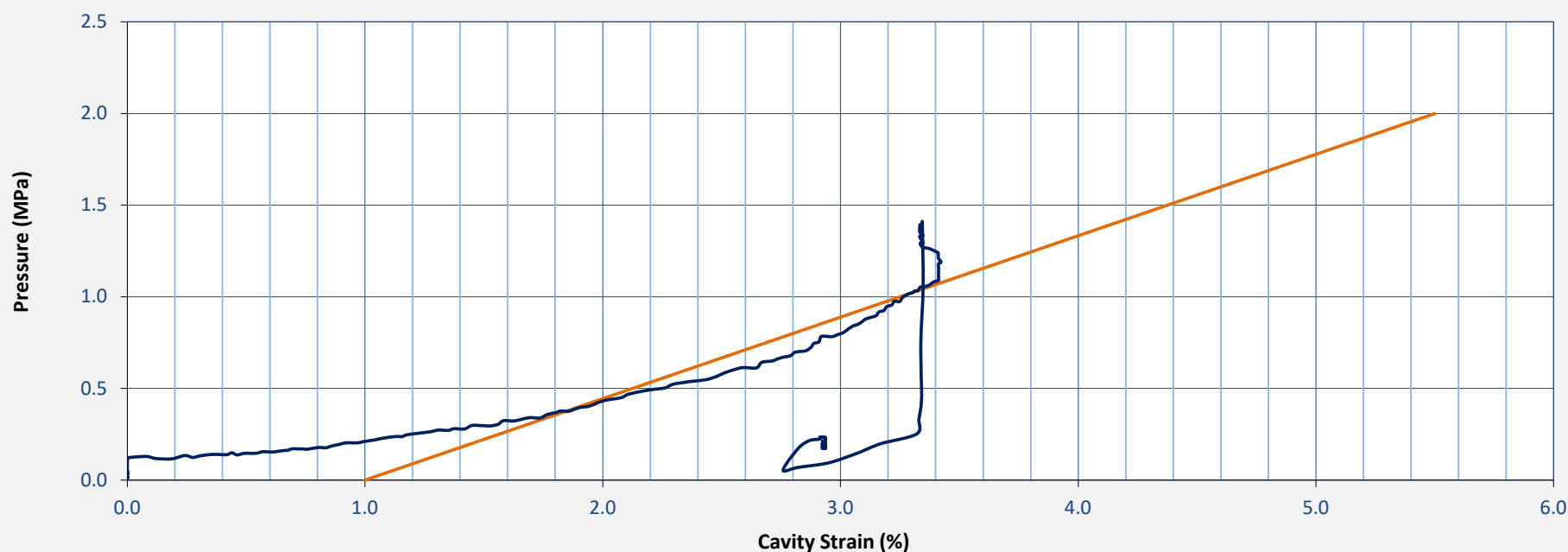
GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS



Pressuremeter Analysis

Project ID:	19130799	Borehole ID:	BH103	Test No:	2	Tested date:	12/11/2019	Golder Associates Pty Ltd Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Client:	Starryland NSW Pty Ltd c/o PDS Group									
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.									
Material description:	SILTSTONE; grey to dark grey, very low strenth, extremely weathered to highly weathered, with ironstaining and pale grey sandstone lamination							Depth to test:	4.5	m
								Test RL:	8	m



Legend: — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

Results:	Initial Young's Modulus (E_i) (MPa):	60	Maximum pressure (P_{max}) (MPa):	1.4	Unloading/Reloading Modulus (E_{ur}) (MPa):	
	Cert. ref.: PMA_19130799_BH103_2_4.5m		Tests performed by:	CW/FY 12/11/2019	Date reported:	31/01/2020
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Note: the test terminated due to achieved the maximum displacement limit, inferred the test section contains a clay layer

Pressuremeter testing

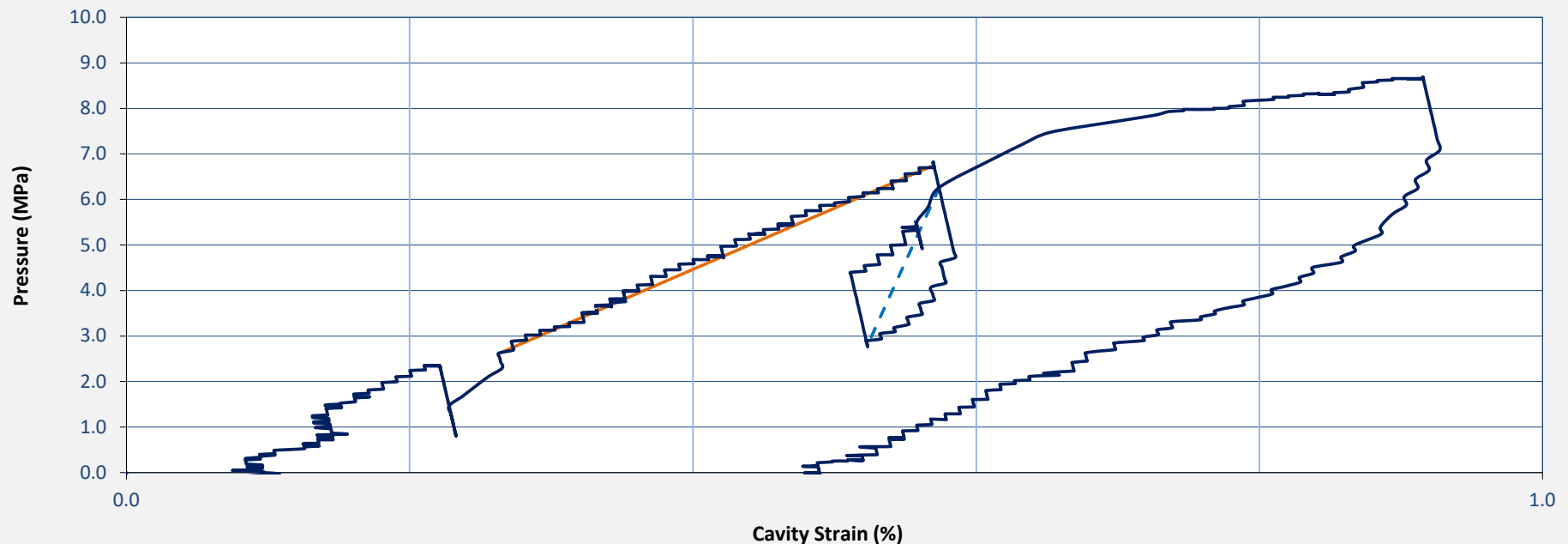
GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS



Pressuremeter Analysis

Project ID:	19130799	Borehole ID:	BH103	Test No:	3	Tested date:	12/11/2019	Golder Associates Pty Ltd Building 7, Botanicca Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Client:	Starryland NSW Pty Ltd c/o PDS Group									
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.									
Material description:	SILTSTONE; dark grey, very low strenth, slightly to moderately weathered, with pale grey sandstone laminations, bedded at 0-5 degrees.							Depth to test:	5	m
								Test RL:	7.5	m



Legend: — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

Results: Initial Young's Modulus (E_i) (MPa): **1700** Maximum pressure (P_{max}) (MPa): **8.7** Unloading/Reloading Modulus (E_{ur}) (MPa): **8700**

Cert. ref.: PMA_19130799_BH103_3_5m

Tests performed by: FY 12/11/2019

Date reported: 31/01/2020

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Results reviewed by: KMM 20/01/2020

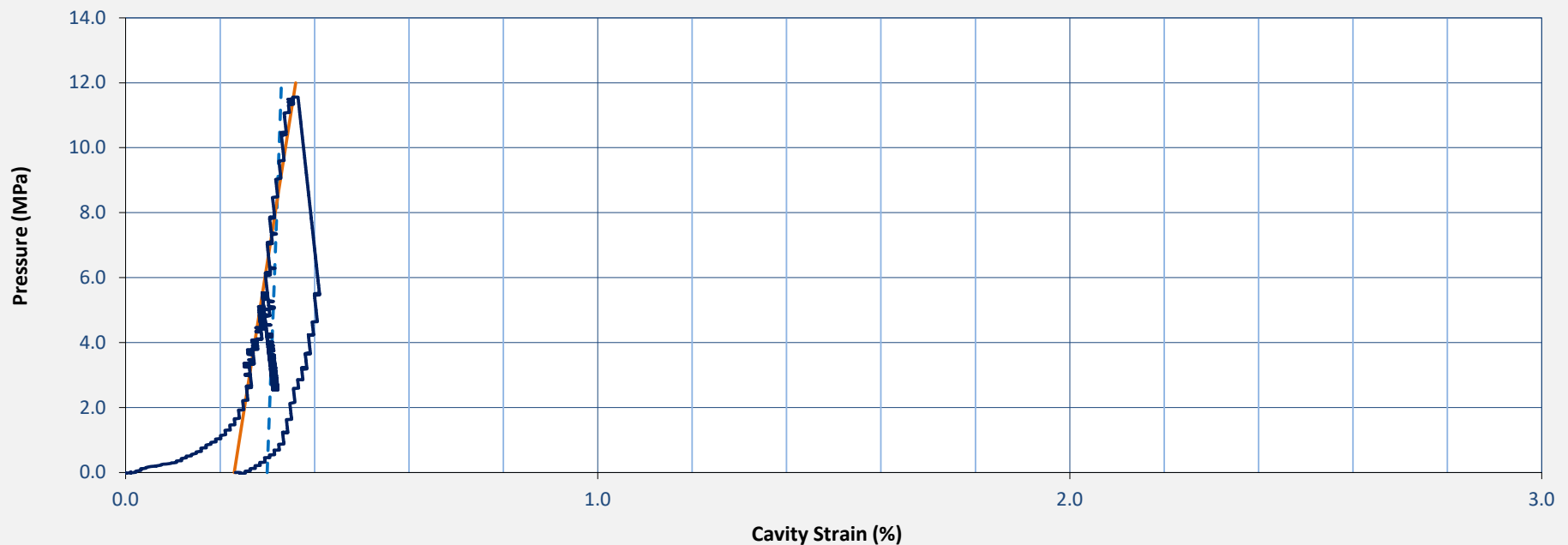
FINAL ISSUE

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH103	Test No:	4	Tested date:	12/11/2019	Golder Associates Pty Ltd Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Client:	Starryland NSW Pty Ltd c/o PDS Group									
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.									
Material description:	SILTSTONE; dark grey, medium strenth, fresh, with pale grey sandstone laminations, bedded at 0-5 degrees.							Depth to test:	6.5	m
								Test RL:	6	m

**Legend:** — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

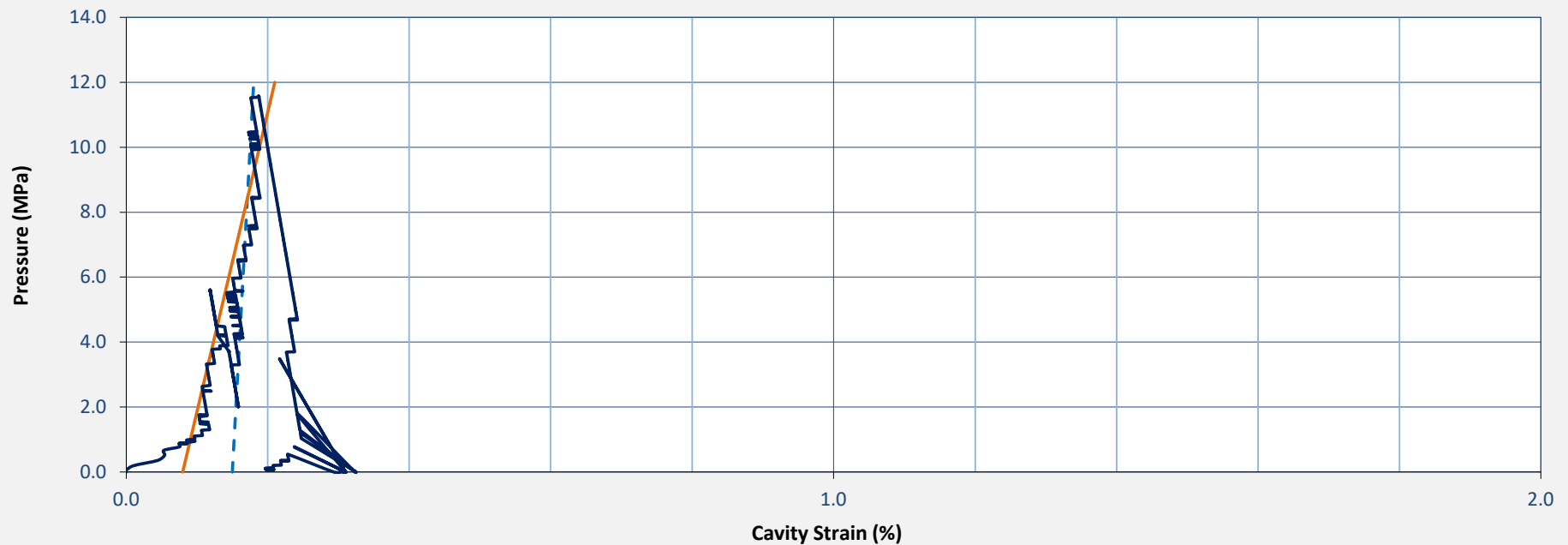
Results:		Initial Young's Modulus (E_i) (MPa):	>10 000	Maximum pressure (P_{max}) (MPa):	11.6	Unloading/Reloading Modulus (E_{ur}) (MPa):	>10 000	
Cert. ref.:	PMA_19130799_BH103_4_6.5m			Tests performed by:	FY	12/11/2019	Date reported:	31/01/2020
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL				Results reviewed by:	KMM	20/01/2020	FINAL ISSUE	

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH103	Test No:	5	Tested date:	12/11/2019	Golder Associates Pty Ltd Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121
Client:	Starryland NSW Pty Ltd c/o PDS Group							
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.							
Material description:	SILTSTONE; dark grey, medium strenth, fresh, with pale grey sandstone laminations, bedded at 0-5 degrees.							Depth to test: 8.5 m Test RL: 4 m

**Legend:** — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

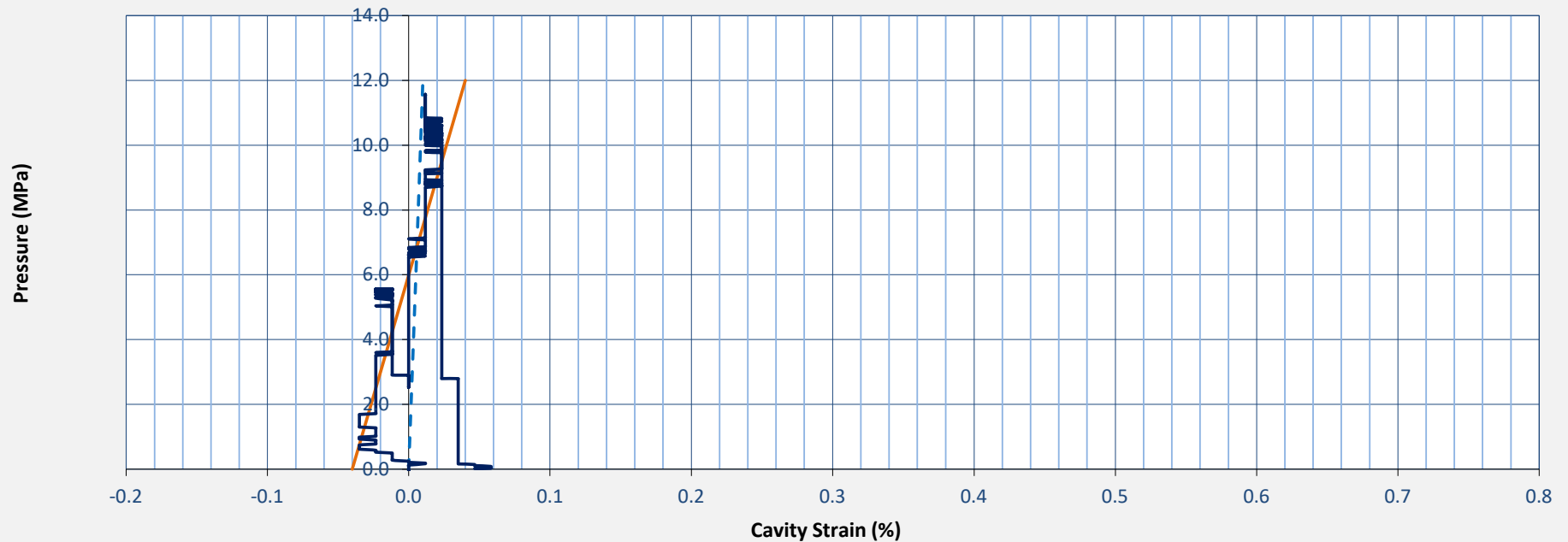
Results:	Initial Young's Modulus (E_i) (MPa):	>10 000	Maximum pressure (P_{max}) (MPa):	11.6	Unloading/Reloading Modulus (E_{ur}) (MPa):	>10 000	
Cert. ref.:	PMA_19130799_BH103_5_8.5m		Tests performed by:	CW	12/11/2019	Date reported:	31/01/2020
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL			Results reviewed by:	KMM	20/01/2020	FINAL ISSUE	

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH103	Test No:	7	Tested date:	12/11/2019	Golder Associates Pty Ltd Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121
Client:	Starryland NSW Pty Ltd c/o PDS Group							
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.							
Material description:	SILTSTONE; dark grey, medium strength, fresh, with pale grey sandstone laminations, bedded at 0-5 degrees.							Depth to test: 10.5 m Test RL: 2 m



Legend: — Pressure-strain curve — Tangent used to determine initial Young's modulus - - - Tangent used to determine initial Unloading/Reloading Modulus

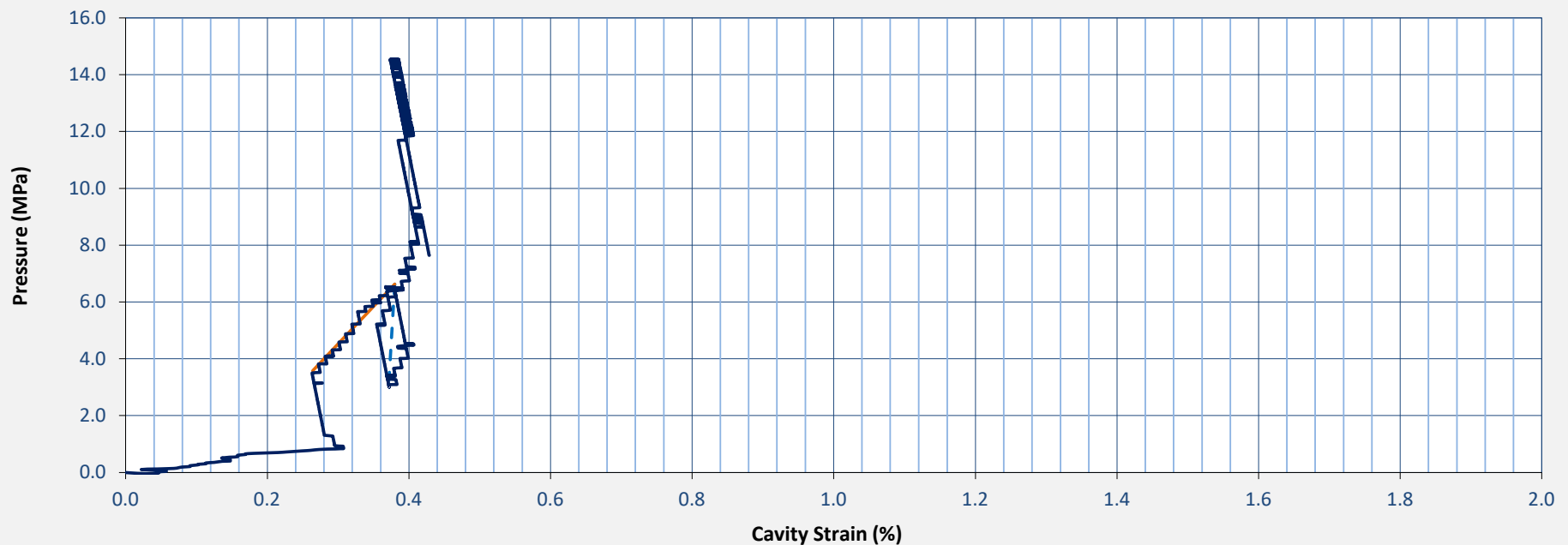
Results:		Initial Young's Modulus (E_i) (MPa):	>10 000	Maximum pressure (P_{max}) (MPa):	11.6	Unloading/Reloading Modulus (E_{ur}) (MPa):	>10 000	
Cert. ref.:	PMA_19130799_BH103_7_10.5m			Tests performed by:	CW	12/11/2019	Date reported:	31/01/2020
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL				Results reviewed by:	KMM	20/01/2020	FINAL ISSUE	

Pressuremeter testing

GA20 (Modified) Pressuremeter

TEST REPORT - SUMMARY OF ANALYSIS**Pressuremeter Analysis**

Project ID:	19130799	Borehole ID:	BH103	Test No:	7	Tested date:	13/11/2019	Golder Associates Pty Ltd Building 7, Botanicca Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121
Client:	Starryland NSW Pty Ltd c/o PDS Group							
Address:	Proposed Gran Central Development, 134-142 Parramatta Road, 26-38 Good Street and 59-61 Cowper Street, Granville.							
Material description:	SILTSTONE; dark grey, medium strenth, fresh, with pale grey sandstone laminations, bedded at 0-5 degrees.							Depth to test: 12.5 m Test RL: 0 m

**Legend:** — Pressure-strain curve

— Tangent used to determine initial Young's modulus

- - - Tangent used to determine initial Unloading/Reloading Modulus

Results:	Initial Young's Modulus (E_i) (MPa):	3300	Maximum pressure (P_{max}) (MPa):	14.5	Unloading/Reloading Modulus (E_{ur}) (MPa):	>10 000
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Cert. ref.: PMA_19130799_BH103_7_12.5m

Tests performed by: CW 13/11/2019

Date reported: 31/01/2020

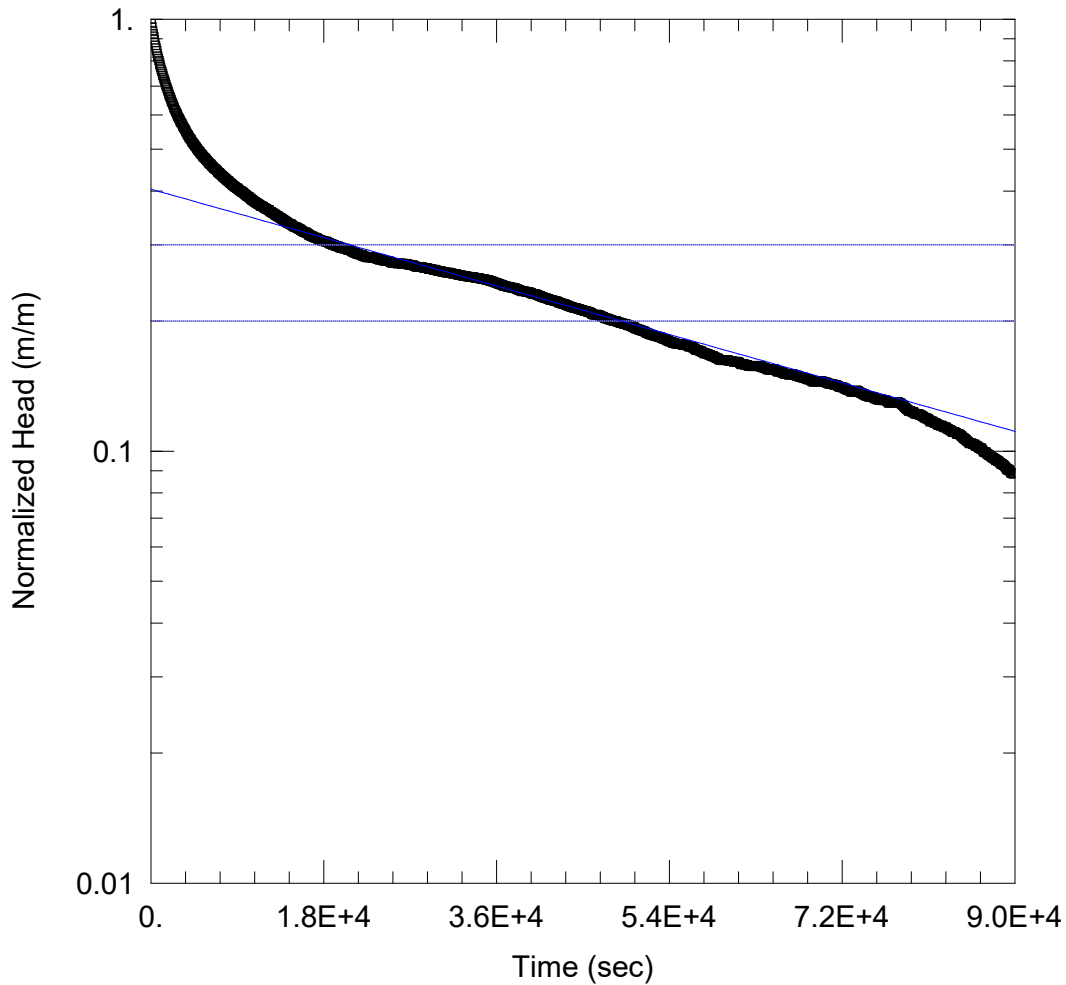
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Results reviewed by: KMM 20/01/2020

FINAL ISSUE

APPENDIX D

Hydraulic Conductivity Results



SLUG TEST 01

Data Set: E:\...\slugBH01 BoR.aqt
 Date: 02/03/20

Time: 08:22:51

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
 Project: 19130799
 Location: Gran Central
 Test Well: BH01

AQUIFER DATA

Saturated Thickness: 4. m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (New Well)

Initial Displacement: 0.8876 m
 Total Well Penetration Depth: 4. m
 Casing Radius: 0.025 m

Static Water Column Height: 4. m
 Screen Length: 3.5 m
 Well Radius: 0.048 m

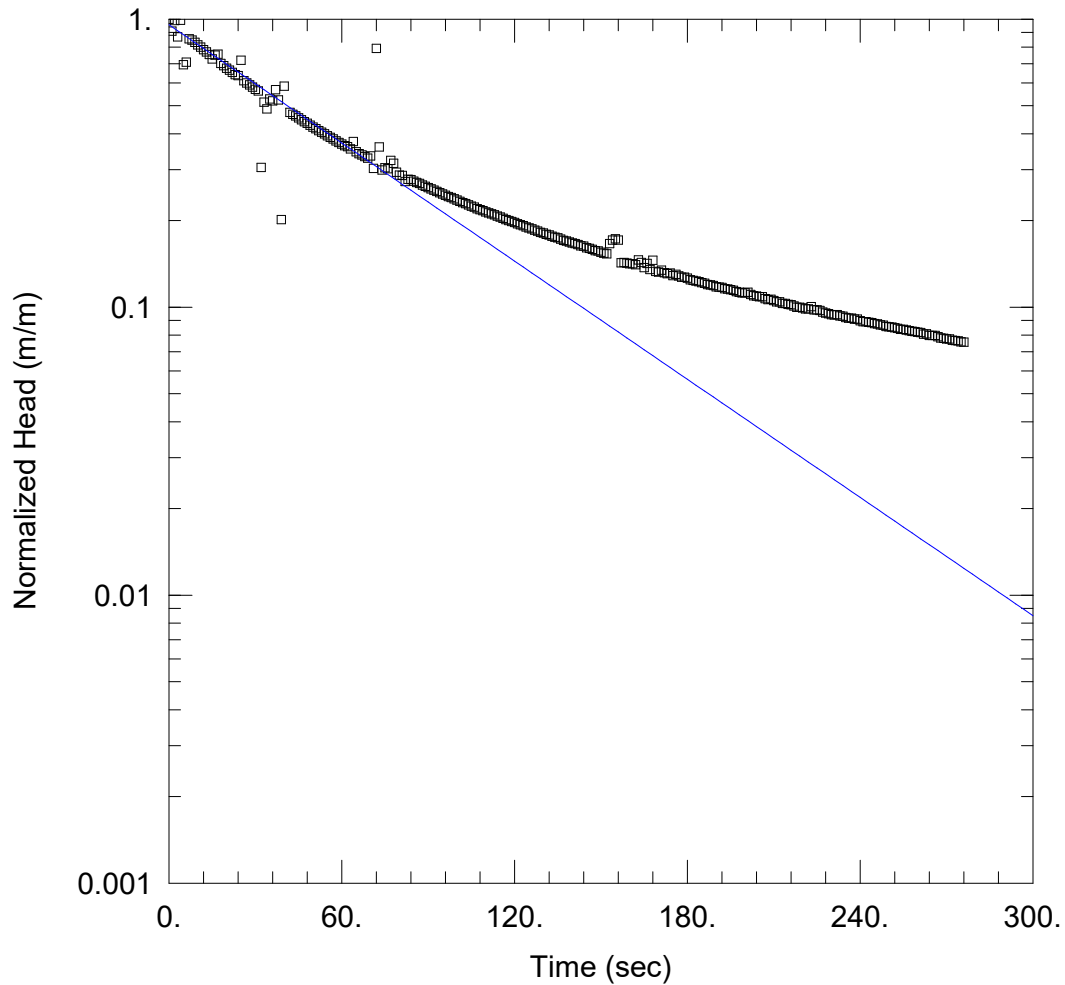
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 4.321E-9$ m/sec

$y_0 = 0.3584$ m



TEST 01

Data Set: E:\...\BH101 T01 BoR.aqt

Date: 02/03/20

Time: 08:25:11

PROJECT INFORMATION

Company: Golder Associates

Client: --

Project: 19130799

Location: --

Test Well: BH101

Test Date: 9 Dec 2019

AQUIFER DATA

Saturated Thickness: 5.97 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (New Well)

Initial Displacement: 0.7283 m

Static Water Column Height: 5.97 m

Total Well Penetration Depth: 5.97 m

Screen Length: 5.9 m

Casing Radius: 0.025 m

Well Radius: 0.048 m

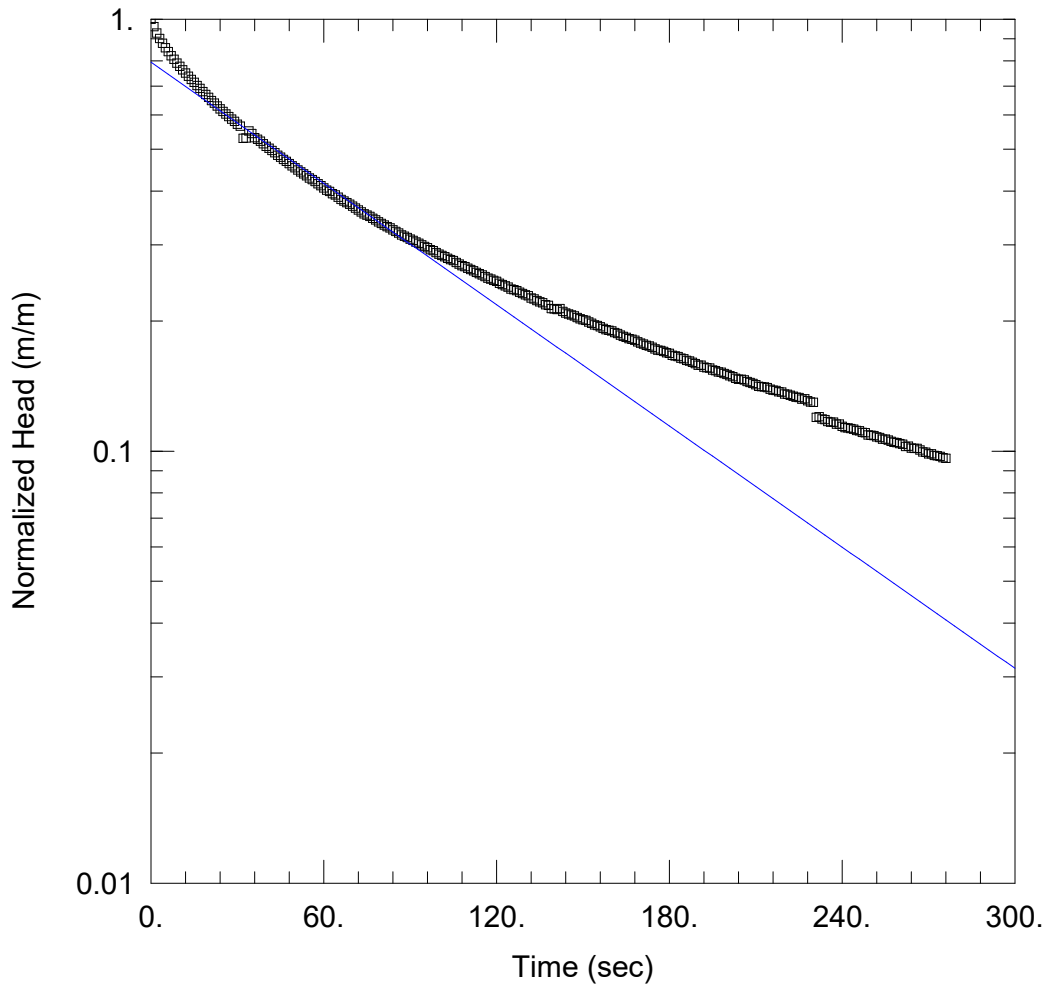
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 3.097E-6$ m/sec

$y_0 = 0.6959$ m



TEST 02

Data Set: E:\...\BH101 T02 BoR.aqt
 Date: 02/03/20

Time: 08:26:02

PROJECT INFORMATION

Company: Golder Associates
 Client: --
 Project: 19130799
 Location: --
 Test Well: BH101
 Test Date: 9 Dec 2019

AQUIFER DATA

Saturated Thickness: 5.97 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

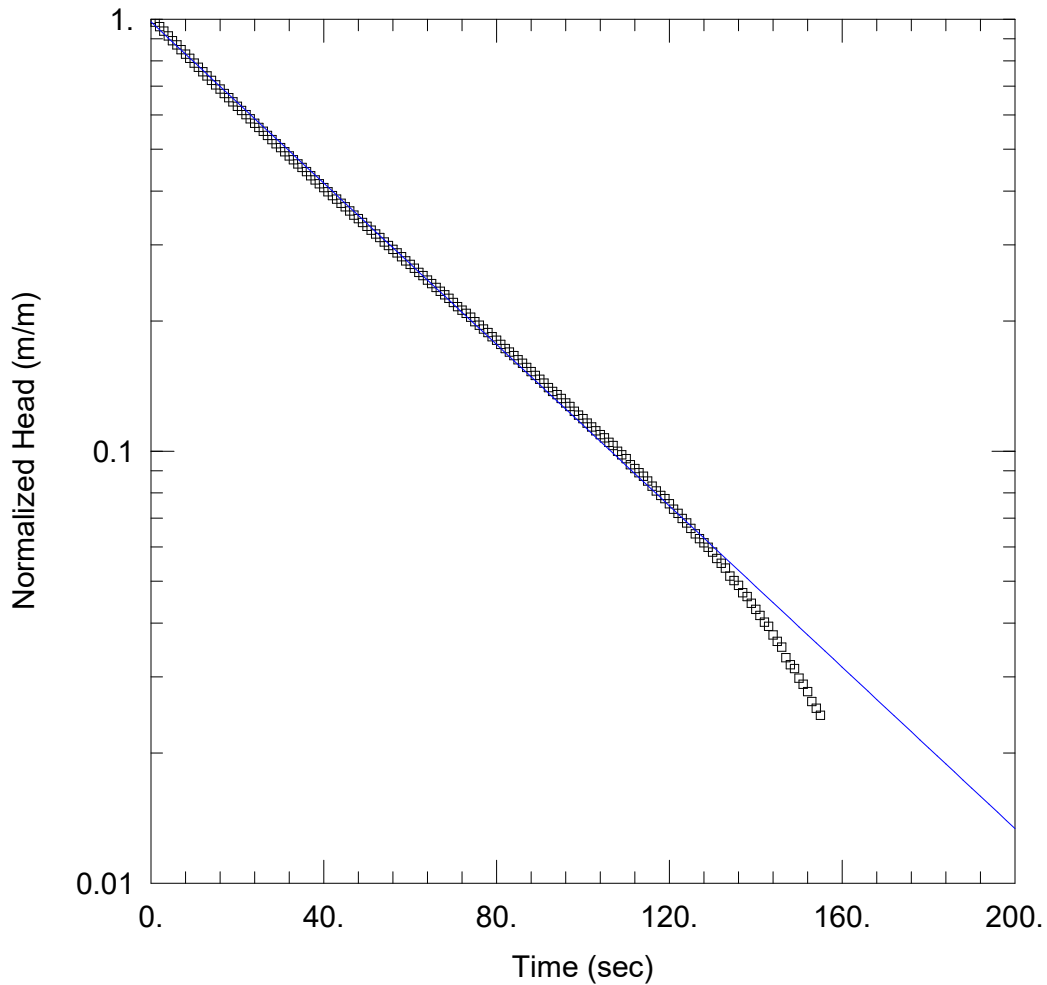
Initial Displacement: 0.5719 m
 Total Well Penetration Depth: 5.97 m
 Casing Radius: 0.025 m

Static Water Column Height: 5.97 m
 Screen Length: 5.9 m
 Well Radius: 0.048 m

SOLUTION

Aquifer Model: Unconfined
 K = 2.118E-6 m/sec

Solution Method: Bouwer-Rice
 y0 = 0.4544 m



TEST 03

Data Set: E:\...\BH101 T03 BoR.aqt

Date: 02/03/20

Time: 08:27:01

PROJECT INFORMATION

Company: Golder Associates

Client: --

Project: 19130799

Location: --

Test Well: BH101

Test Date: 9 Dec 2019

AQUIFER DATA

Saturated Thickness: 5.97 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (New Well)

Initial Displacement: 0.6467 m

Static Water Column Height: 5.97 m

Total Well Penetration Depth: 5.97 m

Screen Length: 5.9 m

Casing Radius: 0.025 m

Well Radius: 0.048 m

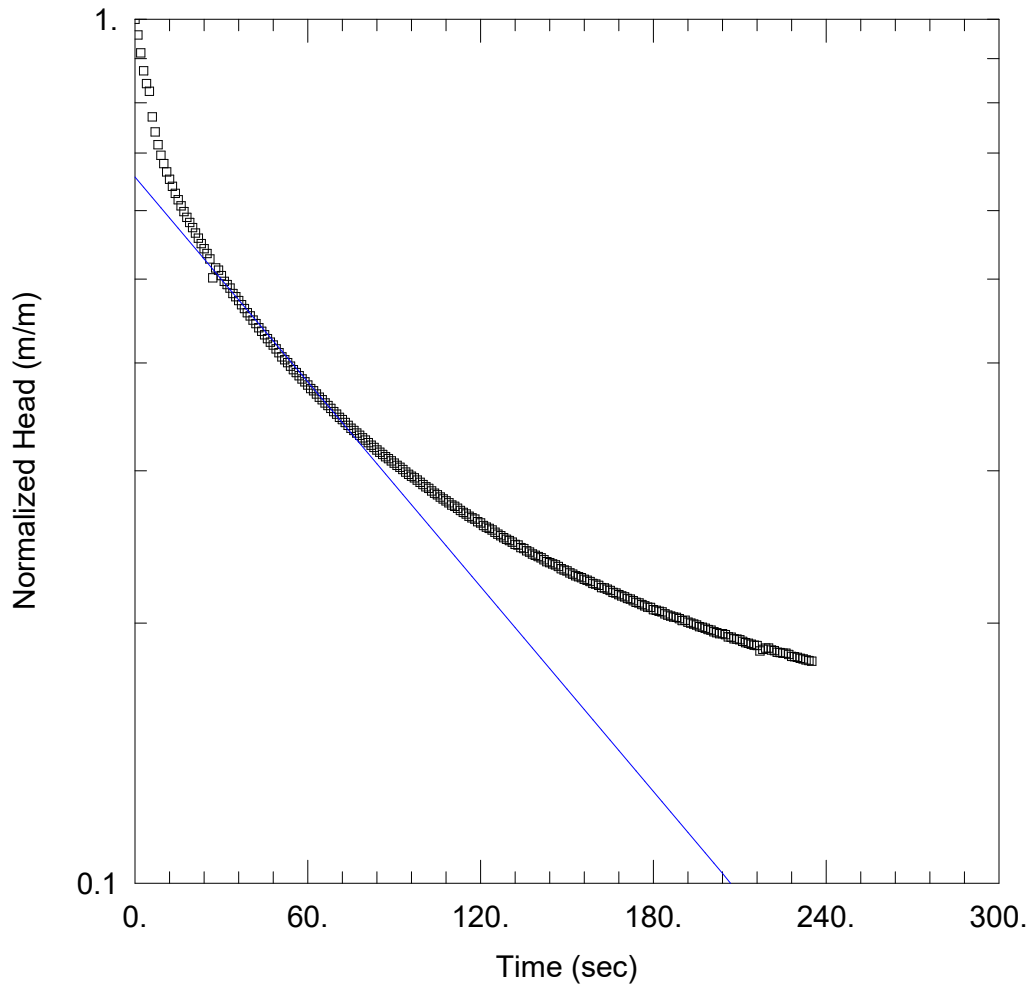
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 4.228E-6$ m/sec

$y_0 = 0.6373$ m



TEST 04

Data Set: E:\...\BH101 T04 BoR.aqt

Date: 02/03/20

Time: 08:27:37

PROJECT INFORMATION

Company: Golder Associates

Client: --

Project: 19130799

Location: --

Test Well: BH101

Test Date: 9 Dec 2019

AQUIFER DATA

Saturated Thickness: 5.97 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (New Well)

Initial Displacement: 0.8503 m

Static Water Column Height: 5.97 m

Total Well Penetration Depth: 5.97 m

Screen Length: 5.9 m

Casing Radius: 0.025 m

Well Radius: 0.048 m

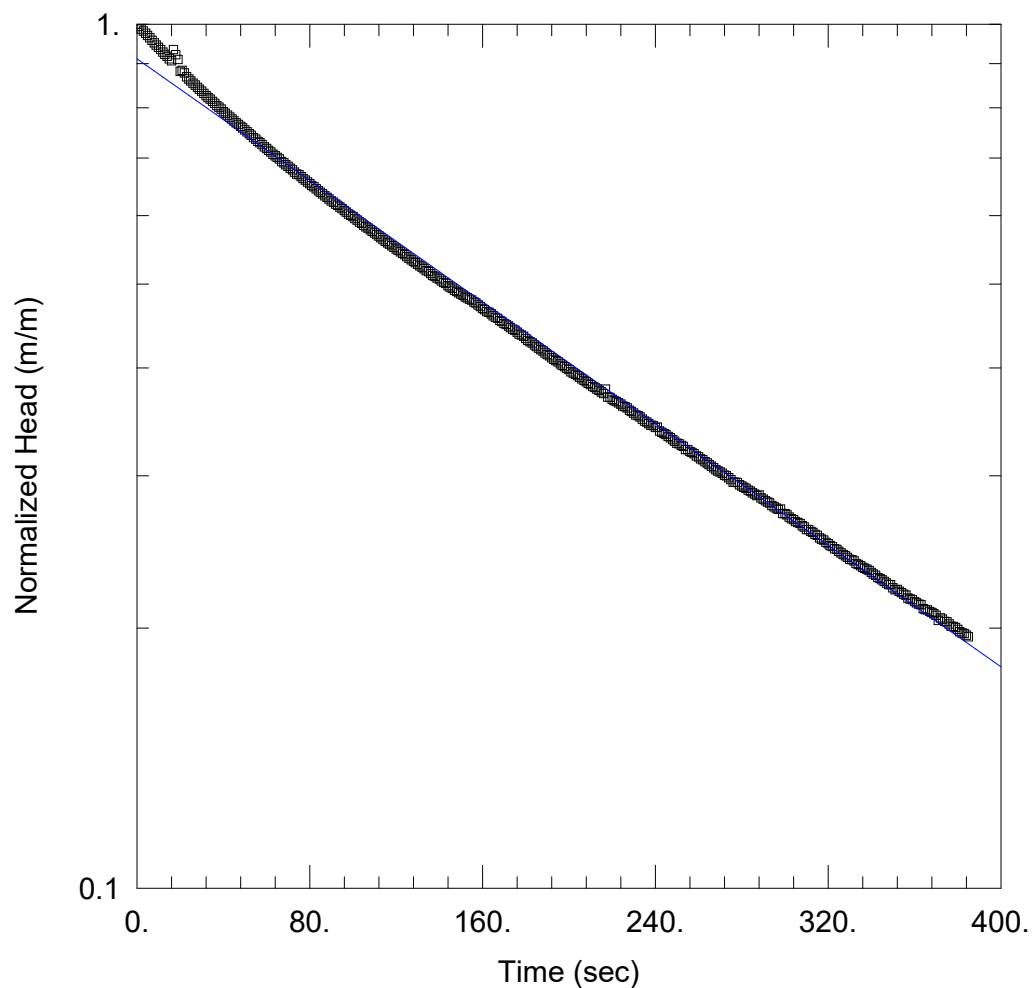
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 1.789E-6$ m/sec

$y_0 = 0.5584$ m



TEST 01

Data Set: E:\...\BH102 T01 BoR.aqt

Date: 02/03/20

Time: 08:28:23

PROJECT INFORMATION

Company: Golder Associates

Client: --

Project: 19130799

Location: --

Test Well: BH102

Test Date: 10 Dec 2019

AQUIFER DATA

Saturated Thickness: 6.4 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (New Well)

Initial Displacement: 0.7479 m

Static Water Column Height: 6.4 m

Total Well Penetration Depth: 6.41 m

Screen Length: 6.4 m

Casing Radius: 0.025 m

Well Radius: 0.048 m

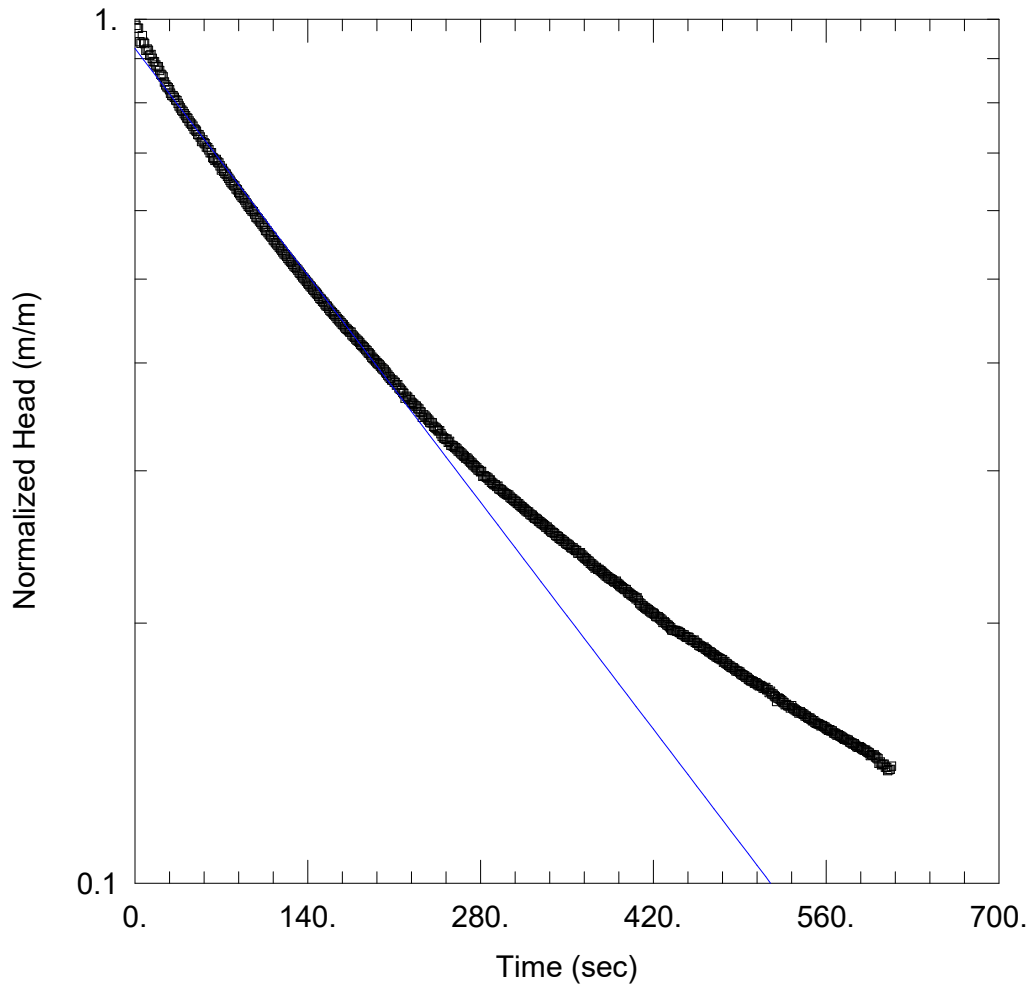
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 7.465E-7$ m/sec

$y_0 = 0.6819$ m



TEST 02

Data Set: E:\...\BH102 T02 BoR.aqt

Date: 02/03/20

Time: 08:28:54

PROJECT INFORMATION

Company: Golder Associates

Client: --

Project: 19130799

Location: --

Test Well: BH102

Test Date: 10 Dec 2019

AQUIFER DATA

Saturated Thickness: 6.4 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (New Well)

Initial Displacement: 0.971 m

Static Water Column Height: 6.4 m

Total Well Penetration Depth: 6.41 m

Screen Length: 6.4 m

Casing Radius: 0.025 m

Well Radius: 0.048 m

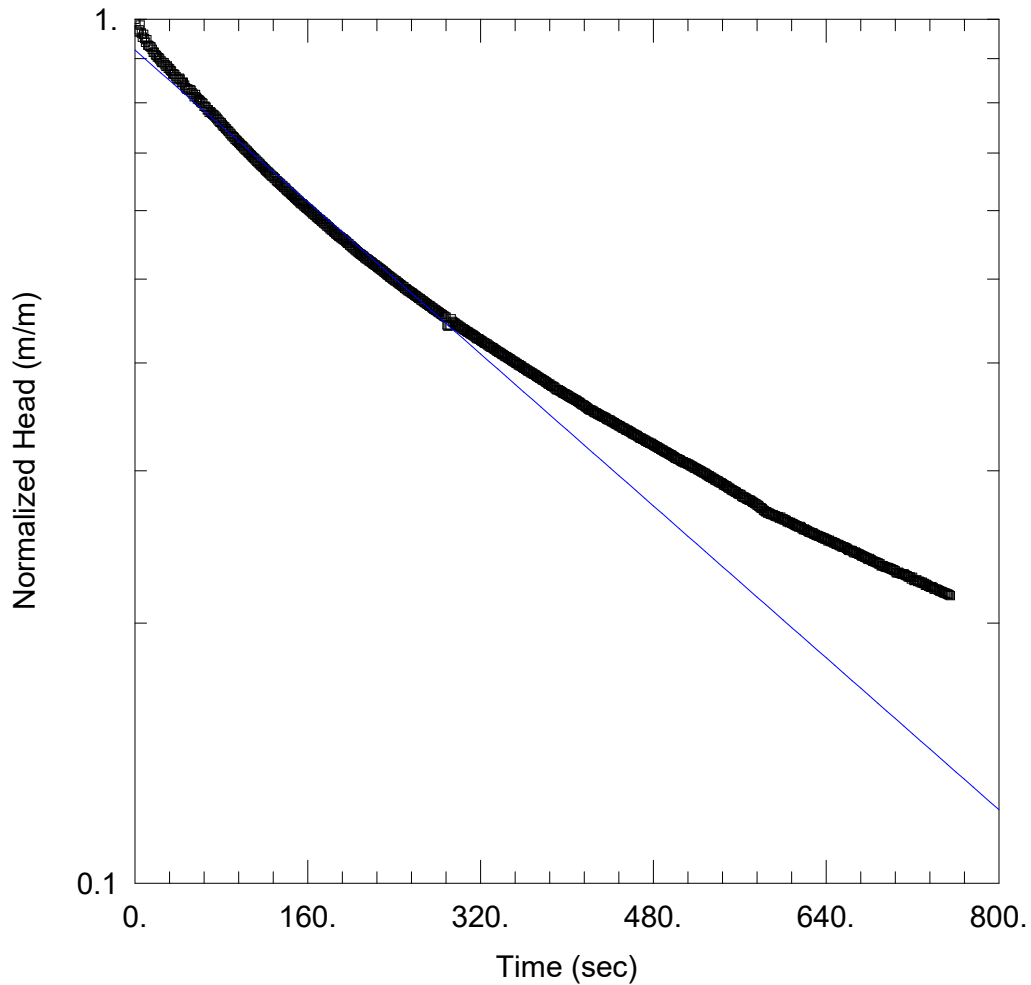
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 7.958E-7$ m/sec

$y_0 = 0.8978$ m



TEST 03

Data Set: E:\...\BH102 T03 BoR.aqt
 Date: 02/03/20

Time: 08:29:44

PROJECT INFORMATION

Company: Golder Associates
 Client: --
 Project: 19130799
 Location: --
 Test Well: BH102
 Test Date: 10 Dec 2019

AQUIFER DATA

Saturated Thickness: 6.4 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

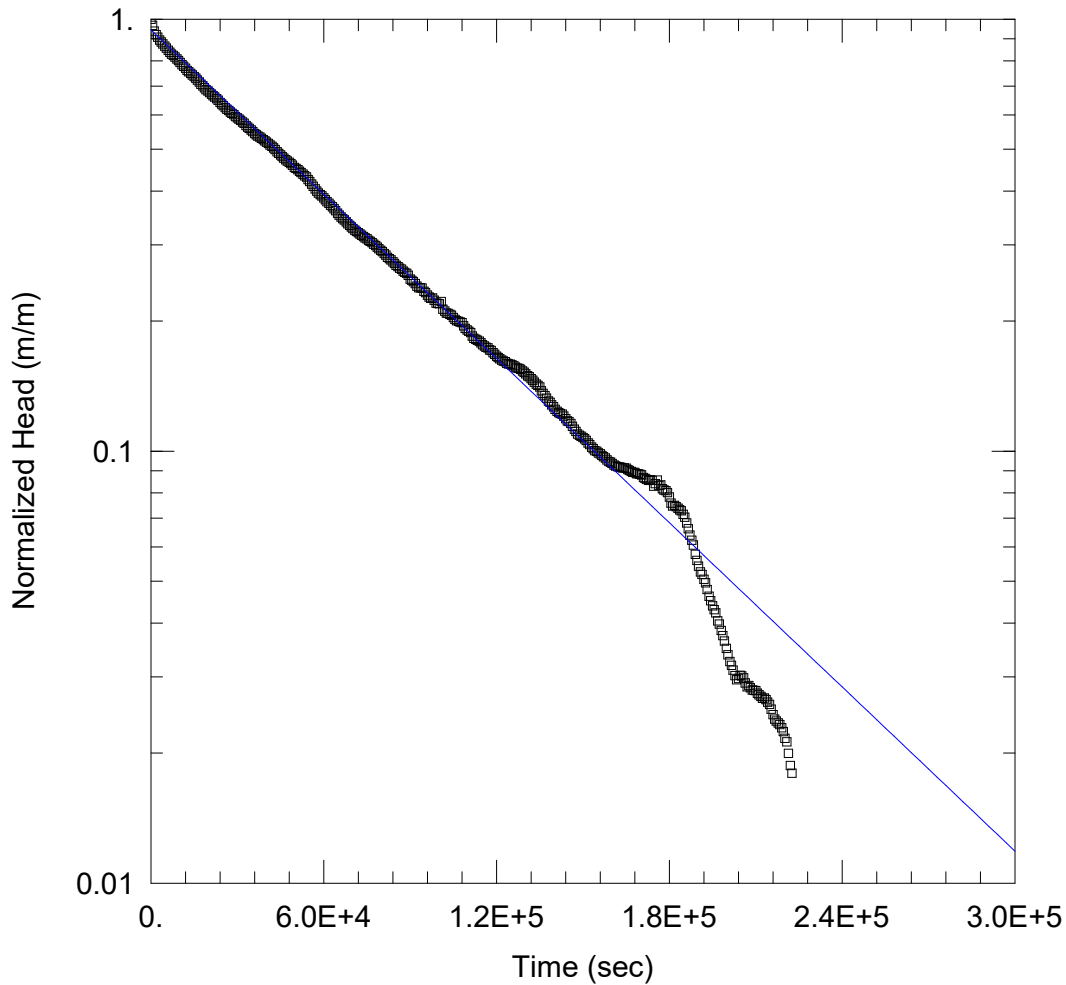
Initial Displacement: 0.9631 m
 Total Well Penetration Depth: 6.41 m
 Casing Radius: 0.025 m

Static Water Column Height: 6.4 m
 Screen Length: 6.4 m
 Well Radius: 0.048 m

SOLUTION

Aquifer Model: Unconfined
 K = 4.663E-7 m/sec

Solution Method: Bouwer-Rice
 y0 = 0.8867 m



POST-DEVELOPMENT DATA

Data Set: E:\...\BH102a T1 BoR.aqt

Date: 02/03/20

Time: 08:31:00

PROJECT INFORMATION

Company: Golder Associates

Client: --

Project: 17130799

Location: Granville

Test Well: BH102a

Test Date: --

AQUIFER DATA

Saturated Thickness: 2.5 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (New Well)

Initial Displacement: 2.288 m

Static Water Column Height: 2.4 m

Total Well Penetration Depth: 2.5 m

Screen Length: 2.4 m

Casing Radius: 0.048 m

Well Radius: 0.048 m

SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 2.114E-8$ m/sec

$y_0 = 2.159$ m

APPENDIX E

Laboratory Certificates

[illegible]

Uniaxial Compressive Strength			
Client:	Golder Associates	Sample Source:	BH102 3.38-3.59m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56236-UCS
Job No.:	S19568	Lab No.:	S56236
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:	Sealed	Storage Environment:	Sealed at as received moisture condition
 			
Uniaxial Compressive Strength 0.14 MPa			
Date Tested:	2/12/2019	Moisture Content:	16.3 %
Specimen Height:	91.0 mm	Duration of Test:	601 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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NATA Accredited Laboratory Number: 14874		Date: 18/12/2019	
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Uniaxial Compressive Strength			
Client:	Golder Associates	Sample Source:	BH102 9.34-9.52m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56237-UCS
Job No.:	S19568	Lab No.:	S56237
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:	Sealed	Storage Environment:	Sealed at as received moisture condition
 			
Uniaxial Compressive Strength 9.5 MPa			
Date Tested:	2/12/2019	Moisture Content:	3.4 %
Specimen Height:	142.5 mm	Duration of Test:	604 seconds
Average Specimen Diameter:	51.8 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type: Mixed mode			
Other Pertinent Observations:			
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Uniaxial Compressive Strength			
Client:	Golder Associates	Sample Source:	BH103 4.76-4.87m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56240-UCS
Job No.:	S19568	Lab No.:	S56240
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:	Sealed	Storage Environment:	Sealed at as received moisture condition
 			
Uniaxial Compressive Strength 0.19 MPa			
Date Tested:	2/12/2019	Moisture Content:	11.8 %
Specimen Height:	101.3 mm	Duration of Test:	601 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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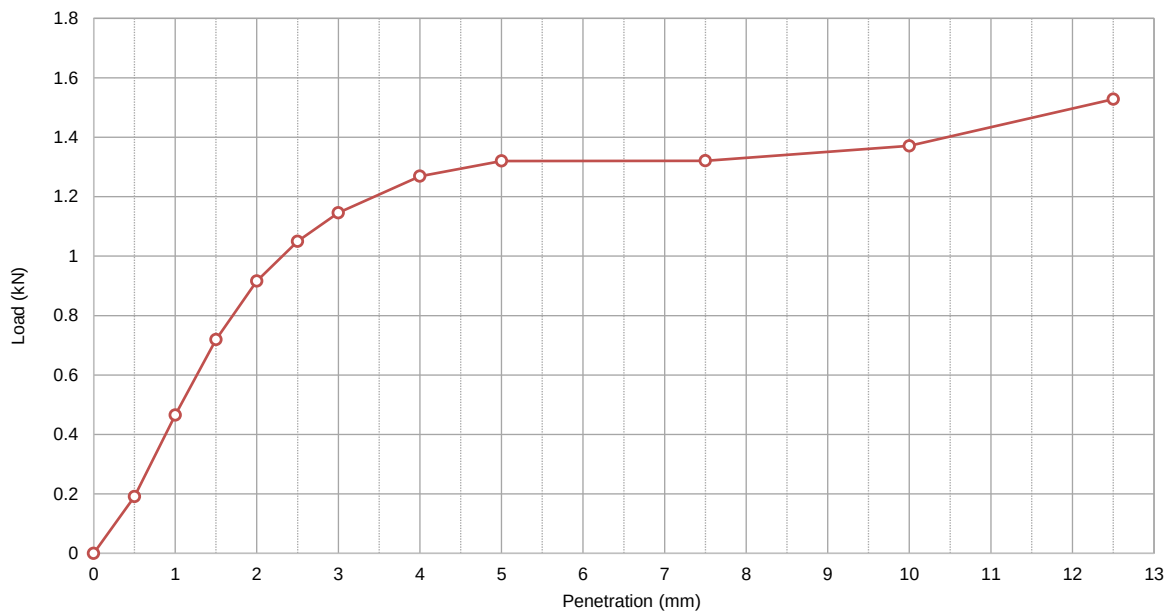
CALIFORNIA BEARING RATIO REPORT

Client	Golder Associates	Source	BH106 0.3-1.49m
Address	124 Pacific Highway St Leonards NSW 2065	Sample Description	Silty CLAY
Project	Starryland Gran Central (19130799)	Report No.	S56245-CBR
Job No.	S19568	Sample No.	S56245

Test Procedure:	☒ AS 1289.6.1.1	☐ RMS T117	California Bearing Ratio
	☒ AS 1289.5.1.1	☐ RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
	☐ AS 1289.5.2.1	☐ RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
	☒ AS 1289.2.1.1	☐ RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client	Date Sampled:	Unknown
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Preparation: Prepared in accordance with the test method



Preparation & Specification		Density & Moisture	Achieved	Target
Retained on 19.0mm Sieve (%)	0	Lab Moisture Ratio - LMR (%)	100.0	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	100.0	100.0
Sample Curing Time (hrs)	103 hrs	Dry Density - At Compaction (t/m³)	1.57	1.57
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.56	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	0.6	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	24.8	
Maximum Dry Density - MDD (t/m³)	1.57	Moisture Content - Top 30mm (%)	17.5	
Optimum Moisture Content - OMC (%)	24.8	Moisture Content - Remainder (%)	19.2	

Material CBR Value (%): 8 at a penetration of 2.5 mm

Notes:



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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

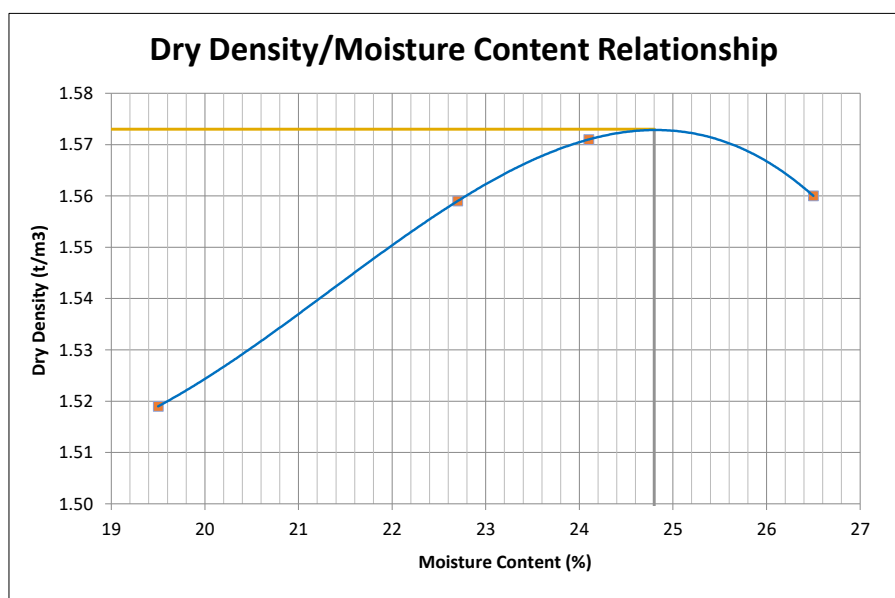
Client	Golder Associates	Source	BH106 0.3-1.49m
Address	124 Pacific Highway St Leonards NSW 2065	Sample Description	Silty CLAY
Project	Starryland Gran Central (19130799)	Report No	S56245-MDD
Job No	S19568-1	Sample No	S56245

Test Procedure: ☒ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction
☒ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling: Sampled by Client

Date Sampled: Unknown

Preparation: Prepared in accordance with the test method



Maximum Dry Density (t/m³)	1.573
Optimum Moisture Content (%)	24.8
Oversize Retained on 19mm sieve (%)	0.4
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	98 hrs
Liquid Limit Determination	Technician Assessment



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9/12/2019

Date:



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MOISTURE CONTENT TEST REPORT

Client:	Golder Associates	Job No:	S19568
Address:	124 Pacific Highway St Leonards NSW 2065	Report No:	S56412-MC
Project:	Starryland Gran Central (19130799)		

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
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Preparation:	Prepared in accordance with the test method
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Notes:



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Uzi

Chris Lloyd

18/12/2019

Date:

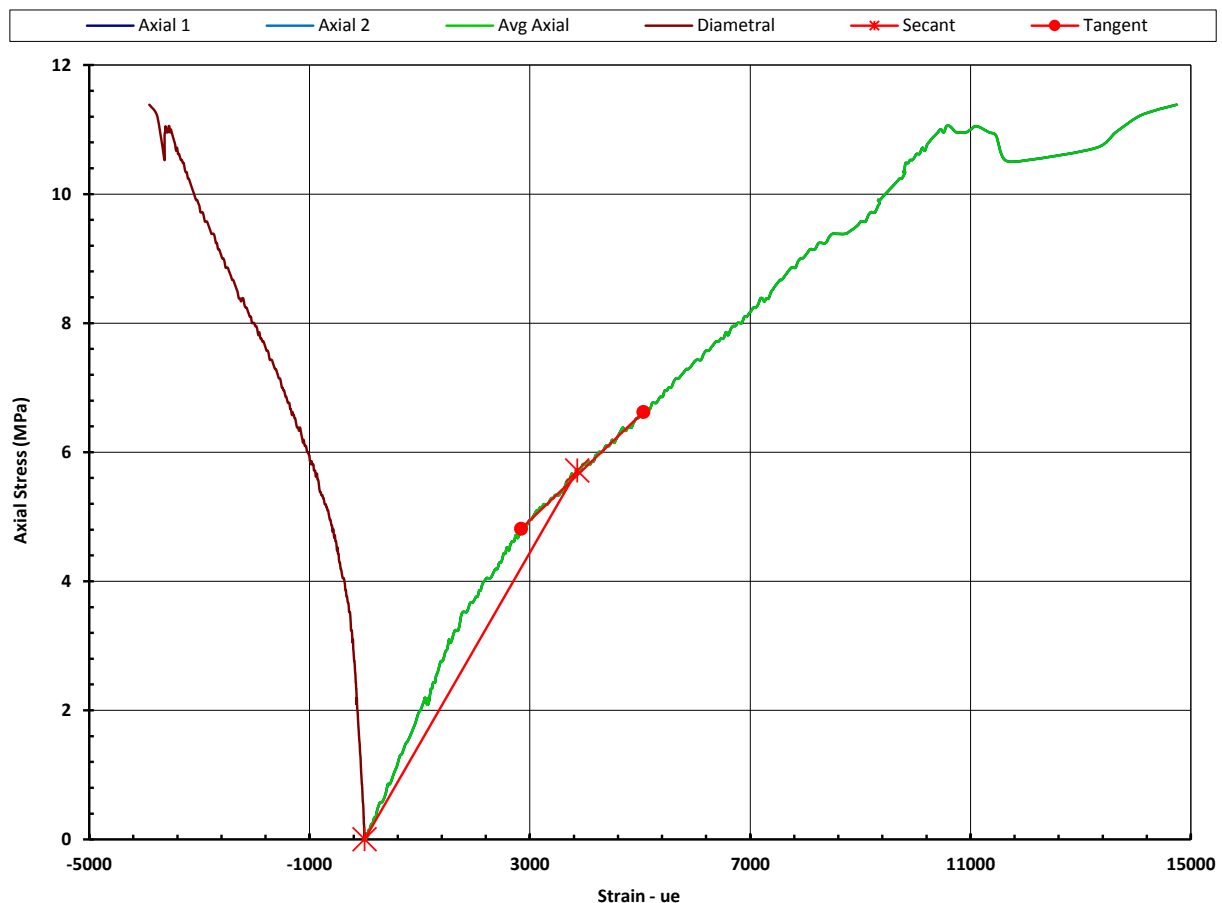
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Deformability of Rock Materials in Uniaxial Compression

Client:	Golder Associates	Sample Source:	BH101 10.50 - 10.67m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56727-MOD
Job No.:	S19568	Lab No.:	S56727
Test Procedure:	AS 4133.4.3.2 Deformability of Rock Materials in Uniaxial Compression - Rock Strength Less Than 50 MPa		
Sampling:	Sampled by client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition

Axial Stress vs Strain Plots



Uniaxial Compressive Strength

11 MPa

Young's Modulus

Poisson's Ratio

Tangent	0.8 GPa	0.26	from 42 % to 58 % of Max UCS
Secant	1.5 GPa	0.23	from 0 % to 50 % of Max UCS



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Authorised Signatory:

Chris Lloyd

Date: 17/12/2019

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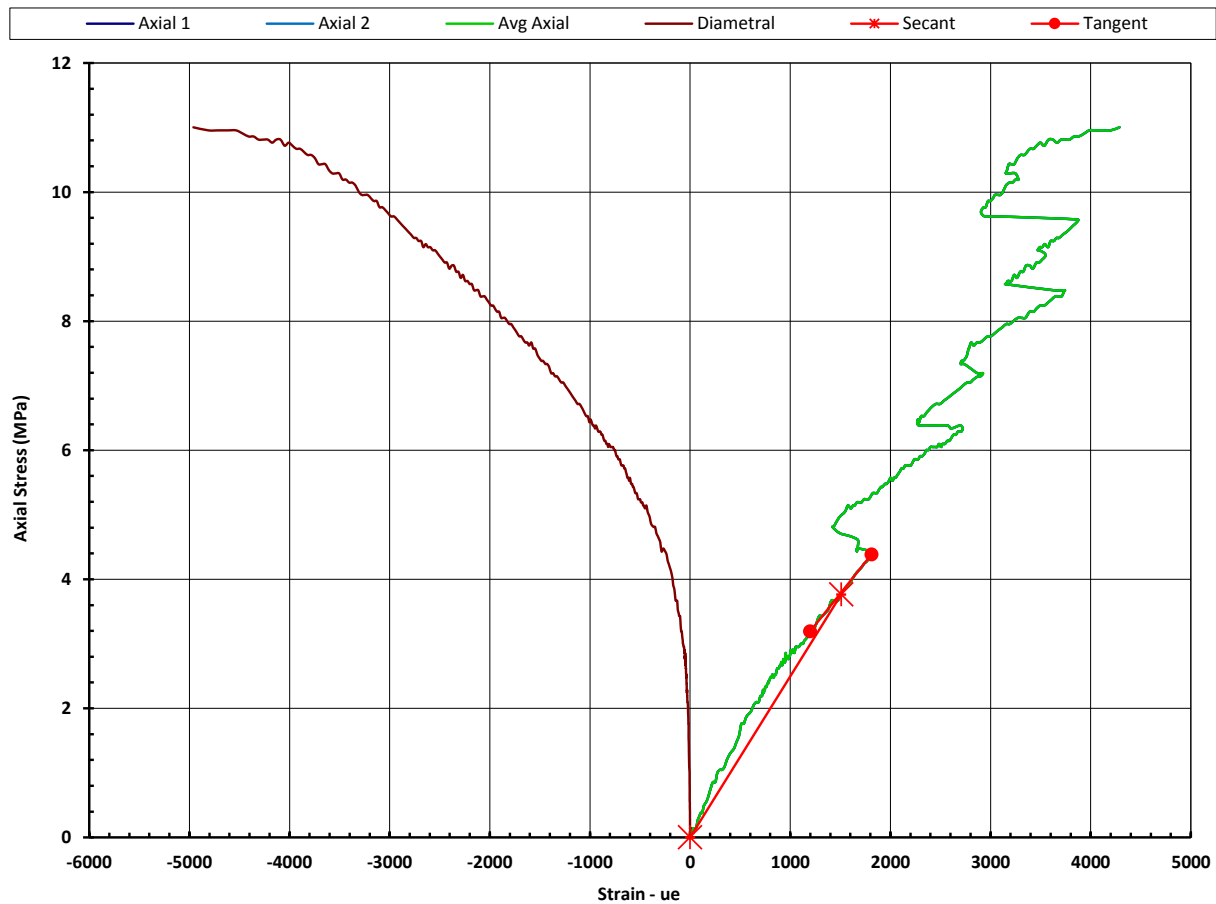
Deformability of Rock Materials in Uniaxial Compression			
Client:	Golder Associates	Sample Source:	BH101 10.50 - 10.67m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56727-MOD
Job No.:	S19568	Lab No.:	S56727
Test Procedure:	AS 4133.4.3.2 Deformability of Rock Materials in Uniaxial Compression - Rock Strength Less Than 50 MPa		
Sampling:	Sampled by client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition
Average Specimen Diameter (mm)	51.7	Moisture Content (%)	3.1
Average Specimen Height (mm)	139.6	Wet Density (t/m³)	2.61
Length to Diameter Ratio	2.7	Dry Density (t/m³)	2.53
Duration of Test (min)	10.65	Specimen Curing	-
Rate of Displacement (mm/min):	< 0.1	Test Apparatus	Matest Compression Machine with Axial and Circumferential Extensometers.
Mode of Failure	Tensile dominated		
  Before Test After Test			
Uniaxial Compressive Strength		11	MPa
Young's Modulus		Poisson's Ratio	
Tangent	0.8 GPa	0.26	from 42 % to 58 % of Max UCS
Secant	1.5 GPa	0.23	from 0 % to 50 % of Max UCS
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Uniaxial Compressive Strength			
Client:	Golder Associates	Sample Source:	BH101 12.37 - 12.51m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56728-UCS
Job No.:	S19568	Lab No.:	S56728
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:	Sealed	Storage Environment:	Sealed at as received moisture condition
 			
Uniaxial Compressive Strength 13 MPa			
Date Tested:	16/12/2019	Moisture Content:	2.7 %
Specimen Height:	73.4 mm	Duration of Test:	618 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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Deformability of Rock Materials in Uniaxial Compression

Client:	Golder Associates	Sample Source:	BH102 11.32 - 11.47m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56729-MOD
Job No.:	S19568	Lab No.:	S56729
Test Procedure:	AS 4133.4.3.2 Deformability of Rock Materials in Uniaxial Compression - Rock Strength Less Than 50 MPa		
Sampling:	Sampled by client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition

Axial Stress vs Strain Plots



Uniaxial Compressive Strength

11.0

MPa

Young's Modulus

Poisson's Ratio

Tangent

1.9 GPa

0.13

from 28 % to 39 % of Max UCS

Secant

2.5 GPa

0.10

from 0 % to 34 % of Max UCS



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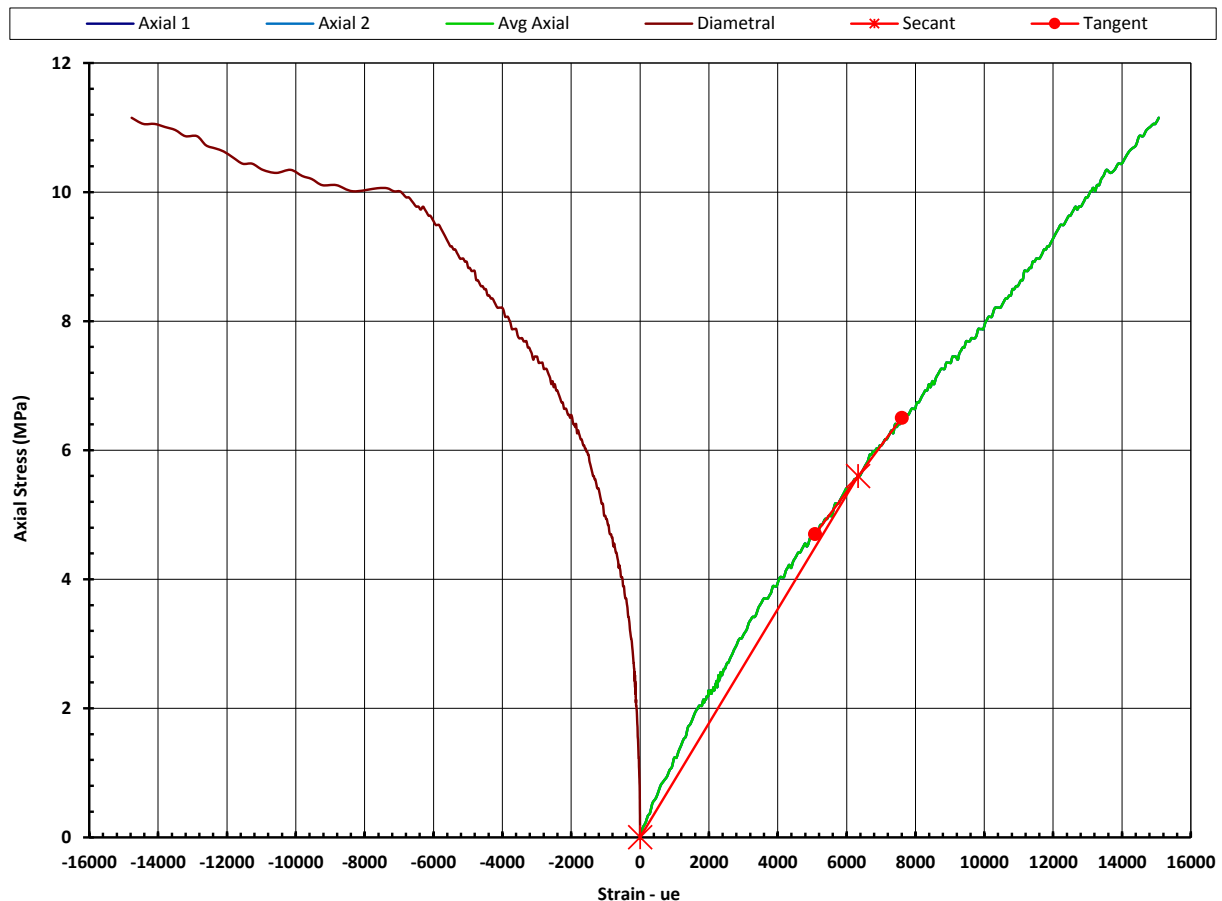
Deformability of Rock Materials in Uniaxial Compression			
Client:	Golder Associates	Sample Source:	BH102 11.32 - 11.47m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56729-MOD
Job No.:	S19568	Lab No.:	S56729
Test Procedure:	AS 4133.4.3.2 Deformability of Rock Materials in Uniaxial Compression - Rock Strength Less Than 50 MPa		
Sampling:	Sampled by client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition
Average Specimen Diameter (mm)	51.7	Moisture Content (%)	3.2
Average Specimen Height (mm)	100.4	Wet Density (t/m ³)	2.57
Length to Diameter Ratio	1.9	Dry Density (t/m ³)	2.48
Duration of Test (min)	10.15	Specimen Curing	-
Rate of Displacement (mm/min):	< 0.1	Test Apparatus	Matest Compression Machine with Axial and Circumferential Extensometers.
Mode of Failure	Tensile dominated		
  Before Test After Test Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.			
Uniaxial Compressive Strength		11.0 MPa	
Young's Modulus		Poisson's Ratio	
Tangent	1.9 GPa	0.13	from 28 % to 39 % of Max UCS
Secant	2.5 GPa	0.10	from 0 % to 34 % of Max UCS
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* Clear sign not working. JL to fix.

Deformability of Rock Materials in Uniaxial Compression

Client:	Golder Associates	Sample Source:	BH103 8.57 - 5.74m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56730-MOD
Job No.:	S19568	Lab No.:	S56730
Test Procedure:	AS 4133.4.3.2 Deformability of Rock Materials in Uniaxial Compression - Rock Strength Less Than 50 MPa		
Sampling:	Sampled by client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition

Axial Stress vs Strain Plots



Uniaxial Compressive Strength

11

MPa

Young's Modulus

Poisson's Ratio

Tangent	0.7 GPa	0.26	from 42 % to 58 % of Max UCS
Secant	0.9 GPa	0.21	from 0 % to 50 % of Max UCS



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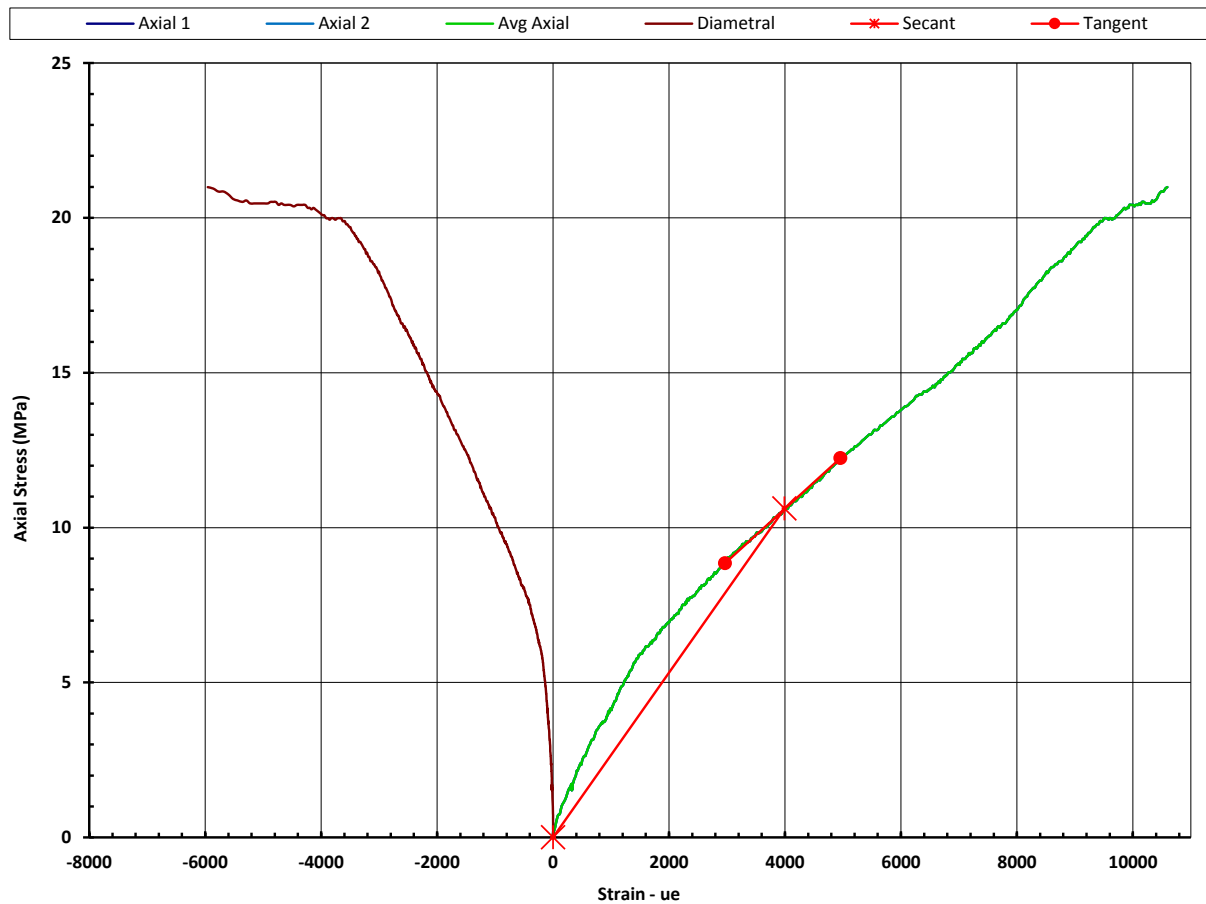
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Deformability of Rock Materials in Uniaxial Compression			
Client:	Golder Associates	Sample Source:	BH103 8.57 - 5.74m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56730-MOD
Job No.:	S19568	Lab No.:	S56730
Test Procedure:	AS 4133.4.3.2 Deformability of Rock Materials in Uniaxial Compression - Rock Strength Less Than 50 MPa		
Sampling:	Sampled by client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition
Average Specimen Diameter (mm)	51.8	Moisture Content (%)	3.3
Average Specimen Height (mm)	141.0	Wet Density (t/m³)	2.58
Length to Diameter Ratio	2.7	Dry Density (t/m³)	2.50
Duration of Test (min)	10.45	Specimen Curing	-
Rate of Displacement (mm/min):	< 0.1	Test Apparatus	Matest Compression Machine with Axial and Circumferential Extensometers.
Mode of Failure	Tensile dominated		
 Before Test  After Test			
Uniaxial Compressive Strength		11	MPa
Young's Modulus		Poisson's Ratio	
Tangent	0.7 GPa	0.26	from 42 % to 58 % of Max UCS
Secant	0.9 GPa	0.21	from 0 % to 50 % of Max UCS
 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. This document shall not be reproduced, except in full. NATA Accredited Laboratory Number: 14874		Authorised Signatory:  Chris Lloyd Date: 17/12/2019	
		Unit 7 & 8, 10 Bradford Street Alexandria NSW 2015	

Deformability of Rock Materials in Uniaxial Compression

Client:	Golder Associates	Sample Source:	BH103 10.87 - 11.0m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56731-MOD
Job No.:	S19568	Lab No.:	S56731
Test Procedure:	AS 4133.4.3.2 Deformability of Rock Materials in Uniaxial Compression - Rock Strength Less Than 50 MPa		
Sampling:	Sampled by client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition

Axial Stress vs Strain Plots



Uniaxial Compressive Strength

21.0

MPa

Young's Modulus

Poisson's Ratio

Tangent

1.7 GPa

0.29

from 42 % to 58 % of Max UCS

Secant

2.7 GPa

0.27

from 0 % to 50 % of Max UCS



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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

Date:

17/12/2019

**MACQUARIE
GEO TECH**

Unit 7 & 8, 10 Bradford Street

Alexandria NSW 2015

Deformability of Rock Materials in Uniaxial Compression			
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Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Shale
Project:	Starryland Gran Central (19130799)	Report No.:	S56731-MOD
Job No.:	S19568	Lab No.:	S56731
Test Procedure:	AS 4133.4.3.2 Deformability of Rock Materials in Uniaxial Compression - Rock Strength Less Than 50 MPa		
Sampling:	Sampled by client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition
Average Specimen Diameter (mm)	51.6	Moisture Content (%)	2.2
Average Specimen Height (mm)	95.9	Wet Density (t/m ³)	2.61
Length to Diameter Ratio	1.9	Dry Density (t/m ³)	2.55
Duration of Test (min)	11.20	Specimen Curing	-
Rate of Displacement (mm/min):	< 0.1	Test Apparatus	Matest Compression Machine with Axial and Circumferential Extensometers.
Mode of Failure	Tensile dominated		
  Before Test After Test			
Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.			
Uniaxial Compressive Strength		21.0	MPa
<u>Young's Modulus</u>		<u>Poisson's Ratio</u>	
Tangent	1.7 GPa	0.29	from 42 % to 58 % of Max UCS
Secant	2.7 GPa	0.27	from 0 % to 50 % of Max UCS
 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. This document shall not be reproduced, except in full.		Authorised Signatory:  Chris Lloyd	
NATA Accredited Laboratory Number: 14874		Date:	17/12/2019
		Unit 7 & 8, 10 Bradford Street Alexandria NSW 2015	

Test Report

Customer: Golder Associates Pty Ltd

Job number: 19-0081

Project: 19122955

Report number: 1

Location: Granville

Page: 1 of 1

Moisture Content

Sampling method: Tested as received

Test method(s): AS 1289.1.1, 2.1.1

	Results				
Laboratory sample no.	19690	19691			
Customer sample no.	BH01_0.53-0.60	BH03_0.50-0.60			
Date sampled	30/07/2019	01/08/2019			
Material description	CLAY, trace of silt and gravel, mottled brown/red/grey	CLAY, trace of silt and gravel, mottled brown/red/grey			
Moisture content (%)	37.5	30.8			

Laboratory sample no.					
Customer sample no.					
Date sampled					
Material description					
Moisture content (%)					

Approved Signatory:  C. Greely

Date: 26/08/2019



ACCREDITED FOR
TECHNICAL
COMPETENCE

Accredited for compliance with ISO/IEC 17025 - Testing.

NATA Accredited Laboratory Number: **17062**

Test Report

Customer: Golder Associates Pty Ltd

Job number: 19-0081

Project: 19122955

Report number: 2

Location: Granville

Page: 1 of 1

Soil Index Properties

Sampling method: Tested as received

Test method(s): AS 1289.1.1, 2.1.1, 3.1.2, 3.2.1, 3.3.1

	Results				
Laboratory sample no.	19690	19691			
Customer sample no.	BH01_0.53-0.60	BH03_0.50-0.60			
Date sampled	30/07/2019	01/08/2019			
Material description	CLAY, trace of silt and gravel, mottled brown/red/grey	CLAY, trace of silt and gravel, mottled brown/red/grey			
Liquid limit (%)	90	108			
Plastic limit (%)	20	32			
Plasticity index (%)	70	76			
Linear shrinkage (%)	-	-			
Cracking / Curling / Crumbling	-	-			
Sample history	Air dried	Air dried			
Preparation	Dry sieved	Dry sieved			

Approved Signatory:



C. Greely

Date: 26/08/2019



ACCREDITED FOR
TECHNICAL
COMPETENCE

Accredited for compliance with ISO/IEC 17025 - Testing.

NATA Accredited Laboratory Number: **17062**

Test Report

Customer: Golder Associates Pty Ltd

Job number: 19-0081

Project: 19122955

Report number: 3 rev.1

Location: Granville

Page: 1 of 1

Shrink Swell Index

Sampling method: Tested as received

Test method(s): AS 1289.1.1, 2.1.1, 7.1.1

	Results				
Laboratory sample no.	19692				
Customer sample no.	BH04_2.00-2.35				
Date sampled	29/07/2019				
Material description	silty CLAY, trace of gravel, grey mottled red/ yellow-brown				
Shrink (%)	2.0				
Moisture content (%)	16.1				
Soil crumbling	n/a				
Extent of cracking	Open cracks				
Inert inclusions (%)	<5				
Swell (%)	2.2				
Moisture content initial (%)	14.3				
Moisture content final (%)	19.6				
Shrink swell index (%)	1.7				
Notes: This report has been amended to correct the material description.					

Approved Signatory:



C. Greely

Date: 26/08/2019



ACCREDITED FOR
TECHNICAL
COMPETENCE

Accredited for compliance with ISO/IEC 17025 - Testing.

NATA Accredited Laboratory Number: **17062**

CLIENT DETAILS

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Project **19122955 - Gran Central - Additional**
Order Number **PO21564**
Samples 3

LABORATORY DETAILS

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SGS Reference **SE196066A R0**
Date Received 7/8/2019
Date Reported 14/8/2019

COMMENTS

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

SIGNATORIES



Dong Liang
 Metals/Inorganics Team Leader

pH in soil (1:2) [AN101] Tested: 12/8/2019

			BH02_1.8-1.85
			SOIL
			-
			31/7/2019
			SE196066A.003
PARAMETER	UOM	LOR	
pH (1:2)	pH Units	-	5.4

Conductivity (1:2) in soil [AN106] Tested: 12/8/2019

			BH02_1.8-1.85
			SOIL
			-
			31/7/2019
			SE196066A.003
PARAMETER	UOM	LOR	
Conductivity (1:2) @25 C*	µS/cm	1	94
Resistivity (1:2)*	ohm cm	-	11000

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography [AN245] Tested: 13/8/2019

			BH02_1.8-1.85
			SOIL
			-
			31/7/2019
			SE196066A.003
PARAMETER	UOM	LOR	
Chloride	mg/kg	0.25	1.9
Sulfate	mg/kg	0.5	60



ANALYTICAL RESULTS

SE196066A R0

Moisture Content [AN002] Tested: 9/8/2019

			BH02_1.8-1.85
			SOIL
			-
			31/7/2019
			SE196066A.003
PARAMETER	UOM	LOR	
% Moisture	%w/w	0.5	8.9

METHOD

METHODOLOGY SUMMARY

AN002

The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.

AN101

pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:2 and the pH determined and reported on the extract after 1 hour extraction (pH 1:2) or after 1 hour extraction and overnight aging (pH (1:2) aged). Reference APHA 4500-H+.

AN106

Conductivity : Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as $\mu\text{mhos/cm}$ or $\mu\text{S/cm}$ @ 25°C. For soils, an extract with water is made at a ratio of 1:2 and the EC determined and reported on the extract basis after the 1 hour extraction (EC(1:2)) or after the 1 hour extraction and overnight aging (EC(1:2) aged). Reference APHA 2510 B.

AN106

Resistivity of the extract is reported on the extract basis and is the reciprocal of conductivity. Salinity and TDS can be calculated from the extract conductivity and is reported back to the soil basis.

AN245

Anions by Ion Chromatography: A water sample or extract is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO₂, NO₃ and SO₄ are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

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

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

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

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

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

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

Note that in terms of units of radioactivity:

- 1 Bq is equivalent to 27 pCi
- 37 MBq is equivalent to 1 mCi

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

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/pv.sgsvr/en-gb/environment.

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Project 19122955 Gran Central - Additional
Order Number PO21564
Samples 6

LABORATORY DETAILS

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SGS Reference SE196071A R0
Date Received 7/8/2019
Date Reported 14/8/2019

COMMENTS

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

SIGNATORIES



Dong Liang
 Metals/Inorganics Team Leader



ANALYTICAL RESULTS

SE196071A R0

pH in soil (1:2) [AN101] Tested: 12/8/2019

			BH04_0.55-0.65
			SOIL
			-
			29/7/2019
			SE196071A.006
PARAMETER	UOM	LOR	
pH (1:2)	pH Units	-	5.0

Conductivity (1:2) in soil [AN106] Tested: 12/8/2019

			BH04_0.55-0.65
			SOIL
			-
			29/7/2019
			SE196071A.006
PARAMETER	UOM	LOR	
Conductivity (1:2) @25 C*	µS/cm	1	150
Resistivity (1:2)*	ohm cm	-	6600

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography [AN245] Tested: 13/8/2019

			BH04_0.55-0.65
			SOIL
			-
			29/7/2019
			SE196071A.006
PARAMETER	UOM	LOR	
Chloride	mg/kg	0.25	42
Sulfate	mg/kg	0.5	87



ANALYTICAL RESULTS

SE196071A R0

Moisture Content [AN002] Tested: 9/8/2019

			BH04_0.55-0.65
			SOIL
			-
			29/7/2019
PARAMETER	UOM	LOR	SE196071A.006
% Moisture	%w/w	0.5	24.8

METHOD

METHODOLOGY SUMMARY

AN002

The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.

AN101

pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:2 and the pH determined and reported on the extract after 1 hour extraction (pH 1:2) or after 1 hour extraction and overnight aging (pH (1:2) aged). Reference APHA 4500-H+.

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Conductivity : Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as $\mu\text{mhos/cm}$ or $\mu\text{S/cm}$ @ 25°C. For soils, an extract with water is made at a ratio of 1:2 and the EC determined and reported on the extract basis after the 1 hour extraction (EC(1:2)) or after the 1 hour extraction and overnight aging (EC(1:2) aged). Reference APHA 2510 B.

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AN245

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Project **19122955 - Good St, Granville**
Order Number (Not specified)
Samples 1

LABORATORY DETAILS

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SGS Reference **SE196280 R0**
Date Received 9/8/2019
Date Reported 16/8/2019

COMMENTS

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

SIGNATORIES



Akheeque Beniamen
Chemist



Dong Liang
Metals/Inorganics Team Leader



Ly Kim Ha
Organic Section Head



ANALYTICAL RESULTS

SE196280 R0

VOCs in Water [AN433] Tested: 13/8/2019

			19122955
			WATER
			-
			8/8/2019
			SE196280.001
PARAMETER	UOM	LOR	
Benzene	µg/L	0.5	<0.5
Toluene	µg/L	0.5	0.9
Ethylbenzene	µg/L	0.5	<0.5
m/p-xylene	µg/L	1	<1
o-xylene	µg/L	0.5	<0.5
Total Xylenes	µg/L	1.5	<1.5
Total BTEX	µg/L	3	<3
Naphthalene	µg/L	0.5	<0.5

Volatile Petroleum Hydrocarbons in Water [AN433] Tested: 13/8/2019

			19122955
			WATER
			-
			8/8/2019
PARAMETER	UOM	LOR	SE196280.001
TRH C6-C9	µg/L	40	<40
Benzene (F0)	µg/L	0.5	<0.5
TRH C6-C10	µg/L	50	<50
TRH C6-C10 minus BTEX (F1)	µg/L	50	<50

TRH (Total Recoverable Hydrocarbons) in Water [AN403] Tested: 12/8/2019

			19122955
			WATER
			-
			8/8/2019
			SE196280.001
PARAMETER	UOM	LOR	
TRH C10-C14	µg/L	50	<50
TRH C15-C28	µg/L	200	<200
TRH C29-C36	µg/L	200	<200
TRH C37-C40	µg/L	200	<200
TRH >C10-C16	µg/L	60	<60
TRH >C16-C34 (F3)	µg/L	500	<500
TRH >C34-C40 (F4)	µg/L	500	<500
TRH C10-C36	µg/L	450	<450
TRH C10-C40	µg/L	650	<650
TRH >C10-C16 - Naphthalene (F2)	µg/L	60	<60

PAH (Polynuclear Aromatic Hydrocarbons) in Water [AN420] Tested: 12/8/2019

			19122955
			WATER
			-
			8/8/2019
			SE196280.001
PARAMETER	UOM	LOR	
Naphthalene	µg/L	0.1	<0.1
2-methylnaphthalene	µg/L	0.1	<0.1
1-methylnaphthalene	µg/L	0.1	<0.1
Acenaphthylene	µg/L	0.1	<0.1
Acenaphthene	µg/L	0.1	<0.1
Fluorene	µg/L	0.1	<0.1
Phenanthrene	µg/L	0.1	<0.1
Anthracene	µg/L	0.1	<0.1
Fluoranthene	µg/L	0.1	<0.1
Pyrene	µg/L	0.1	<0.1
Benzo(a)anthracene	µg/L	0.1	<0.1
Chrysene	µg/L	0.1	<0.1
Benzo(b&j)fluoranthene	µg/L	0.1	<0.1
Benzo(k)fluoranthene	µg/L	0.1	<0.1
Benzo(a)pyrene	µg/L	0.1	<0.1
Indeno(1,2,3-cd)pyrene	µg/L	0.1	<0.1
Dibenzo(ah)anthracene	µg/L	0.1	<0.1
Benzo(ghi)perylene	µg/L	0.1	<0.1
Total PAH (18)	µg/L	1	<1



ANALYTICAL RESULTS

SE196280 R0

Anions by Ion Chromatography in Water [AN245] Tested: 12/8/2019

			19122955
			WATER
			-
			8/8/2019
PARAMETER	UOM	LOR	SE196280.001
Chloride	mg/L	1	1100
Sulfate, SO4	mg/L	1	660



ANALYTICAL RESULTS

SE196280 R0

pH in water [AN101] Tested: 14/8/2019

			19122955
			WATER
			-
			8/8/2019
			SE196280.001
PARAMETER	UOM	LOR	
pH**	No unit	-	6.4

Conductivity and TDS by Calculation - Water [AN106] Tested: 14/8/2019

			19122955
			WATER
			-
			8/8/2019
			SE196280.001
PARAMETER	UOM	LOR	
Conductivity @ 25 C	µS/cm	2	4400



ANALYTICAL RESULTS

SE196280 R0

Trace Metals (Dissolved) in Water by ICPMS [AN318] Tested: 12/8/2019

			19122955
			WATER
			-
			8/8/2019
			SE196280.001
PARAMETER	UOM	LOR	
Arsenic, As	µg/L	1	<1
Cadmium, Cd	µg/L	0.1	0.1
Chromium, Cr	µg/L	1	<1
Copper, Cu	µg/L	1	3
Lead, Pb	µg/L	1	<1
Nickel, Ni	µg/L	1	6
Zinc, Zn	µg/L	5	150



ANALYTICAL RESULTS

SE196280 R0

Mercury (dissolved) in Water [AN311(Perth)/AN312] Tested: 13/8/2019

			19122955
			WATER
			-
			8/8/2019
			SE196280.001
PARAMETER	UOM	LOR	
Mercury	mg/L	0.0001	<0.0001

METHOD

METHODOLOGY SUMMARY

- AN020** Unpreserved water sample is filtered through a 0.45µm membrane filter and acidified with nitric acid similar to APHA3030B.
- AN101** pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
- AN106** Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Salts can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2510 B.
- AN106** Salinity may be calculated in terms of NaCl from the sample conductivity. This assumes all soluble salts present, measured by the conductivity, are present as NaCl.
- AN245** Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO₂, NO₃ and SO₄ are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B
- AN311(Perth)/AN312** Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
- AN318** Determination of elements at trace level in waters by ICP-MS technique, in accordance with USEPA 6020A.
- AN403** Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36 and in recognition of the NEPM 1999 (2013), >C10-C16 (F2), >C16-C34 (F3) and >C34-C40 (F4). Where F2 is corrected for Naphthalene, the VOC data for Naphthalene is used.
- AN403** Additionally, the volatile C6-C9/C6-C10 fractions may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Recoverable Hydrocarbons - Silica (TRH-Silica) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents.
- AN403** The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.
- AN420** (SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols (etc) in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).
- AN433** VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC's are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

FOOTNOTES

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

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

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

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

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

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

Note that in terms of units of radioactivity:

- 1 Bq is equivalent to 27 pCi
- 37 MBq is equivalent to 1 mCi

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

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/pv.sgsvr/en-gb/environment.

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SGS Reference SE200747 R0
Date Received 4/12/2019
Date Reported 12/12/2019

COMMENTS

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

Ion Chromatography - The Limit of Reporting (LOR) for nitrate nitrogen has been raised due to high conductivity of the sample requiring dilution.

Sample #3- insufficient sample provided for TRH/PAH analyses.

SIGNATORIES



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Metals/Inorganics Team Leader



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VOCs in Water [AN433] Tested: 9/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER - 3/12/2019 SE200747.001	WATER - 3/12/2019 SE200747.002	WATER - 3/12/2019 SE200747.003	WATER - 3/12/2019 SE200747.004	WATER - 3/12/2019 SE200747.005
Benzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	µg/L	0.5	0.7	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m/p-xylene	µg/L	1	<1	<1	<1	<1	<1
o-xylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Xylenes	µg/L	1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total BTEX	µg/L	3	<3	<3	<3	<3	<3
Naphthalene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dichlorodifluoromethane (CFC-12)	µg/L	5	-	-	-	-	-
Chloromethane	µg/L	5	<5	<5	<5	<5	<5
Vinyl chloride (Chloroethene)	µg/L	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bromomethane	µg/L	10	<10	<10	<10	<10	<10
Chloroethane	µg/L	5	<5	<5	<5	<5	<5
Trichlorofluoromethane	µg/L	1	<1	<1	<1	<1	<1
Acetone (2-propanone)	µg/L	10	<10	<10	<10	<10	<10
Iodomethane	µg/L	5	<5	<5	<5	<5	<5
1,1-dichloroethene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acrylonitrile	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dichloromethane (Methylene chloride)	µg/L	5	9	<5	<5	<5	<5
Allyl chloride	µg/L	2	<2	<2	<2	<2	<2
Carbon disulfide	µg/L	2	<2	<2	<2	<2	<2
trans-1,2-dichloroethene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
MtBE (Methyl-tert-butyl ether)	µg/L	2	<2	<2	<2	<2	<2
1,1-dichloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Vinyl acetate	µg/L	10	<10	<10	<10	<10	<10
MEK (2-butanone)	µg/L	10	<10	<10	<10	<10	<10
cis-1,2-dichloroethene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromochloromethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloroform (THM)	µg/L	0.5	4.7	<0.5	2.8	<0.5	1.2
2,2-dichloropropane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-dichloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,1-trichloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-dichloropropene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Carbon tetrachloride	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromomethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-dichloropropane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Trichloroethene (Trichloroethylene,TCE)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-nitropropane	µg/L	100	<100	<100	<100	<100	<100
Bromodichloromethane (THM)	µg/L	0.5	<0.5	<0.5	2.3	<0.5	<0.5
MIBK (4-methyl-2-pentanone)	µg/L	5	<5	<5	<5	<5	<5
cis-1,3-dichloropropene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
trans-1,3-dichloropropene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-trichloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-dichloropropane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromochloromethane (THM)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-hexanone (MBK)	µg/L	5	<5	<5	<5	<5	<5
1,2-dibromoethane (EDB)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tetrachloroethene (Perchloroethylene,PCE)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,1,2-tetrachloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorobenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromoform (THM)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
cis-1,4-dichloro-2-butene	µg/L	1	<1	<1	<1	<1	<1
Styrene (Vinyl benzene)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2,2-tetrachloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,3-trichloropropane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
trans-1,4-dichloro-2-butene	µg/L	1	<1	<1	<1	<1	<1

VOCs in Water [AN433] Tested: 9/12/2019 (continued)

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER - 3/12/2019 SE200747.001	WATER - 3/12/2019 SE200747.002	WATER - 3/12/2019 SE200747.003	WATER - 3/12/2019 SE200747.004	WATER - 3/12/2019 SE200747.005
Isopropylbenzene (Cumene)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromobenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
n-propylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-chlorotoluene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-chlorotoluene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3,5-trimethylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
tert-butylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,4-trimethylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
sec-butylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-dichlorobenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,4-dichlorobenzene	µg/L	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
p-isopropyltoluene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-dichlorobenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
n-butylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-dibromo-3-chloropropane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,4-trichlorobenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobutadiene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,3-trichlorobenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total VOC	µg/L	10	-	-	-	-	-

VOCs in Water [AN433] Tested: 9/12/2019 (continued)

PARAMETER	UOM	LOR	QC103	TS	TB
			WATER - 3/12/2019 SE200747.006	WATER - 3/12/2019 SE200747.007	WATER - 3/12/2019 SE200747.008
Benzene	µg/L	0.5	<0.5	22	<0.5
Toluene	µg/L	0.5	<0.5	21	<0.5
Ethylbenzene	µg/L	0.5	<0.5	21	<0.5
m/p-xylene	µg/L	1	<1	22	<1
o-xylene	µg/L	0.5	<0.5	23	<0.5
Total Xylenes	µg/L	1.5	<1.5	45	<1.5
Total BTEX	µg/L	3	<3	110	<3
Naphthalene	µg/L	0.5	<0.5	22	<0.5
Dichlorodifluoromethane (CFC-12)	µg/L	5	-	-	-
Chloromethane	µg/L	5	<5	-	-
Vinyl chloride (Chloroethene)	µg/L	0.3	<0.3	-	-
Bromomethane	µg/L	10	<10	-	-
Chloroethane	µg/L	5	<5	-	-
Trichlorofluoromethane	µg/L	1	<1	-	-
Acetone (2-propanone)	µg/L	10	<10	-	-
Iodomethane	µg/L	5	<5	-	-
1,1-dichloroethene	µg/L	0.5	<0.5	-	-
Acrylonitrile	µg/L	0.5	<0.5	-	-
Dichloromethane (Methylene chloride)	µg/L	5	<5	-	-
Allyl chloride	µg/L	2	<2	-	-
Carbon disulfide	µg/L	2	<2	-	-
trans-1,2-dichloroethene	µg/L	0.5	<0.5	-	-
MtBE (Methyl-tert-butyl ether)	µg/L	2	<2	-	-
1,1-dichloroethane	µg/L	0.5	<0.5	-	-
Vinyl acetate	µg/L	10	<10	-	-
MEK (2-butanone)	µg/L	10	<10	-	-
cis-1,2-dichloroethene	µg/L	0.5	<0.5	-	-
Bromochloromethane	µg/L	0.5	<0.5	-	-
Chloroform (THM)	µg/L	0.5	<0.5	-	-
2,2-dichloropropane	µg/L	0.5	<0.5	-	-
1,2-dichloroethane	µg/L	0.5	<0.5	-	-
1,1,1-trichloroethane	µg/L	0.5	<0.5	-	-
1,1-dichloropropene	µg/L	0.5	<0.5	-	-
Carbon tetrachloride	µg/L	0.5	<0.5	-	-
Dibromomethane	µg/L	0.5	<0.5	-	-
1,2-dichloropropane	µg/L	0.5	<0.5	-	-
Trichloroethene (Trichloroethylene,TCE)	µg/L	0.5	<0.5	-	-
2-nitropropane	µg/L	100	<100	-	-
Bromodichloromethane (THM)	µg/L	0.5	<0.5	-	-
MIBK (4-methyl-2-pentanone)	µg/L	5	<5	-	-
cis-1,3-dichloropropene	µg/L	0.5	<0.5	-	-
trans-1,3-dichloropropene	µg/L	0.5	<0.5	-	-
1,1,2-trichloroethane	µg/L	0.5	<0.5	-	-
1,3-dichloropropane	µg/L	0.5	<0.5	-	-
Dibromochloromethane (THM)	µg/L	0.5	<0.5	-	-
2-hexanone (MBK)	µg/L	5	<5	-	-
1,2-dibromoethane (EDB)	µg/L	0.5	<0.5	-	-
Tetrachloroethene (Perchloroethylene,PCE)	µg/L	0.5	<0.5	-	-
1,1,1,2-tetrachloroethane	µg/L	0.5	<0.5	-	-
Chlorobenzene	µg/L	0.5	<0.5	-	-
Bromoform (THM)	µg/L	0.5	<0.5	-	-
cis-1,4-dichloro-2-butene	µg/L	1	<1	-	-
Styrene (Vinyl benzene)	µg/L	0.5	<0.5	-	-
1,1,2,2-tetrachloroethane	µg/L	0.5	<0.5	-	-
1,2,3-trichloropropane	µg/L	0.5	<0.5	-	-
trans-1,4-dichloro-2-butene	µg/L	1	<1	-	-

VOCs in Water [AN433] Tested: 9/12/2019 (continued)

PARAMETER	UOM	LOR	QC103	TS	TB
			WATER - 3/12/2019 SE200747.006	WATER - 3/12/2019 SE200747.007	WATER - 3/12/2019 SE200747.008
Isopropylbenzene (Cumene)	µg/L	0.5	<0.5	-	-
Bromobenzene	µg/L	0.5	<0.5	-	-
n-propylbenzene	µg/L	0.5	<0.5	-	-
2-chlorotoluene	µg/L	0.5	<0.5	-	-
4-chlorotoluene	µg/L	0.5	<0.5	-	-
1,3,5-trimethylbenzene	µg/L	0.5	<0.5	-	-
tert-butylbenzene	µg/L	0.5	<0.5	-	-
1,2,4-trimethylbenzene	µg/L	0.5	<0.5	-	-
sec-butylbenzene	µg/L	0.5	<0.5	-	-
1,3-dichlorobenzene	µg/L	0.5	<0.5	-	-
1,4-dichlorobenzene	µg/L	0.3	<0.3	-	-
p-isopropyltoluene	µg/L	0.5	<0.5	-	-
1,2-dichlorobenzene	µg/L	0.5	<0.5	-	-
n-butylbenzene	µg/L	0.5	<0.5	-	-
1,2-dibromo-3-chloropropane	µg/L	0.5	<0.5	-	-
1,2,4-trichlorobenzene	µg/L	0.5	<0.5	-	-
Hexachlorobutadiene	µg/L	0.5	<0.5	-	-
1,2,3-trichlorobenzene	µg/L	0.5	<0.5	-	-
Total VOC	µg/L	10	-	-	-

Volatile Petroleum Hydrocarbons in Water [AN433] Tested: 9/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019 SE200747.001	3/12/2019 SE200747.002	3/12/2019 SE200747.003	3/12/2019 SE200747.004	3/12/2019 SE200747.005
TRH C6-C9	µg/L	40	<40	<40	<40	<40	<40
Benzene (F0)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TRH C6-C10	µg/L	50	<50	<50	<50	<50	<50
TRH C6-C10 minus BTEX (F1)	µg/L	50	<50	<50	<50	<50	<50

PARAMETER	UOM	LOR	QC103	TB
			WATER	WATER
			-	-
			3/12/2019 SE200747.006	3/12/2019 SE200747.008
TRH C6-C9	µg/L	40	<40	<40
Benzene (F0)	µg/L	0.5	<0.5	<0.5
TRH C6-C10	µg/L	50	<50	<50
TRH C6-C10 minus BTEX (F1)	µg/L	50	<50	<50

TRH (Total Recoverable Hydrocarbons) in Water [AN403] Tested: 6/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER - 3/12/2019 SE200747.001	WATER - 3/12/2019 SE200747.002	WATER - 3/12/2019 SE200747.003	WATER - 3/12/2019 SE200747.004	WATER - 3/12/2019 SE200747.005
TRH C10-C14	µg/L	50	<50	<50	IS	<50	<50
TRH C15-C28	µg/L	200	<200	<200	IS	<200	<200
TRH C29-C36	µg/L	200	<200	<200	IS	<200	<200
TRH C37-C40	µg/L	200	<200	<200	IS	<200	<200
TRH >C10-C16	µg/L	60	<60	<60	IS	<60	<60
TRH >C10-C16 - Naphthalene (F2)	µg/L	60	<60	<60	IS	<60	<60
TRH >C16-C34 (F3)	µg/L	500	<500	<500	IS	<500	<500
TRH >C34-C40 (F4)	µg/L	500	<500	<500	IS	<500	<500
TRH C10-C40	µg/L	320	<320	<320	IS	<320	<320

PARAMETER	UOM	LOR	QC103
			WATER - 3/12/2019 SE200747.006
TRH C10-C14	µg/L	50	<50
TRH C15-C28	µg/L	200	<200
TRH C29-C36	µg/L	200	<200
TRH C37-C40	µg/L	200	<200
TRH >C10-C16	µg/L	60	<60
TRH >C10-C16 - Naphthalene (F2)	µg/L	60	<60
TRH >C16-C34 (F3)	µg/L	500	<500
TRH >C34-C40 (F4)	µg/L	500	<500
TRH C10-C40	µg/L	320	<320

PAH (Polynuclear Aromatic Hydrocarbons) in Water [AN420] Tested: 6/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH102_w	BH102a_s	QC103
			WATER - 3/12/2019 SE200747.001	WATER - 3/12/2019 SE200747.002	WATER - 3/12/2019 SE200747.004	WATER - 3/12/2019 SE200747.005	WATER - 3/12/2019 SE200747.006
Naphthalene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-methylnaphthalene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1-methylnaphthalene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b&j)fluoranthene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(ah)anthracene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(ghi)perylene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total PAH (18)	µg/L	1	<1	<1	<1	<1	<1

Anions by Ion Chromatography in Water [AN245] Tested: 6/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019 SE200747.001	3/12/2019 SE200747.002	3/12/2019 SE200747.003	3/12/2019 SE200747.004	3/12/2019 SE200747.005
Fluoride	mg/L	0.1	0.44	0.43	IS	2.4	0.26
Chloride	mg/L	1	720	580	IS	1600	630
Nitrate Nitrogen, NO3-N	mg/L	0.005	<0.025 †	<0.025 †	IS	<0.050 †	0.072
Sulfate, SO4	mg/L	1	710	490	IS	610	780

PARAMETER	UOM	LOR	QC103
			WATER
			-
			3/12/2019 SE200747.006
Fluoride	mg/L	0.1	0.47
Chloride	mg/L	1	600
Nitrate Nitrogen, NO3-N	mg/L	0.005	<0.050 †
Sulfate, SO4	mg/L	1	510



ANALYTICAL RESULTS

SE200747 R0

Alkalinity [AN135] Tested: 9/12/2019

			BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019	3/12/2019	3/12/2019	3/12/2019	3/12/2019
PARAMETER	UOM	LOR	SE200747.001	SE200747.002	SE200747.003	SE200747.004	SE200747.005
Total Alkalinity as CaCO3	mg/L	5	370	15	IS	150	IS

			QC103
			WATER
			-
			3/12/2019
PARAMETER	UOM	LOR	SE200747.006
Total Alkalinity as CaCO3	mg/L	5	16



ANALYTICAL RESULTS

SE200747 R0

Nitrite in Water [AN277] Tested: 6/12/2019

			BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019	3/12/2019	3/12/2019	3/12/2019	3/12/2019
PARAMETER	UOM	LOR	SE200747.001	SE200747.002	SE200747.003	SE200747.004	SE200747.005
Nitrite Nitrogen, NO2 as N	mg/L	0.005	0.006	<0.005	IS	<0.005	0.009

			QC103
			WATER
			-
			3/12/2019
PARAMETER	UOM	LOR	SE200747.006
Nitrite Nitrogen, NO2 as N	mg/L	0.005	<0.005

Ammonia Nitrogen by Discrete Analyser (Aquakem) [AN291] Tested: 6/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019	3/12/2019	3/12/2019	3/12/2019	3/12/2019
			SE200747.001	SE200747.002	SE200747.003	SE200747.004	SE200747.005
Ammonia Nitrogen, NH ₃ as N	mg/L	0.005	0.21	0.11	IS	0.19	0.12

PARAMETER	UOM	LOR	QC103
			WATER
			-
			3/12/2019
			SE200747.006
Ammonia Nitrogen, NH ₃ as N	mg/L	0.005	0.058

TKN Kjeldahl Digestion by Discrete Analyser [AN281/AN292(Sydney only)] Tested: 10/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019 SE200747.001	3/12/2019 SE200747.002	3/12/2019 SE200747.003	3/12/2019 SE200747.004	3/12/2019 SE200747.005
Total Kjeldahl Nitrogen	mg/L	0.05	0.77	0.24	1.5	0.32	0.43
Total Nitrogen (calc)	mg/L	0.05	0.78	0.24	-	0.32	0.52

PARAMETER	UOM	LOR	QC103
			WATER
			-
			3/12/2019 SE200747.006
Total Kjeldahl Nitrogen	mg/L	0.05	0.07
Total Nitrogen (calc)	mg/L	0.05	0.07

Total Phosphorus by Kjeldahl Digestion DA in Water [AN279/AN293(Sydney only)] Tested: 10/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019	3/12/2019	3/12/2019	3/12/2019	3/12/2019
			SE200747.001	SE200747.002	SE200747.003	SE200747.004	SE200747.005
Total Phosphorus (Kjeldahl Digestion) as P	mg/L	0.02	0.10	0.04	0.59	0.24	0.02

PARAMETER	UOM	LOR	QC103
			WATER
			-
			3/12/2019
			SE200747.006
Total Phosphorus (Kjeldahl Digestion) as P	mg/L	0.02	<0.02



ANALYTICAL RESULTS

SE200747 R0

Filterable Reactive Phosphorus (FRP) [AN278] Tested: 6/12/2019

			BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019	3/12/2019	3/12/2019	3/12/2019	3/12/2019
PARAMETER	UOM	LOR	SE200747.001	SE200747.002	SE200747.003	SE200747.004	SE200747.005
Filterable Reactive Phosphorus as P	mg/L	0.005	<0.005	0.008	IS	0.18	0.007

			QC103
			WATER
			-
			3/12/2019
PARAMETER	UOM	LOR	SE200747.006
Filterable Reactive Phosphorus as P	mg/L	0.005	<0.005



ANALYTICAL RESULTS

SE200747 R0

pH in water [AN101] Tested: 6/12/2019

			BH01_s	BH101_w	BH102_w	BH102a_s	QC103
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019	3/12/2019	3/12/2019	3/12/2019	3/12/2019
PARAMETER	UOM	LOR	SE200747.001	SE200747.002	SE200747.004	SE200747.005	SE200747.006
pH**	No unit	-	6.4	4.9	6.0	5.8	5.0



ANALYTICAL RESULTS

SE200747 R0

Acidity and Free CO₂ [AN140] Tested: 11/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019 SE200747.001	3/12/2019 SE200747.002	3/12/2019 SE200747.003	3/12/2019 SE200747.004	3/12/2019 SE200747.005
Acidity to pH 8.3	mg CaCO ₃ /L	5	120	110	IS	110	50

PARAMETER	UOM	LOR	QC103
			WATER
			-
			3/12/2019 SE200747.006
Acidity to pH 8.3	mg CaCO ₃ /L	5	52



ANALYTICAL RESULTS

SE200747 R0

Total and Volatile Suspended Solids (TSS / VSS) [AN114] Tested: 11/12/2019

			BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019	3/12/2019	3/12/2019	3/12/2019	3/12/2019
PARAMETER	UOM	LOR	SE200747.001	SE200747.002	SE200747.003	SE200747.004	SE200747.005
Total Suspended Solids Dried at 103-105°C	mg/L	5	84	6	IS	28	46

			QC103
			WATER
			-
			3/12/2019
PARAMETER	UOM	LOR	SE200747.006
Total Suspended Solids Dried at 103-105°C	mg/L	5	8



ANALYTICAL RESULTS

SE200747 R0

Total Dissolved Solids (TDS) in water [AN113] Tested: 10/12/2019

			BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019	3/12/2019	3/12/2019	3/12/2019	3/12/2019
PARAMETER	UOM	LOR	SE200747.001	SE200747.002	SE200747.003	SE200747.004	SE200747.005
Total Dissolved Solids Dried at 175-185°C	mg/L	10	2700	1900	IS	3800	2500

			QC103
			WATER
			-
			3/12/2019
PARAMETER	UOM	LOR	SE200747.006
Total Dissolved Solids Dried at 175-185°C	mg/L	10	1900

Metals in Water (Dissolved) by ICPOES [AN320] Tested: 9/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019 SE200747.001	3/12/2019 SE200747.002	3/12/2019 SE200747.003	3/12/2019 SE200747.004	3/12/2019 SE200747.005
Calcium, Ca	mg/L	0.1	27	2.0	26	8.4	14
Magnesium, Mg	mg/L	0.1	46	20	4.1	69	27
Sodium, Na	mg/L	0.1	770	550	58	1200	680
Potassium, K	mg/L	0.2	6.0	4.0	1.6	9.3	7.4

PARAMETER	UOM	LOR	QC103
			WATER
			-
			3/12/2019 SE200747.006
Calcium, Ca	mg/L	0.1	2.0
Magnesium, Mg	mg/L	0.1	21
Sodium, Na	mg/L	0.1	550
Potassium, K	mg/L	0.2	4.0

Trace Metals (Dissolved) in Water by ICPMS [AN318] Tested: 11/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			- 3/12/2019 SE200747.001	- 3/12/2019 SE200747.002	- 3/12/2019 SE200747.003	- 3/12/2019 SE200747.004	- 3/12/2019 SE200747.005
Arsenic, As	µg/L	1	3	<1	<1	<1	<1
Cadmium, Cd	µg/L	0.1	<0.1	<0.1	<0.1	0.1	<0.1
Chromium, Cr	µg/L	1	2	<1	2	<1	3
Copper, Cu	µg/L	1	<1	2	12	<1	280
Lead, Pb	µg/L	1	<1	<1	4	<1	<1
Nickel, Ni	µg/L	1	32	11	3	27	130
Zinc, Zn	µg/L	5	<5	54	100	98	73
Aluminium, Al	µg/L	5	21	510	1300	380	180
Iron, Fe	µg/L	5	13000	1300	1200	2500	170
Manganese, Mn	µg/L	1	580	520	200	2700	240

PARAMETER	UOM	LOR	QC103
			WATER
			- 3/12/2019 SE200747.006
Arsenic, As	µg/L	1	<1
Cadmium, Cd	µg/L	0.1	<0.1
Chromium, Cr	µg/L	1	<1
Copper, Cu	µg/L	1	2
Lead, Pb	µg/L	1	<1
Nickel, Ni	µg/L	1	11
Zinc, Zn	µg/L	5	55
Aluminium, Al	µg/L	5	510
Iron, Fe	µg/L	5	1300
Manganese, Mn	µg/L	1	530

Trace Metals (Total) in Water by ICPMS [AN022/AN318] Tested: 11/12/2019

PARAMETER	UOM	LOR	BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019 SE200747.001	3/12/2019 SE200747.002	3/12/2019 SE200747.003	3/12/2019 SE200747.004	3/12/2019 SE200747.005
Total Aluminium	µg/L	5	990	540	IS	730	1100
Total Iron	µg/L	5	14000	1300	IS	2800	1800

PARAMETER	UOM	LOR	QC103
			WATER
			-
			3/12/2019 SE200747.006
Total Aluminium	µg/L	5	550
Total Iron	µg/L	5	1300



ANALYTICAL RESULTS

SE200747 R0

Mercury (dissolved) in Water [AN311(Perth)/AN312] Tested: 6/12/2019

			BH01_s	BH101_w	BH101a_s	BH102_w	BH102a_s
			WATER	WATER	WATER	WATER	WATER
			-	-	-	-	-
			3/12/2019	3/12/2019	3/12/2019	3/12/2019	3/12/2019
PARAMETER	UOM	LOR	SE200747.001	SE200747.002	SE200747.003	SE200747.004	SE200747.005
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

			QC103
			WATER
			-
			3/12/2019
PARAMETER	UOM	LOR	SE200747.006
Mercury	mg/L	0.0001	<0.0001

METHOD

METHODOLOGY SUMMARY

AN020	Unpreserved water sample is filtered through a 0.45µm membrane filter and acidified with nitric acid similar to APHA3030B.
AN022/AN318	Following acid digestion of un filtered sample, determination of elements at trace level in waters by ICP-MS technique, in accordance with USEPA 6020A.
AN022	The water sample is digested with Nitric Acid and made up to the original volume similar to APHA3030E.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN113	Total Dissolved Solids: A well-mixed filtered sample of known volume is evaporated to dryness at 180°C and the residue weighed. Approximate methods for correlating chemical analysis with dissolved solids are available. Reference APHA 2540 C.
AN113	The Total Dissolved Solids residue may also be ignited at 550 C and volatile TDS (Organic TDS) and non-volatile TDS (Inorganic) can be determined.
AN114	Total Suspended and Volatile Suspended Solids: The sample is homogenised by shaking and a known volume is filtered through a pre-weighed GF/C filter paper and washed well with deionised water. The filter paper is dried and reweighed. The TSS is the residue retained by the filter per unit volume of sample. Reference APHA 2540 D. Internal Reference AN114
AN135	Alkalinity (and forms of) by Titration: The sample is titrated with standard acid to pH 8.3 (P titre) and pH 4.5 (T titre) and permanent and/or total alkalinity calculated. The results are expressed as equivalents of calcium carbonate or recalculated as bicarbonate, carbonate and hydroxide. Reference APHA 2320. Internal Reference AN135
AN140	Acidity by Titration: The water sample is titrated with sodium hydroxide to designated pH end point. In a sample containing only carbon dioxide, bicarbonates and carbonates, titration to pH 8.3 at 25°C corresponds to stoichiometric neutralisation of carbonic acid to bicarbonate. Method reference APHA 2310 B.
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO ₂ , NO ₃ and SO ₄ are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B
AN277/WC250.312	Nitrite ions, when reacted with a reagent containing sulphanilamide and N-(1-naphthyl)-ethylenediamine dihydrochloride produce a highly coloured azo dye that is measured photometrically at 540nm.
AN278	Filterable Reactive Phosphorus by DA (determined on filtered sample): Orthophosphate reacts with ammonium molybdate (Mo VI) and potassium antimonyl tartrate (Sb III) in acid medium to form an antimony-phosphomolybdate complex. This complex is subsequently reduced with ascorbic acid to form a blue colour and the absorbance is read at 880 nm. The sensitivity of the automated method is 10-20 times that of the macro method. Reference APHA 4500-P F
AN279/AN293(Sydney)	The sample is digested with Sulphuric acid, K ₂ SO ₄ and CuSO ₄ . All forms of phosphorus are converted into orthophosphate. The digest is cooled and placed on the discrete analyser for colorimetric analysis.
AN281	An unfiltered water or soil sample is first digested in a block digester with sulfuric acid, K ₂ SO ₄ and CuSO ₄ . The ammonia produced following digestion is then measured colourimetrically using the Aquakem 250 Discrete Analyser. A portion of the digested sample is buffered to an alkaline pH, and interfering cations are complexed. The ammonia then reacts with salicylate and hypochlorite to give a blue colour whose absorbance is measured at 660nm and compared with calibration standards. This is proportional to the concentration of Total Kjeldahl Nitrogen in the original sample.
AN291	Ammonia in solution reacts with hypochlorite ions from Sodium Dichloroisocyanate, and salicylate in the presence of Sodium Nitroprusside to form indophenol blue and measured at 670 nm by Discrete Analyser.
AN311(Perth)/AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN318	Determination of elements at trace level in waters by ICP-MS technique, in accordance with USEPA 6020A.
AN320	Metals by ICP-OES: Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components.
AN320	Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference APHA 3120 B.

AN403

Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36 and in recognition of the NEPM 1999 (2013), >C10-C16 (F2), >C16-C34 (F3) and >C34-C40 (F4). Where F2 is corrected for Naphthalene, the VOC data for Naphthalene is used.

AN403

Additionally, the volatile C6-C9/C6-C10 fractions may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Recoverable Hydrocarbons - Silica (TRH-Silica) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents.

AN403

The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.

AN420

(SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols (etc) in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).

AN433

VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC's are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

Calculation

Free and Total Carbon Dioxide may be calculated using alkalinity forms only when the samples TDS is <500mg/L. If TDS is >500mg/L free or total carbon dioxide cannot be reported. APHA4500CO2 D.

FOOTNOTES

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

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

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

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

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

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

Note that in terms of units of radioactivity:

- 1 Bq is equivalent to 27 pCi
- 37 MBq is equivalent to 1 mCi

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

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/pv.sgsvr/en-gb/environment.

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APPENDIX F

Important Information

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

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The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification



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