



GEOTECHNICAL REPORT
CIVIL CONTRACTORS (AUST) PTY LTD
YARRABILBA PRECINCT 3B AND 3C
SGSE/16/020N
16 DECEMBER 2016

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

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This report is not a guarantee that the site ground conditions will behave in accordance with the interpretation set out herein, but rather our opinion as to the correct interpretations based on the results of site investigations, in situ testing and/or laboratory testing in accordance with generally accepted consulting practice. To the best of our knowledge, information contained in this report is accurate at the date of issue. The interpretation of scientific data, however, often involves both professional and subjective judgments. As such, interpretation is open to error. In addition, site conditions are subject to change in a limited time and there remains a risk that the site ground conditions will differ from these interpretations.

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All appendices should be carefully read in conjunction with this report

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This report is not a guarantee that the site ground conditions will behave in accordance with the geotechnical interpretation set out herein, but rather our opinion as to the correct geotechnical interpretations based on the results of site investigations, insitu testing and laboratory testing, in accordance with appropriate Australian Standards and related engineering principles. There remains a risk that the site ground conditions will differ from these geotechnical interpretations.

1 INTRODUCTION

This report presents the results and interpretations of a geotechnical investigation carried out by SGS for proposed earthworks within Precinct 3B and 3C of Yarrabilba.

It is understood that the proposed works in the subject area will involve cut to fill earthworks with cut depths up to 9m. It is further understood that underground services may be installed a further 3m below finished surface level. A road embankment comprising predominately fill earthworks to depths between approximately 0.5m and 6m is proposed to connect to the Precinct 3B and 3C areas across a low lying wetland.

The aim of this investigation was to assess and report the nature of subsurface conditions at the site in order to provide geotechnical data and parameters to determine excavation risks.

The scope of the investigation in terms of the number and position of test pits was nominated by KN Group.

The investigation was carried out in general accordance with the SGS proposal (SGSE/16P/020N) dated 12 December 2016.

The investigation and interpretation of results was carried out in general accordance with the following Australian Standards:

- | | | |
|---|---------|--|
| * | AS 1726 | "Geotechnical Site Investigations" |
| * | AS 1289 | "Testing of Soils for Engineering Purposes" |
| * | AS 3798 | "Guidelines on earthworks for commercial and residential developments" |

2 INVESTIGATION PROCEDURE

The site investigation in accordance with AS 1726 "Geotechnical Site Investigations" comprised the following stages:

- Excavation of twenty-four (24) test pits to depths of up to 3.0m.
(Test pit locations are shown on the site sketch in Appendix B)
Target depths were not reached in several of the pits due to refusal on rock.
- Soil and rock classification by a geotechnical engineer.
- Pocket penetrometer testing in the clay soils to estimate undrained shear strength.
- Point Load index testing on rock samples to classify rock strength.
- Site Description.

3 INVESTIGATION RESULTS

3.1 SITE DESCRIPTION

Precincts 3B and 3C are located to the southeast of the current stages of development at Yarrabilba. Precinct 3C is bound by Steele Road to the west, National Park to the north and east and a watercourse to the south. Precinct 3B is located south of 3C and is bound by Steele Road to the West, National Park to the east and a powerline easement to the south.



Figure 1 - Subject Site
(Source: Google Maps)

Precinct 3C

Precinct 3C is positioned on the mid and lower slopes of the hill, generally falling towards the west. Slopes magnitudes were gentle on the lower slopes and increased further towards the top of the hill.

Two watercourses (tributaries to Quinzeh Creek) ran east west through the site. As the investigation was undertaken in a dry period, very small ponds or no surface water was observed in the creek beds.

At the time of the investigation the site was heavily vegetated with small trees. Larger trees and more dense vegetation was observed around the watercourses. Access was not available to test pit location TP23.

Precinct 3B

The topography of Precinct 3B is characterised a crest on the eastern boundary falling towards a watercourse along the western and northern boundaries. A sandstone outcrop was observed in the north eastern corner of the site at the location of TP17. Photographs of the exposed rock are provided below.

At the time of the investigation the majority of the site was heavily vegetated. Access was restricted in the central portion of the site. Access was not available to test pit locations TP11 to 15 and TP18. Subsequently, three test pits were moved to accessible locations generally on the perimeter of the site.



Figure 2 - Sandstone Outcrop at TP17

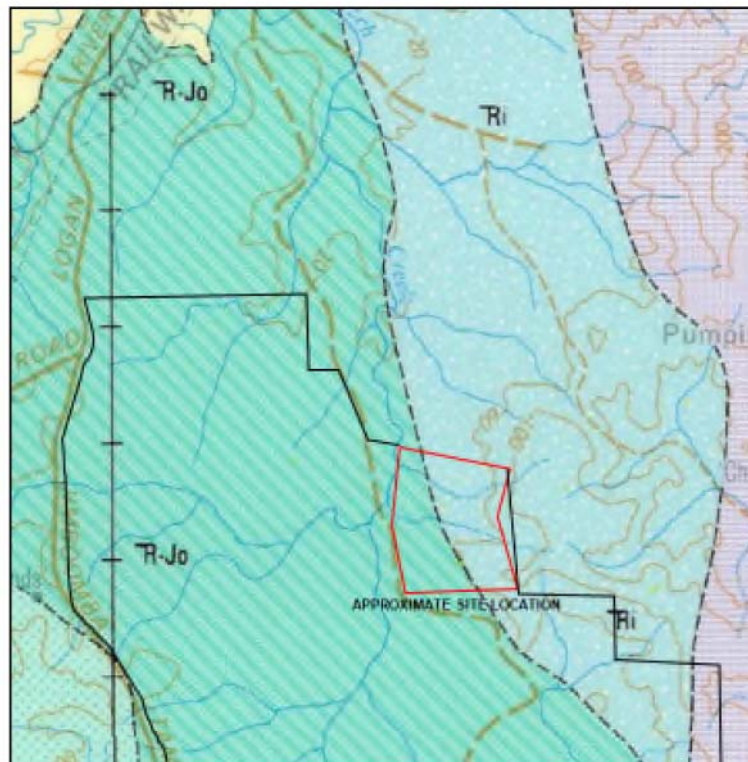


Figure 3 – Photo taken facing southwest on top of rock outcrop

Additional site description information is provided in Appendix B.

3.2 REGIONAL GEOLOGY

The site is positioned in two geological units as shown in Figure 2 below.



The regional geology as described by the Department of Mines geology map for Beenleigh (sheet 9542) is as follows:

Geological Unit / Rock Name:	R-Jo – Woogaroo Subgroup
Age:	Triassic - Jurassic
Lithology:	Sandstone, siltstone, shale, conglomerate
Geological Unit / Rock Name:	Ri – Ipswich Coal Measures
Age:	Triassic
Lithology:	Conglomerate, sandstone, shale, tuff, coal seams

3.3 SUBSURFACE PROFILE

The soil profiles encountered in the test pits were generally consistent with the regional geology. Typically, the subsurface profile comprised surface sands overlying sandy clays transitioning to weathered sandstone. Deeper clay profiles were observed in the lower areas of the site.

Sandy gravel was observed to the test pit termination depths in test pits 26 and 27 positioned on the upper slopes of Precinct 3B.

Sands were observed to a depth of 2.0m in TP1. The sides of the test pit collapsed during the investigation as a result of the presence of seepage.

Detailed soil profiles are provided in the Test Pit Logs in Appendix C and a summary of the Test Pit data is provided in the following table.

Table 1 Summary of Soil Profiles

B/hole No.	Topsoil Depth (mm)	Natural Ground											
		Silty SAND	SAND/ Clayey SAND			Sandy GRAVEL		Sandy CLAY		Weathered SANDSTONE			
			Loose	Medium Dense	Dense	Medium Dense	Dense	Very Stiff	Hard	Extremely Low Strength	Very Low – Low Strength	Medium Strength	High Strength
TP1	100	0.0 – 0.1	0.5 – 2.0	0.1 – 0.5									
TP2	90			0.0 – 0.3					0.3 – 1.2		1.2 – 1.5		
TP3	100	0.0 – 0.1		0.1 – 0.4					0.4 – 1.5				
TP4	110	0.0 – 0.4							0.4 – 0.9		0.9 – 1.2	1.2 – 1.4	
TP5	120	0.0 – 0.4						0.4 – 2.0					
TP6	100	0.0 – 0.5							0.5 – 1.5				
TP7	100	0.0 – 0.4		0.4 – 0.6				0.6 – 0.9	0.9 – 1.5				
TP8	200	0.0 – 0.4							0.4 – 2.0				
TP9	100	0.0 – 0.3			0.3 – 0.5				0.5 – 1.5				
TP10	90	0.0 – 0.2			0.2 – 0.4			0.4 – 0.5	0.5 – 1.5				
TP12*	90	0.0 – 0.3			0.3 – 0.4					0.4 – 0.8	0.8 – 1.9		
TP15*	80	0.0 – 0.3								0.3 – 0.7	0.7 – 2.5		
TP16	0		0.0 – 0.1								0.1 – 0.2		0.2 – 1.2
TP18*	120	0.0 – 0.3		0.3 – 0.7	0.7 – 1.0						1.0 – 1.8		
TP19	90	0.0 – 0.3			0.3 – 0.6				0.6 – 1.8				
TP20	120	0.0 – 0.3			0.3 – 0.8				0.8 – 1.8				
TP21	100	0.0 – 0.3			0.3 – 1.7				1.7 – 2.2				
TP22	110		0.0 – 0.4	0.4 – 0.6	0.6 – 1.1				1.1 – 1.7	1.7 – 2.0			
TP24	90	0.0 – 0.2		0.2 – 0.6	0.6 – 1.2					1.2 – 1.5	1.5 -2.1		
TP25	70	0.0 – 0.2		0.2 – 0.5				0.5 – 0.8	0.8 – 1.7		1.7 – 2.7		
TP26	100	0.0 – 0.2		0.2 – 0.8		0.8 – 1.2	1.2 – 2.0						
TP27	0		0.0 – 0.2			0.2 – 0.5	0.5 – 1.5						
TP28	100	0.0 – 0.3			0.3 – 0.8				0.8 – 1.1				1.1 – 1.4

*Test Pit relocated due to access restrictions

4 ENGINEERING ASSESSMENT

4.1 EARTHWORKS

Earthworks should be carried out in a systematic and responsible manner in accordance with the relevant parts of AS3798-2007. Geotechnical Inspection and testing involvement should, as a minimum, include the activities labelled “(GITA)” in this section of the report.

4.1.1 EARTHWORK PREPARATION (GROUND SURFACE TREATMENT)

It is recommended that preparation for earthworks should include the following:

1. Removal of all organic rich (topsoil) material from all cut and structural fill areas. Based on the site investigation results, it is expected that an average topsoil stripping depth in the order of 100mm is applicable. However, topsoil depths ranging up to approximately 200mm were encountered on the site. Deeper topsoil may be present along gully lines, in areas of dense vegetation and in previously cultivated areas, if applicable. Topsoil is not considered suitable for use as structural fill.
2. Inspection of the stripped structural fill area to assess adequate topsoil stripping and the presence and extent of any existing (uncontrolled) fill. All uncontrolled fill should be removed down to a sound natural base and stockpiled to assess suitability for re-use as structural fill. **(GITA)**
3. Tining of structural fill areas to a nominal depth of 300mm. This will break up and disperse remaining fine root fiber and assist with the removal of larger roots and stumps. Spacing between tines should not exceed 500mm.
4. Remove larger roots and stumps.
5. Moisture condition tined areas as necessary to achieve a standard moisture ratio in the approximate range of 85% to 95% for sand soils (silty sand, clayey sand) and 95% to 110% for clay soils (clay, silty clay, sandy clay). **(GITA)**
6. Compact and proof roll structural fill areas (including areas under batters) with compaction equipment of similar capacity to the plant proposed to compact and traffic the fill. **(GITA)**
7. Remove any soft/loose (unsound) areas down to a sound base. Replace with suitable materials and compact. **(GITA)**
8. Test for compaction compliance (minimum 95% standard compaction). **(GITA)**

It should be noted that deep sand layers were observed in the test pits along the proposed road embankment. These soils are susceptible to collapse and loss of strength if seepage and/or groundwater is present. This may present construction issues in the vicinity of culverts (if excavated below current ground level) and trafficability issues when preparing the foundation for embankment filling.

4.1.2 TRAFFICABILITY

Trafficability conditions will in general decrease once topsoil has been disturbed and would be exacerbated considerably if wet weather occurs in the period pending, or after commencement of earthworks.

As mentioned above, the sandy soils (silty/clayey sand) encountered on the site are extremely sensitive to water and subsequent loss of strength (and trafficability) in wet conditions.

Similarly, the clay soils (clay, silty/sandy clay) encountered on the site are sensitive to water and subsequent loss of traction (and trafficability) in wet conditions. Repeated loading of very moist clay may also lead to loss of strength.

This report cannot predict what soil moisture conditions may prevail at the start of earthworks. It is therefore strongly recommended that the contractor (and other interested parties) become familiar with the site surface and subsurface conditions at the time of tendering and immediately prior to the start of earthworks.

As a matter of caution, it is recommended that temporary catch drains or mounds be constructed to divert overland flow away from cut and fill areas, Cut and fill areas should also be maintained to be free draining at all times.

4.1.3 EXCAVATION CHARACTERISTICS

Excavation characteristics of rock can be crudely assessed based on the rock mass properties including rock type, intact strength and discontinuities. Rock properties which influence excavation characteristics can vary both vertically and horizontally over very short distances. Therefore, any inference provided from test pit data must be considered as a guide only.

Based on the results of the investigation the following comments are provided:

- Soil and extremely low strength Siltstone and Sandstone should be readily excavated using small to medium plant (eg. D4 – D6 or equivalent in bulk earthworks and 15t-20t excavator in trenching).
- The very low strength to low strength Sandstone encountered may require medium to large plant using a single tine (eg. D7–D9 or equivalent in bulk earthworks and large excavators (20-25t) in trenching).
- The medium strength Sandstone encountered during the investigation may require large plant (30t or greater) using a single tine.
- Bands of high strength Sandstone were encountered in some of the test pits. Rock breaking equipment may be required to expedite trench excavation in this material.
- Large sandstone boulders were observed at the surface in the area of test pit 17. The boulders were of very high strength. Specialised equipment may be required in trenching and ripping in this area.

The following table provides a summary of the rock strength profiles for each borehole.

Table 2 Rock Strength Profile

B/hole No.	Weathered SANDSTONE (m)			
	Extremely Low	Very Low – Low Strength	Medium Strength	High Strength
TP2		1.2 – 1.5		
TP4		0.9 – 1.2	1.2 – 1.4*	
TP12	0.4 – 0.8	0.8 – 1.9		
TP13	0.3 – 0.7	0.7 – 2.5		
TP15	0.3 – 0.7	0.7 – 2.5		
TP16		0.1 – 0.2		0.2 – 1.2*
TP18		1.0 – 1.8		
TP22	1.7 – 2.0			
TP24	1.2 – 1.5	1.5 -2.1		
TP25		1.7 – 2.7		
TP28				1.1 – 1.4*

*effective refusal of backhoe with 600mm GP Bucket

4.1.4 FILLING

Cut to Fill

With the exception of the organic rich soils (topsoil), materials encountered in the boreholes are considered suitable for use as structural filling provided that the engineering properties of the excavated and compacted materials are considered in earthworks planning and the subsequent engineering design. In particular, the following issues should be considered.

The sandy materials (silty/clayey sand) when well compacted (> 98% Std) at less than or equal to the optimum moisture content are sound engineering materials with relatively high CBR and low reactivity properties. Conversely, the same materials with lower density (< 98% Std) and moisture content greater than the optimum moisture content, have very poor engineering properties including low insitu CBR, low strength, poor handling and reduced trafficability. How well these materials will perform as structural fill will depend upon:

1. Soil moisture conditions at the start of earthworks, and
2. Weather conditions during earthworks

At the time of the investigation the sandy soils appeared to be generally wet of optimum moisture content.

Based on the borehole data, it is considered likely that excavation in the weathered rock may produce some large intact rocks in the excavated material. A maximum rock size of 2/3 of the compacted layer thickness is recommended. Assuming large compaction plant (eg. Cat. 815) and a nominal compacted layer thickness of 300mm, this will limit rock size in the fill to approximately 200mm. It is therefore recommended that some consideration be given to the possibility of the necessity to remove oversize rock from the fill. **(GITA)**

In addition, filling procedures as a minimum should include the following:

1. Fill areas with slopes > 20% should be benched to "key" the fill into the natural ground and minimise the risk of slip occurring at the fill/natural interface. Benches should be cut at regular intervals (maximum 5m spacings) along the contour to a minimum width of 0.5m. **(GITA)**
2. Depressions formed by the removal of trees, footings, underground services, etc should have all disturbed and softened soil removed and be backfilled with compacted approved material. **(GITA)**
3. Place fill in layers of suitable thickness for the capacity of the compaction plant available. A maximum (compacted) layer thickness of 300mm is recommended. **(GITA)**
4. Moisture condition incoming fill as necessary (before compaction) to achieve a standard moisture ratio in the approximate range as follows: **(GITA)**
 - Silty and Clayey SAND - 85% to 95%
 - CLAY, Silty and Sandy CLAY - 95% to 110%
5. Compact fill to the minimum dry density ratio as follows: **(GITA)**
 - Building areas - 95 % (standard)
 - Pavement areas - top 300mm - 100% (standard)
- below top 300mm - 95 % (standard)

4.1.5 EARTHWORKS SUPERVISION AND CERTIFICATION

Earthworks should be carried out in a systematic and responsible manner in accordance with the relevant parts of AS 3798 – 2007.

Geotechnical inspection and testing involvement should, as a minimum, include the activities labelled "(GITA)" in this section of the report.

It is recommended that all earthworks be carried out under Level 1 geotechnical inspection and testing arrangements as detailed in Clause 8.2 of AS 3798. It is further recommended that as a minimum, the Level 1 statement of compliance include the following:

- A statement of certification that the fill foundation comprises either:
 1. Natural ground compliant with Table 5.1 of AS 3798; or
 2. Previous controlled fill compliant with Table 5.1 of AS 3798; or
 3. A geotechnical engineered alternative previously documented and approved by the superintendent.
- A statement of certification that the testing frequency for all fill compiles with Table 8.1 of AS 3798.
- A statement of certification that all fill compaction complies with Table 5.1 of AS 3798.
- A statement of certification for all other specified geotechnical items, for example:
 - Maximum particle size
 - Material quality (CBR, Shrink-Swell, etc)
 - Placement moisture content
- A statement of certification that the GITA complied with the requirements in Clause 8.2 of AS 3798.
- Certification by a Registered Professional Engineer of Queensland (RPEQ).

It is recommended that the specification writer include these requirements in the project specification and also in pre-start discussions.

The attached earthwork notes (Appendix D) should be considered and implemented during design and construction phases as appropriate.

5 COMMENTS AND LIMITATIONS

The development and any associated infrastructure should be designed to accommodate for the ground conditions reported and which otherwise may be encountered during construction.

The geotechnical parameters given in this report should be considered as preliminary only and subject to confirming inspections, and potentially additional testing by an experienced geotechnical professional at the construction stage. SGS offer inspection services and it is recommended that the client and their agents and contractors avail themselves of these services.

The interpretation of geotechnical reports and the preferred or proposed engineering outcomes are often compromised by the non-continuity of geotechnical consultants on a project. In addition, there is an inherent potential for a conflict of interest and therefore increased potential for inappropriate administration of the geotechnical specification when the GITA is commissioned by the contractor.

For these reasons, it is strongly recommended that:

1. SGS be commissioned as the Geotechnical Engineering Consultant and the GITA for all geotechnical related activities associated with this project; and
2. The Geotechnical Engineering Consultant and the GITA are commission independently of the contractor.

SGS cannot accept any responsibility for any interpretations and/or application of the contents of this report by any other Geotechnical Engineering Consultant or GITA.

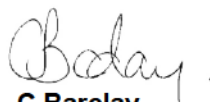
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APPENDIX A: NOTES RELATING TO THIS REPORT

INTRODUCTION

The following notes are intended to complement the report and assist the reader in interpreting the report in regard to investigation procedures, definitions, terminology and limitations. Not all notes are necessarily relevant to this report.

The ground exhibits a variety of properties and characteristics which vary from place to place and can also change with time, weather patterns, changes in vegetation and human interaction. A geotechnical investigation puts into practice accepted methods and procedures to gather data relevant to the site and the proposed development. This report may contain such data obtained from drilling, excavation, inspection, sampling and testing. If so, the data are directly relevant to the ground at the place and time of the actual test sites. The client should be aware that in some cases soil conditions can change dramatically over short distances therefore conditions other than those represented in this report may occur on the site.

SITE INVESTIGATION PROCEDURES

a) *Subsurface Investigations*

Borehole/test locations are generally located to gain maximum coverage over the site giving consideration to contrasting topography. However, on occasions existing structures or other access restrictions do not permit ideal borehole locations.

Subsurface investigations may be carried out using one or more of the following methods:

- **Test Pits:** Test pits can be excavated by power equipment (backhoe, excavator etc) or in some cases by hand. Hand excavated test pits are usually limited to a maximum depth of about 1m.
- **Hand Auger:** Hand auger equipment is normally only used where drill rig access is unavailable. Hand auger refusal may occur on materials which could have otherwise been drilled if drill rig access was available.
- **Drill Rig:** **Spiral Flight Auger:** Spiral flight auger drilling is more economical and is usually adopted if ground conditions are suitable. Samples are returned to the surface by the flights or may otherwise be taken from the base of the borehole. Various drill bits may be attached to the auger during drilling. The depth of refusal of the different bit types can provide a useful indication of the strength of the material.
- **Drill Rig Wash Drilling:** Wash drilling is normally used below the water table when collapsing soils are encountered. Steel casing is pushed to support the collapsing soil and water is pumped through the drill rods to advance the borehole. The rods are withdrawn to allow sampling and testing at the base of the borehole.

b) *Insitu Testing*

- **Dynamic Cone Penetrometer:** The Dynamic Cone Penetrometer (DCP) test is carried out using a cone of 20mm diameter with a 30° tapered tip attached to steel rods of smaller diameter. The cone is driven by a 9kg hammer falling 510mm and results are recorded in blows per 100mm penetration. DCP test results can be used to estimate bearing capacity and insitu California Bearing Ratio. The test procedure is described in Australian Standard AS1289 6.3.2.
- **Standard Penetration Test:** The Standard Penetration Test (SPT) is carried out using a standard split steel tube sampler driven by a 63.5kg mass falling 760mm. Results are recorded in number of blows per 150mm penetration for a maximum depth of 450mm. The SPT "N" value is the sum of the blows for the 2nd and 3rd 150mm increments. The first 150mm is referred to as the seating penetration. In cases where the number of blows per 150mm exceeds 20, the result is recorded as 20/penetration (mm) and the 'N' value determined by linear interpolation. The SPT N value can be used to estimate allowable bearing pressure for foundations. The test procedure is detailed in Australian Standard AS1289 6.3.1.
- **Pocket Penetrometer:** The Pocket Penetrometer (PP) is used on undisturbed samples as a relatively simple and economical method of estimating the unconfined compressive strength of clay soils. The cohesive (undrained) shear strength (C_u) is generally taken as 0.5 of the PP value.

c) *Sampling*

The type and frequency of sampling and testing on a site is dependent on several issues including:

- * number and depth of boreholes
- * variability of soil types and conditions
- * type and magnitude of the development
- **Undisturbed Samples:** Undisturbed samples are taken by pushing a thin walled steel tube, 50mm diameter (U50) into cohesive soils. U50 samples are necessary for laboratory testing such as shrink-swell index, consolidation, shear strength etc.
- **Disturbed Samples:** Disturbed samples (D) are taken from drill augers, hand auger or open test pits. Disturbed samples are generally used for laboratory testing such as Atterberg Limits, Moisture Content, California Bearing Ratio, Particle Size Distribution etc.

d) *Site Description*

Underground Services: If underground services (sewer, stormwater etc) were observed during the site investigation, a record of the observation will usually be made on the site description notes included in this report. It should be noted however that our commission **does not** typically extend to locating underground services.

As underground services can potentially affect a structure in the vicinity, it is important that any underground services are located and considered in the development of the site.

- **Site Sketch:** The site sketch is intended only as a general pictorial of relative locations of boreholes and site features. Any dimensions, slope directions, magnitudes, feature orientation, north point, etc are approximate and should be used as a guide only.

e) *Soil and Rock Descriptions*

Soil and rock descriptions contained in this report are in general accordance with Appendix A2 and A3 of AS1726 'Geotechnical Site Investigations'. Details of the soil profiles provided in the Engineering Borehole Logs are based on visual descriptions of the soils and rock on site. Some soil descriptions may differ marginally from the format as described in AS1726, but this will in no way affect the results of this investigation.

- **Controlled Fill:** Controlled fill as described in this report refers to:

- (1) sand fill up to 0.8m deep and non-sand fill up to 0.4m deep which has been placed in layers not more than 150mm thick and compacted with mechanical compaction equipment.

or

- (2) fill which has been supervised and tested and for which a statement has been provided certifying compliance with Table 5.1 of AS3798 "Guidelines on Earthworks for Residential and Commercial Developments". The statement of compliance can only be provided by the Geotechnical Testing Authority under a Level 1 commission as defined in Appendix B of AS3798

and

- (3) subject to the results of this investigation verifying the quality of the fill.

- **Uncontrolled Fill:** Uncontrolled fill is described as any fill not meeting the requirements of controlled fill as defined above.

SITE CLASSIFICATION

Site Classification as defined in AS2870 "Residential Slabs and Footings" is divided into various classes depending on the y_s (predicted surface movement) and other relevant ground conditions.

The classes are:

CLASS	SOIL TYPE	y_s (mm)
A	stable (sand or rock)	
S	slightly reactive clay	$0 < y_s \leq 20$
M	moderately reactive clay	$20 < y_s \leq 40$
H1	highly reactive clay	$40 < y_s \leq 60$
H2	(very) highly reactive clay	$60 < y_s \leq 75$
E	extremely reactive clay	$y_s > 75$
P	problem	

Problem Site: Problem sites include those which are filled, have soft and/or collapsing soils, have soils subject to erosion, subject to abnormal moisture conditions, have bearing pressure $< 100\text{kPa}$ and any other sites which do not otherwise comply with class A, S, M, H or E requirements.

- **Effect of Trees:** Trees can have a significant drying effect resulting in abnormal moisture conditions of the soils in the vicinity of the tree(s). On reactive clay sites, this can have the effect of dramatically increasing the predicted surface movement (y_s) within the zone of influence of the tree(s). Past, present and future trees all potentially affect the site classification and subsequent footing and slab design. When it is known that large trees have been removed from a site, the site classifier or footing design engineer should be advised of the size, location and date of removal, so that appropriate consideration can be given to the footing design.

As recommended, and in accordance with AS2870, our preferred option for determination of Instability Index is by a combination of the shrink-swell index and identification of the soil profile. In some cases where shrink-swell index testing is not practicable, soil classification testing (Atterberg Limits and Particle Size Distribution) may have been used.

Values used in determination of the y_s value were:

- * soil profiles - refer borehole logs
- * shrinkage index - refer laboratory results
- * extreme suction change - 1.2pF
- * depth of suction change - 1.5 to 2.3
- * cracked zone - 0.5Hs (zero for reactive clay on controlled filled sites < 5 years old)
- * α cracked zone - 1.0
- * α uncracked zone - $2.0 - z/5$

where z = depth from ground surface to the centroid of the layer under consideration.

Provision of y_s values and/or site classification is intended for use in residential applications only. Where this information has been provided in non-residential cases it is done so as supplementary information only and may not be suitable for application to AS2870 design principles.

EARTHWORKS

All earthworks should be carried out in strict accordance with the full requirements of Australian Standard AS 3798 "Guidelines on Earthworks for Commercial and Residential Developments". If local authority requirements apply to the earthworks and differ from AS 3798 the more stringent requirements should be adopted. Unless approved, the following materials are generally not suitable for use as structural filling:

- * Organic Soils - topsoils, severely root affected soils and peat
- * Materials which may be contaminated with toxic substances through past site usages.
- * Filling which contains wood, metal, plastic, boulders and other deleterious materials.
- * Any other materials which have deleterious engineering properties.

Any earthworks carried out after the site investigation will change the findings of the report. Particular care and consideration should be given to the site reactivity and classification which is likely to change with cutting and/or filling of the site.

On cut-and-fill sloping sites the fill shall be controlled and extend a minimum of 1m past the edge of any construction areas. Embankment slopes shall be protected from erosion and be not steeper than two horizontal to one vertical. The suitability of any such embankments shall be verified by an experienced geotechnical engineer prior to construction.

GROUNDWATER

Groundwater levels (where encountered) are provided on the borelog sheets.

Generally, groundwater or seepage tends to travel in the more permeable layers over less permeable materials (ie. along sand/clay interfaces, fill/natural interfaces, etc.) and in joints of rock.

Bulk earthworks (ie. cut/fill or fill operations) should not be carried out during wet periods and should be delayed sufficiently to ensure the moisture content of the materials approximates the optimum moisture content for compaction.

Should footing excavation commence during or following an extended wet period and where the soil profile comprises sandy soils or sandy soils overlying clays, the surface sands will tend to collapse during trench excavations requiring temporary shoring and the construction of a sump area from which groundwater can be pumped. Under no circumstances should softening of foundation soils be allowed to occur.

It is advised that a test pit be excavated to assess ground conditions prior to commencing trench excavations or earthworks if prevailing weather conditions are poor.

SITE MANAGEMENT

The short and long term serviceability of the development is largely dependent upon a responsible approach by the developer, builder and the owner/occupant towards drainage, landscaping and vegetation. The following basic requirements apply to most developments.

- * **Surface Drainage**
Site preparations should include provision for slopes of no less than 1 vertical in 20 horizontal away from structures for a distance of at least 2m where possible. Spoon drains and catch drains should be constructed where necessary to direct surface drainage away from the structure.
- * **Landscaping**
Landscaping should be planned to ensure excessive watering and/or water ponding areas do not occur. Landscaping areas should be considered in the design of site drainage systems.
- * **Vegetation**
To reduce (but not eliminate) the possibility of damage to structural elements, trees should be restricted to a distance of no closer than 1.5 times the mature height from the structure.

A more extensive discussion on site management is contained in the CSIRO document "Guides to Home Owners on Foundation Maintenance and Footing Performance" and its recommendations should be followed in full.

THE REPORT

This report was compiled in accordance with the relevant standards, sound geotechnical practices and general market requirements as appropriate.

Unless instructed otherwise, this investigation and report does not address the following issues:

- * Existing and/or proposed mining influence
- * Slope stability
- * Specific site drainage requirements and potential effects
- * Contamination and/or hazardous materials on the site
- * Specific effects of post investigative works on the site
- * Existing underground services

The client should understand that whilst our investigation and report has been conducted within appropriate guidelines and with suitable diligence to accurately determine the ground conditions, on occasion, construction (earthworks/excavations) may indicate ground conditions differing from those shown in this report. Should this occur, SGS, should be advised immediately for further advice.

The work undertaken and reported is intended for the sole use of the client named on this report for the specific purpose of determining the parameters necessary for the design and construction of the development outlined. It may not contain sufficient information for other purposes. It is intended that this report will provide advice on geotechnical and related issues only and that SGS **will not** accept any responsibility for any structural design which does not fully consider and correctly apply the findings of this report.

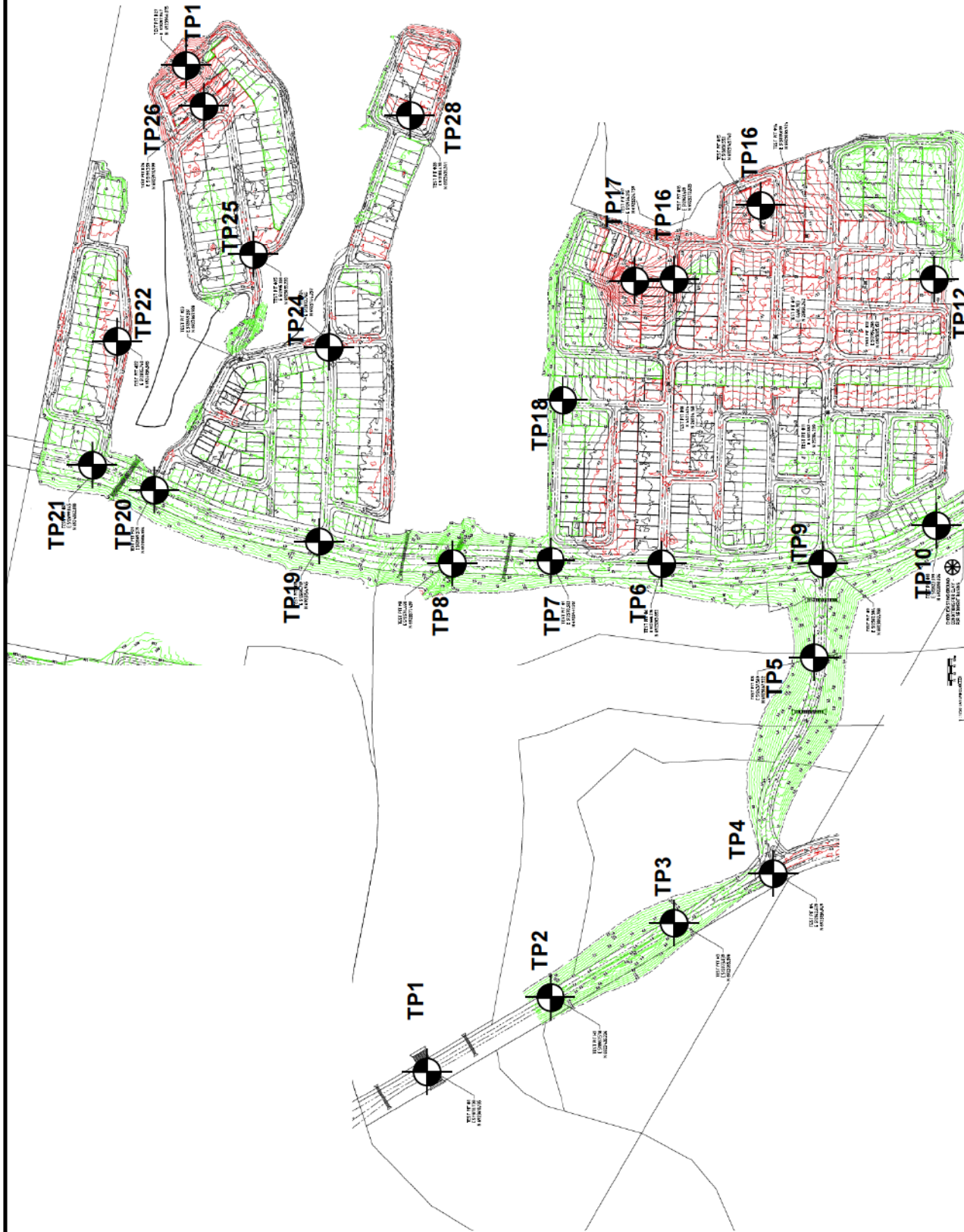
It is important for the client to understand that long term serviceability of the structure will require all the findings of this report to be considered and undertaken. No responsibility will be accepted where these are not put into effect prior to commencement or in conjunction with construction as required.

Any bearing capacity parameters provided in the report must be considered as preliminary only and should be confirmed by an experienced geotechnical engineer during construction.

INSPECTIONS

SGS provides inspection services for any geotechnical issues in relation to this report. We encourage the client, their designers and contractors, to make use of this service to verify the findings of the report, particularly if there is any doubt regarding the ground conditions being encountered during construction.

APPENDIX B: SITE DESCRIPTION AND SITE SKETCH



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 www.sgs.com

TITLE
SITE PLAN

JOB LOCATION
YARRABILBA PRECINCT 3B AND 3C

CLIENT
CIVIL CONTRACTORS (AUST) PTY LTD

DRAWING NO.
SGSE.16.020N.1

SCALE
SCALE NOT SHOWN

DATE
15.12.16

DRAWN
CK

SIZE
A4

APPENDIX C: TEST PIT RECORDS, SAMPLING AND INSITU TEST RESULTS



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EXCAVATION LOG

EXCAVATION NO.: **TP1**
SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **14.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **14.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 2.2 Easting: 511870.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923610.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, grey, with fine gravel (100mm topsoil)	D	MD				
							SC	Clayey SAND, fine to medium grained, grey mottled orange	D	MD				
							SP	SAND, medium grained, pale grey mottled orange, trace of clay	W	L				
							SP	SAND, medium grained, pale grey mottled orange	W	L				
				1.0										
				1.5										
				2.0										
				2.5										
				3.0										
								End of TP1 at 2.2m						

- Sides of test pit collapsing



	SGS Australia Pty Ltd ABN 44 000 964 278 Unit 1/ 18 Leanne Crescent Lawnton, QLD 4501 t +61 (7) 3481 9444 www.sgs.com	TITLE TEST PIT 1		DRAWING NO. SGSE.16.020N.1		
		JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
		CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP10**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD**

DATE COMMENCED: **14.12.2016**

PROJECT: **GEOTECHNICAL INVESTIGATION**

DATE COMPLETED: **14.12.2016**

LOCATION: **YARRABILBA PRECINCT 3B/3C**

LOGGED BY: **CK**

JOB NUMBER: **SGSE/16/020N**

CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.5 Easting: 512623.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6922898.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP				0.5			SM	NATURAL - Silty SAND, fine to medium grained, pale grey, 90mm topsoil	D	MD				
							SP	SAND, fine to medium grained, yellow, grey, with clay	D	D				
							SC	Clayey SAND, fine to medium grained, high plasticity clay, yellow mottled orange	D	VSt				
							CI	Sandy CLAY, medium plasticity, grey, orange	D	H				
				1.0			CH	Sandy CLAY, red, grey	D	H				
				1.5				End of TP10 at 1.5m						
				2.0										
				2.5										
				3.0										



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TITLE	DRAWING NO.		
	SGSE.16.020N.1		
JOB LOCATION	SCALE		
	SCALE NOT SHOWN		
CLIENT	DATE	DRAWN	SIZE
	15.12.16	CK	A4

TEST PIT 2

YARRABILBA PRECINCT 3B & 3C

CIVIL CONTRACTORS (AUST) PTY LTD



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EXCAVATION LOG

EXCAVATION NO.: **TP12**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **15.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **15.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.9 Easting: 513046.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6922875.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP				0.5			SM	NATURAL - Silty SAND, fine to medium grained, pale grey, 90mm topsoil	D	MD			-Test pit relocated due to access	
							SC	Clayey SAND, fine to medium grained, yellow	D	H				
							XW	SANDSTONE, fine to medium grained, grey, orange	D	EL-VL				
				1.0			DW	SANDSTONE, fine to medium grained, grey, orange	D	LS				
				1.5										
				2.0				End of TP12 at 1.9m						
				2.5										
				3.0										



 SGS Australia Pty Ltd ABN 44 000 964 278 Unit 1/ 18 Leanne Crescent Lawnton, QLD 4501 t +61 (7) 3481 9444 www.sgs.com	TITLE TEST PIT 3		DRAWING NO. SGSE.16.020N.1		
	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP15**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **14.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **14.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 2.5 Easting: 513030.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923145.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, grey (80mm topsoil)	D	D				
							XW	SANDSTONE, medium to coarse grained, orange, white, red - 300mm clay band	D	EL				
							DW	SANDSTONE, medium to coarse grained, orange, white, red		LS				
				1.0										
				1.5										
				2.0										
				2.5										
								End of TP15 at 2.5m						
				3.0										



 SGS Australia Pty Ltd ABN 44 000 964 278 Unit 1/ 18 Leanne Crescent Lawnton, QLD 4501 t +61 (7) 3481 9444 www.sgs.com	TITLE TEST PIT 4		DRAWING NO. SGSE.16.020N.1		
	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP16**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD**

DATE COMMENCED: **14.12.2016**

PROJECT: **GEOTECHNICAL INVESTIGATION**

DATE COMPLETED: **14.12.2016**

LOCATION: **YARRABILBA PRECINCT 3B/3C**

LOGGED BY: **CK**

JOB NUMBER: **SGSE/16/020N**

CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.2 Easting: 512961.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923272.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained	D	L				
							DW	SANDSTONE, blocky, fine to coarse grained, red, orange, grey	D	VL				
							DW	SANDSTONE, blocky, fine to coarse grained, red, orange, grey	D	M				
				1.0										
				1.5										
				2.0										
				2.5										
				3.0										
								End of TP16 at 1.2m						



 SGS Australia Pty Ltd ABN 44 000 964 278 Unit 1/ 18 Leanne Crescent Lawnton, QLD 4501 t +61 (7) 3481 9444 www.sgs.com	TITLE TEST PIT 5		DRAWING NO. SGSE.16.020N.1		
	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP18**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD**

DATE COMMENCED: **15.12.2016**

PROJECT: **GEOTECHNICAL INVESTIGATION**

DATE COMPLETED: **15.12.2016**

LOCATION: **YARRABILBA PRECINCT 3B/3C**

LOGGED BY: **CK**

JOB NUMBER: **SGSE/16/020N**

CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.8 Easting: 512826.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923441.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, grey (120mm topsoil)	D	L			-Test pit relocated due to access	
							SP	SAND, pale grey, with silt		MD				
							SP	SAND, pale grey, with silt		D				
							XW	SANDSTONE, fine to coarse grained, red, orange, grey		LS				
				1.0										
				1.5										
				2.0				End of TP18 at 1.8m						
				2.5										
				3.0										



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP19**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD**

DATE COMMENCED: **15.12.2016**

PROJECT: **GEOTECHNICAL INVESTIGATION**

DATE COMPLETED: **15.12.2016**

LOCATION: **YARRABILBA PRECINCT 3B/3C**

LOGGED BY: **CK**

JOB NUMBER: **SGSE/16/020N**

CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.8 Easting: 512669.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923986.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, grey (90mm topsoil)	D	MD				
							SC	Clayey SAND, fine to coarse grained, pale grey mottled orange	D-M	D				
							CI	Sandy CLAY, medium plasticity, fine to coarse grained sand, grey, orange	D-M	H				
							CH	Sandy CLAY, high plasticity, fine to coarse grained, grey, red, with silt	D-M	H				
				1.0										
				1.5										
				2.0				End of TP19 at 1.8m						
				2.5										
				3.0										



 SGS Australia Pty Ltd ABN 44 000 964 278 Unit 1/ 18 Leanne Crescent Lawnton, QLD 4501 t +61 (7) 3481 9444 www.sgs.com	TITLE TEST PIT 7		DRAWING NO. SGSE.16.020N.1		
	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP2**
SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **14.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **14.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.5 Easting: 511967.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923435.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, pale grey, 90mm topsoil	D	MD				
							CH	Sandy CLAY, high plasticity, fine to coarse grained sand, orange, grey	D	H				
							DW	SANDSTONE, pale grey, orange	D	VL				
				1.5				End of TP2 at 1.5m						
				2.0										
				2.5										
				3.0										



TITLE TEST PIT 8	DRAWING NO. SGSE.16.020N.1		
	SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD	DATE 15.12.16	DRAWN CK
			SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP20**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **15.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **15.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.8 Easting: 512669.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923986.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, grey (120mm topsoil)						
							SP	SAND, fine to medium grained, pale grey, with clay	D	D				
							SC	Clayey SAND, fine to coarse grained, medium plasticity clay, grey, yellow, with fine to medium gravel	D	D				
							CI	Sandy CLAY, medium plasticity, fine to coarse sand, grey, orange	D	H				
							CH	Sandy CLAY, medium to high plasticity, fine to coarse sand, red, grey, with silt	D	H	D			
				1.0										
				1.5										
				2.0										
				2.5										
				3.0										
								End of TP20 at 1.8m						



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP21**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **15.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **15.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 2.2 Easting: 512699.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6924062.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole						SM	NATURAL - Silty SAND, fine to medium grained, dark grey (100mm topsoil)	D	L				
							SM	Silty SAND, fine to medium, pale grey	D	MD				
				0.5			SC	Clayey SAND, fine to coarse grained, medium plasticity clay, yellow, orange, with fine to medium sized gravel	D	D				
				1.0			SC	Clayey SAND, fine to coarse grained, medium plasticity clay, red, orange, with fine to medium sized gravel	D	D				
				1.5			SC	Clayey SAND, fine to coarse grained, medium plasticity clay, red, orange, with fine to medium sized gravel	D	D				
				2.0			CI	Sandy CLAY, medium plasticity, fine to coarse grained sand, grey, red, tending to sandstone	M	H				
				2.5				End of TP21 at 2.2m						
				3.0										



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP22**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **15.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **15.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 2 Easting: 512875.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6924036.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, dark grey (110mm topsoil)	D	L				
							SP	SAND, fine to medium grained, dark grey	D	MD				
							SC	Clayey SAND, fine to coarse grained, medium plasticity clay, yellow, grey	D	D				
							CI	Sandy CLAY, medium plasticity, fine to coarse grained, orange-grey, red	D	H				
							XW	SANDSTONE, fine to coarse grained, grey, orange, red	D	EL				
				2.0				End of TP22 at 2m						
				2.5										
				3.0										



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C	SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD	DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP24**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD**

DATE COMMENCED: **15.12.2016**

PROJECT: **GEOTECHNICAL INVESTIGATION**

DATE COMPLETED: **15.12.2016**

LOCATION: **YARRABILBA PRECINCT 3B/3C**

LOGGED BY: **CK**

JOB NUMBER: **SGSE/16/020N**

CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 2.1 Easting: 512873.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923855.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole						SM	NATURAL - Silty SAND, fine to medium grained, grey (90mm topsoil)	D	L				
				0.5			SP	SAND, fine to medium grained, pale grey, white, witt silt	D	MD				
				1.0			SC	Clayey SAND, fine to coarse grained, pale grey, yellow, motorange	D	D				
				1.5			XW	SANDSTONE, fine to coarse grained, grey, yellow, orange	D	EL				
				2.0			DW	SANDSTONE, fine to coarse grained, grey, yellow, orange	D	LS				
				2.5				End of TP24 at 2.1m						
				3.0										



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP25**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD**

DATE COMMENCED: **15.12.2016**

PROJECT: **GEOTECHNICAL INVESTIGATION**

DATE COMPLETED: **15.12.2016**

LOCATION: **YARRABILBA PRECINCT 3B/3C**

LOGGED BY: **CK**

JOB NUMBER: **SGSE/16/020N**

CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 2.7 Easting: 512995.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923855.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, dark grey (70mm topsoil)	D	L				
							SP	SAND, fine to medium grained, pale grey, with silt	D	MD				
							SC	Clayey SAND, fine to medium grained, pale grey mottled orange	D	VSt				
							CI	Sandy CLAY, medium plasticity, fine to coarse grained sand, grey, orange	D	H				
							DW	SANDSTONE, fine to coarse grained, orange, grey	D	VL				
				2.0										
				2.5										
				3.0				End of TP25 at 2.7m						



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TITLE

TEST PIT 16

DRAWING NO.

SGSE.16.020N.1

JOB LOCATION

YARRABILBA PRECINCT 3B & 3C

SCALE

SCALE NOT SHOWN

CLIENT

CIVIL CONTRACTORS (AUST) PTY LTD

DATE

15.12.16

DRAWN

CK

SIZE

A4



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EXCAVATION LOG

EXCAVATION NO.: **TP26**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **15.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **15.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 2 Easting: 513199.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923910.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, grey (100mm topsoil)	D	L				
							SP	SAND, fine to coarse grained, pale grey, trace silt	D	MD				
							SC	Clayey SAND, fine to coarse grained, medium plasticity clay, yellow, orange, with fine gravel	D	MD				
				1.0			GP	Sandy GRAVEL, fine to coarse grained, fine to medium sized gravel, pale orange, with clay	D	MD				
				1.5			GP	Sandy GRAVEL, fine to coarse grained, fine to medium sized gravel, pale orange, with clay	D	D				
				2.0				End of TP26 at 2m						
				2.5										
				3.0										



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP27**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **15.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **15.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.5 Easting: 513257.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923944.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SP	NATURAL - Gravelly SAND, fine to medium grained, fine to medium sized gravel, grey, with silt (150mm topsoil)	D	L				
							GP	Gravelly SANDY, fine to medium grained, fine to coarse grained sand, pale orange, trace of clay	D	MD				
							GP	Sandy GRAVEL, fine to coarse sized, fine to coarse grained sand, orange, yellow, with clay	D	D				
				1.0										
				1.5										
								End of TP27 at 1.5m						
				2.0										
				2.5										
				3.0										



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP28**

SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD**

DATE COMMENCED: **15.12.2016**

PROJECT: **GEOTECHNICAL INVESTIGATION**

DATE COMPLETED: **15.12.2016**

LOCATION: **YARRABILBA PRECINCT 3B/3C**

LOGGED BY: **CK**

JOB NUMBER: **SGSE/16/020N**

CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.4 Easting: 513188.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923635.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, grey, with fine gravel (100mm topsoil)	D	MD				
							SC	Clayey SAND, fine to medium grained, yellow, grey, with fine gravel	D	D				
							SC	Clayey SAND, fine to medium grained, yellow, grey, with fine gravel	D	VD				
							CI	Sandy CLAY, medium plasticity, orange, grey, red	D	H				
							DW	SANDSTONE, medium to coarse grained, white, yellow, red, orange	D	Hi				
				1.5				End of TP28 at 1.4m						
				2.0										
				2.5										
				3.0										



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP3**
SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **14.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **14.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.5 Easting: 6923435.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923265.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, pale grey, 100mm topsoil	D	MD				
							SP	SAND, fine to medium grained, yellow, with clay	D	MD				
							SC	Sandy CLAY, high plasticity, fine to coarse grained sand, yellow mottled orange	D	H				
							CH	Sandy CLAY, high plasticity, fine to coarse grained sand, red, grey	D	H				
				1.0										
				1.5				-tending to sandstone						
								End of TP3 at 1.5m						
				2.0										
				2.5										
				3.0										



 SGS Australia Pty Ltd ABN 44 000 964 278 Unit 1/ 18 Leanne Crescent Lawnton, QLD 4501 t +61 (7) 3481 9444 www.sgs.com	TITLE TEST PIT 21		DRAWING NO. SGSE.16.020N.1		
	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP4**
SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **14.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **14.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.4 Easting: 512142.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923136.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine grained, pale yellow, grey, 110mm topsoil	D	MD				
							CI	Sandy CLAY, high plasticity, rey, red, with ironstone	D	H				
							DW	SANDSTONE, fine to medium grained, orange, grey, red	D	VL				
							DW	SANDSTONE, fine to medium grained, orange, grey, red	D	M				
				1.5				End of TP4 at 1.4m					LIMIT OF BACKHOE (600mm GP Bucket)	
				2.0										
				2.5										
				3.0										



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP5**
SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **14.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **14.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 2 Easting: 512437.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923067.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole						SM	NATURAL - Silty SAND, fine to medium grained, high plasticity silt, grey, 120mm topsoil	D	MD				
				0.5			CH	Silty CLAY, high plasticity, grey mottled orange, with sand	M	VSt			PP=200kPa	
				1.0										
				1.5										
				2.0										
								End of TP5 at 2m						
				2.5										
				3.0										



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP6**
SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **14.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **14.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.5 Easting: 512565.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923283.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, grey, 100mm topsoil	D-M	MD				
				1.0			CH	Sandy CLAY, medium plasticity, fine to medium grained, orange, grey	D-M	H				
				1.5				End of TP6 at 1.5m						
				2.0										
				2.5										
				3.0										



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TITLE TEST PIT 25	DRAWING NO. SGSE.16.020N.1		
	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD	DATE 15.12.16	DRAWN CK
		SIZE A4	



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EXCAVATION LOG

EXCAVATION NO.: **TP7**
SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **14.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **14.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.5 Easting: 512570.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923441.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole			0.5			SM	NATURAL - Silty SAND, fine to medium grained, pale grey, 100mm topsoil	D	L				
							SC	Clayey SAND, fine to medium grained, grey mottled orange	D-M	MD				
							CI	Sandy CLAY, medium plasticity, fine to medium grained sand, orange, grey	D-M	VSt				
							CI	Sandy CLAY, medium plasticity, fine to medium grained sand, red, grey	D-M	H				
				1.0										
				1.5										
								End of TP7 at 1.5m						
				2.0										
				2.5										
				3.0										



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP8**
SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **14.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **14.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 2 Easting: 512574.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923571.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP	Open Hole						SM	NATURAL - Silty SAND, fine to medium grained, pale grey, heavy organics	D-M	L				
				0.5			CI	Sandy CLAY, medium plasticity, fine to medium grained sand, orange, grey	D-M	H				
				1.0				-red, grey						
				1.5										
				2.0										
								End of TP8 at 2m						
				2.5										
				3.0										



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	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4



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EXCAVATION LOG

EXCAVATION NO.: **TP9**
SHEET: 1 OF 1

CLIENT: **CIVIL CONTRACTORS (AUST) PTY LTD** DATE COMMENCED: **14.12.2016**
PROJECT: **GEOTECHNICAL INVESTIGATION** DATE COMPLETED: **14.12.2016**
LOCATION: **YARRABILBA PRECINCT 3B/3C** LOGGED BY: **CK**
JOB NUMBER: **SGSE/16/020N** CHECKED BY: **CB**

Contractor: CIVIL CONTRACTORS Hole Width (mm): 1.2 Excav. Depth (m): 1.5 Easting: 512567.00 Surface R.L.:
Equipment Model: BACKHOE Hole Length (m): 5 Bearing: Northing: 6923052.00 Datum:

Method	Support	Excavation Rate	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Sample	DCP Results	Field Records / Comments	Water
600mm GP				0.5			SM	NATURAL - Silty SAND, fine to medium grained, grey	D	MD				
							SC	Clayey SAND, fine to medium grained, low plasticity, white, yellow	D	D				
							CI	Sandy CLAY, medium plasticity, fine to medium grained sand, grey, orange	D	H				
				1.0			CH	Sandy CLAY, high plasticity, fine to medium grained, red, grey	D	H	D			
				1.5				End of TP9 at 1.5m						
				2.0										
				2.5										
				3.0										



 SGS Australia Pty Ltd ABN 44 000 964 278 Unit 1/ 18 Leanne Crescent Lawnton, QLD 4501 t +61 (7) 3481 9444 www.sgs.com	TITLE TEST PIT 28		DRAWING NO. SGSE.16.020N.1		
	JOB LOCATION YARRABILBA PRECINCT 3B & 3C		SCALE SCALE NOT SHOWN		
	CLIENT CIVIL CONTRACTORS (AUST) PTY LTD		DATE 15.12.16	DRAWN CK	SIZE A4

APPENDIX D: EARTHWORKS NOTES

PROJECT: LEVEL 1 EARTHWORKS CONTROL

These notes apply to this project unless otherwise instructed by the project superintendent.

(A) TEST PROCEDURES

Test procedures to be used on the site will be selected from the following:

- AS1289 5.1.1 Dry Density/Moisture Content Relationship (Standard Compaction)
- AS1289 5.2.1 Dry Density/Moisture Content Relationship (Modified Compaction)
- AS1289 5.3.1 Determination of the Field Density of a Soil (Sand Replacement)
- AS1289 5.4.1 Dry Density Ratio, Moisture Variation and Moisture Ratio
- AS1289 5.5.1 Determination of the Minimum and Maximum Dry Density of a Cohesionless Material
- AS1289 5.6.1 Density Index for a Cohesionless Material
- AS1289 5.7.1 Half Density Ratio and Moisture Variation
- AS1289 5.8.1 Determination of the Field Density of a Soil (Nuclear Gauge)

(B) CONTRACTORS RESPONSIBILITIES

Construction/Compaction Equipment

Careful consideration should be given to the selection of compaction equipment and the proportion of compaction equipment to incoming fill quantities. The plant should be capable of compacting all of the fill area including its edges, batters, irregular surfaces and junctions with the natural ground.

Construction Equipment Operators

It is the responsibility of the contractor to ensure that operators are adequately trained in the basic standard practices and requirements of earthwork construction (eg. rolling patterns, benching, appropriate layer thicknesses, etc.).

Notification of Filling

The Geotechnical Testing Authority relies on the Contractor, Constructor or Superintendent to advise when the filling operation will commence, or re-commence following delay periods. Level 1 certification cannot be given for fill placed without the knowledge of the Geotechnical Testing Authority.

Specification Compliance

Regardless of the role of the Geotechnical Testing Authority, the contractor is responsible for complying with all aspects of the specification including the quality, placement methods and compaction of the fill.

(C) UNSUITABLE MATERIALS

In relation to structural filling, unsuitable materials may be termed either "unsuitable" or "temporary unsuitable".

1) *Unsuitable*

Unless otherwise approved by the superintendent, the following materials are not suitable for forming any part of structural filling. At the direction of the superintendent, unsuitable materials should either be removed to spoil or used in non-structural areas (eg. park areas, footpaths, etc.).

- organic soils - topsoils, severely root affected soils and peat
- materials which may be contaminated with toxic substances through past site usages
- filling which contains wood, metal, plastic, boulders and other deleterious materials
- any other materials which have deleterious engineering properties

2) *Temporary Unsuitable*

"Temporary unsuitable" refers to materials which are deemed unsuitable for use as structural fill in the present condition but may be rectified for subsequent use by some form of treatment.

Typical examples of temporary unsuitable materials and appropriate treatments are shown below:

<u>Temporary Unsuitable Material</u>	<u>Possible Remedial Treatment</u>
Material too wet	Spread and Dry
Excessive oversize	Screen/remove oversize
Excessive organics (sticks/stumps)	Remove sticks/stumps

(D) REACTIVE CLAYS

Soil reactivity is a term which refers to the volume change (shrinking and swelling) of clay soils undergoing moisture change. Reactive clay soils swell when wetted up and shrink when dried out. This characteristic is measured in the laboratory and used extensively for residential site classification and footing design. The following issues should be considered.

- 1) The site classification of a lot is not only affected by filling of the lot but also by the reactivity characteristics of the soils used to fill the lot.
- 2) Clay soils placed in a new environment (fill) will, over a period, adjust to equilibrium conditions (moisture and density). Clay soils which are over dried and over compacted (beyond equilibrium conditions) may result in a fill area with a high swell potential.

A Modified Compaction specification will often necessitate the drying of clay soils well beyond the equilibrium conditions to meet the specification requirements. In temperate climates, the Standard Compaction Optimum Moisture Content is more likely to approximate the equilibrium moisture content (AS 3798 - 2007 Clause 5.3).

(E) SANDY SOILS (SILTY SANDS AND CLAYEY SANDS)

Sandy soils are generally prone to loss of strength and stability (heaving under load) as the moisture content approaches the standard optimum moisture content. The condition generally worsens as the moisture content increases above the optimum moisture content. This condition can develop and be evident on fill areas that may otherwise comply with the density requirement. As a general rule, the moisture content should be maintained approximately 1% to 3% dry of the optimum moisture content (standard compaction).

(F) TOPSOILING

Spreading of topsoil in excessive quantities over controlled fill may reduce the likelihood of a site being re-classified from a 'P' site. As a general rule, topsoil depth should be restricted to about 100mm in proposed building areas.

(G) COMPACTION STANDARDS

Unless otherwise notified, the compaction standard specified by the local authority will be adopted as the density acceptance/rejection criteria.

(H) CONTROLLED FILL ACCEPTANCE/REJECTION CRITERIA

Any combination of the following issues may influence an acceptance/rejection instruction on a section of fill presented for testing.

- density testing
- load testing - deflection/surface heaving
- quality of fill - organics/deleterious materials
- consistency of compaction

(I) EXCLUSIONS

Unless specifically requested Level 1 compaction control does not address the following issues:

- slope stability
- reactive soils
- soft natural soils and/or pre-existing (uncontrolled) fill on the site outside of the nominated controlled fill area
- soils which may be contaminated with toxic substances
- backfill to service trenches, subsequent to the controlled fill commission or when not included in the controlled fill commission
- site drainage
- topsoil placed subsequent to completion of controlled filling
- where the filling exceeds 5m, advice from a geotechnical professional should be sought

PROJECT: LEVEL 1 EARTHWORKS CONTROL

These instructions apply to this project unless otherwise addressed in the job specifications or subsequently by the superintendent.

(A) PRIOR TO FILLING

- (1) Topsoil and organic matter must be stripped to the nominated depth from the proposed cut and fill areas.
- (2) The superintendent or GTA should be notified if the required stripping exceeds the nominated depth.
- (3) Any existing (uncontrolled) fill must be either removed or investigated, approved and documented.
- (4) The stripped natural surface (fill foundation) must be inspected, proof rolled and approved.
- (5) Any unsound areas are subject to supplementary site instructions (in general, the fill foundation is subject to the same compaction requirements as the fill). The practice of "bridging" over soft, unstable and wet fill foundation is generally not acceptable.

(B) FILLING

- (6) If necessary, the fill material must be moisture conditioned as required.
 - a) Too wet - dry fill to within a moisture range that the specified density can be achieved and the fill area is not deflecting (surface heaving) under construction traffic to the detriment of the fill in general.
 - b) Too dry - moisten the fill to within a moisture range that the specified density can be achieved.
 - c) The fill should be mixed to ensure reasonably uniform distribution of the moisture.
- (7) Remove excessive vegetation (sticks, stumps, etc.) as required.
- (8) Place fill in layers generally not exceeding 200mm thick and compact to specification (larger or more efficient compaction equipment may enable the placement of thicker fill layers).
- (9) The fill must be tested at the rate of:
 - a) Minimum of one (1) test every 2nd layer (each 400mm lift)
 - b) Minimum of one (1) test/500m³ of fill - large scale project
 - c) Minimum of one (1) test/200m³ of fill - small scale projector as directed by the GTA or superintendent
- (10) Areas represented by a failed test must be reworked and retested and a positive result obtained prior to placing additional fill.
- (11) Where fill abuts against sloping ground, benches should be cut in the ground generally to a depth of 200mm to 300mm.
- (12) Fill should be placed in near horizontal layers of uniform thickness deposited systematically across the fill area.
- (13) If topsoil is stockpiled adjacent to the fill area, care should be taken to ensure that structural fill does not encroach into the stockpile area.
- (14) The maximum particle size of rocks within the layer after compaction should not exceed two-thirds of the compacted layer thickness.
- (15) Equipment and haul roads should be selected to avoid the overloading (and development of surface heaving) of the fill areas.
- (16) If the filling programme is interrupted (eg. by rainfall periods), the interrupted surface must be inspected and assessed prior to placing additional fill (i.e. in accordance with "(A)").