REPORT TO

SYESUN PTY LTD

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED REDEVELOPMENT OF GARDEN CENTRE

AT

277 MONA VALE ROAD, TERREY HILLS, NSW

Date: 3 September 2021
Ref: 34278Brpt

JKGeotechnics
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Report prepared by:

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For and on behalf of
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DOCUMENT REVISION RECORD

Report Reference	Report Status	Report Date
34278Brpt	Final Report	3 September 2021

Table of Contents

ATTACHMENTS

1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed redevelopment of the Flower Power Garden Centre located at 277 Mona Vale Road, Terrey Hills, NSW. The location of the site is shown in Figure 1. The investigation was commissioned by Brent Jones of Statewide Project Management Pty Ltd, on behalf of Syesun Pty Ltd, and was carried out in accordance with our proposal dated 18 June 2021, Ref: P54404B.

As shown in the preliminary architectural drawings by Leffler Simes Architects (Job No. 4932, Drawing Nos SK01 to SK15, dated July 2021) the existing Flower Power development will be demolished and a new garden centre constructed. The main garden centre building will be located in the north-eastern corner of the site and will have one above ground level over a basement car park. The basement is proposed at RL196.5m and will require excavation to depths of about 1.5m to 3m. To the west of the main building will be the open nursery, with a loading dock and staff area in the north-western corner. The loading dock is proposed at RL202m, which will require excavation to a maximum depth of about 2.5m. A second single storey commercial building is proposed in the south-eastern corner of the site containing a fruit store and pet store. This building will have a floor level at RL198.7m, requiring fill to a maximum depth of about 3.5m. An on-grade car park is proposed between the garden centre building and the building on the southern side of the site.

The purpose of the investigation was to obtain geotechnical information on the subsurface conditions, and to use this as a basis for providing comments and recommendations on excavation, earthworks. retention, footings and pavements.

This geotechnical investigation was carried out in conjunction with an environmental site assessment by our environmental division, JK Environments (JKE). Reference should be made to the separate report by JKE, Ref: E34278PHrpt, for the results of the environmental site assessment.

2 INVESTIGATION PROCEDURE

Boreholes BH1 to BH10 were auger drilled using our truck mounted JK400 drilling rig. BH1 to BH9 were drilled to depths ranging from 6m to 10m below the existing ground surface, with BH10 refusing at a depth of 2.2m.

The borehole locations, as shown on Figure 2, were set out by taped measurements from exiting surface features. The approximate surface levels, as shown on the borehole logs, were estimated by interpolation between spot levels and contours shown on the supplied survey plan by Boxall (Ref: 10115, Drawing No. 10115-001, Revision A, dated 3/12/14). We note that given the age of the survey plan the surface levels may have changed since that time. The datum of the levels is the Australian Height Datum (AHD).

The apparent compaction of the fill and the relative density and strength of the natural soils were assessed from Standard Penetration Test (SPT) 'N' values, augmented by hand penetrometer readings on cohesive samples recovered in the SPT split tube sampler. The strength of the underlying weathered sandstone was assessed from observation of the resistance to penetration of a Tungsten Carbide (TC) bit attached to the augers, together with inspection of the recovered rock chip samples and subsequent correlation with laboratory moisture content test results. Rock strengths assessed in this way are approximate only and variations of one strength order should not be unexpected.

Groundwater observations were made during and on completion of drilling of each borehole. Since the site is an active garden centre the boreholes had to be backfilled on competition and further monitoring of groundwater levels on the day of drilling was not possible. No longer term monitoring of groundwater levels was carried out.

Our geotechnical engineer, Ben Sheppard, set out the borehole locations, nominated the testing and sampling locations, and logged the subsurface conditions encountered. The borehole logs are attached, together with a set of explanatory notes which describe the investigation techniques, and their limitations, and define the logging terms and symbols used.

Selected samples were returned to Soil Test Services Pty Ltd (STS) and Envirolab Services Pty Ltd, both NATA accredited laboratories, for testing to determine moisture contents, Atterberg Limits, linear shrinkages, standard compaction properties, four day soaked CBR values, pH, sulphate contents, chloride contents and resistivity values. The results are summarised in the attached STS Tables A and B and Envirolab Certificate of Analysis 276168. Samples were also collected from the boreholes for testing as part of the environmental assessment by JKE.

3 RESULTS OF INVESTIGATION

3.1 Site Description

The site is located on a relatively level portion of a plateau associated with surrounding ridge and valley topography. The site itself slopes down to the south-east at about 2°, with surface levels ranging from about RL202.5m in the north-western corner to about RL194.5m in the south-eastern corner. The site is bound to the east by Mona Vale Road, to the north by Cooyong Road, to the west by Myoora Road, and to the south by a predominantly undeveloped property.

The site was contains a Flower Power Garden Centre, which comprises several one storey rendered, concrete block, brick and metal clad structures generally situated within the eastern third of the site. An Asphaltic Concrete (AC) surfaced carpark is located along the Mona Vale Road frontage and along the eastern half of the Cooyong Road frontage, and appears to be in good condition apart from some minor localised depressions and associated cracking. A concrete pavement extends along the southern boundary towards material stockpiles, contained within bays formed by large stacked concrete blocks and steel post and timber lagging retaining systems to a maximum height of about 2.3m. The concrete pavement appears to be in good condition. The retaining walls appear to be in fair condition, with some deformation observed of the concrete blocks. Other minor retaining walls of generally less than about 1m in height are present throughout the site, predominantly forming garden beds.

The remainder of the site comprises gravel and concrete pathways throughout the garden nursery. A densely vegetated swampy/boggy area is present to the west of the main under croft nursery. A fill platform is located to the south of the swampy area with the fill cut vertically for a height of about 1.5m and stockpiles and other material stored on the platform. Adjacent to the western portion of the southern boundary a vegetated embankment of about 1m to 1.5m in height slopes down to the southern boundary at about 15° to 20°. Numerous medium to large sized trees are present throughout the site.

To the south of the site is a primarily undeveloped property with a small plantation towards the Mona Vale Road frontage. Single storey metal clad and brick structures are present within the middle of the property. Ground levels across the common boundary are generally similar to those within the subject site, apart from the embankment at the western end as described above.

3.2 Subsurface Conditions

Reference to the Sydney Geological Series Sheet indicates that the site is mapped to be underlain by Hawkesbury Sandstone, which comprises medium to coarse grained quartz sandstone with minor shale and laminite lenses.

In summary, the boreholes encountered fill covering variable soils, comprised clays and sands grading into poor quality weathered sandstone. Further comments on the subsurface conditions encountered are provided below. Reference should be made to the borehole logs for detailed descriptions of the subsurface conditions encountered at each location.

Pavements

In BH1, BH2 and BH3 asphaltic concrete was initially encountered of 40mm to 100mm thickness and was underlain by gravelly silty sand fill to depths ranging from 0.2m to 0.4m and this may be the base or subbase layer of the pavement. In BH5 and BH6 concrete was initially encountered of 135mm and 230mm thickness, respectively. The concrete was underlain by silty sand fill to depths of 0.4m and this may be the subbase layer of the pavement.

Fill

Fill was encountered in all boreholes, to generally shallow depths of 0.3m to 0.8m, but deeper in BH2, BH7 and BH8 to depths of 1.5m, 2.7m and 1.55m, respectively. The fill mainly comprised silty sand with some gravelly sandy clay and sandy clay fill in BH2 and BH3. Inclusions within the fill comprised brick, concrete, tile, steel and glass fragments. Where testing was possible of the deeper fill it was generally assessed to be poorly compacted, with some moderately compacted layers in BH7 and BH9.

Natural Soils

The natural soils were variable, comprising sandy clay, silty clay, silty sand and clayey sand. The clays were of variable plasticity from low plasticity to medium plasticity and ranged in strength from firm strength to hard strength. The sandy soils were generally of loose relative density with some very loose and medium dense layers.

Weathered Sandstone

Weathered sandstone was encountered at variable depths ranging from 1m to 8m, generally shallow within the northern and western portions of the site and increasing in depth towards the south-east. The sandstone, and siltstone with the upper portion of BH2, was generally assessed to be extremely weathered, with some sandstone of very low or low strength in some boreholes. However, there was not a consistent increase in rock strength with depth, with some very low strength sandstone underlain by extremely weathered sandstone.

Groundwater

Groundwater seepage was encountered during drilling of all boreholes apart from BH2, BH6 and BH10 at depths ranging from 1.3m to 6.5m. On completion of drilling, groundwater was measured in BH1, BH3 to BH5 and BH7 to BH9 at depths ranging from 1.7m to 7.3m. Due to the site being used at the time of drilling the boreholes were unable to be left open to allow longer monitoring of groundwater levels.

3.3 Laboratory Test Results

The laboratory moisture content, Atterberg Limits and linear shrinkage test results generally showed a reasonably good correlation with our field logging of clay plasticity and rock strength. The clays tested were of low or medium plasticity and are assessed to have a low to moderate potential for shrink/swell movements with changes in moisture content.

The four day soaked CBR tests on samples of the fill from BH2 and BH7 compacted to 98% of their standard Maximum Dry Density (SMDD) gave CBR values of 12% and 20%, respectively. A sample of natural gravelly silty sand from BH10 compacted to 98% of its SMDD gave CBR value of 35%.

The soil pH values ranged from 4.8 to 7.1, indicating acidic to neutral soil conditions. The sulphate contents ranged from 10mg/kg to 54mg/kg, the chloride contents ranged from <10mg/kg to 24mg/kg and the resistivity ranged from 210ohm.m to 430ohm.m. Based on these results, the soils would be classified as 'mild' exposure classification for concrete piles in accordance with Table 6.4.2(C) of AS2159-2009 'Piling – Design and Installation'. For steel piles, the soils would be classified as 'non-aggressive' in accordance with Table 6.5.2(C) of AS2159-2009.

4 COMMENTS AND RECOMMENDATIONS

4.1 Main Geotechnical Issues

The aim of this geotechnical investigation was to obtain initial information on the subsurface conditions to assist with DA planning and submission. Therefore, only a broad spread of boreholes was drilled, with some areas of the site inaccessible due to the current development.

The results obtained have indicated somewhat variable conditions, with areas of deeper fill, variable natural soils and a variable depth of the bedrock. In addition, the bedrock encountered is of poor quality.

Groundwater seepage was encountered in the boreholes and may be encountered within the basement excavation.

The proposed development is feasible from a geotechnical perspective, but the following needs to be considered in the design and construction:

- Areas of fill are present within the site and since we are unaware of any records of placement or compaction control of the fill it must be considered 'uncontrolled' and is not suitable to support footing or slab loads. Where this fill is present within building areas it will need to be fully excavated and replaced with controlled, engineered fill.
- The soils are variable and do not provide a uniform foundation stratum for the proposed buildings. The most competent stratum is the underlying weathered sandstone bedrock, which is expected to be encountered within the basement excavation.
- The sandstone is of poor quality, mostly being extremely weathered and so only low bearing pressures will be able to be used for design.
- Groundwater seepage is expected within the basement excavation and drainage will need to be provided to control such seepage.

Due to the wide spacing of the current boreholes and the variable conditions encountered, we recommend that additional boreholes be drilled to confirm the subsurface conditions between the existing boreholes. Some boreholes could be drilled prior to demolition, but demolition would be required in order to drill boreholes within the footprint of the proposed basement. Therefore, it would be preferable to drill the additional boreholes following demolition so the boreholes can be drilled at targeted locations.

We expect that the groundwater encountered in the boreholes is seepage within the soils and rock and may dissipate quickly, but as part of this investigation we were unable to leave the boreholes open to monitor groundwater levels. Therefore, as part of the additional geotechnical investigation we recommend that groundwater monitoring wells be installed to allow longer term monitoring of groundwater levels.

The comments and recommendations provided herein may be used for planning and initial design, but should be reviewed as part of the additional geotechnical investigation.

4.2 Excavation and Groundwater

Excavation will be required for the proposed basement to a maximum depth of about 3m and for the loading dock in the north-western corner to a depth of about 2.5m. Such excavations are expected to encounter fill, natural clayey and sandy soils and the upper extremely weathered bedrock.

Excavation of the soils and the extremely weathered sandstone will be possible using conventional excavation equipment, such as the buckets of hydraulic excavators. However, if some low strength or higher strength sandstone bands are encountered the use of ripping hooks or other rock excavation equipment may be required. We do not expect that the use of hydraulic rock hammers will be required, but if they are proposed additional geotechnical advice should be obtained on precautions required during rock hammer use depending on the location of the excavation area in relation to adjoining structures. If excavation using a rock hammer is proposed close to adjoining structures monitoring of the vibrations generated by the hammer may be required.

Groundwater seepage was encountered in the boreholes and may be encountered within the basement excavation. Given the location of the site on the plateau, we expect that the seepage is flow through the soils and weathered rock and not the standing groundwater level and as such should reduce with time. During construction, we expect that any seepage that does occur will be able to be controlled using conventional sump and pump techniques. In the long term, drainage should be provided behind all retaining walls to collect and direct seepage into the stormwater system.

4.3 Earthworks and Filling

Fill was generally encountered to shallow depths of less than 0.8m, but deeper in BH2, BH7 and BH8 to depths of 1.56m, 2.7m and 1.55m. We are unaware of any records of placement or compaction control of the fill and as such it must be considered 'uncontrolled' and is not suitable for support of footings or floor slabs. In addition, the testing carried out in the boreholes indicates that the fill appears to generally be poorly compacted.

Within building areas, all existing uncontrolled fill should be fully excavated and replaced with controlled, engineered fill, unless the floor slabs are designed as fully suspended slabs supported on footings founded below the fill. Within pavement areas, the existing fill may remain in place provided it performs satisfactorily during proof rolling. However, given the poorly compacted nature of the fill our preference would be to excavate all existing uncontrolled fill and replace it as required within engineered fill.

Where fill is required and below all floor slabs and pavements the following earthworks preparation measures should be followed:

- Strip vegetation and root affected soils and stockpile separately for reuse in landscaped areas or remove from site.
- Remove pavements and existing fill from within building areas, but preferably within the entire site, to expose the natural soils.
- Proof roll the exposed subgrade with at least 8 passes of a minimum 10 tonne dead weight, smooth drum, vibratory roller. The aim of the proof rolling is to improve the compaction of the near surfacer soils and to detect any weak subgrade areas.
- The final pass of the proof rolling should be carried out without vibration and in the presence of a geotechnical engineer to detect any weak or unstable subgrade areas.
- During use of the roller care must be taken in regard to vibrations adjacent to existing structures. Given the nature of this site this is unlikely to be a concern, but must be considered by the earthworks contractor. It may be necessary to reduce vibrations or operate the roller in static mode only in some areas of the site.

- Any weak subgrade areas detected should be locally excavated to a sound base and the excavated material replaced with engineered fill, or as directed by the geotechnical engineer during the proof rolling inspection.
- Following treatment of any weak areas fill may be placed to the required level in thin horizontal layers compacted as recommended below.

Weak subgrade areas should be expected where the existing poorly compacted fill is left in place or where very loose sand or clays of firm strength are exposed. The extent of the weak areas may be reduced provided the earthworks are carried out during dry weather and water is not allowed to pond. Adequate falls should be maintained during the earthworks to reduce the risk of water ponding.

4.4 Engineered Fill and Compaction Control

Engineered fill should preferably comprise well graded granular materials, such as ripped rock or crushed sandstone, free of deleterious substances and having a maximum particle size not exceeding 75mm. Such fill should be compacted in horizontal layers of not greater than 200mm loose thickness, to a density of at least 98% of Standard Maximum Dry Density (SMDD). For backfilling confined excavations such as service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then the layer thickness should be limited to 100mm loose thickness.

The excavated fill, natural soils and weathered sandstone may be reused as engineered fill, provided it is free of deleterious material and particles in excess of 75mm in size. Any clay fill should be placed in maximum 200mm loose thickness layers compacted to a density strictly between 98% and102% of SMDD and at a moisture content within 2% of Standard Optimum Moisture Content (SOMC).

Density tests should be regularly carried out on the fill to confirm the above specifications are achieved. The frequency of density testing should be at least one test per layer per 500m^2 or three tests per visit, whichever requires the most tests. Where the fill is to support building loads it should be placed under Level 1 control, as defined by AS3798. Preferably the geotechnical testing authority should be engaged directly on behalf of the client and not by the earthworks subcontractor.

4.5 Batters and Retaining Walls

Given the offset of the proposed basement from the site boundaries the use of temporary batters would be feasible, with permanent retaining walls constructed at the toe of the batters. However, for the excavations in the north-eastern corner retaining wall may need to be constructed prior to excavation so temporary batters do not extend past the site boundaries.

Where space permits, temporary batters of no more than 3m in height should be no steeper than 1 Vertical in 1 Horizontal (1V:1H). Such batters should remain stable in the short term, provided all surcharge loads, including construction loads, are kept well clear of the crest of the batters.

Permanent batters, if required, should be no steeper than 1V:2H, but flatter batters of the order of 1V:3H may be preferred to allow access for maintenance of vegetation. All permanent batters should be covered with topsoil and panted with a deep rooted runner grass, or other suitable surface protection, to reduce erosion. All stormwater runoff should be directed away from all temporary and permanent batters to also reduce erosion.

Where batters cannot be accommodated, or are not preferred, suitable retention system are expected to comprise solider pile retaining walls with shotcrete infill panels given that no structures will be present behind the wall. However, where sandy soils are encountered a close pile spacing will be required to reduce the risk of collapse until the shotcrete is placed. If this is to attempted, we recommend that trial excavations be carried out to assess if the soils can stand sufficiently to allow placement of the shotcrete. If collapse occurs, then contiguous pile walls may need to be used.

Difficulties may also be experienced if bored piers for the retaining walls are attempted due to collapse of the sandy soils and groundwater inflow. If such piles are to be used, trial piers should be drilled to assess if the difficulties can be overcome using temporary liners and pumps. The use of auger, grout injected (CFA) piles may be required if bored piers prove impractical.

Permanent retaining walls, either piled walls or wall constructed at the base of temporary batters, may be designed as cantilevered walls as they will retain no more than 3.5m. Such walls may be designed based on a triangular earth pressure distribution using an active earth pressure coefficient, K_a, of 0.33 and a bulk unit weight of 20kN/m^3. This assumes that some resulting ground movement behind the wall is acceptable. Where movements are to be reduced or the walls are propped by other structural elements in front of the wall, an 'at rest' earth pressure coefficient, K_0, of 0.6 should be used.

The above coefficients assume horizontal backfill surfaces and where inclined backfill is proposed the coefficients should be increased or the inclined backfill taken as a surcharge load. All surcharge loads should be allowed for in the design plus full hydrostatic pressures, unless measures are undertaken to provide complete and permanent drainage behind the wall.

Backfill behind the wall should be compacted to the specifications as given in Section 4.4, but a reduced layer thickness should be adopted due to the need to use light compaction equipment so that additional pressures are not placed on the walls. Good quality granular material should be used for backfill directly behind walls to aid compaction.

4.6 Footings

Since extremely weathered sandstone is expected to be encountered within the excavation for the proposed basement all footings for that structure should be founded within the sandstone to provide uniform support and reduce the risk of differential settlement.

For the other buildings where excavation is not proposed, the natural soils are variable, with sandy soils of very loose relative density and clays of firm strength. Therefore, such soils would only be appropriate for very limited bearing pressures and we recommend that these buildings also be supported on footings founded within the underlying weathered sandstone.

Where sandstone is exposed or is at shallow depths pad or strip footings may be used. Where the depth of the sandstone is more than about 1m, piles would be more practical. Difficulties may be experienced with bored piers due to the sandy soils and groundwater and the use of CFA piles may need to be adopted.

The sandstone encountered is of poor quality and as such footings founded within the extremely weathered sandstone should be designed based on an allowable bearing pressure of no more than 600kPa. Where piers are adopted, an allowable shaft adhesion in compression of 60kPa, or 30kPa for uplift loads, may adopted below a nominal 0.3m socket and provided socket cleanliness and roughness is maintained.

Given the variable depth and quality of the sandstone additional boreholes should be drilled following demolition, as recommended in section 4.1, to better profile the rock depth. This will be particularly important where CFA piles are adopted, as inspection of the rock cuttings is not generally possible. At least the initial drilling of piers should be inspected by a geotechnical engineer to confirm that appropriate foundation material has been encountered.

4.7 Pavements

The pavement subgrade should be prepared as recommended in section 4.3 above. The CBR tests on samples of the sandy fill and natural sandy soils gave high CBR values. Since much of the proposed pavement area will be filled the appropriate CBR value for design of the pavements will depend on the material used as fill. Where granular fill is used, then a CBR value similar to those measures, say 8%, may be used, but if clay fill is used the CBR may be of the order of 2% to 4%. We recommend that testing of the fill used be carried out to determine the appropriate CBR value for design.

Adequate drainage should be provided to prevent moisture ingress into the pavement and subgrade.

Concrete pavements should have a subbase layer of at least 100mm thickness of crushed rock to TfNSW QA specification 3051 unbound base material (or similar good quality and durable fine crushed rock), which is compacted to at least 100% of SMDD. Concrete pavements should be designed with an effective shear transmission at all joints by way of either doweled or keyed joints.

4.8 Further Geotechnical Input

The following is a summary of the further geotechnical input which is required and which has been detailed in the preceding sections of this report:

- Additional boreholes following demolition to better profile the subsurface conditions.
- Inspection of the proof rolling of subgrade areas prior to the placement of fill.
- Density testing of fill placed.

- Inspection of foundation material during initial footing excavation.

5 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. As an example, special treatment of soft spots may be required as a result of their discovery during proof-rolling, etc. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and JK Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

The long term successful performance of floor slabs and pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance program should not be limited to routine compaction density testing only. Other critical factors associated with the earthworks may include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer. Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience. In order to identify potential problems, we recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and potential difficulties. This meeting should clearly define the lines of communication and responsibility.

Occasionally, the subsurface conditions between the completed boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of JK Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE A
MOISTURE CONTENT, ATTERBERG LIMITS AND LINEAR SHRINKAGE TEST REPORT

Client:	JK Geotechnics	**Report No.:**	34278B - A
Project:	Proposed Redevelopment of Garden Centre	**Report Date:**	31/08/2021
Location:	277 Mona Vale Road, Terrey Hills, NSW	**Page 1 of 1**	

AS 1289	**TEST METHOD**	**2.1.1**	**3.1.2**	**3.2.1**	**3.3.1**	**3.4.1**
BOREHOLE NUMBER	**DEPTH m**	**MOISTURE CONTENT %**	**LIQUID LIMIT %**	**PLASTIC LIMIT %**	**PLASTICITY INDEX %**	**LINEAR SHRINKAGE %**
1	5.00 - 6.00	12.1	-	-	-	-
2	7.00 - 7.50	6.8	-	-	-	-
5	3.00 - 3.45	17.0	28	14	14	8.0
7	3.00 - 3.45	20.9	46	24	22	11.0
9	2.50 - 3.00	6.5	-	-	-	-
10	2.00 - 2.20	4.5	-	-	-	-

Notes:
- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 18/08/2021.
- Sampled and supplied by client. Samples tested as received.

NATA

NATA Accredited Laboratory Number:1327

Accredited for compliance with ISO/IEC 17025 - Testing.
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In full without approval of the laboratory. Results relate only to the items tested or sampled.

31/08/2021
Authorised Signature / Date
(D. Treweek)

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE B
FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client:	JK Geotechnics	**Ref No:**	34278B
Project:	Proposed Redevelopment of Garden Centre	**Report:**	B
Location:	277 Mona Vale Road, Terrey Hills, NSW	**Report Date:**	25/08/2021
		Page 1 of 1	

BOREHOLE NUMBER		BH 2	BH 7	BH 10
DEPTH (m)		0.35 - 1.20	0.00 - 1.00	0.30 - 1.20
Surcharge (kg)		4.5	4.5	4.5
Maximum Dry Density (t/m^3)		1.79 STD	1.90 STD	1.96 STD
Optimum Moisture Content (%)		15.8	14.1	12.4
Moulded Dry Density (t/m^3)		1.77	1.87	1.93
Sample Density Ratio (%)		98	98	98
Sample Moisture Ratio (%)		97	98	99
Moisture Contents				
Insitu (%)		20.2	13.2	11.2
Moulded (%)		15.3	13.8	12.3
After soaking and				
After Test, Top 30mm(%)		16.7	14.0	12.6
Remaining Depth (%)		16.4	13.4	12.4
Material Retained on 19mm Sieve (%)		2*	1*	3*
Swell (%)		0.0	0.0	0.5
C.B.R. value:	@2.5mm penetration	12		35
	@5.0mm penetration		20	

NOTES: Sampled and supplied by client. Samples tested as received.

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods : AS 1289 6.1.1, 5.1.1 & 2.1.1.
- Date of receipt of sample: 18/08/2021.
- * Denotes not used in test sample.

NATA

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the items tested or sampled.

25/08/2021

Authorised Signature / Date
(D. Treweek)

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CERTIFICATE OF ANALYSIS 276168

Client Details	
Client	JK Geotechnics
Attention	Ben Sheppard
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details	
Your Reference	**34278B, Terrey Hills**
Number of Samples	6 Soil
Date samples received	19/08/2021
Date completed instructions received	19/08/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details	
Date results requested by	26/08/2021
Date of Issue	25/08/2021

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Results Approved By
Jenny He, Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		276168-1	276168-2	276168-3	276168-4	276168-5
Your Reference	UNITS	BH1	BH3	BH5	BH6	BH8
Depth		0.5-0.95	3-3.45	4.5-4.95	0.5-0.95	1.55-1.95
Date Sampled		12/08/2021	12/08/2021	12/08/2021	13/08/2021	13/08/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	24/08/2021	24/08/2021	24/08/2021	24/08/2021	24/08/2021
Date analysed	-	24/08/2021	24/08/2021	24/08/2021	24/08/2021	24/08/2021
pH 1:5 soil:water	pH Units	5.2	7.1	4.8	5.7	6.9
Sulphate, SO4 1:5 soil:water	mg/kg	39	10	46	54	51
Chloride, Cl 1:5 soil:water	mg/kg	20	24	<10	<10	<10
Resistivity in soil*	ohm m	210	290	250	220	240

Misc Inorg - Soil		
Our Reference		276168-6
Your Reference	UNITS	BH10
Depth		0.5-0.95
Date Sampled		13/08/2021
Type of sample		Soil
Date prepared	-	24/08/2021
Date analysed	-	24/08/2021
pH 1:5 soil:water	pH Units	5.8
Sulphate, SO4 1:5 soil:water	mg/kg	22
Chloride, Cl 1:5 soil:water	mg/kg	<10
Resistivity in soil*	ohm m	430

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			24/08/2021	2	24/08/2021	24/08/2021		24/08/2021	[NT]
Date analysed	-			24/08/2021	2	24/08/2021	24/08/2021		24/08/2021	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	2	7.1	7.1	0	102	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	10	10	0	90	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	24	23	4	81	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	2	290	290	0	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

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BOREHOLE LOG

Borehole No.
1
1/2

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS
Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE
Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 199.6m
Date: 12/8/21 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		0	-	ASPHALTIC CONCRETE: 40mm.t				
				FILL: Silty sand, medium grained, brown, trace of medium to coarse grained igneous and ironstone gravel.	M			
	N = 6 3,3,3	1	CL	Gravelly sandy CLAY: low plasticity, orange brown, fine to medium grained ironstone gravel, medium grained sand, trace of silt.	w>PL	(St)		RESIDUAL TOO GRAVELLY FOR HP TESTING
	N > 21 2,9,12/ 50mm REFUSAL		SC	Clayey SAND: medium to coarse grained, grey and brown, with iron indurated bands, trace of coarse grained sand lenses, and silt.	M	VD		
		2	-	Extremely Weathered sandstone: clayey SAND, fine to coarse grained, grey and orange brown, with iron indurated bands, trace of silt.	XW	VD		HAWKESBURY SANDSTONE VERY LOW 'TC' RESISTANCE
▶	N = SPT 4/10mm REFUSAL	3		as above, but with very low strength bands.				VERY LOW RESISTANCE WITH LOW BANDS
		4						
		5		SANDSTONE: fine to medium grained, red brown, with extremely weathered bands.	DW	VL		VERY LOW TO LOW RESISTANCE
▼ ON COMPLETION		6		Extremely Weathered sandstone: silty CLAY, medium plasticity, red brown and grey.	XW	(St-VSt)		SOIL 'TC' BIT RESISTANCE
		7						

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BOREHOLE LOG

Borehole No. 1

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS

Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE

Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B | **Method:** SPIRAL AUGER | **R.L. Surface:** ≈ 199.6m

Date: 12/8/21 | **Datum:** AHD

Plant Type: JK400 | **Logged/Checked by:** B.S./D.B.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
									Extremely Weathered sandstone: silty CLAY, medium plasticity, red brown and grey.	XW	(St-VSt)		
									END OF BOREHOLE AT 7.5m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No. 2

1/2

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS

Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE

Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 198.2m

Date: 12/8/21 **Datum:** AHD

Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION		0		ASPHALTIC CONCRETE: 100mm.t				
			-	FILL: Gravelly silty sand, fine to coarse grained, dark grey, fine grained igneous gravel, trace of concrete fragments.	M			APPEARS POORLY COMPACTED
	N = 3 3,1,2			FILL: Gravelly sandy clay, low plasticity, dark grey, fine to coarse grained ironstone gravel, medium grained sand, trace of glass, carbonaceous organic matter and silt.	w>PL			ORGANIC ODOUR
		1		as above, but with metal and timber fragments, and silty sand lenses.				
	N = SPT 34/150mm REFUSAL		-	Extremely Weathered siltstone: silty CLAY, medium grained, light grey and red brown, with iron indurated bands.	XW	Hd		HAWKESBURY SANDSTONE VERY LOW 'TC' BIT RESISTANCE
		2						
	N = 17 4,8,9	3					>600 >600 >600	
		4						
		5	-	Extremely Weathered sandstone: silty SAND, fine to medium grained, grey, with extremely weathered siltstone bands.		(D)		
		6						
				SANDSTONE: medium to coarse grained, red brown.	DW	L		LOW RESISTANCE
		7						

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BOREHOLE LOG

Borehole No.
2

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS
Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE
Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 198.2m
Date: 12/8/21 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
									SANDSTONE: medium to coarse grained, red brown.	DW	L		
						8			END OF BOREHOLE AT 7.5m				
						9							
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No.
3
1/2

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS
Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE
Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 196.0m
Date: 12/8/21 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		0		ASPHALTIC CONCRETE: 70mm.t				
			-	FILL: Gravelly silty sand, fine to medium grained, dark grey, fine to medium grained igneous gravel.	M / w>PL			ORGANIC ODOUR
	N = 2 1,1,1	1		FILL: Sandy clay, low plasticity, dark grey and brown, fine to medium grained sand, trace of fine grained igneous and carbonaceous organic matter and silt.				
			SM	Silty SAND: fine to coarse grained, orange brown, with clay fines.	M	VL		RESIDUAL
	N = 3 1,1,2	2	CL	Sandy CLAY: low plasticity, brown and orange brown, medium grained sand, trace of fine to medium grained weakly cemented ironstone gravel, clayey sand lenses, and silt.	w>PL	F-St	90 100 110	
ON COMPLETION	N - 7 2,3,4	3		as above, but medium to coarse grained sand and trace of sand bands		St	180 180 180	
	N = 8 3,4,4	4–5				St-VSt	190 270 240	
		6						
		7						

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BOREHOLE LOG

Borehole No. 3

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS

Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE

Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 196.0m

Date: 12/8/21 **Datum:** AHD

Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
									Sandy CLAY: low plasticity, brown and orange brown, medium to coarse grained sand, trace of fine to medium grained weakly cemented ironstone gravel, clayey sand lenses, sand bands, and silt.	w>PL	St-VSt		
						8		CI-CH	Silty CLAY: medium to high plasticity, grey and red brown.		(Hd)		POSSIBLY EXTREMELY WEATHERED SILTSTONE
						9							
								-	SANDSTONE: fine to medium grained, red brown.	DW	VL		HAWKESBURY SANDSTONE
						10			END OF BOREHOLE AT 10.0m				VERY LOW TO LOW 'TC' BIT RESISTANCE
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No.
4

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS
Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE
Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 201.2m
Date: 12/8/21 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			FILL: Sandy gravel, fine to coarse grained, igneous gravel, brown, dark brown and grey, fine grained sand, trace of silt and concrete fragments.	M			
		N = 6 3,2,4			SM	FILL: Silty sand, fine to medium grained, brown, trace of fine grained igneous gravel.	M	L		RESIDUAL
			1		-	Silty SAND: medium to coarse grained, yellow brown and brown, with fine to coarse grained ironstone gravel, trace of clay.				
		N = SPT 7/10mm REFUSAL				SANDSTONE: fine to coarse grained, yellow brown and grey.	DW	VL		HAWKESBURY SANDSTONE VERY LOW TO LOW 'TC' BIT RESISTANCE
			2							
			3			as above, but with extremely weathered bands.				
			4							
						SANDSTONE: medium to coarse grained, yellow brown, purple brown and grey.				
			5							
			6			as above, but with extremely weathered bands.				VERY LOW RESISTANCE WITH LOW BANDS
▶										
			7							

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BOREHOLE LOG

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS
Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE
Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 201.2m
Date: 12/8/21 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
ON COMPLETION				■					SANDSTONE: medium to coarse grained, yellow brown, purple brown and grey, with extremely weathered bands.	DW	VL		
									END OF BOREHOLE AT 7.5m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No.
5
1/1

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS
Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE
Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 194.7m
Date: 12/8/21 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			CONCRETE: 135mm.t				8mm DIA. REINFORCEMENT, 85mm TOP COVER
	ES				-	FILL: Silty sand, medium grained, brown and orange brown, trace of fine grained igneous gravel.	M			
	ES, DB	N = 3 1,1,2	1		SM	Silty SAND: medium grained, orange brown.	M	VL		RESIDUAL
		N = 2 1,1,1	2			as above, but trace of clay.				
ON COMPLETION		N = 6 2,3,3	3		CL	Sandy CLAY: low plasticity, grey, medium grained sand, trace of silt and clayey sand lenses.	w>PL	St	140 170 140	
		N = 7 2,2,5	4–5		SC	Clayey SAND: medium grained, grey, with sandy clay bands, trace of silt.	W	L		
		N > 23 5,23/50mm REFUSAL	6		CL/SC	Interbedded sandy CLAY and clayey SAND: low plasticity, medium grained, grey, trace of silt.	w>PL/W	St-VSt /L	110 270 200	
					-	Extremely Weathered sandstone: silty SAND, medium to coarse grained, grey, with iron indurated bands.	XW	VD		HAWKESBURY SANDSTONE
			7			END OF BOREHOLE AT 6.3m				

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BOREHOLE LOG

Borehole No. 6

1/1

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS

Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE

Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 196.8m

Date: 13/8/21 **Datum:** AHD

Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0		CONCRETE: 230mm.t				7mm DIA. REINFORCENMENT, 145mm TOP COVER
			-	FILL: Silty sand, fine to medium grained, brown and orange brown, trace of clay nodules.	M			
	N = 3 2,2,1	1	SM	Silty SAND: medium grained, orange brown, with clay.	M	L		RESIDUAL
	N = 15 3,6,9	2	CL	Gravelly sandy CLAY: low plasticity, grey and brown, fine to coarse grained ironstone gravel, coarse grained sand, trace of silt and coarse grained sand lenses.	w>PL	F	50 70 70	
	N = 20 7,13,7	3	SM/CL	Interbedded silty SAND and sandy CLAY: medium to coarse grained, low plasticity, light grey, trace of weakly cemented iron indurated bands, silty clay bands and fine grained quartz gravel.	M/ w>PL	MD/ St-VSt	190 250 200	
		4	ML	Sandy SILT: low plasticity, light grey, fine grained sand, with silty sand bands, trace of silty clay lenses.	w<PL	VSt-Hd		
	N = 28 6,14,14	5	-	Extremely Weathered sandstone: clayey sand, fine grained, purple brown, trace of silt.	XW	MD-D	220 410 400	HAWKESBURY SANDSTONE VERY LOW 'TC' BIT RESISTANCE
		6		END OF BOREHOLE AT 6.0m				
		7						

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BOREHOLE LOG

Borehole No. **7**

1/1

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS

Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE

Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 198.2m

Date: 13/8/21 **Datum:** AHD

Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		0		FILL: Gravelly silty sand, fine to medium grained, dark brown, fine to coarse grained igneous gravel, trace of concrete, tile and brick fragments, and ash.	M			APPEARS MODERATELY COMPACTED
	N = 9 4,5,4							
		1		as above, but with steel and glass fragments.				
ON COMPLETION	N = 1 2,1,0				W			ORGANIC ODOUR APPEARS POORLY COMPACTED
		2		FILL: Sandy clay, low plasticity, dark grey and brown, fine grained sand, trace of fine to medium grained igneous gravel, carbonaceous, trace of roots, silt and steel fragments.	w>PL			
			CI	Silty CLAY: medium plasticity, red brown mottled grey, with iron indurated bands.	w<PL	Hd		RESIDUAL TOO FRIABLE FOR HP TESTING
	N = 24 5,10,14	3						
		4	-	Extremely Weathered sandstone: clayey SAND, fine grained, red brown and grey, trace of silt.	XW	VD		HAWKESBURY SANDSTONE VERY LOW 'TC' BIT RESISTANCE
	N = SPT 17/150mm REFUSAL	5						
		6		END OF BOREHOLE AT 6.0m				
		7						

SAMPLES: ES, U50, DB, DS

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BOREHOLE LOG

Borehole No.
8
1/1

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS
Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE
Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 201.5m
Date: 13/8/21 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			FILL: Silty sand, fine to medium grained, dark brown, trace of medium to coarse grained igneous gravel, concrete and timber fragments.	M			APPEARS POORLY COMPACTED
		N = 2 2,1,1	1			FILL: Silty sand, medium grained, yellow brown and brown, trace of medium to coarse grained sandstone gravel, trace of fine grained igneous gravel.				
		N = 6 5,4,2	2		SM	Gravelly silty SAND: medium grained, yellow brown and orange brown, medium to coarse grained ironstone gravel, trace of clay fines.	M	L		RESIDUAL
		N = SPT 14/100mm REFUSAL	3		-	Extremely Weathered sandstone: sandy CLAY, low to medium plasticity, red brown, grey and orange brown, fine to medium grained sand, trace of silt.	DW	VD		HAWKESBURY SANDSTONE VERY LOW 'TC' BIT RESISTANCE
ON COMPLET-ION			4 5			SANDSTONE: medium grained, grey, with iron indurated and extremely weathered bands.	DW	VL		VERY LOW TO LOW RESISTANCE
			6			END OF BOREHOLE AT 6.0m				
			7							

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BOREHOLE LOG

Borehole No.
9
1/1

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS

Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE

Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 201.9m

Date: 13/8/21 **Datum:** AHD

Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	SAMPLES ES / U50 / DB / DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			FILL: Gravelly silty sand, fine to medium grained, dark brown, medium to coarse grained igneous and ironstone gravel, trace of concrete, brick and tile fragments.	M			APPEARS MODERATELY TO WELL COMPACTED
		N = 13 15,9,4								
			1		SM	Gravelly silty SAND: medium grained, orange brown, fine to coarse grained ironstone gravel.	M			RESIDUAL
						Silty SAND: medium grained, orange brown, trace of clay fines.				
		N > 4 10,4/10mm REFUSAL			-	SANDSTONE: fine to coarse grained, yellow brown and red brown, with medium strength bands and extremely weathered bands.	DW	VL		HAWKESBURY SANDSTONE VERY LOW 'TC' BIT RESISTANCE WITH LOW BANDS
			2							
			3			as above, but orange brown and grey, with iron indurated bands.				
			4							
			5							
ON COMPLETION			6			END OF BOREHOLE AT 6.0m				
			7							

JKGeotechnics

BOREHOLE LOG

Borehole No. 10

1/1

Client: SYESUN PTY LTD - FLOWER POWER TERREY HILLS

Project: PROPOSED REDEVELOPMENT OF GARDEN CENTRE

Location: 277 MONA VALE ROAD, TERREY HILLS, NSW

Job No.: 34278B **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 203.0m

Date: 13/8/21 **Datum:** AHD

Plant Type: JK400 **Logged/Checked by:** B.S./D.B.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0		FILL: Gravelly silty sand, fine to medium grained, dark brown, fine to medium grained, igneous and ironstone gravel, trace plastic, concrete and glass fragments.	M			
	N = 5 3,2,3		SM	Gravelly silty SAND: medium grained, orange brown, medium to coarse grained ironstone gravel.	M	L		RESIDUAL
	N = SPT 6/50mm REFUSAL	1	-	Extremely Weathered sandstone: sandy clay, low plasticity, grey mottled orange brown, medium grained sand, trace of silt.	XW	(Hd)		HAWKESBURY SANDSTONE
				SANDSTONE: medium grained, grey and orange brown, with extremely weathered and iron indurated bands.	DW	VL-L		VERY LOW 'TC' BIT RESISTANCE
						H		LOW RESISTANCE
		2						HIGH RESISTANCE
				SANDSTONE: coarse grained, red brown and grey.				'TC' BIT REFUSAL
				END OF BOREHOLE AT 2.2m				

SAMPLES: ES, U50, DB, DS

AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

This plan should be read in conjunction with the JK Geotechnics report.

Title:	**SITE LOCATION PLAN**
Location:	277 MONA VALE ROAD, TERREY HILLS, NSW
Report No: 34278B	Figure No: 1

JKGeotechnics

PLOT DATE: 24/08/2021 11:41:47 AM DWG FILE: Y:\34000's\34278B TERREY HILLS\CAD\34278B.DWG

0 8 16 24 32 40
SCALE 1:800 @A3 METRES

This plan should be read in conjunction with the JK Geotechnics report.

Title:	BOREHOLE LOCATION PLAN
Location:	277 MONA VALE ROAD, TERREY HILLS, NSW
Report No:	34278B
Figure No:	2

JKGeotechnics

PLOT DATE: 1/09/2021 4:51:13 PM DWG FILE: Y:\34000's\34278B TERREY HILLS\CAD\34278B.DWG

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726:2017 *'Geotechnical Site Investigations'*. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached soil classification table qualified by the grading of other particles present (eg. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	< 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2.36mm
Gravel	2.36 to 63mm
Cobbles	63 to 200mm
Boulders	> 200mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose (VL)	< 4
Loose (L)	4 to 10
Medium dense (MD)	10 to 30
Dense (D)	30 to 50
Very Dense (VD)	> 50

Cohesive soils are classified on the basis of strength (consistency) either by use of a hand penetrometer, vane shear, laboratory testing and/or tactile engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength (kPa)	Indicative Undrained Shear Strength (kPa)
Very Soft (VS)	≤ 25	≤ 12
Soft (S)	> 25 and ≤ 50	> 12 and ≤ 25
Firm (F)	> 50 and ≤ 100	> 25 and ≤ 50
Stiff (St)	> 100 and ≤ 200	> 50 and ≤ 100
Very Stiff (VSt)	> 200 and ≤ 400	> 100 and ≤ 200
Hard (Hd)	> 400	> 200
Friable (Fr)	Strength not attainable – soil crumbles	

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'shale' is used to describe fissile mudstone, with a weakness parallel to bedding. Rocks with alternating inter-laminations of different grain size (eg. siltstone/claystone and siltstone/fine grained sandstone) is referred to as 'laminite'.

SAMPLING

Sampling is carried out during drilling or from other excavations to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shrink-swell behaviour, strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All methods except test pits, hand auger drilling and portable Dynamic Cone Penetrometers require the use of a mechanical rig which is commonly mounted on a truck chassis or track base.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils and 'weaker' bedrock if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for a large excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Refusal of the hand auger can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of limited reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock cuttings. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be assessed from the cuttings, together with some information from "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, NMLC or HQ triple tube core barrels, which give a core of about 50mm and 61mm diameter, respectively, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as NO CORE. The location of NO CORE recovery is determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the bottom of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289.6.3.1–2004 (R2016) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Standard Penetration Test (SPT)'*.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63.5kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

  N > 30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

A modification to the SPT is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as 'N_c' on the borehole logs, together with the number of blows per 150mm penetration.

Cone Penetrometer Testing (CPT) and Interpretation: The cone penetrometer is sometimes referred to as a Dutch Cone. The test is described in Australian Standard 1289.6.5.1–1999 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Static Cone Penetration Resistance of a Soil – Field Test using a Mechanical and Electrical Cone or Friction-Cone Penetrometer'*.

In the tests, a 35mm or 44mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm or 165mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck. The CPT does not provide soil sample recovery.

As penetration occurs (at a rate of approximately 20mm per second), the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa. There are two scales presented for the cone resistance. The lower scale has a range of 0 to 5MPa and the main scale has a range of 0 to 50MPa. For cone resistance values less than 5MPa, the plot will appear on both scales.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

  The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between CPT and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of CPT values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

There are limitations when using the CPT in that it may not penetrate obstructions within any fill, thick layers of hard clay and very dense sand, gravel and weathered bedrock. Normally a 'dummy' cone is pushed through fill to protect the equipment. No information is recorded by the 'dummy' probe.

Flat Dilatometer Test: The flat dilatometer (DMT), also known as the Marchetti Dilometer comprises a stainless steel blade having a flat, circular steel membrane mounted flush on one side.

The blade is connected to a control unit at ground surface by a pneumatic-electrical tube running through the insertion rods. A gas tank, connected to the control unit by a pneumatic cable, supplies the gas pressure required to expand the membrane. The control unit is equipped with a pressure regulator, pressure gauges, an audio-visual signal and vent valves.

The blade is advanced into the ground using our CPT rig or one of our drilling rigs, and can be driven into the ground using an SPT hammer. As soon as the blade is in place, the membrane is inflated, and the pressure required to lift the membrane (approximately 0.1mm) is recorded. The pressure then required to lift the centre of the membrane by an additional 1mm is recorded. The membrane is then deflated before pushing to the next depth increment, usually 200mm down. The pressure readings are corrected for membrane stiffness.

The DMT is used to measure material index (I_D), horizontal stress index (K_D), and dilatometer modulus (E_D). Using established correlations, the DMT results can also be used to assess the 'at rest' earth pressure coefficient (K_o), over-consolidation ratio (OCR), undrained shear strength (C_u), friction angle (ϕ), coefficient of consolidation (C_h), coefficient of permeability (K_h), unit weight (γ), and vertical drained constrained modulus (M).

The seismic dilatometer (SDMT) is the combination of the DMT with an add-on seismic module for the measurement of shear wave velocity (V_s). Using established correlations, the SDMT results can also be used to assess the small strain modulus (G_o).

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod with a 20mm diameter cone end with a 9kg hammer dropping 510mm. The test is described in Australian Standard 1289.6.3.2–1997 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – 9kg Dynamic Cone Penetrometer Test'*.

The results are used to assess the relative compaction of fill, the relative density of granular soils, and the strength of cohesive soils. Using established correlations, the DCP test results can also be used to assess California Bearing Ratio (CBR).

Refusal of the DCP can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Vane Shear Test: The vane shear test is used to measure the undrained shear strength (C_u) of typically very soft to firm fine grained cohesive soils. The vane shear is normally performed in the bottom of a borehole, but can be completed from surface level, the bottom and sides of test pits, and on recovered undisturbed tube samples (when using a hand vane).

The vane comprises four rectangular blades arranged in the form of a cross on the end of a thin rod, which is coupled to the bottom of a drill rod string when used in a borehole. The size of the vane is dependent on the strength of the fine grained cohesive soils; that is, larger vanes are normally used for very low strength soils. For borehole testing, the size of the vane can be limited by the size of the casing that is used.

For testing inside a borehole, a device is used at the top of the casing, which suspends the vane and rods so that they do not sink under self-weight into the 'soft' soils beyond the depth at which the test is to be carried out. A calibrated torque head is used to rotate the rods and vane and to measure the resistance of the vane to rotation.

With the vane in position, torque is applied to cause rotation of the vane at a constant rate. A rate of 6° per minute is the common rotation rate. Rotation is continued until the soil is sheared and the maximum torque has been recorded. This value is then used to calculate the undrained shear strength. The vane is then rotated rapidly a number of times and the operation repeated until a constant torque reading is obtained. This torque value is used to calculate the remoulded shear strength. Where appropriate, friction on the vane rods is measured and taken into account in the shear strength calculation.

LOGS

The borehole or test pit logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment, but is not always practicable or possible to justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The terms and symbols used in preparation of the logs are defined in the following pages.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than 'straight line' variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or 'reverted' chemically if reliable water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after the groundwater level has stabilised at intervals ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg. bricks, steel, etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably assess the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soils for Engineering Purposes'* or appropriate NSW Government Roads & Maritime Services (RMS) test methods. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Reasonable care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.
- Details of the development that the Company could not reasonably be expected to anticipate.

If these occur, the Company will be pleased to assist with investigation or advice to resolve any problems occurring.

SITE ANOMALIES

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. Licence to use the documents may be revoked without notice if the Client is in breach of any obligation to make a payment to us.

REVIEW OF DESIGN

Where major civil or structural developments are proposed <u>or</u> where only a limited investigation has been completed <u>or</u> where the geotechnical conditions/constraints are quite complex, it is prudent to have a joint design review which involves an experienced geotechnical engineer/engineering geologist.

SITE INSPECTION

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types and appropriate footing or pile founding depths, or

iii) full time engineering presence on site.

SYMBOL LEGENDS

SOIL

- FILL
- TOPSOIL
- CLAY (CL, CI, CH)
- SILT (ML, MH)
- SAND (SP, SW)
- GRAVEL (GP, GW)
- SANDY CLAY (CL, CI, CH)
- SILTY CLAY (CL, CI, CH)
- CLAYEY SAND (SC)
- SILTY SAND (SM)
- GRAVELLY CLAY (CL, CI, CH)
- CLAYEY GRAVEL (GC)
- SANDY SILT (ML, MH)
- PEAT AND HIGHLY ORGANIC SOILS (Pt)

ROCK

- CONGLOMERATE
- SANDSTONE
- SHALE/MUDSTONE
- SILTSTONE
- CLAYSTONE
- COAL
- LAMINITE
- LIMESTONE
- PHYLLITE, SCHIST
- TUFF
- GRANITE, GABBRO
- DOLERITE, DIORITE
- BASALT, ANDESITE
- QUARTZITE

OTHER MATERIALS

- BRICKS OR PAVERS
- CONCRETE
- ASPHALTIC CONCRETE

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

Major Divisions		Group Symbol	Typical Names	Field Classification of Sand and Gravel	Laboratory Classification	
Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Fines behave as clay
	SAND (more than half of coarse fraction is smaller than 2.36mm)	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	N/A
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	

Major Divisions		Group Symbol	Typical Names	Field Classification of Silt and Clay			Laboratory Classification
				Dry Strength	Dilatancy	Toughness	% < 0.075mm
ine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT and CLAY (low to medium plasticity)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL, CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silt	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	Highly organic soil	Pt	Peat, highly organic soil	–	–	–	–

Laboratory Classification Criteria

A well graded coarse grained soil is one for which the coefficient of uniformity $Cu > 4$ and the coefficient of curvature $1 < C_c < 3$. Otherwise, the soil is poorly graded. These coefficients are given by:

$$C_U = \frac{D_{60}}{D_{10}} \quad and \quad C_C = \frac{(D_{30})^2}{D_{10}\,D_{60}}$$

Where D_{10}, D_{30} and D_{60} are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

NOTES:

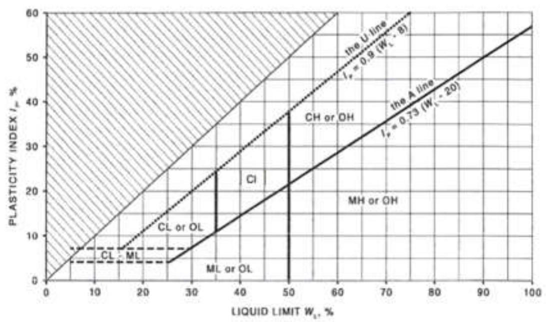
1 For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.

2 Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.

3 Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.

4 The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

Modified Casagrande Chart for Classifying Silts and Clays according to their Behaviour



JKGeotechnics

LOG SYMBOLS

<table>
<tr><th>Log Column</th><th colspan="2">Symbol</th><th colspan="3">Definition</th></tr>
<tr><td>Groundwater Record</td><td colspan="2">▼
C
▶</td><td colspan="3">Standing water level. Time delay following completion of drilling/excavation may be shown.
Extent of borehole/test pit collapse shortly after drilling/excavation.
Groundwater seepage into borehole or test pit noted during drilling or excavation.</td></tr>
<tr><td>Samples</td><td colspan="2">ES
U50
DB
DS
ASB
ASS
SAL</td><td colspan="3">Sample taken over depth indicated, for environmental analysis.
Undisturbed 50mm diameter tube sample taken over depth indicated.
Bulk disturbed sample taken over depth indicated.
Small disturbed bag sample taken over depth indicated.
Soil sample taken over depth indicated, for asbestos analysis.
Soil sample taken over depth indicated, for acid sulfate soil analysis.
Soil sample taken over depth indicated, for salinity analysis.</td></tr>
<tr><td rowspan="3">Field Tests</td><td colspan="2">N = 17
4, 7, 10</td><td colspan="3">Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. ‘Refusal’ refers to apparent hammer refusal within the corresponding 150mm depth increment.</td></tr>
<tr><td>N_c =</td><td>5
7
3R</td><td colspan="3">Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60° solid cone driven by SPT hammer. ‘R’ refers to apparent hammer refusal within the corresponding 150mm depth increment.</td></tr>
<tr><td colspan="2">VNS = 25
PID = 100</td><td colspan="3">Vane shear reading in kPa of undrained shear strength.
Photoionisation detector reading in ppm (soil sample headspace test).</td></tr>
<tr><td>Moisture Condition
(Fine Grained Soils)

(Coarse Grained Soils)</td><td colspan="2">w > PL
$w \approx$ PL
w < PL
$w \approx$ LL
w > LL

D
M
W</td><td colspan="3">Moisture content estimated to be greater than plastic limit.
Moisture content estimated to be approximately equal to plastic limit.
Moisture content estimated to be less than plastic limit.
Moisture content estimated to be near liquid limit.
Moisture content estimated to be wet of liquid limit.

DRY – runs freely through fingers.
MOIST – does not run freely but no free water visible on soil surface.
WET – free water visible on soil surface.</td></tr>
<tr><td>Strength (Consistency)
Cohesive Soils</td><td colspan="2">VS
S
F
St
VSt
Hd
Fr
( )</td><td colspan="3">VERY SOFT – unconfined compressive strength ≤ 25kPa.
SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa.
FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa.
STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa.
VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa.
HARD – unconfined compressive strength > 400kPa.
FRIABLE – strength not attainable, soil crumbles.
Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.</td></tr>
<tr><td rowspan="8">Density Index/
Relative Density
(Cohesionless Soils)</td><td colspan="2"></td><td></td><td>Density Index (I_D) Range (%)</td><td>SPT ‘N’ Value Range (Blows/300mm)</td></tr>
<tr><td colspan="2">VL</td><td>VERY LOOSE</td><td>≤ 15</td><td>0 – 4</td></tr>
<tr><td colspan="2">L</td><td>LOOSE</td><td>> 15 and ≤ 35</td><td>4 – 10</td></tr>
<tr><td colspan="2">MD</td><td>MEDIUM DENSE</td><td>> 35 and ≤ 65</td><td>10 – 30</td></tr>
<tr><td colspan="2">D</td><td>DENSE</td><td>> 65 and ≤ 85</td><td>30 – 50</td></tr>
<tr><td colspan="2">VD</td><td>VERY DENSE</td><td>> 85</td><td>> 50</td></tr>
<tr><td colspan="2">( )</td><td colspan="3">Bracketed symbol indicates estimated density based on ease of drilling or other assessment.</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td>Hand Penetrometer
Readings</td><td colspan="2">300
250</td><td colspan="3">Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise.</td></tr>
</table>

Log Column	Symbol	Definition
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Twin pronged tungsten carbide bit.
	T_{60}	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.
	Soil Origin	The geological origin of the soil can generally be described as:
		RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock.
		EXTREMELY WEATHERED – soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock.
		ALLUVIAL – soil deposited by creeks and rivers.
		ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents.
		MARINE – soil deposited in a marine environment.
		AEOLIAN – soil carried and deposited by wind.
		COLLUVIAL – soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description 'slopewash' is used for thinner surficial deposits.
		LITTORAL – beach deposited soil.

Classification of Material Weathering

<table>
<tr><th colspan="2">Term</th><th colspan="2">Abbreviation</th><th>Definition</th></tr>
<tr><td colspan="2">Residual Soil</td><td colspan="2">RS</td><td>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.</td></tr>
<tr><td colspan="2">Extremely Weathered</td><td colspan="2">XW</td><td>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.</td></tr>
<tr><td>Highly Weathered</td><td rowspan="2">Distinctly Weathered (Note 1)</td><td>HW</td><td rowspan="2">DW</td><td>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 recognisable. 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.</td></tr>
<tr><td>Moderately Weathered</td><td>MW</td><td>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 recognisable, but shows little or no change of strength from fresh rock.</td></tr>
<tr><td colspan="2">Slightly Weathered</td><td colspan="2">SW</td><td>Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.</td></tr>
<tr><td colspan="2">Fresh</td><td colspan="2">FR</td><td>Rock shows no sign of decomposition of individual minerals or colour changes.</td></tr>
</table>

NOTE 1: The term ‘Distinctly Weathered’ is used where it is not practicable to distinguish between ‘Highly Weathered’ and ‘Moderately Weathered’ rock. ‘Distinctly Weathered’ is defined as follows: *‘Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores’*. There is some change in rock strength.

Rock Material Strength Classification

Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Guide to Strength: Point Load Strength Index $Is_{(50)}$ (MPa)	Guide to Strength: Field Assessment
Very Low Strength	VL	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low Strength	L	2 to 6	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium Strength	M	6 to 20	0.3 to 1	Scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High Strength	H	20 to 60	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High Strength	VH	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High Strength	EH	> 200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Abbreviations Used in Defect Description

Cored Borehole Log Column		Symbol Abbreviation	Description
Point Load Strength Index		• 0.6	Axial point load strength index test result (MPa)
		x 0.6	Diametral point load strength index test result (MPa)
Defect Details	– Type	Be	Parting – bedding or cleavage
		CS	Clay seam
		Cr	Crushed/sheared seam or zone
		J	Joint
		Jh	Healed joint
		Ji	Incipient joint
		XWS	Extremely weathered seam
	– Orientation	Degrees	Defect orientation is measured relative to normal to the core axis (ie. relative to the horizontal for a vertical borehole)
	– Shape	P	Planar
		C	Curved
		Un	Undulating
		St	Stepped
		Ir	Irregular
	– Roughness	Vr	Very rough
		R	Rough
		S	Smooth
		Po	Polished
		Sl	Slickensided
	– Infill Material	Ca	Calcite
		Cb	Carbonaceous
		Clay	Clay
		Fe	Iron
		Qz	Quartz
		Py	Pyrite
	– Coatings	Cn	Clean
		Sn	Stained – no visible coating, surface is discoloured
		Vn	Veneer – visible, too thin to measure, may be patchy
		Ct	Coating ≤ 1mm thick
		Filled	Coating > 1mm thick
	– Thickness	mm.t	Defect thickness measured in millimetres