

**St Vincent's Foundation Pty Ltd**

**Proposed Residential Subdivision, Precinct A, Lot 64 DP1226839,  
Rainbow Beach, Lake Cathie**

**Geotechnical Assessment – Revised Report**

Report No. RGS20337.1-AS

30 July 2018

**REGIONAL**  
GEOTECHNICAL SOLUTIONS





**Manning-Great Lakes**

**Port Macquarie**

**Coffs Harbour**

RGS20337.1-AS

30 July 2018

St Vincent's Foundation Pty Ltd c-/  
King Campbell Pty Ltd  
PO Box 243  
PORT MACQUARIE NSW 2444

**Attention: Scott Marchant**

Dear Scott,

**RE: Proposed Residential Subdivision, Precinct A, Lot 64 DP1226839, Rainbow Beach,  
Lake Cathie**

**Geotechnical Assessment – Revised Report**

As requested, Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken a geotechnical assessment of the proposed Precinct A residential development, Rainbow Beach, Lot 64 DP1226839, Ocean Drive, Lake Cathie.

Surface and subsurface conditions at the site and recommendations and advice on foundation conditions are presented in the attached report.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

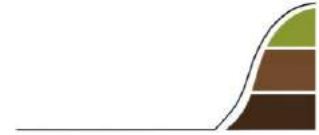
For and on behalf of

**Regional Geotechnical Solutions Pty Ltd**

A handwritten signature in black ink, appearing to read 'Tim Morris', is written over a light blue horizontal line.

**Tim Morris**

Senior Engineering Geologist



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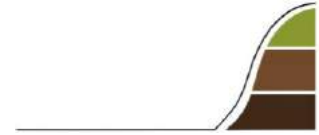
Figure 1 Investigation Location Plan

## Appendices

Appendix A Results of Field Investigations

Appendix B Results of Laboratory Testing

Appendix C Pavement Thickness Design Sheets



## 1 INTRODUCTION

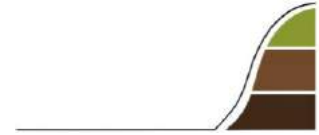
As requested, Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken a geotechnical assessment for the Precinct A residential development, Rainbow Beach, Lot 64 DP1226839, Ocean Drive, Lake Cathie.

The proposed development is located in an area of gently to moderately undulating topography situated between Lake Cathie and Bonny Hills. It will involve:

- Significant site regrading works comprising up to approximately 2m of cut and placement of up to 2m of fill;
- Site preparation works for approximately 67 residential lots;
- Construction of retaining walls up to approximately 1m in height;
- Construction of seven sections of road pavement comprising:
  - Road 1 (Ch30 – 165m) – Collector Road
  - Road 3 (Ch0 – 27m) – Local Street
  - Road 10 (Ch0 – 215m) – Collector
  - Road 26 (Ch0 – 145m) – Local Street
  - Road 25 (Ch0 – 130m) – Local Street
  - Road 28 (Ch0 – 44m) – Local Street
  - Road 29 (Ch0 – 175m) – Local Street
- Construction works for associated infrastructure including water, sewer and stormwater services.

The purpose of the work described herein was to address the following issues:

- A geotechnical model of the Precinct A site that includes general foundation conditions, depth of soil profiles and presence of rock;
- Preliminary site classification to AS2870-2011 *Residential Slabs and Footings*. Re-classification will be required in areas that undergo future regrade;
- Recommended foundation types, including bearing capacities, expected settlements, and construction methods;
- Pavement thickness design, including material requirements and construction recommendations for the internal roads. Where roads will be constructed on fill embankments further subgrade CBR testing will be required following completion of bulk earthworks to confirm adopted embankment fill CBR values were appropriate;
- Recommendations as to site preparation to support concentrated building loads from foundations, floor slabs and pavements;
- Recommendations as to site preparation requirements for the adjacent Precinct J where excess fill from Precinct A may be placed. Fill thicknesses will be up to approximately 2m;



- Summary of excavation conditions and suitability of excavated material for re-use, including comment on options for blending materials to produce a suitable fill;
- Support of cuts and excavations including design parameters for retaining wall design;
- General recommendations on management of construction and drainage at the site from a geotechnical perspective; and
- Presence of groundwater.

The work was commissioned by Scott Marchant on behalf of St Vincent's Pty Ltd and was undertaken in general accordance with proposal number RGS20337.1-AJ dated 29 November 2017.

## **2 FIELD WORK**

Field work for the assessment was undertaken on 12 December 2017 was based on the supplied drawing titled "GEOTECHNICAL\_ SETOUT\_15.12.2017". Fieldwork included:

- Observation of site and surrounding features relevant to the geotechnical conditions of the site;
- Eleven (11) test pits excavated by a backhoe, logged and sampled by an Engineering Geologist;
- U50 tube samples, collected from representative cohesive soil profiles for site classification purposes; and
- Samples for CBR testing collected from subgrade level.

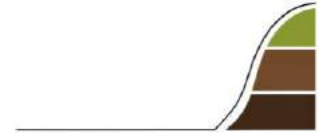
Engineering logs of the test pits results are presented in Appendix A. The locations of the test pits are shown on Figure 1. They were obtained on site by measurement relative to existing site features.

## **3 LABORATORY TESTING**

Samples retrieved during field work were returned to a NATA registered laboratory for testing which included the following;

- California Bearing Ratio (CBR) testing of samples from subgrade level and proposed cut areas;
- Shrink-swell test for preliminary site classification and footing design, including two tests on bulk samples of material compacted at 98% Standard Compaction to simulate re-use of material in a placed fill platform; and
- Atterberg Limits to assess plasticity properties;

The test results are presented in Appendix B. The results of the laboratory testing are summarised in Table 1. CBR results are presented separately in Table 4, Section 4.4.



**Table 1: Summary of Laboratory Test Results**

Location	Depth (m)	Material Type	Shrink (%)	Swell (%)	Shrink-Swell Index (iss)	% Passing 75µm (%)	PI (%)	CBR (%)
TP205	0.2 – 0.7	3 - Colluvial	5.9	-0.8	3.3	--	--	--
TP206	0.4 – 0.9	5 – Residual	3.8	-0.1	2.1*	--	53	--
TP209	0.4 – 0.8	4 - Alluvial	8.7	0.4	4.9*	--	--	--
TP214	0.5 – 1.0**	7- HW Dolerite***	--	--	--	15	23	7
TP215	1.7 – 3.0	Mixed clay/rock	--	--	--	--	26	13
TP217+ TP229	**	50% blend clay and rock	--	--	--	38	45	--

Note: \*Shrink-swell testing undertaken on remoulded bulk sample compacted to approximately 98% SMDD

\*\* Mechanical pre-treatment (RMS-T102) undertaken prior to testing

\*\*\* Classified (AS 1726:2017) as Sandy Clayey GRAVEL (GC) following mechanical pre-treatment

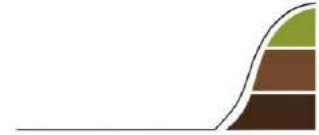
## 4 SITE CONDITIONS

### 4.1 Surface conditions

Precinct A is located on cleared farmland to the south of Ocean Drive in an area of gently to moderately undulating topography where its situated on the south west facing upper to lower slopes of a broad rounded south east plunging ridgeline that is up to 20m AHD in elevation. The lower slopes grade down on to an alluvial plain situated at the toe of the hill.

Surface elevations across Precinct A range from approximately RL 18m along the northern boundary to approximately RL 7.5m in the south western corner. Surface slopes across the site range from approximately 3 - 5° grading down to near flat on the alluvial plain.

An image of the site taken from the NSW Department of Property Information website is reproduced below.



*Approximate extent of Precinct A, Lot 64 DP1226839, Rainbow Beach, Lake Cathie outlined in red.*

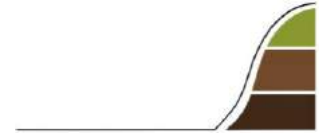
Two large stockpiles are located on the crest of the ridge in the north within the site. It is understood that they will be moved from site prior to commencement of the Precinct A development. Road 1 is located on the western boundary and construction of the road embankment and associated pavement is understood to be commencing shortly.

Surrounding developments include Lake Cathie Public School to the west of the future Road 1, Ocean Drive to the north and open farmland to the south and east where future developments are proposed as part of the Rainbow Beach development.

Ocean Drive is constructed in cut on the northern boundary of Precinct A and extremely to highly weathered dolerite rock is exposed in the cutting. A small farm dam or possible historical borrow pit is located just outside the north east corner of Precinct A in the adjacent Precinct B. Slightly weathered dolerite, massive and high strength was exposed in the wall of the dam excavation. Water was present in the dam at the time of fieldwork.

Vegetation comprised grass and scattered trees. Site was trafficable by 4WD at the time of the fieldwork, although RGS has previously undertaken works near the Ocean Drive and Houston Mitchell Drive roundabout when water was pooling on the surface near the commencement of





Road 1 following rainfall. Site trafficability in such conditions in the alluvial plain landscape would be reduced.

Drainage of the site would be via a combination of surface infiltration and overland flow towards the south west.

A selection of images of the site is presented below.



*Looking north across gently undulating slope. Large fill stockpile located on eastern boundary.*



*Looking south at the toe of the residual slope to the east (left of image) grading onto alluvial plain to the west (right of image).*

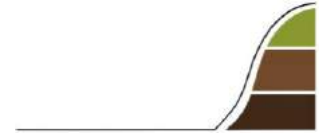


*Extremely to highly weathered dolerite exposed in Ocean Drive road cutting on northern site boundary.*



*Farm dam, or former borrow pit, located to north east of Precinct A where slightly weathered dolerite rock exposed in excavation, massive and high strength.*





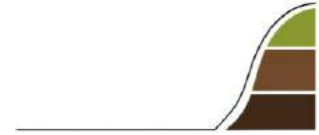
## 4.2 Subsurface conditions

The site is situated in an area underlain by undifferentiated rocks of the Watonga Formation which can include slate, chert, mudstone and the intrusive Karikeree Meta-dolerite. The Port Macquarie 1:25,000 Quaternary geology sheet indicates an alluvial / colluvial fan and Holocene freshwater swamp are present in the south of the site.

The test pits encountered a variable soil profile as summarised below in Table 2 and Table 3.

**Table 2: Summary of Subsurface Conditions**

Geotechnical Unit	Material	Material Description
1	FILL	Sandy GRAVEL, fine to medium, orange/pale grey/pink
2	TOPSOIL	Clayey SILT to Sandy Silty CLAY, low plasticity, dark grey/black, trace grass roots
3	COLLUVIAL	Gravelly Sandy CLAY, medium plasticity, grey/yellow/pale yellow /pale brown/brown, friable
4	ALLUVIAL	Sandy CLAY, medium plasticity, grey/yellow/pale brown with red/grey/pale brown mottling, stiff to very stiff, some gravel, fine to medium
5	RESIDUAL	Sandy CLAY to CLAY, medium to high plasticity, yellow/pale yellow with grey mottling, very stiff/friable, trace gravel, fine
6	EW DOLERITE	Gravelly Sandy CLAY, medium to high plasticity, yellow/dark grey/ pale brown, friable, trace rock fabric
7	HW/ MW DOLERITE	Highly grading to Moderately Weathered Dolerite with depth, fine grained, pale brown to pale grey, low to high strength, highly fractured to fractured, foliated fabric. Excavated as Sandy Gravel, fine to coarse, angular, trace to some clay. Foliated fabric indicates it has been subject to some regional metamorphism and can be considered to be a meta-dolerite. Moderately weathered dolerite typically resulted in backhoe bucket refusal.



**Table 3: Summary of Subsurface Conditions**

Investigation	Depth to Base of Material Layer (m)						
	Unit 1 Fill	Unit 2 Topsoil	Unit 3 Colluvial	Unit 4 Alluvial	Unit 5 Residual	Unit 6 EW Dolerite	Unit 7 HW Dolerite
<b>Terrain A - Undulating Slopes overlying Weathered Dolerite</b>							
TP201	--	0.2	0.4	--	0.9	≥1.5	--
TP202	0.1	--	--	--	0.4	≥1.5	--
TP203	0.1	0.4	--	--	1.1	--	≥1.5
TP204	--	0.15	0.5	--	1.1	--	≥1.5
TP205	--	0.2	0.5	--	0.7	--	≥1.0*
TP206	--	0.4	--	--	≥1.5	--	--
TP207	--	0.25	0.5	--	0.9	--	≥1.5
TP210	--	0.4	--	--	--	≥1.5	--
TP212	--	0.3	--	--	1.1	≥1.5	--
<b>Terrain B – Alluvial Floodplain</b>							
TP209	--	0.4	--	≥1.5	--	--	--
TP211	--	0.4	--	1.1	≥1.5	--	--

Table Notes: -- Material not encountered  
 ≥ Base of material layer not encountered  
 \* Backhoe refusal on rock

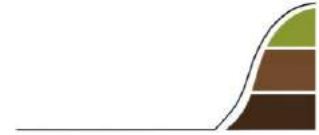
Groundwater was not encountered. It should be noted that fluctuations in groundwater levels can occur as a result of seasonal variations, temperature, rainfall and other similar factors, the influence of which may not have been apparent at the time of the assessment.

### 4.3 Geotechnical Terrains

Site observations, test pitting and laboratory testing results indicated two distinct geotechnical profiles on the site that were associated with topographical features. On this basis, the site has been divided into two geotechnical terrains as summarised in the following sections. The approximate distribution of the terrains are delineated on Figure 1.

#### 4.3.1 Terrain A: Undulating Slopes overlying Weathered Dolerite

Encountered on the hill slopes in the north and east of the site. The soil profile typically consisted of colluvial (Unit 3) clay overlaying residual (Unit 5) yellow high plasticity clays. The yellow clays graded



with depth into extremely (Unit 6) to highly weathered dolerite rock (Unit 7). In some locations the highly weathered dolerite graded into moderately weathered dolerite of higher strength which typically resulted in backhoe digging bucket refusal.

Previous experience in the local area indicates that moisture tends to concentrate in the colluvial horizon, above the underlying high plasticity residual clays and this can pose construction issues. The underlying residual clays (Unit 5) are typically highly reactive and have low CBR values.

The residual clays graded into extremely weathered dolerite (Unit 6) comprising gravelly clays which CBR values ranging from 18 -19% due presence of gravel bands. The highly weathered dolerite rock (Unit 7) had CBR value of 12%. It is noted that the CBR result for a sample of highly weathered dolerite from TP214 that was subject to mechanical pre-compaction (RMS-T102) was a CBR of 7, indicating the rock may break down during placement and compaction with large plant.



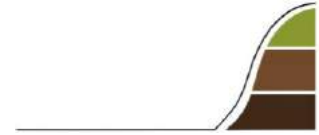
*TP208– Colluvial gravelly clays to 0.5m where moisture can concentrate, overlying residual low CBR yellow clay (Unit 5) grading into highly weathered dolerite from 0.9m*



*TP203 – Highly weathered dolerite (Unit 7) present from 1.1m below the surface and excavated as low strength gravel.*

#### 4.3.2 Terrain B: Alluvial Floodplain

Encountered in the south east of the site below approximately 10m AHD. The profile typically consisted of alluvial clays (Unit 3) overlying residual clays (Unit 5). The alluvial clay had a CBR value of 8% and was highly reactive with a Iss value of 4.9%. It is anticipated that this area of the site would be poorly drained following high rainfall events as evidenced by the presence of the shallow field drains. Road in this area will be typically constructed on raised fill embankments.



TP211 – Mottled orange alluvial clay (Unit 4) overlying residual (Unit 5) yellow clay.



TP209- Mottled alluvial sandy clay soils.

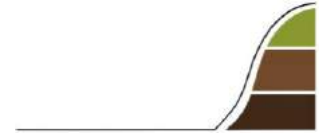
#### 4.4 Subgrade conditions

A summary of the CBR test results from samples collected at design subgrade level is presented in Table 4.

**Table 4 - Summary of Subgrade Properties (Depths in m)**

Sample	Location	Material Description	Terrain	Condition	CBR Swell (%)	CBR
TP201 (0.4-0.7m)	Road 10 Ch0m	5 – Residual	A	+0.16m	0.0	2.5
TP202 (0.4 – 0.7m)	Road 10 Ch100m	6 – EW Dolerite	A	-0.68m	0.5	19
TP203 (0.4 – 0.8m)	Road 10 Ch180m	5 – Residual	A	-0.26m	1.5	5
TP204 (0.5 – 0.9m)	Road 29 Ch100m	5 – Residual	A	-0.07m	3.5	2
TP205 (0.2 – 0.5m)	Road 29 Ch0m	3 - Colluvial	A	+0.38m	3	3
TP206 (0.4 – 0.9m)	Road 26 Ch0m	5 – Residual	A	+0.54m	4.5	3
TP207 (0.9 – 1.3m)	Road 26 Ch110m	7 – HW Dolerite	A	-0.38m	0.5	12
TP209 (0.4 – 0.8m)	Road 25 Ch11m	4 – Alluvial	B	+1.31m	0.5	8
TP210 (0.4 – 0.8m)	Road 25 Ch122m	6 – EW Dolerite	A	+0.71m	0.5	18
TP212 (0.5 – 0.9m)	Road 1 Ch162m	5 – Residual	A	+0.61m	3.5	2





## 5 PROPOSED DEVELOPMENT

The proposed development area in Precinct A is located on cleared farm land in an area of gently to moderately undulating topography that grades down onto an alluvial plain to the south and will involve:

- Site regrading works comprising up to 2m of cut and placement of up to 2m of fill;
- Site preparation works for approximately 67 residential lots;
- Construction of retaining walls up to approximately 1m in height for lot terracing works;
- Construction of seven sections of road pavements for access to the site and connecting minor roads;
- Construction works for associated infrastructure including water, sewer and stormwater services.

## 6 EARTHWORKS

### 6.1 Site Preparation

The site is currently vegetated with grass and scattered trees. Areas of the site that are to support foundations or pavements should be stripped to remove all topsoil, root affected or other potentially deleterious material which can be retained on site for re-use in landscaping, or, removed from the site. Topsoil depths ranged from 150 to 400mm and topsoil stripping will likely involve removing about 150 to 300mm of topsoil.

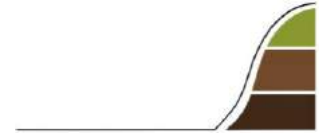
Moisture concentrations have been observed in the colluvial soil profile overlying the residual clay soils on adjacent sites that have similar subsurface profiles. This has sometimes required over-excavation of the colluvial soils, or deep ripping to blend the colluvial soils with the underlying residual clays and allow drying back to occur prior to placement of lot fill.

Weathered dolerite rock will be encountered in deeper excavations at the site, with dolerite at depths of 1m to >1.5m in most test pits as shown on Figures 1 and 2. Where present at the base of the proposed bulk excavation level, consideration should be given to excavating an additional 500mm below subgrade level and then recompacting the excavated material to facilitate construction of future service trenches.

In areas where extensive filling works comprising >1.8m of fill such as in the south of Precinct A and in the adjacent Precinct J, the stripping can be reduced to the removal of the upper approximate 50mm of vegetated and root affected material and the remaining topsoil left in place. It is noted that following prolonged rainfall the remnant topsoil profile may be impacted by moisture and placement of a bridging layer may be required prior to the placement of lot fill. Geotechnical assessment of the subgrade is recommended in such instances.

The site comprises open farm land that has been used for grazing purposes. Past land uses are therefore considered to be non-contaminating. There was no visual or olfactory evidence of contamination or presence of sulfidic ores within the natural soils/ rock. All natural excavated materials removed from the site would be classified in accordance with current NSW EPA waste





classification guidelines as Virgin Excavated Natural Material, and can be disposed of or re-used accordingly.

The origin of the fill stockpiles that are present on site is not known. Should any fill from the stockpiles require removal off-site, it will require assessment for a Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014 in accordance with the Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 – the Excavated Natural Material (ENM) Order 2014.

The topsoil and natural clays at the site are considered susceptible to erosion on exposure (i.e. where vegetation is removed) or where exposed to concentrated flows. It is therefore essential that:

- Earthworks should be undertaken progressively, minimising the area and length of time that any part of the site is denuded of vegetation at any one time;
- Re-vegetation or other erosion protection should be undertaken as soon as possible; and
- The erodibility of the soils should be taken into account in the long term stormwater management plan for the site (eg. Sizing and ongoing management or maintenance of detention ponds).

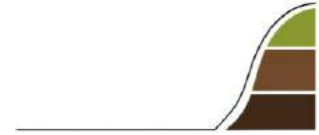
## **6.2 Excavation and Retention**

The test pits were excavated with a backhoe and the test pits on the ridge slopes encountered residual clays (Unit 5), extremely weathered dolerite (recovered as hard clay – Unit 6) and highly to moderately weathered dolerite rock (Unit 7). Slow digging conditions and backhoe refusal at the depths shown on the attached test pit engineering logs were encountered in the weathered dolerite (Unit 7) profile which occurs in Terrain A.

The excavation of clay soils should be achievable with a conventional small to medium sized excavator or backhoe. Bulk excavations within the moderately weathered dolerite at the base of Unit 7 may require ripping with a single tyne ripper prior to excavation by a large (>20T) excavator. An allowance should also be made for the use of hydraulic rock breakers in confined detail excavations such as service trenches where weathered rock is encountered below bulk excavation levels. It is noted that deeper excavations are proposed in the adjacent Precinct B and C sites and that weathered dolerite rock was encountered at shallower levels. Specific excavation advice will be provided for such conditions in the geotechnical assessment that is currently being prepared for those sites.

The materials encountered to excavation depth were such that for bulk excavation in a direct cut to fill operation, the use of scrapers in clay soils and ripped materials may provide efficiencies in comparison with the use of excavators and trucks. Pre-ripping by large bulldozer may be required where weathered rock is present in deeper cuts. Scraper trafficability in Terrain B may be restricted following periods of prolonged rainfall.

Entry into unsupported trenches deeper than 1.2m should be avoided and appropriate signage and barricading should be installed around all open excavations. Excavation design should take



into account maximum batter angle and setback requirements for vehicle traffic as detailed in the Excavation Work Code of Practice (Safe Work Australia – 2014).

Temporary excavations up to 2.0m high (during construction) in controlled fill, residual soils and extremely weathered rock can be battered at 1.H:1V. Permanent slopes shall be battered no steeper than 2H:1V and will require re-vegetation or other erosion protection. In weathered rock, subject to geotechnical appraisal on bulk excavation, steeper batters may be adopted, but are likely to require face protection by shotcrete or similar.

Where site constraints preclude the use of such batters, excavations should be supported by temporary shoring or permanent support as appropriate. Retaining walls are proposed in some areas of the site.

Gravity or cantilever retaining walls can be designed on the basis of the parameters presented in Table 5 for walls retaining natural clays or clay fill. Design can be undertaken on the basis of a triangular lateral earth pressure distribution using the characteristic earth pressure coefficients and subsoil parameters provided and should include assessment of the overall stability of the wall.

**Table 5: Retention Design Parameters**

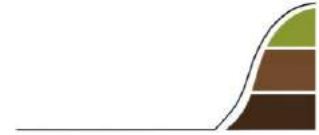
Material	Unit Weight, $\gamma$	Effective Friction Angle	Effective Cohesion, $c'$	Active Earth Pressure Coefficient, $k_a$	At Rest Earth Pressure Coefficient, $k_o$	Passive Earth Pressure Coefficient, $k_p$
Controlled Fill (Blended clay)	20 kN/m <sup>3</sup>	28°	5 kPa	0.36	1.13	2.76
3 – Colluvial Clay	20 kN/m <sup>3</sup>	25°	5 kPa	0.41	1.14	2.46
5 – Residual Clay (Yellow)	20 kN/m <sup>3</sup>	25°	5 kPa	0.41	1.14	2.46
6– EW Dolerite (Clay)	20 kN/m <sup>3</sup>	28°	10 kPa	0.36	1.13	2.76

The earth pressure coefficients detailed in Table 5 have been calculated using Rankine's Theory assuming level backfill. The retaining wall designer should ensure that the use of this method is appropriate for the individual retaining wall(s). Any surcharge affecting the walls such as adjacent footings, adjacent retaining walls and their backfill, or sloping surfaces, should be allowed for in the design.

### 6.3 Suitability of Site Soils for Use as Engineering Fill

#### Terrain A: Undulating Slopes with Weathered Dolerite

The yellow/brown residual clay (Unit 5) soils that are present are moderately to highly reactive and are not recommended for reuse as controlled fill due to their significant shrink-swell potential. If they



must be used due to site cut/fill balances then it is recommended that they are blended with highly weathered dolerite (Unit 7) rock material at a ratio of 1:1 to reduce the potential reactivity.

Reuse of the weathered dolerite rock as engineering fill or road embankment fill will be possible, however, any oversize material (>100mm) will require screening or further breaking down using large compaction plant. Mechanical pre-treatment of the weathered dolerite rock samples was undertaken prior to testing to simulate placement and compaction and this process resulted in a lower CBR value of 7 than might typically be encountered for weathered rock. Should slightly weathered dolerite be encountered in the base of the deep cuts it may be excavated in large boulders that will not break down upon compaction and would require either sorting or crushing with suitable plant.

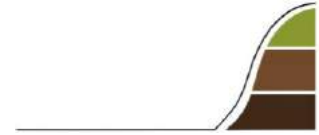
A blend of 50% residual clay and 50% weathered dolerite gravel was prepared from recovered materials in the adjacent Precinct B (TP217 + TP229) then subject to mechanical pre-treatment to simulate placement and compaction. Following pre-treatment the blended material had a PI of 45 and 38% of the sample was <75µm, however, it is classified as a Sandy Clayey GRAVEL in accordance with AS1726-2017. The weighted PI (PI x fraction passing 425µm) of the blended material is 2070, equivalent to a 'Class B' classification, which has a medium potential for volume change.

The high PI indicates the material is likely to be moisture sensitive despite the gravel content and proposed reuse of the blended material should therefore allow for potential reworking and moisture conditioning time that may be required if prolonged rainfall occurs. This may include grading of the subgrade towards embankment shoulders or edges of fill platforms and temporary drainage diversion measures to prevent water pooling on the surface.

Achieving a thorough blend of clay and weathered rock gravels will be difficult and potentially costly due to additional handling and placing requirements. Blending may be attempted by placing approximately 150mm of weathered rock fill and then overlaying with a layer of 150mm of clay fill before cross ripping to 300mm and then compacting with a pad foot roller. If site conditions permit, the use of scrapers sourcing different materials from different cuts for alternating layers may result in a more efficient blending methodology but will require close supervision.

#### Terrain B: Alluvial Floodplain

Due to the low-lying nature of the alluvial depression, excavation works are expected to be minor this terrain, however, soils that may be encountered during service trenching comprising topsoil (Unit 2) and alluvial clay (Unit 4). The topsoil has a high clay content and may be difficult to reuse for landscaping purposes. The alluvial clay soils are moderately to highly reactive and are not recommended for reuse as controlled fill due to their significant shrink-swell potential unless they can be blended with weathered rock as per Terrain A.



## 6.4 Bulking Factors

Based on test results and previous experience with similar soils, material properties and potential bulking factors are presented in Table 6. Bulking factors will require revision once earthworks commence and reconciliation of cut and placed material volumes and density test results can be undertaken.

**Table 6: Material Properties\* and Bulking Factors**

Material Type	Field Moisture Content (%)	Optimum Moisture Content (%)	Maximum Dry Density (t/m <sup>3</sup> )	Cut to Truck (Loose Bulking Factor)	Cut to Fill Platform** (Compacted bulking factor)
Clay Soils	23.2 – 32.8	24 – 27.9	1.49 – 1.58	1.3	1
Blend of Clay and Rock	15.4	14.3	1.87	N/A	N/A
EW/ HW Rock	8 – 10.5	12.2 – 14.4	1.92 – 2.07	1.4	1 – 1.1
Slightly Weathered/ Fresh Rock	N/A	N/A	N/A	1.5	1.2

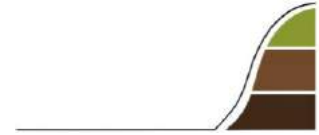
\* From CBR test results (100% Standard Compaction)

\*\* Assuming average 98% Standard Compaction

## 6.5 Fill Placement and Compaction Control

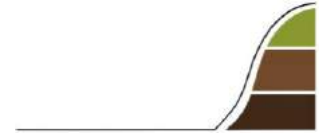
All fill placed for the support of structures or pavements should be placed and compacted as outlined below:

- After unsuitable material (including topsoil) has been stripped the exposed natural subgrade should be proof roll tested in the presence of a suitably experienced geotechnical practitioner to highlight any soft, wet or excessively deflecting areas. Where these are encountered they should be over-excavated and removed to spoil and either re-used on site as non-structural landscaping material or removed from the site. Excavated areas should be backfilled with an approved granular material;
- Topsoil material below the root zone in the alluvial plain (Terrain B) has a high clay content and may therefore be difficult to reuse as landscaping material;
- In areas where extensive filling works comprising >1.8m of fill such as in the adjacent Precinct J, stripping can be reduced to the removal of the upper approximate 50mm of vegetated and root affected material and the remaining topsoil left in place. Moisture conditioning of the exposed soils will then be required prior to placement of site won fill. Use of site won weathered rock as a bridging layer may be required, pending geotechnical assessment. It is noted that in areas of soft soils identified in the previous Douglas Partners assessment in the adjacent Precincts, that there is a potential for consolidation settlement and an appropriate filling plan will be required for these areas;



- Previous experience in the general area with the yellow residual clay soils (Unit 5) in Terrain A has revealed that they can be difficult to bridge when over-wet and incorporation of a granular bridging layer or potentially a rock drainage blanket may be required before placement of fill and it is recommended that an allowance be made for such conditions. The bridging layer may comprise site won weathered rock, if available. Alternatively, consideration could be given to over-excavation of the clay to weathered rock, blending the excavated clay soils with site won weathered rock and then replacement of the blended material to design level. Treatment of the clay foundation with 2% quick lime to 300mm depth to form a suitable compaction surface and to minimise excavation and replacement works is another alternative treatment;
- In areas where pavements are proposed, the subgrade will be required to be within  $\pm 2\%$  of OMC prior to placement of pavement layers. Moisture conditioning of the subgrade may be required prior to compaction;
- The yellow residual clay (Unit 5) soils are typically low CBR and where encountered at road subgrade level are likely to require excavation and replacement with suitable granular material and it is recommended that an allowance be made for such conditions;
- The investigation was undertaken following a period of dry weather, however, over-wet subgrade conditions are likely to be encountered in the alluvial Terrain B in the south of the site following high rainfall events and subgrade improvement works may then be required in this area prior to filling. Treatment of the exposed subgrade with quick lime, incorporation of a granular bridging layer, or, potentially a rock drainage blanket may be required before placement of fill pending geotechnical assessment and it is recommended that an allowance be made for such conditions;
- Where weathered rock is exposed at subgrade level it will require ripping to a depth of 300mm below subgrade level and re-compaction to break up preferential drainage paths that concentrate water beneath the pavement or potential residential lots;
- Maximum particle size for general lot fill is 100mm;
- Careful management of the moisture sensitive blended clay and rock material will be required during and after placement as fill. This may include grading of the subgrade towards embankment shoulders, or, edges of fill platforms and temporary drainage diversion measures to prevent water pooling on the surface;
- Where surface slopes are more than  $7^\circ$  the existing surface should be benched prior to placement of fill to provide a level surface suitable for compaction. Each bench will require a minimum width of 3m to allow access for compaction equipment;
- Proposed fill material should comprise suitable fill as defined in AS 3798-2007 *Guidelines on Earthworks for Residential and Commercial Developments*. Inspection by a geotechnical authority may be required to confirm suitability of proposed fill material;
- Where filling is required beneath structures, approved fill should be placed in layers not exceeding 250 mm loose thickness and compacted to a minimum dry density ratio of not less than 95% of standard compaction. Clay fill should be placed and maintained at no more than  $\pm 2\%$  of standard optimum moisture content;



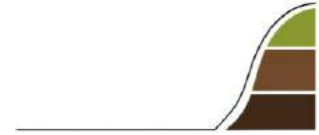


- Where filling is required beneath pavement layers, suitable fill should be placed in layers not exceeding 300 mm loose thickness and compacted to a minimum dry density ratio of 98% standard compaction. The top 300mm of natural subgrade below pavements or the final 300mm of placed road subgrade fill should be compacted to a minimum density ratio of 100% Standard Compaction. Clay fill should be placed and maintained within 2% of standard optimum moisture content;
- Where site won weathered rock is used as a bridging layer, a maximum particle size of 300mm is recommended. Bridging layer material should be tracked in layers not exceeding 500mm loose thickness and then compacted with a minimum six passes by a large compactor (>12T) before being proof rolled under the direction of a geotechnician. The number of passes may require revision depending on material properties. Loss of fines from overlying placed fill may occur where there are large voids present if the rock fill does not break down during compaction. A geo-fabric separation layer may be placed above the rock fill to prevent loss of fines. This will need to be assessed upon placement of excavated rock fill material;
- All fill for the support of structures should be placed and compacted in accordance with the recommendations outlined in AS3798-2007 *Guidelines on Earthworks for Residential and Commercial Developments*, under Level 1 supervision. Areas of the site that are filled to support pavements should be filled under Level 2 supervision and testing.

## **7 FOUNDATIONS (Site Classification)**

AS2870-2011, '*Residential Slabs and Footings*', sets out criteria for the classification of a site and the design and construction of a footing system for a single dwelling house, townhouse or a similar structure.

Based on encountered profiles, previous experience with similar soil types in the general vicinity and shrink-swell testing undertaken on collected insitu samples and recompacted samples, estimated surface movements based on potential development conditions are summarised in Table 7.



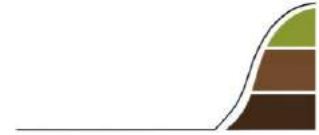
**Table 7: Summary of Potential Site Classifications**

Development Condition	Subsurface Soil Unit	Adopted Shrink Swell Index ( $I_{ss}$ )	Estimated Surface Movement $y_s$ (mm)	Potential Site Classification
<b>Terrain A – Undulating Slopes with Weathered Dolerite</b>				
On Grade	Unit 5 – Residual Clay	2 – 4.5	20 - 60mm	M / H1
Cut (>0.75m)	Unit 7 – Dolerite Rock	0 – 1.5	10 - 25mm	S/ M
Fill (>0.75m)	Unit 4A – Residual Clay as Fill	2 – 4.5	35 - 70mm	M / H2
Fill (>0.75m)	Blend Clay/Rock	1 – 2.5	20 - 40mm	M
<b>Terrain B – Alluvial Plain</b>				
Fill (>0.5m)	Blend Clay/Rock	1 – 2.5	20 - 40mm	M

In summary, the following comments are made with relation to the potential site classifications outlined in Table 7:

- The potential site classifications are preliminary in nature and will require confirmation following site re-grading once final site levels and natural/fill soil profiles are known;
- The natural profile in Terrain A can vary from weathered rock to highly reactive clays and the existing site profiles have potential site classifications ranging from M to H1;
- A cut profile in Terrain A can vary from weathered rock to highly reactive clays and the cut site profiles have potential site classifications ranging from S to H1;
- The natural profiles in Terrain B are moderately to highly reactive and the existing site profiles have a potential site classification ranging from M to H2;
- If site won highly reactive residual yellow clay from Terrain A is used as engineering fill it can result in Class H1 or H2 site classifications. It is therefore recommended that if the yellow clay must be used, that it be blended at a ratio of 1:1 with site won weathered rock to reduce the potential reactivity. Testing of the blended material is recommended to confirm the potential reactivity. Based on previous experience with the blended gravel / clay fill material a Class M site classification is possible;
- Use of clay fill imported from other sites should be avoided until the properties of the imported material have been assessed.

It is noted that all fill for the support of structures should be placed and compacted in accordance with the recommendations outlined in AS3798-2007 under Level 1 inspection and testing to be considered as Controlled Fill.



## 8 PAVEMENT DESIGN

### 8.1 Proposed Works

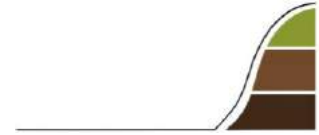
The proposed development includes construction of seven sections of road pavements for access to the site and connecting minor roads as shown on Figure 1. Site regrading works comprising up to 2m of cut and placement of up to 2m of fill will be required for these sections of road.

Representative samples of subgrade soils were collected for CBR testing from subgrade level and proposed fill source areas based on the supplied cut /fill plan. Results of the subgrade testing was summarised in Table 4.

### 8.2 Design Parameters

With reference to Port Macquarie Hastings Aus-Spec, options for pavement design considered the following:

- Local Street design traffic loading =  $5 \times 10^5$  ESA;
- Collector Road design traffic loading =  $1 \times 10^6$  ESA;
- Port Macquarie Hastings Council Aus-Spec requires an AC seal for each section of road.
  - AC10 is proposed for 40mm AC on Collector Roads; and
  - AC10 is proposed for 30mm AC on Local Streets
- Design levels range from approximately 2m embankment fill to 2m cut below existing surface level;
- Terrain A - Design CBR for residual yellow clay of 2%;
- Terrain A - Design CBR for weathered rock of 10%;
- The residual clay and weathered rock profile in Terrain A can be highly irregular. It is therefore proposed that pavements in Terrain A where weathered rock subgrade is anticipated, are boxed out to nominal design thickness and a geotechnical assessment of the exposed subgrade undertaken. Where residual yellow clays are present, excavation and replacement of the subgrade with a Select Fill layer (CBR >15 and PI <15) of minimum 300mm thickness will be required. It is noted that this may need to be thickened or replaced with a rock blanket where the clay profile is thick and /or over-wet;
- For low CBR residual clays an alternative treatment is in-situ stabilisation with quick lime to reduce moisture content, improve the material handling properties and in-situ CBR. This results in reduced pavement thickness and excavation and replacement of high plasticity clay soils which are typically not suitable for reuse without blending with weathered rock. Based on previous lime trials undertaken on similar clay soils a nominal treatment would be stabilisation with 3.5% quicklime to 300mm depth which may result in a design CBR of 8%. If this is a preferred option, then lime stabilisation trials are recommended. Roads with a consistent low CBR subgrade where this treatment may be appropriate includes Roads 28 and 29;
- Terrain B – Alluvial Depression: Fill embankments are proposed across most of this terrain. It is assumed that site won yellow clay (Unit 5) blended with weathered dolerite (Unit 7) will be



used for embankment fill construction. A design CBR of 7% has been adopted based on laboratory testing of blended materials. Further testing is recommended during fill blending and CBR testing will also be required at subgrade level following completion of fill embankment construction to confirm the design CBR is appropriate.

### **8.3 Pavement Design Parameters**

Flexible pavement thickness designs based on Austroads design procedures with reference to the empirical design chart (Figure 8.4) are summarised in Table 8 for subgrade soils in their existing condition without lime stabilisation.



**Table 8 – Flexible Pavement Thickness Design Summary**

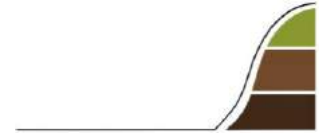
Road	Design Category	Chainage	Development Condition	Subgrade	Subgrade Design CBR	AC (mm)	Base (mm)	Subbase (mm)	Granular Select (mm)	Design Thickness # (mm)	Total Actual Thickness (mm)
1	Collector	Ch30 - 165	Fill	Embankment Fill	7	40	140	150	--	330	330@
3	Local Street	Ch0 - 27	Fill	Embankment Fill	7	30	120	150	--	300	300@
10	Collector	Ch0 - 170	Cut	6 – EW Dolerite 7 – HW Dolerite	10	40	140	150	**	240	330
10	Collector	Ch170 - 215	Ongrade / Cut	5 – Residual Clay 6 – EW Dolerite	2	40	140	150	300	630	630@
25	Local Street	Ch0 - 80	Fill	Embankment Fill	7	30	120	150	--	300	300@
25	Local Street	Ch80 -130	Ongrade / Cut	6 – EW Dolerite	10	30	120	150	**	270	300
26	Local Street	Ch0 - 48	Fill	Embankment Fill	7	30	120	150	--	300	300@
26	Local Street	Ch48 – 145	Ongrade / Cut	5 - Residual 6- EW Dolerite	2	30	120	150	280	580	580@
28	Local Street	Ch0 – 44	Cut	6 – EW Dolerite 7 – HW Dolerite	10	30	120	150	**	240	300
29	Local Street	Ch0 – 175	Ongrade / Cut	3 – Colluvial 5 – Residual	2	30	120	150	280	580	580@

\*\* Replacement of residual yellow clay subgrade required where identified following subgrade assessment, with minimum 300mm Select Fill = CBR>15, PI<12 and maximum particle size <100mm

# Design thickness based on Austroads design procedures with reference to the empirical design chart (Figure 8.4)

@ Density testing required as the AC is included in the design thickness.

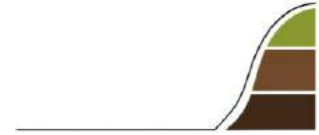




## 8.4 Pavement Construction

Construction recommendations for specific pavement designs are included in the appended Pavement Thickness Design Sheets. In addition, the following general construction advice is given:

- A geotechnical assessment of the roads should be undertaken following boxing out of pavement areas to assess the need for localised areas requiring subgrade replacement or other treatment. Particular attention should be paid to cut/ fill boundaries, zones of moisture concentration and the presence of yellow clay soils or colluvial gravel lenses at subgrade level;
- The residual clay and weathered rock profile in Terrain A can be highly irregular. It is therefore proposed that pavements in Terrain A be boxed out to nominal design thickness where weathered rock subgrade is anticipated, and a geotechnical assessment of the exposed subgrade be undertaken. Where residual yellow clays are present, excavation and replacement of the subgrade with a Select Fill layer (CBR >15 and PI <15) of minimum 300mm thickness will be required. It is noted that this may need to be thickened or replaced with a rock blanket where the clay profile is thick and /or over-wet;
- Preparation of areas for road construction should involve stripping of all topsoil to spoil or stockpile for re-use as landscaping material only;
- Proof roll the exposed subgrade to highlight any loose, soft, wet, or heaving areas. Where such areas are identified they should be removed and replaced with approved granular or Select Fill to design subgrade level;
- At the time of the field investigation, moisture content of the clay subgrade was above standard Optimum Moisture Content (OMC) at several locations. Drying back and moisture conditioning of the subgrade may therefore be required prior to compaction and make take several days depending on weather conditions;
- Where potentially poor drainage conditions were observed during the investigation in Terrain B, there may be a need for a 300mm rock drainage blanket wrapped in heavy duty geo-fabric (RMC Class C or greater) to provide a suitable compaction surface following extended rainfall. This should be allowed for but will firstly require further geotechnical assessment following stripping;
- Where filling is required beneath pavement layers, suitable fill should be placed in layers not exceeding 300 mm loose thickness and compacted to a minimum dry density ratio of 98% Standard Compaction. The top 300mm of natural subgrade below pavements or the final 300mm of placed road subgrade fill should be compacted to a minimum density ratio of 100% Standard Compaction or as specified in the applicable pavement thickness design sheet(s);
- Where weathered rock is exposed at subgrade level during reconstruction or widening it would require ripping to a depth of 300mm below base of pavement and re-compaction to break up preferential drainage paths that concentrate water beneath the pavement;
- Select Fill (CBR>15 and PI<15) should be placed in layers not exceeding 300mm loose thickness and compacted to 100% Standard compaction;
- Select Fill and pavement gravels should be placed and maintained at 60% to 90% of Optimum Moisture Content;



- DGS sub-base material should be placed in layers not exceeding 200mm loose thickness and compacted to 95% Modified Compaction;
- DGB base material should be placed and compacted to 98% Modified Compaction;
- Place AC seal as per Council requirements;
- Where final sealing cannot be undertaken within a few days of completion of the base course, a primer seal should be used to protect the pavement and maintain equilibrium moisture content;
- Should wet weather occur prior to final sealing, the base course should be allowed to dry back to not more than 90% of Optimum Moisture Content prior to sealing. Trapping of excess moisture below the final seal will significantly reduce pavement life;
- Care will be required to promote subsurface drainage to avoid accumulation of water in the pavement profile. Subsoil drains should therefore be installed and extend to 300mm below base of pavement.

## 9 LIMITATIONS

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical design practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points. If site conditions encountered during construction vary significantly from those discussed in this report, Regional Geotechnical Solutions Pty Ltd should be contacted for further advice.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

For and on behalf of

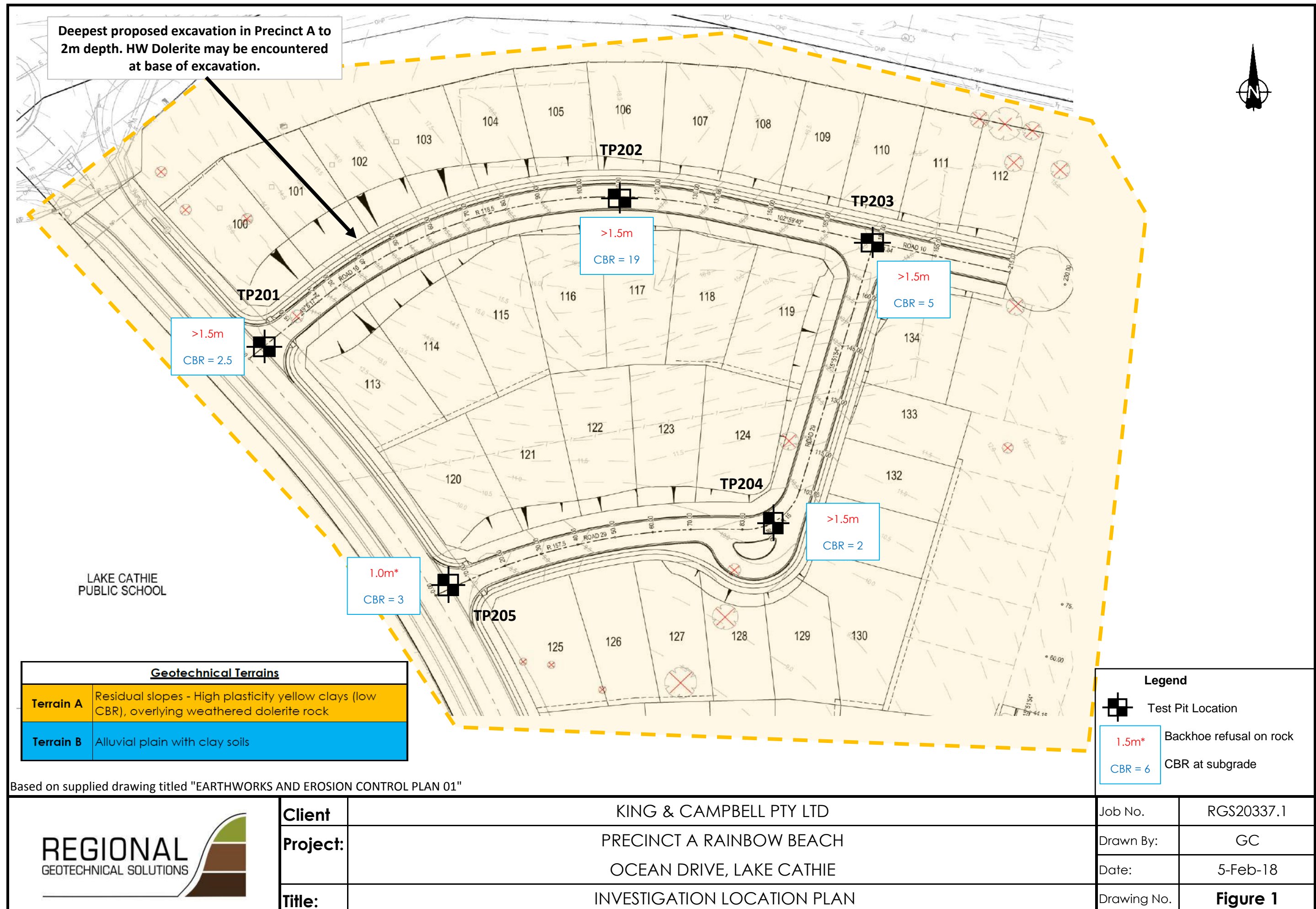
**Regional Geotechnical Solutions Pty Ltd**

**Tim Morris**

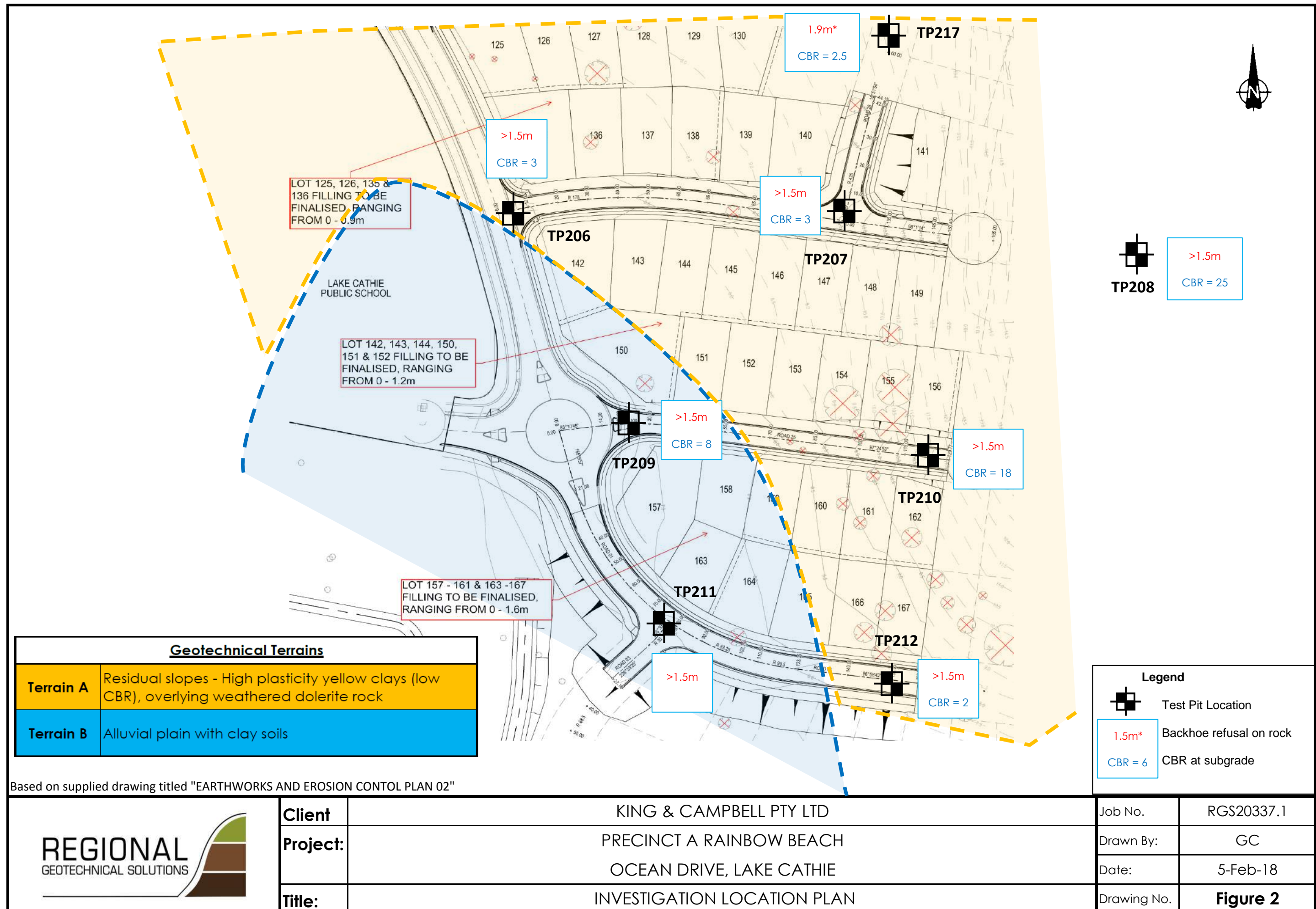
Senior Engineering Geologist



**Figure**

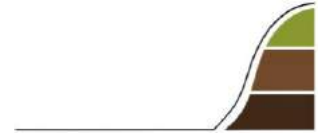






Client	KING & CAMPBELL PTY LTD	Job No.	RGS20337.1
Project:	PRECINCT A RAINBOW BEACH	Drawn By:	GC
	OCEAN DRIVE, LAKE CATHIE	Date:	5-Feb-18
Title:	INVESTIGATION LOCATION PLAN	Drawing No.	Figure 2





# **Appendix A**

## **Results of Field Investigations**



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 10 Ch0m

**TEST PIT NO:** TP201  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483706 m  
**NORTHING:** 6507491 m  
**SURFACE RL:** 11.0 m  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					CL	<b>TOPSOIL:</b> Sandy Silty CLAY, low plasticity, dark grey, Sand fine to medium grained, traces of grass roots tup to 5mm	M < w <sub>p</sub>	Fb	HP	350	TOPSOIL
		0.40m			CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, yellow/grey, Sand fine to medium grained, Gravel fine to medium grained, subangular	COLLUVIAL					
		CBR	10.5	0.5		CH	<b>Sandy CLAY:</b> Medium to high plasticity, yellow, Sand fine to medium grained, some Gravel, fine to medium grained, subangular		Fb / VSt			RESIDUAL SOIL
		0.70m			CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, yellow/dark grey, Sand fine to medium grained, Gravel fine to medium grained, subangular, traces of Rock fabric			EXTREMELY WEATHERED DOLERITE			
			9.5	1.5		1.50m	Hole Terminated at 1.50 m					
			9.0	2.0								
			8.5	2.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	



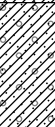



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 10 Ch100m

**TEST PIT NO:** TP202  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483729 m  
**NORTHING:** 6502528 m  
**SURFACE RL:** 17.7 m  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					GP	<b>FILL:</b> Sandy GRAVEL, fine, subangular, orange/pale grey, Sand fine to medium grained	D		HP	320	FILL
		0.40m	17.5		CH	<b>Sandy CLAY:</b> Medium to high plasticity, yellow, Sand fine to medium grained, traces o Gravel, fine to medium grained, subangular, Dolerite	M < w <sub>p</sub>	Fb / VSt	RESIDUAL SOIL			
		CBR	0.5		CH	<b>Gravelly Sandy CLAY:</b> Medium to high plasticity, pale yellow/pale brown, trace of pale grey, Sand fine to medium grained, Gravel fine to coarse grained, subangular, traces of Rock fabric			EXTREMELY WEATHERED DOLERITE			
		0.70m	17.0									
				1.0								
				16.5								
				1.5			Hole Terminated at 1.50 m					
				16.0								
				2.0								
				15.5								
				2.5								
				15.0								

<b>LEGEND:</b> <b>Water</b> Water Level (Date and time shown) Water Inflow Water Outflow <b>Strata Changes</b> Gradational or transitional strata Definitive or distinct strata change		<b>Notes, Samples and Tests</b> U <sub>50</sub> 50mm Diameter tube sample CBR Bulk sample for CBR testing E Environmental sample ASS Acid Sulfate Soil Sample B Bulk Sample <b>Field Tests</b> PID Photoionisation detector reading (ppm) DCP(x-y) Dynamic penetrometer test (test depth interval shown) HP Hand Penetrometer test (UCS kPa)		<b>Consistency</b> VS Very Soft <25 S Soft 25 - 50 F Firm 50 - 100 St Stiff 100 - 200 VSt Very Stiff 200 - 400 H Hard >400 Fb Friable <b>Density</b> V Very Loose L Loose MD Medium Dense D Dense VD Very Dense		<b>UCS (kPa)</b> <25 25 - 50 50 - 100 100 - 200 200 - 400 >400 <b>Moisture Condition</b> D Dry M Moist W Wet W <sub>p</sub> Plastic Limit W <sub>L</sub> Liquid Limit Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85% Density Index 85 - 100%	
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# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 10 Ch180m

**TEST PIT NO:** TP203  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483862 m  
**NORTHING:** 6507518 m  
**SURFACE RL:** 14.3 m  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					GP	<b>FILL:</b> Sandy GRAVEL, fine to medium grained, subrounded, pink, Sand fine to medium	D				FILL
		0.40m		14.0		CL	<b>TOPSOIL:</b> Sandy Silty CLAY, dark grey, Sand fine to medium, traces of grass roots up to 5mm	M < w <sub>p</sub>	Fb			TOPSOIL
		CBR		0.5		CH	<b>Sandy CLAY:</b> Medium to high plasticity, yellow/pale yellow, with pale grey mottling, Sand fine to medium grained, some Gravel, fine grained, subangular, trace rock fabric	Fb / VSt		HP	220	RESIDUAL SOIL TO EXTREMELY WEATHERED DOLERITE
		0.80m		13.5								
				1.0								
				1.10m			<b>DOLERITE:</b> Fine grained, pale yellow/pale blue/pale grey, highly fractured, foliated, medium to high strength, excavated as Sandy GRAVEL					HIGHLY WEATHERED DOLERITE
				1.5								
				1.50m			Hole Terminated at 1.50 m					
				12.5								
				2.0								
				12.0								
				2.5								
				11.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L		L	Loose	Density Index 15 - 35%
				MD		MD	Medium Dense	Density Index 35 - 65%
				D		D	Dense	Density Index 65 - 85%
				VD		VD	Very Dense	Density Index 85 - 100%



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precint A Rainbow Beach  
**TEST LOCATION:** Road 29 Ch100m

**TEST PIT NO:** TP204  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483849 m  
**NORTHING:** 6507451 m  
**SURFACE RL:** 10.4 m  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					CL	<b>TOPSOIL:</b> Sandy Silty CLAY, low plasticity, dark grey, trace of grass roots up to 5mm	M < w <sub>p</sub>	Fb			TOPSOIL
		0.50m		0.5		CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, pale yellow/pale brown, Sand fine to medium grained, Gravel fine to medium grained					COLLUVIAL
		CBR				CH	<b>CLAY:</b> Medium to high plasticity, yellow with grey mottling, traces of Gravel, fine grained, subangular		VSt	HP	300	RESIDUAL SOIL
		0.90m		0.9			<b>DOLERITE:</b> Fine grained, pale grey/pale yellow/pale blue, highly fractured, foliated, medium to high strength, excavated as Sandy GRAVEL					EXTREMELY TO HIGHLY WEATHERED DOLERITE
							Hole Terminated at 1.50 m					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	







# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 29 Ch0m

**TEST PIT NO:** TP205  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483750 m  
**NORTHING:** 6507427 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered	0.20m		0.5		CL	<b>TOPSOIL:</b> Sandy Silty CLAY, low plasticity, dark grey, Sand fine to medium grained, traces of grass roots up to 5mm	M < w <sub>p</sub>	Fb	HP	300	TOPSOIL
					CH	<b>Gravelly Sandy CLAY:</b> Medium to high plasticity, yellow/dark brown, Sand fine to medium grained, Gravel, fine to medium grained, subangular	COLLUVIAL					
					CH	<b>Sandy CLAY:</b> Medium to high plasticity, yellow, Sand fine to medium grained, traces of Gravel, fine grained, subangular	Fb / VSt					RESIDUAL SOIL
		U50 0.70m					<b>DOLERITE:</b> Fine grained, pale yellow/pale grey, fractured to highly fractured, medium to high strength, excavated as Sandy GRAVEL					HIGHLY WEATHERED DOLERITE
				1.0			Hole Terminated at 1.00 m Refusal					
				1.5								
				2.0								
				2.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L		L	Loose	Density Index 15 - 35%
				MD		MD	Medium Dense	Density Index 35 - 65%
				D		D	Dense	Density Index 65 - 85%
				VD		VD	Very Dense	Density Index 85 - 100%





# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 26 Ch0m

**TEST PIT NO:** TP206  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483782 m  
**NORTHING:** 6507352 m  
**SURFACE RL:** 7.4 m  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered	0.40m	7.0	0.40m	CL		<b>TOPSOIL:</b> Sandy Silty CLAY, low plasticity, dark grey, Sand fine to medium grained, traces of grass roots up to 5mm	M < w <sub>p</sub>	Fb			TOPSOIL
		CBR	6.5	0.90m	CH		<b>CLAY:</b> Medium to high plasticity, yellow with grey mottling, traces of Gravel, fine grained, subrounded	VSt		HP	350	RESIDUAL SOIL
			6.0	1.0								
			5.5	2.0								
			5.0	2.5								
			4.5									
							Hole Terminated at 1.50 m					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L		L	Loose	Density Index 15 - 35%
				MD		MD	Medium Dense	Density Index 35 - 65%
				D		D	Dense	Density Index 65 - 85%
				VD		VD	Very Dense	Density Index 85 - 100%



RG LIB 1.04.3.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS20337.1 RAINBOW BEACH TP 201-230 LOGS.GPJ <<DrawingFile>> 08/02/2018 16:27 8.30.004 Datagel Lab and In Situ Tool



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 25 Ch11m

**TEST PIT NO:** TP209  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483797 m  
**NORTHING:** 6507270 m  
**SURFACE RL:** 6.4 m  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered			6.0		ML	<b>TOPSOIL:</b> Clayey SILT, dark grey/black	M				TOPSOIL
		0.40m		0.5		CH	<b>Sandy CLAY:</b> Medium plasticity, grey, with red/pale brown mottling, some Gravel, fine to medium grained, subangular/subrounded	M < w <sub>p</sub>	Fb / VSt	HP	220	ALLUVIAL
		0.80m		5.5								
				5.0								
				1.5			Hole Terminated at 1.50 m					
				4.5								
				2.0								
				4.0								
				2.5								
				3.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L		L	Loose	Density Index 15 - 35%
				MD		MD	Medium Dense	Density Index 35 - 65%
				D		D	Dense	Density Index 65 - 85%
				VD		VD	Very Dense	Density Index 85 - 100%


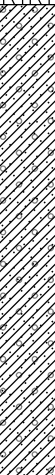


# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 25 Ch122m

**TEST PIT NO:** TP210  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483897 m  
**NORTHING:** 6507280 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					CL	<b>TOPSOIL:</b> Sandy Silty CLAY, dark grey, Sand fine to medium grained, traces of Gravel, fine to medium grained, subangular, traces of grass roots up to 5mm	M < w <sub>p</sub>	Fb	HP	300	TOPSOIL
		0.40m										
		U50 CBR		0.5		CH	<b>Gravelly Sandy CLAY:</b> Medium to high plasticity, yellow/pale brown, Sand fine to medium grained, Gravel fine to coarse grained, subangular, Dolerite, traces of rock fabric		Fb / VSt			EXTREMELY WEATHERED DOLERITE
		0.70m										
		0.80m										
				1.0								
				1.5								
							Hole Terminated at 1.50 m					
				2.0								
				2.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L		L	Loose	Density Index 15 - 35%
				MD		MD	Medium Dense	Density Index 35 - 65%
				D		D	Dense	Density Index 65 - 85%
				VD		VD	Very Dense	Density Index 85 - 100%



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 1 Ch80m

**TEST PIT NO:** TP211  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483850 m  
**NORTHING:** 6507220 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					ML	<b>TOPSOIL:</b> Clayey SILT, dark grey/black, traces of grass roots up to 5mm	M < w <sub>p</sub>	Fb			TOPSOIL
						CH	<b>Sandy CLAY:</b> Medium to high plasticity, yellow/pale brown with grey/red mottling, some Gravel fine grained, subrounded  At 0.9m, colour change to red with yellow mottling	Fb / St	HP	200		ALLUVIAL
						CH	<b>CLAY:</b> Medium to high plasticity, yellow	M > w <sub>p</sub>	St	HP	150	RESIDUAL SOIL
							Hole Terminated at 1.50 m					

**LEGEND:**  
**Water**  
 Water Level (Date and time shown)  
 Water Inflow  
 Water Outflow  
**Strata Changes**  
 Gradational or transitional strata  
 Definitive or distinct strata change

**Notes, Samples and Tests**  
U<sub>50</sub> 50mm Diameter tube sample  
CBR Bulk sample for CBR testing  
E Environmental sample  
ASS Acid Sulfate Soil Sample  
B Bulk Sample  
**Field Tests**  
PID Photoionisation detector reading (ppm)  
DCP(x-y) Dynamic penetrometer test (test depth interval shown)  
HP Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)	Moisture Condition
VS	Very Soft	<25	D Dry
S	Soft	25 - 50	M Moist
F	Firm	50 - 100	W Wet
St	Stiff	100 - 200	W <sub>p</sub> Plastic Limit
VSt	Very Stiff	200 - 400	W <sub>L</sub> Liquid Limit
H	Hard	>400	
Fb	Friable		
Density			
V	Very Loose		Density Index <15%
L	Loose		Density Index 15 - 35%
MD	Medium Dense		Density Index 35 - 65%
D	Dense		Density Index 65 - 85%
VD	Very Dense		Density Index 85 - 100%





# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 1 Ch162m

**TEST PIT NO:** TP212  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483883 m  
**NORTHING:** 6507192 m  
**SURFACE RL:** 7.8 m  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered			7.5		ML	<b>TOPSOIL:</b> Clayey SILT, dark grey/black, traces of grass roots up to 5mm	D	Fb			TOPSOIL
		0.50m		0.5		CH	<b>CLAY:</b> Medium to high plasticity, yellow, traces of Gravel, fine grained, subangular	M > w <sub>p</sub>	St	HP	150	RESIDUAL SOIL
		CBR		7.0								
		0.90m		1.0		CH	<b>Gravelly Sandy CLAY:</b> Medium to high plasticity, yellow/pale blue/pale grey, Sand fine to medium grained, Gravel fine to medium grained, subangular, traces of rock fabric	M < w <sub>p</sub>	Fb / St			EXTREMELY WEATHERED DOLERITE
				6.5								
				1.5			Hole Terminated at 1.50 m					
				6.0								
				2.0								
				5.5								
				2.5								
				5.0								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 1 Ch220m

**TEST PIT NO:** TP213  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483925 m  
**NORTHING:** 6507163 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered	0.30m				CL	<b>TOPSOIL:</b> Sandy Silty CLAY, low plasticity, dark grey, traces of grass roots up to 5mm	M < w <sub>p</sub>	Fb			TOPSOIL
		CBR		0.5		CH	<b>Gravelly Sandy CLAY:</b> Medium to high plasticity, yellow/pale brown, Sand fine to medium grained, Gravel fine to medium grained, subangular		Fb / St	HP	180	EXTREMELY WEATHERED DOLERITE
		0.70m		1.0			<b>DOLERITE:</b> Fine grained, pale yellow/pale grey/pale blue, fractured to highly fractured, low to medium strength, excavated as Sandy GRAVEL					HIGHLY TO MODERATELY WEATHERED DOLERITE
				1.5			Hole Terminated at 1.50 m					
				2.0								
				2.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	

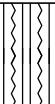
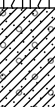



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 27 Ch150m

**TEST PIT NO:** TP214  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/18/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:**  
**NORTHING:**  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					CL	<b>TOPSOIL:</b> Sandy Silty CLAY, low plasticity, dark grey, Sand fine to medium grained, traces of grass roots up to 5mm	M < w <sub>p</sub>	Fb	HP	180	TOPSOIL
		0.50m		0.5		CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, yellow/pale brown, traces of red, Sand fine to medium grained, Gravel fine to coarse grained, subangular		Fb / St			RESIDUAL SOIL
			B		1.0			<b>DOLERITE:</b> Fine grained, pale yellow/pale brown/dark blue, highly fractured, medium strength, excavated as Sandy GRAVEL				
				2.0								
				2.5								
								</				

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)				L	Loose	Density Index 15 - 35%
						MD	Medium Dense	Density Index 35 - 65%
						D	Dense	Density Index 65 - 85%
						VD	Very Dense	Density Index 85 - 100%





# ENGINEERING LOG - TEST PIT

CLIENT: King & Campbell  
PROJECT NAME: Residential Subdivision  
SITE LOCATION: Precint A Rainbow Beach  
TEST LOCATION: Precint A Rainbow Beach

TEST PIT NO: **TP215**  
PAGE: 1 of 1  
JOB NO: RGS20337.1  
LOGGED BY: GC  
DATE: 12/18/17

EQUIPMENT TYPE: Backhoe  
TEST PIT LENGTH: 2.0 m  
WIDTH: 0.5 m  
EASTING: 483974 m  
NORTHING: 6507333 m  
SURFACE RL: AHD  
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered			0.5			MULCH			HP	150	FILL
				1.0								
				1.5								
				2.0								
				1.70m	CH	Gravelly Sandy CLAY: Medium plasticity, red/brown, Sand fine to medium grained, Gravel fine to medium grained	M < w <sub>p</sub>	Fb			COLLUVIAL	
				2.10m	CH	Sandy CLAY: Medium to high plasticity, yellow/pale brown, with grey mottling, Sand fine to medium grained, traces of Gravel, fine to medium grained, subangular		Fb / VSt			RESIDUAL SOIL	
				2.5			DOLERITE: Fine grained, pale yellow/pale grey, highly fractured, low to medium strength, excavated as Sandy GRAVEL					HIGHLY TO MODERATELY WEATHERED DOLERITE
				3.00m								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)		Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS Very Soft		<25		D Dry	
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S Soft		25 - 50		M Moist	
Water Inflow		E Environmental sample		F Firm		50 - 100		W Wet	
Water Outflow		ASS Acid Sulfate Soil Sample		St Stiff		100 - 200		W <sub>p</sub> Plastic Limit	
<b>Strata Changes</b>		B Bulk Sample		VSt Very Stiff		200 - 400		W <sub>L</sub> Liquid Limit	
Gradational or transitional strata		<b>Field Tests</b>		H Hard		>400			
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb Friable					
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V Very Loose		Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)		L Loose		Medium Dense		Density Index 15 - 35%	
				MD Medium Dense		Dense		Density Index 35 - 65%	
				D Dense		Very Dense		Density Index 65 - 85%	
				VD Very Dense				Density Index 85 - 100%	



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 28 Ch150m

**TEST PIT NO:** TP216  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483930 m  
**NORTHING:** 6507502 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					CH	<b>FILL:</b> Sandy CLAY, medium plasticity, brown, Sand fine to medium grained, traces of grass roots up to 5mm	M < w <sub>p</sub>	Fb	HP	220	FILL
		0.60m		0.5		CL	<b>TOPSOIL:</b> Sandy Silty CLAY, black/dark grey, Sand fine to medium grained, traces of grass roots up to 5mm					TOPSOIL
		CBR		1.0		CH	<b>Gravelly Sandy CLAY:</b> Medium to high plasticity, yellow/pale brown/pale grey, Sand fine to medium grained, subangular					EXTREMELY WEATHERED DOLERITE
		1.00m		2.0			Hole Terminated at 2.00 m					
				2.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precint A Rainbow Beach  
**TEST LOCATION:** Road 28 Ch50m

**TEST PIT NO:** TP217  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 483931 m  
**NORTHING:** 6507402 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					CL	<b>TOPSOIL:</b> Clayey SILT, black/dark grey, traces of grass roots up to 5mm	D	Fb			TOPSOIL
				0.40m		CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, pale brown, traces of red, Sand fine to coarse grained, Gravel fine grained, subangular					COLLUVIAL
		0.90m		0.75m		CH	<b>CLAY:</b> Medium to high plasticity, yellow, traces of Gravel fine grained, subangular	St	HP	120		RESIDUAL SOIL
		1.30m		1.40m			<b>DOLERITE:</b> Fine grained, pale yellow/pale brown/dark blue, fractured medium to high strength, excavated as Sandy GRAVEL					HIGHLY TO MODERATELY WEATHERED DOLERITE
				1.90m								
				2.0			Hole Terminated at 1.90 m Refusal due to Rock					
				2.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	







## ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precint A Rainbow Beach  
**TEST LOCATION:** Road 26 Ch399m




TEST PIT NO:	<b>TP218</b>
PAGE:	1 of 1
JOB NO:	RGS20337.1
LOGGED BY:	GC
DATE:	12/19/17

<b>EQUIPMENT TYPE:</b>	Backhoe	<b>EASTING:</b>	484083 m	<b>SURFACE RL:</b>	
<b>TEST PIT LENGTH:</b>	2.0 m	<b>WIDTH:</b>	0.5 m	<b>NORTHING:</b>	6507474 m
				<b>DATUM:</b>	AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered	0.80m		0.5		CL	<b>TOPSOIL:</b> Sandy Silty CLAY, low plasticity, dark grey, Sand fine to medium grained, traces of grass roots up to 5mm	M < w <sub>p</sub>	Fb	HP	350	TOPSOIL
						CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, pale brown/red, Sand fine to medium grained, Gravel fine grained, subangular					COLLUVIAL
						CH	<b>Sandy CLAY:</b> Medium to high plasticity, yellow/pale brown, Sand fine to medium grained, some Gravel, fine to medium grained, subangular		Fb / Vst			RESIDUAL SOIL
					<b>DOLERITE:</b> Fine grained, grey/dark blue, fractured, medium to high strength, excavated as Sandy GRAVEL		HIGHLY TO MODERATELY WEATHERED DOLERITE					
		1.50m	1.5			1.50m	Hole Terminated at 1.50 m Refusal					
				2.0								
				2.5								

**LEGEND:**

## Water

-  Water Level  
 (Date and time shown)
-  Water Inflow
-  Water Outflow

### Strata Changes

- — Gradational or transitional strata  
—— Definitive or distinct strata change

## Notes, Samples and Tests

- |                 |                             |
|-----------------|-----------------------------|
| U <sub>50</sub> | 50mm Diameter tube sample   |
| CBR             | Bulk sample for CBR testing |
| E               | Environmental sample        |
| ASS             | Acid Sulfate Soil Sample    |
| B               | Bulk Sample                 |

## Field Tests

- |          |   |
|----------|---|
| PID      | Photoionisation detector reading (ppm)                |
| DCP(x-y) | Dynamic penetrometer test (test depth interval shown) |
| HP       | Hand Penetrometer test (UCS kPa)                      |

### Consistency

- |     |            |           |
|-----|------------|-----------|
| VS  | Very Soft  | <25       |
| S   | Soft       | 25 - 50   |
| F   | Firm       | 50 - 100  |
| St  | Stiff      | 100 - 200 |
| VSt | Very Stiff | 200 - 400 |
| H   | Hard       | >400      |
| Fb  | Friable    |           |

## UCS (kPa)

- |     |            |           |
|-----|------------|-----------|
| VS  | Very Soft  | <25       |
| S   | Soft       | 25 - 50   |
| F   | Firm       | 50 - 100  |
| St  | Stiff      | 100 - 200 |
| VSt | Very Stiff | 200 - 400 |
| H   | Hard       | >400      |
| Fb  | Friable    |           |

### Moisture Condition

- |       |               |
|-------|---------------|
| D     | Dry           |
| M     | Moist         |
| W     | Wet           |
| $W_p$ | Plastic Limit |
| $W_l$ | Liquid Limit  |

## Density

- | <u>Density</u> |              |               |           |
|----------------|--------------|---------------|-----------|
| V              | Very Loose   | Density Index | <15%      |
| L              | Loose        | Density Index | 15 - 35%  |
| MD             | Medium Dense | Density Index | 35 - 65%  |
| D              | Dense        | Density Index | 65 - 85%  |
| VD             | Very Dense   | Density Index | 85 - 100% |



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 10 Ch480m

**TEST PIT NO:** TP219  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 484156 m  
**NORTHING:** 6507436 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					ML	<b>TOPSOIL:</b> Sandy SILT, dark grey	D	Fb			TOPSOIL
		0.40m				CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, brown/red, Sand fine to medium grained, Gravel fine to subrounded	M < W <sub>p</sub>				COLLUVIAL
		U50		0.5		CH	<b>Sandy CLAY:</b> Medium to high plasticity, yellow/pale brown with grey mottling, Sand fine to medium, some Gravel, fine to medium rained, subangular	Fb / VSt		HP	320	RESIDUAL SOIL
		0.70m										
		0.80m										
		CBR		1.0			<b>DOLERITE:</b> Fine grained, pale grey/brown/dark blue, fractured to highly fractured, medium to high strength, excavated as Sandy GRAVEL					HIGHLY TO MODERATELY WEATHERED DOLERITE
		1.20m		1.5								
				1.50m			Hole Terminated at 1.50 m Refusal due to Rock					
				2.0								
				2.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L		L	Loose	Density Index 15 - 35%
				MD		MD	Medium Dense	Density Index 35 - 65%
				D		D	Dense	Density Index 65 - 85%
				VD		VD	Very Dense	Density Index 85 - 100%



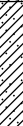
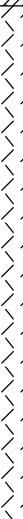


# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Precinct A Rainbow Beach

**TEST PIT NO:** TP220  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 484120 m  
**NORTHING:** 6507360 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result		
450mm TOOTHED BUCKET	Not Encountered	0.80m	B	0.5		ML	<b>TOPSOIL:</b> Sandy SILT, dark grey, Sand fine to medium grained	D	Fb	HP	220	TOPSOIL	
						CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, brown/red, Sand fine to medium grained, Gravel fine to medium gained, subangular	M < w <sub>p</sub>	Fb / VSt			COLLUVIAL	
						CH	<b>Sandy CLAY:</b> Medium to high plasticity, yellow/pale brown, Sand fine to medium grained, Gravel fine to medium grained, traces of Rock fabric					EXTREMELY WEATHERED DOLERITE	
							<b>DOLERITE:</b> Fine grained, pale grey/pale blue, highly fractured, foliated, low to medium strength, excavated as Sandy GRAVEL						
		2.00m		2.0		2.00m	Hole Terminated at 2.00 m						
				2.5									

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	

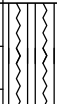

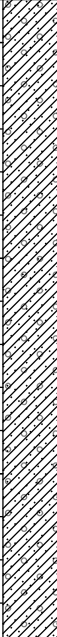


# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 24 Ch150m

**TEST PIT NO:** TP221  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 484121 m  
**NORTHING:** 6507291 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					ML	<b>TOPSOIL:</b> Sandy SILT, dark grey, Sand fine to medium grained, traces of grass roots up to 5mm	D	Fb			TOPSOIL
						CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, pale brown/red/brown, Sand fine to medium grained, Gravel fine to medium grained, subangular	M < w <sub>p</sub>				COLLUVIAL
						CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, yellow/dark brown, traces of dark blue, Sand fine to medium grained, Gravel fine to coarse, subangular, traces of Cobbles up to 200mm, traces of Boulders up to 400mm		Fb / St	HP	180	EXTREMELY WEATHERED DOLERITE
		1.40m										
		CBR										
		1.90m										
				2.0			Hole Terminated at 1.90 m Refusal due to Boulders					
				2.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 1 Ch375m

**TEST PIT NO:** TP222  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 484123 m  
**NORTHING:** 6507217 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered			<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></di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LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L	Loose	MD	Medium Dense	Density Index 15 - 35%
				D	Dense	D	Dense	Density Index 35 - 65%
				VD	Very Dense			Density Index 65 - 85%
								Density Index 85 - 100%



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 25 Ch225m

**TEST PIT NO:** TP223  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 484009 m  
**NORTHING:** 6507261 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					ML	<b>TOPSOIL:</b> Sandy SILT, dark grey, Sand fine to medium grained, traces of grass roots up to 5mm	D	Fb			TOPSOIL
		0.70m		0.5		CH	<b>Sandy CLAY:</b> Medium to high plasticity, pale brown/yellow, Sand fine to medium grained, some Gravel, fine to medium grained, subangular		Fb / VSt	HP	220	RESIDUAL SOIL
		1.10m		1.0			<b>DOLERITE:</b> Fine grained, pale grey/pale blue, highly fractured, foliated, low to medium strength, excavated as Sandy GRAVEL					HIGHLY TO MODERATELY WEATHERED DOLERITE
				1.5								
				2.0								
				2.5								
							Hole Terminated at 1.80 m Refusal due to Rock					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L		L	Loose	Density Index 15 - 35%
				MD		MD	Medium Dense	Density Index 35 - 65%
				D		D	Dense	Density Index 65 - 85%
				VD		VD	Very Dense	Density Index 85 - 100%





# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 1 Ch460m

**TEST PIT NO:** TP224  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 484208 m  
**NORTHING:** 6507232 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					ML	<b>TOPSOIL:</b> Sandy SILT, dark grey/black, Sand fine to medium grained, traces of grass roots up to 5mm	D	Fb			TOPSOIL
						CH	<b>Sandy CLAY:</b> Medium to high plasticity, yellow/pale brown, with grey mottling, traces of Gravel, fine to subangular	M < w <sub>p</sub>	VSt	HP	220	RESIDUAL SOIL
							<b>DOLERITE:</b> Fine grained, dark blue/pale brown, pale grey, fractured, medium to high strength, some Clay seams, excavated as Clayey GRAVEL					HIGHLY WEATHERED DOLERITE
							Hole Terminated at 1.75 m					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)				L	Loose	Density Index 15 - 35%
						MD	Medium Dense	Density Index 35 - 65%
						D	Dense	Density Index 65 - 85%
						VD	Very Dense	Density Index 85 - 100%



## ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 2 Ch160m

**TEST PIT NO:** TP225  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 484215 m  
**NORTHING:** 6507330 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					ML	<b>TOPSOIL:</b> Sandy SILT, dark grey, Sand fine to medium grained, traces of grass roots up to 5mm	D	Fb			TOPSOIL
						CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, pale brown, traces of yellow/red, Sand fine to medium grained, Gavel fine grained, subangular	M < w <sub>p</sub>				COLLUVIAL
						CH	<b>CLAY:</b> Medium to high plasticity, yellow with grey mottling	M > w <sub>p</sub>	St	HP	180	RESIDUAL SOIL
							Hole Terminated at 1.50 m					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L	Loose			Density Index 15 - 35%
				MD	Medium Dense			Density Index 35 - 65%
				D	Dense			Density Index 65 - 85%
				VD	Very Dense			Density Index 85 - 100%

**CLIENT:** King & Campbell

**PAGE:** 1 of 1

**PROJECT NAME:** Residential Subdivision

**JOB NO:** RGS20337.1

**SITE LOCATION:** Precint A Rainbow Beach

LOGGED BY: GC

**TEST LOCATION:** Road 2 Ch50m

**DATE:** 12/19/17

EQUIPMENT TYPE: Backhoe

**EASTING:** 484235 m

**SURFACE RL:**

**TEST PIT LENGTH:**

**WIDTH:** 0.5 m

**NORTHING:** 6507459 m




**DATUM:**

AHD

Drilling and Sampling					Material description and profile information						Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result		
450mm TOOTHED BUCKET	Not Encountered				ML		<b>TOPSOIL:</b> Sandy SILT, dark grey, Sand fine to medium grained, traces of grass roots up to 5mm	D	Fb	HP	120	TOPSOIL	
					CH	0.40m	<b>Gravelly Sandy CLAY:</b> Medium plasticity, pale brown/pale orange, with red mottling, Sand fine to medium grained, Gravel fine to subangular	M > w <sub>p</sub>	Fb / St			COLLUVIAL	
					CH	1.00m	<b>CLAY: Medium to high plasticity, yellow, with grey mottling, traces of Gravel, fine, subangular</b>		St			RESIDUAL SOIL	
				1.5		1.50m	Hole Terminated at 1.50 m						
				2.0									
				2.5									

**LEGEND:**

**Water**

-  Water Level  
 (Date and time shown)  
 Water Inflow  
 Water Outflow

### Strata Changes

- Strata changes
- — Gradational or transitional strata
  - Definitive or distinct strata change

## Notes, Samples and Tests

- |                 |                             |
|-----------------|-----------------------------|
| U <sub>50</sub> | 50mm Diameter tube sample   |
| CBR             | Bulk sample for CBR testing |
| E               | Environmental sample        |
| ASS             | Acid Sulfate Soil Sample    |
| B               | Bulk Sample                 |

## Field Tests

- |          |   |
|----------|---|
| PID      | Photoionisation detector reading (ppm)                |
| DCP(x-y) | Dynamic penetrometer test (test depth interval shown) |
| HP       | Hand Penetrometer test (UCS kPa)                      |


**Consistency**

- |     |            |
|-----|------------|
| VS  | Very Soft  |
| S   | Soft       |
| F   | Firm       |
| St  | Stiff      |
| VSt | Very Stiff |
| H   | Hard       |
| Fb  | Friable    |

UCS (kPa)
-----------

- |     |            |           |
|-----|------------|-----------|
| VS  | Very Soft  | <25       |
| S   | Soft       | 25 - 50   |
| F   | Firm       | 50 - 100  |
| St  | Stiff      | 100 - 200 |
| VSt | Very Stiff | 200 - 400 |
| H   | Hard       | >400      |
| Fb  | Friable    |           |
- 
- |                |    |              |
|----------------|----|--------------|
| <b>Density</b> | V  | Very Loose   |
|                | L  | Loose        |
|                | MD | Medium Dense |
|                | D  | Dense        |
|                | VD | Very Dense   |

## Moisture Condition

- |       |               |
|-------|---------------|
| D     | Dry           |
| M     | Moist         |
| W     | Wet           |
| $W_p$ | Plastic Limit |
| $W_l$ | Liquid Limit  |

- Density Index <15%  
Density Index 15 - 35%  
Density Index 35 - 65%  
Density Index 65 - 85%  
Density Index 85 - 100%



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Precinct A Rainbow Beach

**TEST PIT NO:** TP227  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 484291 m  
**NORTHING:** 6507392 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered				ML	0.30m	<b>TOPSOIL:</b> Sandy SILT, dark grey, Sand fine to medium, traces of grass roots up to 5mm	D	Fb	HP	300	TOPSOIL
					CH	0.60m	<b>Gravelly Sandy CLAY:</b> Medium plasticity, pale brown, traces of red, Sand fine to medium grained, Gravel fine, subrounded	M < w <sub>p</sub>	Fb / VSt			COLLUVIAL
					CH	1.10m	<b>Sandy CLAY:</b> Medium to high plasticity, yellow/pale brown with grey mottling, some Gravel, fine to medium grained, subangular					RESIDUAL SOIL TO EXTREMELY WEATHERED DOLERITE
							<b>DOLERITE:</b> Fine to medium grained, pale brown/pale yellow/dark blue, highly fractured, medium to high strength					HIGHLY TO MODERATELY WEATHERED DOLERITE
							Hole Terminated at 1.60 m Refusal due to Rock					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	



# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Precinct A Rainbow Beach

**TEST PIT NO:** TP228  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 484334 m  
**NORTHING:** 6507435 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered				ML	0.35m	<b>TOPSOIL:</b> Sandy SILT, dark grey, traces of grass roots up to 5mm	D	Fb	HP	220	TOPSOIL
					CH	0.60m	<b>Gravelly Sandy CLAY:</b> Medium plasticity, pale brown/yellow, Sand fine to medium grained, Gravel, fine, subangular	M < w <sub>p</sub>	Fb / VSt			COLLUVIAL
					CH	0.90m	<b>Sandy CLAY:</b> Medium to high plasticity, pale brown/yellow, with grey mottling, Sand fine to medium grained, some Gravel, fine to coarse grained, subangular					RESIDUAL SOIL
							<b>SLATE:</b> Fine grained, pale yellow/pale brown/pale grey, fractured to highly fractured, foliated, medium to high strength, excavated as Sandy GRAVEL					HIGHLY TO MODERATELY WEATHERED SLATE
							Hole Terminated at 1.10 m Refusal due to Rock					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L	Loose			Density Index 15 - 35%
				MD	Medium Dense			Density Index 35 - 65%
				D	Dense			Density Index 65 - 85%
				VD	Very Dense			Density Index 85 - 100%



## ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Near existing dwelling

**TEST PIT NO:** TP229  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:**  
**NORTHING:**  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					ML	<b>TOPSOIL:</b> Sandy SILT, dark grey/black, Sand fine to medium grained, traces of grass roots up to 5mm	D	Fb			TOPSOIL
		0.50m		0.5		CH	<b>Gravelly Sandy CLAY:</b> Medium plasticity, brown, traces of yellow/red, Sand fine to medium grained, Gravel, fine, subangular	M < W <sub>p</sub>				COLLUVIAL
		B		1.0			<b>DOLERITE:</b> Fine grained, pale grey/dark blue, traces of fractured, foliated, some Clay seams, excavated as Sandy Clayey GRAVEL					HIGHLY TO MODERATELY WEATHERED DOLERITE
		1.10m		1.10			Hole Terminated at 1.10 m Refusal due to Rock					
				1.5								
				2.0								
				2.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	





# ENGINEERING LOG - TEST PIT

**CLIENT:** King & Campbell  
**PROJECT NAME:** Residential Subdivision  
**SITE LOCATION:** Precinct A Rainbow Beach  
**TEST LOCATION:** Road 1 Ch560m

**TEST PIT NO:** TP230  
**PAGE:** 1 of 1  
**JOB NO:** RGS20337.1  
**LOGGED BY:** GC  
**DATE:** 12/19/17

**EQUIPMENT TYPE:** Backhoe  
**TEST PIT LENGTH:** 2.0 m  
**WIDTH:** 0.5 m  
**EASTING:** 484303 m  
**NORTHING:** 6507210 m  
**SURFACE RL:**  
**DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm TOOTHED BUCKET	Not Encountered					CL	<b>TOPSOIL:</b> Sandy CLAY, dark grey, Sand fine to medium grained, traces of grass roots up to 5mm	M < w <sub>p</sub>	Fb			TOPSOIL
				0.30m		CH	<b>Sandy CLAY:</b> Medium to high plasticity, pale brown/yellow, Sand fine medium, some Gravel, fine to coarse, subangular		Fb / VSt	HP	250	EXTREMELY WEATHERED DOLERITE
		0.90m		0.90m			<b>DOLERITE:</b> Fine grained, pale brown/dark blue, pale grey, fractured, medium to high strength, excavated as Sandy GRAVEL					HIGHLY TO MODERATELY DOLERITE
		0.20m B		1.20m			Hole Terminated at 1.20 m Refusal due to Rock					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
<b>Water</b>		U <sub>50</sub> 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W <sub>p</sub>	Plastic Limit
<b>Strata Changes</b>		B Bulk Sample		VSt	Very Stiff	200 - 400	W <sub>L</sub>	Liquid Limit
Gradational or transitional strata		<b>Field Tests</b>		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Friable			
		DCP(x-y) Dynamic penetrometer test (test depth interval shown)		<b>Density</b>		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L		Loose		Density Index 15 - 35%
				MD		Medium Dense		Density Index 35 - 65%
				D		Dense		Density Index 65 - 85%
				VD		Very Dense		Density Index 85 - 100%



## **Appendix B**

### **Laboratory Test Results**

# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S01**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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

*B. Cullen*

Approved Signatory: Brent Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686

Date of Issue: 17/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S01

**Test Request No.:** RGS20337.1

**Sampling Method:** Sampled by Client

**Specification:** No Specification

**Location:** TP201 - (0.4 - 0.7m)

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

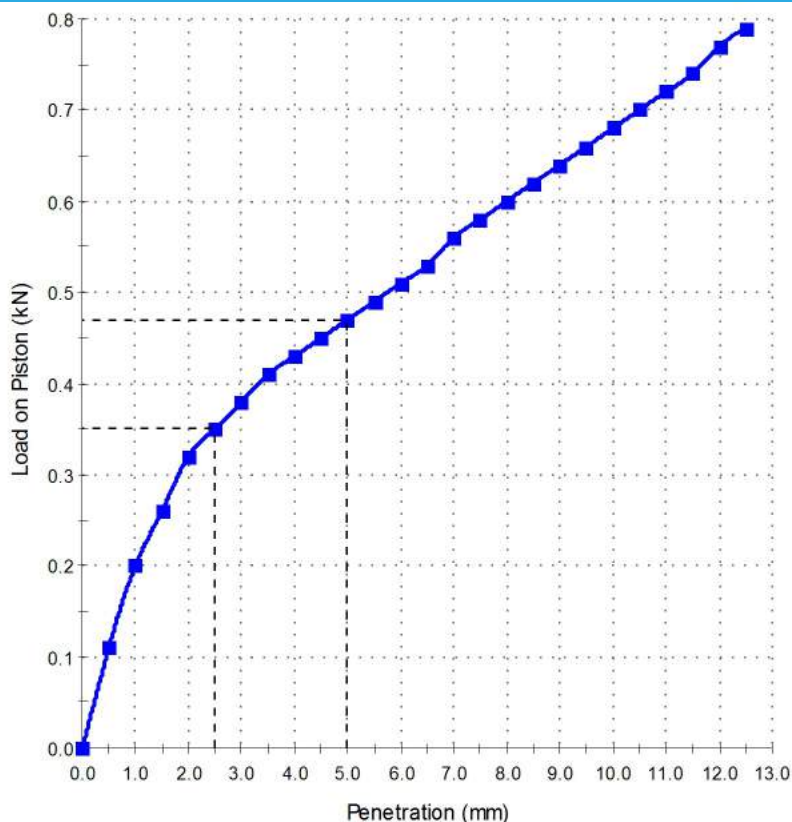
**Lot No.:** -

**Date Sampled:** 21/12/2017

**Source:** On-Site

**Material:** Clay

## Load vs Penetration



## Test Results

AS 1289.6.1.1

**CBR At 2.5mm (%):** 2.5

Maximum Dry Density (t/m³): 1.58

Optimum Moisture Content (%): 24.0

Dry Density before Soaking (t/m³): 1.58

Density Ratio before Soaking (%): 100

Moisture Content before Soaking (%): 24.5

Moisture Ratio before Soaking (%): 102

Dry Density after Soaking (t/m³): 1.58

Density Ratio after Soaking (%): 100

Moisture Content of Top 30mm (%): 35.0

Moisture Content of Remaining Depth (%): 25.9

Compactive Effort: Standard

Surcharge Mass (kg): 4.50

Period of Soaking (Days):

Oversize Material (%): 0.0

Moisture Content

Field Moisture Content (%): 26.5

## Comments

Laboratory Density Ratio (LDR): 99.5% Laboratory Moisture Ratio (LMR): 102.5%

Method of establishing plasticity level: Visual Assessment

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs

# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S02**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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

*B. Cullen*

Approved Signatory: Brent Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 17/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S02

**Lot No.:** -

**Test Request No.:** RGS20337.1

**Date Sampled:** 21/12/2017

**Sampling Method:** Sampled by Client

**Specification:** No Specification

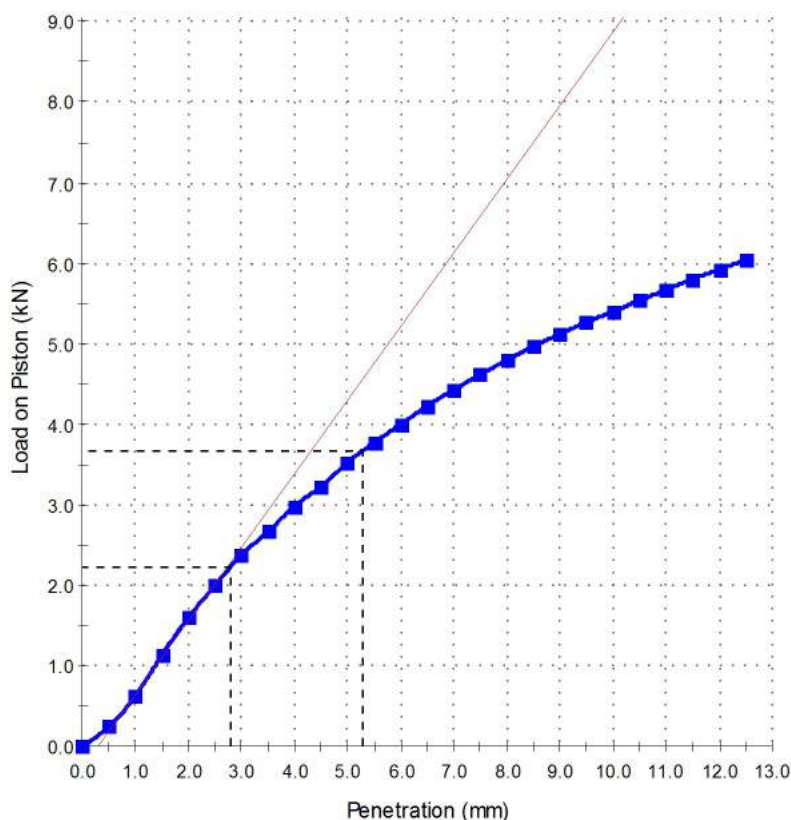
**Source:** On-Site

**Location:** TP202 - (0.4 - 0.7m)

**Material:** Clay

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

## Load vs Penetration



## Test Results

AS 1289.6.1.1

**CBR At 5.0mm (%):** 19

Maximum Dry Density (t/m³): 2.01

Optimum Moisture Content (%): 12.2

Dry Density before Soaking (t/m³): 2.01

Density Ratio before Soaking (%): 100

Moisture Content before Soaking (%): 11.7

Moisture Ratio before Soaking (%): 96

Dry Density after Soaking (t/m³): 2.01

Density Ratio after Soaking (%): 100

Swell (%): 0.5

Moisture Content of Top 30mm (%): 14.5

Moisture Content of Remaining Depth (%): 13.7

Compactive Effort: Standard

Surcharge Mass (kg): 4.50

Period of Soaking (Days): 4

Oversize Material: Excluded

Oversize Material (%): 31.5

Moisture Content

Field Moisture Content (%): 9.2

## Comments

Laboratory Density Ratio (LDR): 100.5% Laboratory Moisture Ratio (LMR): 96.0%

Method of establishing plasticity level: Visual Assessment

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs

# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S03**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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*B. Cullen*

Approved Signatory: Brent Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 23/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S03

**Test Request No.:** RGS20337.1

**Sampling Method:** Sampled by Client

**Specification:** No Specification

**Location:** TP203 - (0.4 - 0.8m)

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

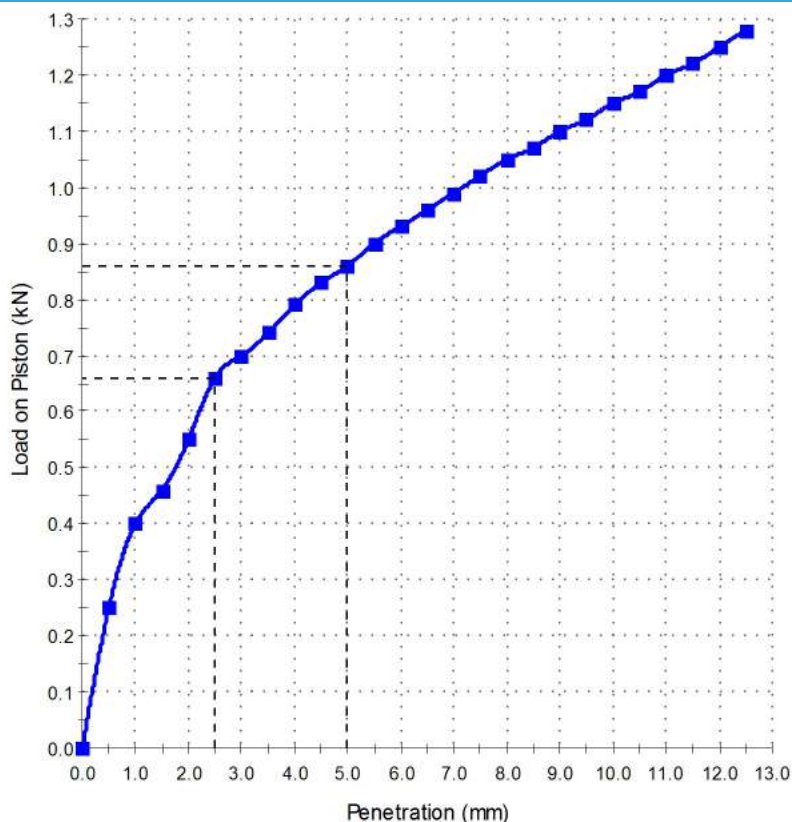
**Lot No.:** -

**Date Sampled:** 21/12/2017

**Source:** On-Site

**Material:** Clay

## Load vs Penetration



## Test Results

AS 1289.6.1.1

**CBR At 2.5mm (%):** **5.0**

Maximum Dry Density (t/m<sup>3</sup>): 1.55

Optimum Moisture Content (%): 26.4

Dry Density before Soaking (t/m<sup>3</sup>): 1.56

Density Ratio before Soaking (%): 101

Moisture Content before Soaking (%): 25.9

Moisture Ratio before Soaking (%): 98

Dry Density after Soaking (t/m<sup>3</sup>): 1.54

Density Ratio after Soaking (%): 99

Swell (%): 1.5

Moisture Content of Top 30mm (%): 32.8

Moisture Content of Remaining Depth (%): 27.7

Compactive Effort: Standard

Surcharge Mass (kg): 4.50

Period of Soaking (Days): 4

Oversize Material (%): 0.0

Moisture Content

Field Moisture Content (%): 27.8

## Comments

Laboratory Density Ratio (LDR): 100.5% Laboratory Moisture Ratio (LMR): 98.0%

Method of establishing plasticity level: Visual Assessment

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs



# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S04**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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Approved Signatory: Dane Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 24/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S04

**Lot No.:** -

**Test Request No.:** RGS20337.1

**Date Sampled:** 21/12/2017

**Sampling Method:** Sampled by Client

**Specification:** No Specification

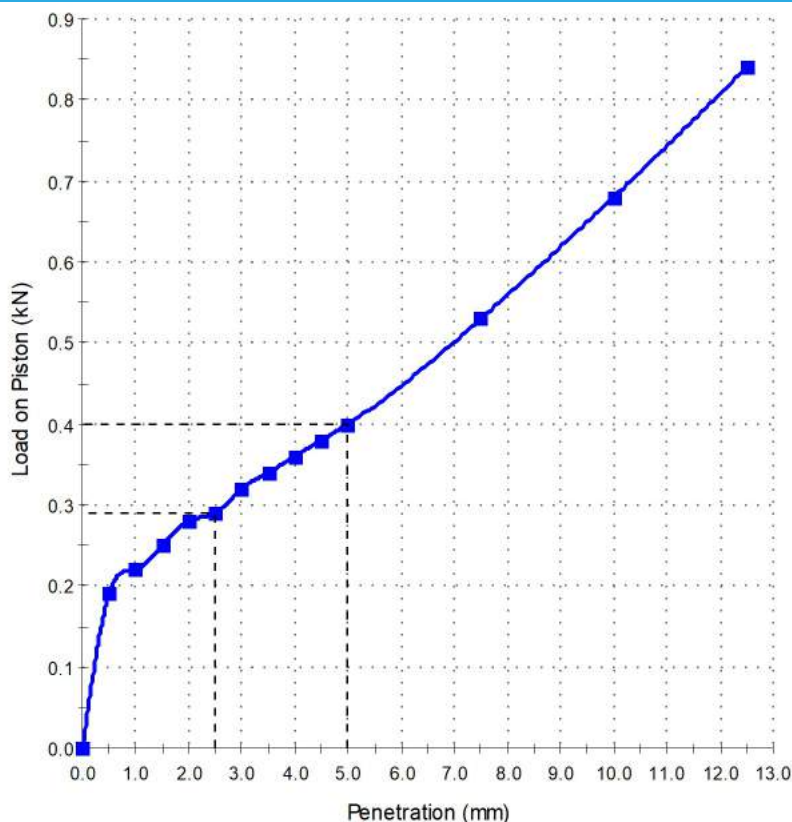
**Source:** On-Site

**Location:** TP204 - (0.5 - 0.9m)

**Material:** Clay

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

## Load vs Penetration



## Test Results

AS 1289.6.1.1

**CBR At 2.5mm (%):** 2.0

Maximum Dry Density (t/m<sup>3</sup>): 1.57

Optimum Moisture Content (%): 25.9

Dry Density before Soaking (t/m<sup>3</sup>): 1.56

Density Ratio before Soaking (%): 99

Moisture Content before Soaking (%): 26.4

Moisture Ratio before Soaking (%): 102

Dry Density after Soaking (t/m<sup>3</sup>): 1.51

Density Ratio after Soaking (%): 96

Swell (%): 3.5

Moisture Content of Top 30mm (%): 43.0

Moisture Content of Remaining Depth (%): 28.7

Compactive Effort: Standard

Surcharge Mass (kg): 4.50

Period of Soaking (Days): 4

Oversize Material (%): 0.0

Moisture Content

Field Moisture Content (%): 32.1

## Comments

Laboratory Density Ratio (LDR): 99.5% Laboratory Moisture Ratio (LMR): 102.0%

Method of establishing plasticity level: Visual Assessment

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs



# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S06**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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*B. Cullen*

Approved Signatory: Brent Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 17/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S06

**Lot No.:** -

**Test Request No.:** RGS20337.1

**Date Sampled:** 21/12/2017

**Sampling Method:** Sampled by Client

**Specification:** No Specification

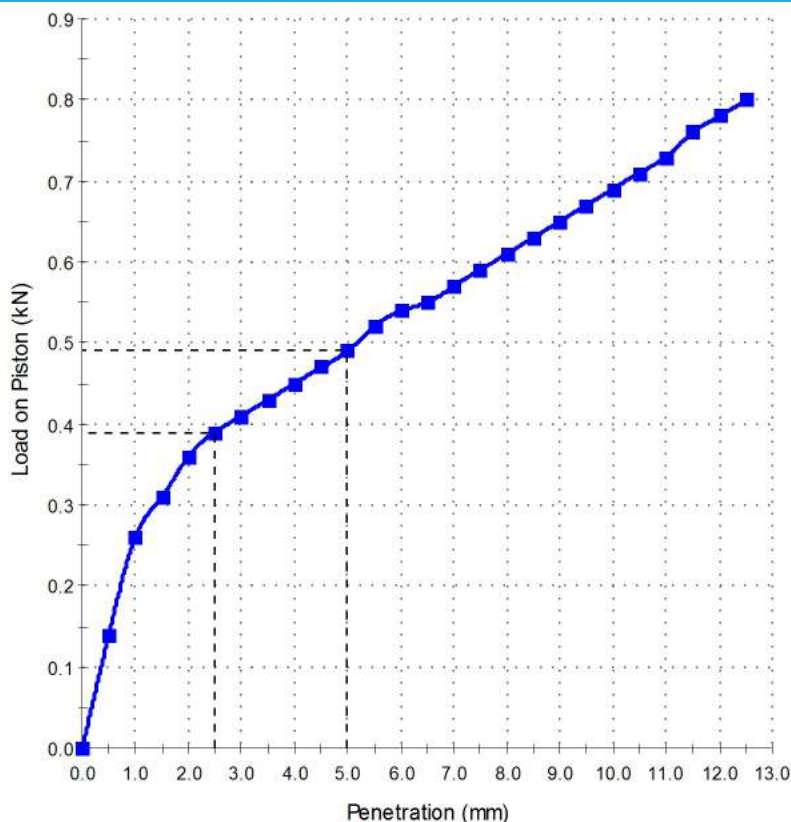
**Source:** On-Site

**Location:** TP205 - (0.2 - 0.5m)

**Material:** Clay

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

## Load vs Penetration



## Test Results

AS 1289.6.1.1

**CBR At 2.5mm (%):** **3.0**

Maximum Dry Density (t/m<sup>3</sup>): 1.49

Optimum Moisture Content (%): 27.6

Dry Density before Soaking (t/m<sup>3</sup>): 1.49

Density Ratio before Soaking (%): 100

Moisture Content before Soaking (%): 27.6

Moisture Ratio before Soaking (%): 100

Dry Density after Soaking (t/m<sup>3</sup>): 1.44

Density Ratio after Soaking (%): 97

Swell (%): 3.0

Moisture Content of Top 30mm (%): 36.8

Moisture Content of Remaining Depth (%): 29.2

Compactive Effort: Standard

Surcharge Mass (kg): 4.50

Period of Soaking (Days): 4

Oversize Material (%): 0.0

Moisture Content

Field Moisture Content (%): 27.6

## Comments

Laboratory Density Ratio (LDR): 100.0% Laboratory Moisture Ratio (LMR): 100.0%

Method of establishing plasticity level: Visual Assessment

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs

# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S07**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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Approved Signatory: Dane Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 24/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S07

**Lot No.:** -

**Test Request No.:** RGS20337.1

**Date Sampled:** 21/12/2017

**Sampling Method:** Sampled by Client

**Specification:** No Specification

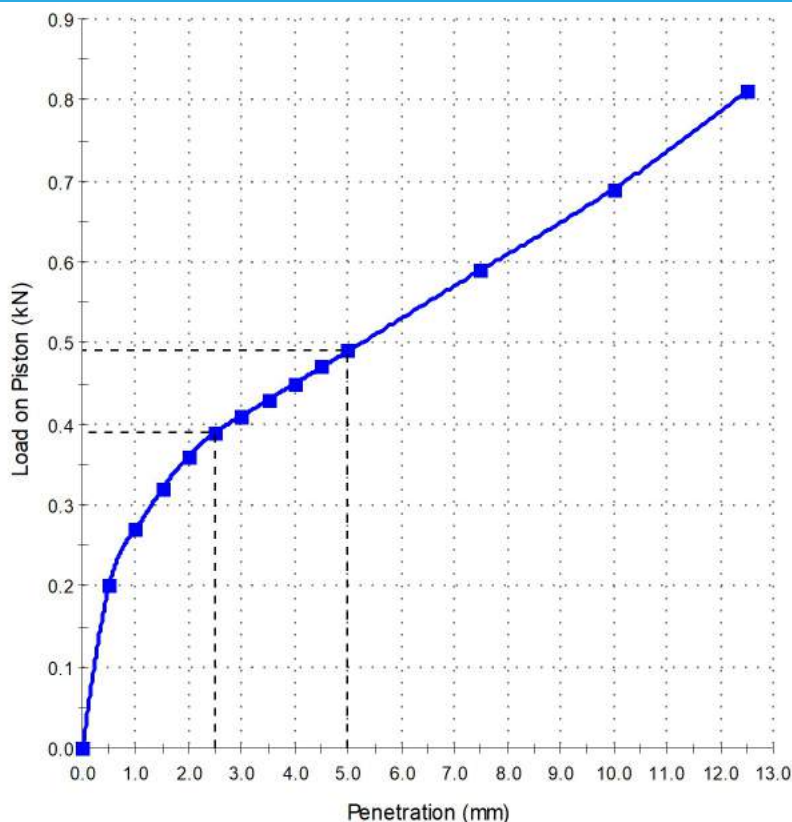
**Source:** On-Site

**Location:** TP206 - (0.4 - 0.9m)

**Material:** Clay

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

## Load vs Penetration



## Test Results

AS 1289.6.1.1

**CBR At 2.5mm (%):** **3.0**

Maximum Dry Density (t/m<sup>3</sup>): 1.70

Optimum Moisture Content (%): 21.3

Dry Density before Soaking (t/m<sup>3</sup>): 1.71

Density Ratio before Soaking (%): 101

Moisture Content before Soaking (%): 20.8

Moisture Ratio before Soaking (%): 98

Dry Density after Soaking (t/m<sup>3</sup>): 1.64

Density Ratio after Soaking (%): 96

Swell (%): 4.5

Moisture Content of Top 30mm (%): 29.7

Moisture Content of Remaining Depth (%): 22.0

Compactive Effort: Standard

Surcharge Mass (kg): 4.50

Period of Soaking (Days): 4

Oversize Material (%): 0.0

Moisture Content

Field Moisture Content (%): 23.2

## Comments

Laboratory Density Ratio (LDR): 100.5% Laboratory Moisture Ratio (LMR): 97.5%

Method of establishing plasticity level: Liquid Limit (AS 1289.3.1.1)

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs

# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S08**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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*B. Cullen*

Approved Signatory: Brent Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686

Date of Issue: 23/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S08

**Lot No.:** -

**Test Request No.:** RGS20337.1

**Date Sampled:** 21/12/2017

**Sampling Method:** Sampled by Client

**Specification:** No Specification

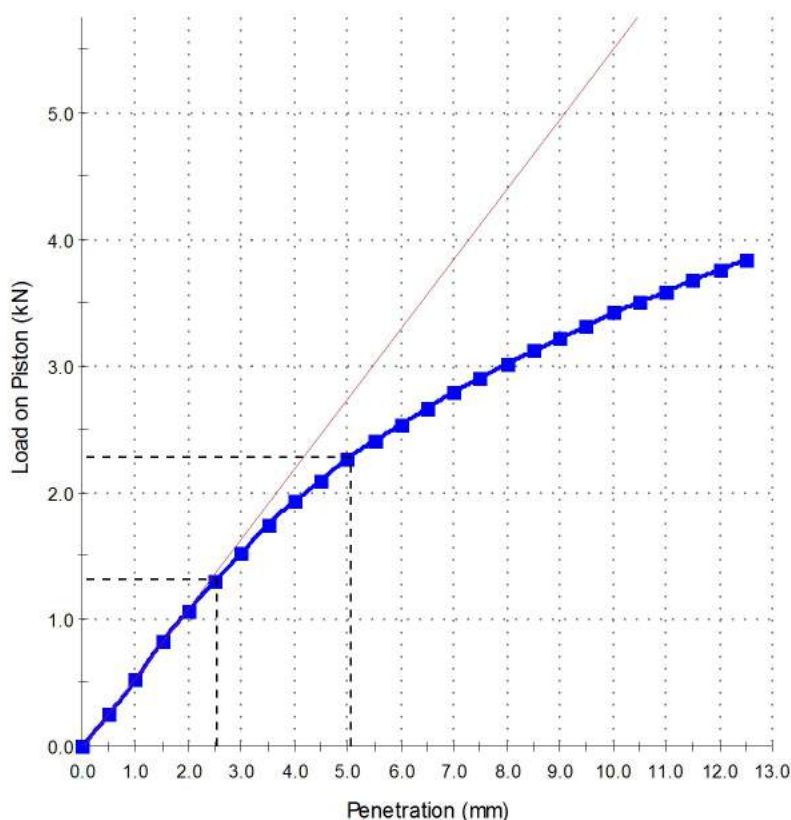
**Source:** On-Site

**Location:** TP207 - (0.9 - 1.3m)

**Material:** Gravel

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

## Load vs Penetration



## Test Results

AS 1289.6.1.1

<b>CBR At 5.0mm (%):</b>	<b>12</b>
Maximum Dry Density (t/m³):	2.04
Optimum Moisture Content (%):	13.7
Dry Density before Soaking (t/m³):	2.05
Density Ratio before Soaking (%):	100
Moisture Content before Soaking (%):	13.2
Moisture Ratio before Soaking (%):	97
Dry Density after Soaking (t/m³):	2.04
Density Ratio after Soaking (%):	100
Swell (%):	0.5
Moisture Content of Top 30mm (%):	14.7
Moisture Content of Remaining Depth (%):	13.8
Compactive Effort:	Standard
Surcharge Mass (kg):	4.50
Period of Soaking (Days):	4
Oversize Material:	Excluded
Oversize Material (%):	29.8

Moisture Content  
Field Moisture Content (%): 9.8

## Comments

Laboratory Density Ratio (LDR): 100.5 Laboratory Moisture Ratio (LMR): 96.5%

Method of establishing plasticity level: Visual Assessment

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs

# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S09**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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*B. Cullen*

Approved Signatory: Brent Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 23/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S09

**Lot No.:** -

**Test Request No.:** RGS20337.1

**Date Sampled:** 21/12/2017

**Sampling Method:** Sampled by Client

**Specification:** No Specification

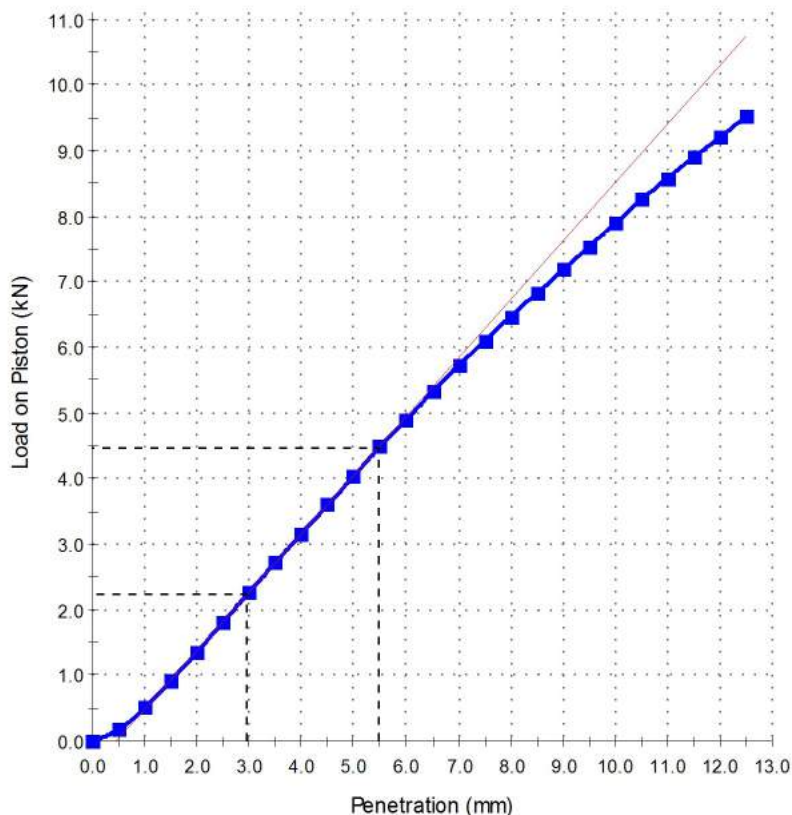
**Source:** On-Site

**Location:** TP208 - (0.9 - 1.3m)

**Material:** Gravel

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

## Load vs Penetration



## Test Results

AS 1289.6.1.1

**CBR At 5.0mm (%):** 25

Maximum Dry Density (t/m<sup>3</sup>): 2.07

Optimum Moisture Content (%): 11.8

Dry Density before Soaking (t/m<sup>3</sup>): 2.06

Density Ratio before Soaking (%): 100

Moisture Content before Soaking (%): 12.3

Moisture Ratio before Soaking (%): 104

Dry Density after Soaking (t/m<sup>3</sup>): 2.06

Density Ratio after Soaking (%): 99

Swell (%): 0.0

Moisture Content of Top 30mm (%): 13.3

Moisture Content of Remaining Depth (%): 11.9

Compactive Effort: Standard

Surcharge Mass (kg): 4.50

Period of Soaking (Days): 4

Oversize Material: Excluded

Oversize Material (%): 12.5

Moisture Content

Field Moisture Content (%): 8.0

## Comments

Laboratory Density Ratio (LDR): 99.5% Laboratory Moisture Ratio (LMR): 104.5%

Method of establishing plasticity level: Visual Assessment

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs



# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S10**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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*B. Cullen*

Approved Signatory: Brent Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 17/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S10

**Lot No.:** -

**Test Request No.:** RGS20337.1

**Date Sampled:** 21/12/2017

**Sampling Method:** Sampled by Client

**Specification:** No Specification

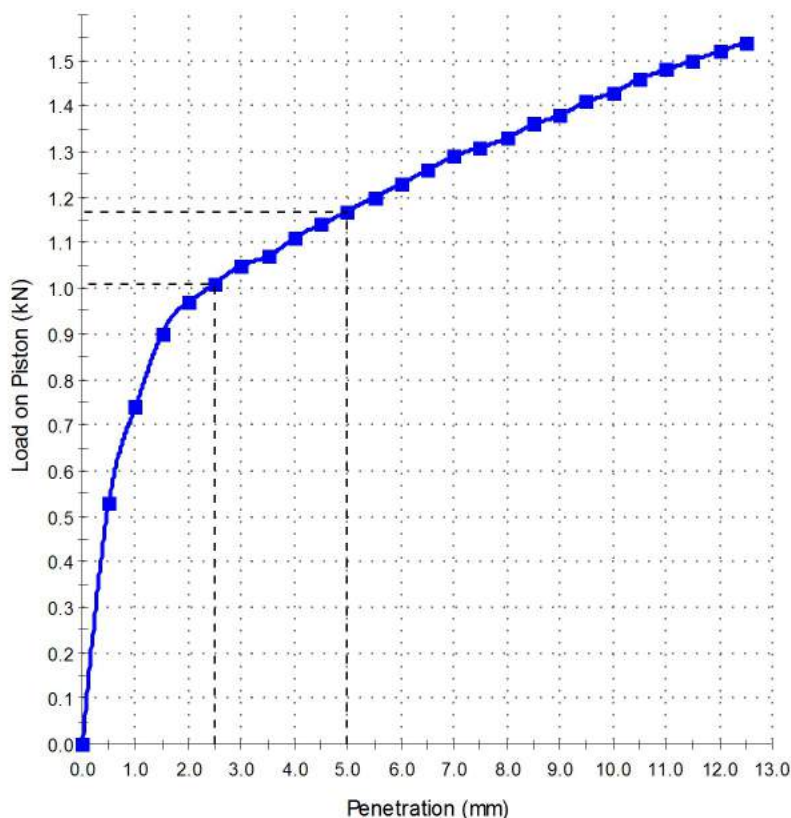
**Source:** On-Site

**Location:** TP209 - (0.4 - 0.8m)

**Material:** Clay

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

## Load vs Penetration



## Test Results

AS 1289.6.1.1

**CBR At 2.5mm (%):** 8

Maximum Dry Density (t/m³): 1.57

Optimum Moisture Content (%): 26.4

Dry Density before Soaking (t/m³): 1.56

Density Ratio before Soaking (%): 99

Moisture Content before Soaking (%): 26.9

Moisture Ratio before Soaking (%): 102

Dry Density after Soaking (t/m³): 1.56

Density Ratio after Soaking (%): 99

Swell (%): 0.5

Moisture Content of Top 30mm (%): 29.9

Moisture Content of Remaining Depth (%): 27.4

Compactive Effort: Standard

Surcharge Mass (kg): 4.50

Period of Soaking (Days): 4

Oversize Material (%): 0.0

Moisture Content

Field Moisture Content (%): 26.3

## Comments

Laboratory Density Ratio (LDR): 99.5% Laboratory Moisture Ratio (LMR): 101.5%

Method of establishing plasticity level: Visual Assessment

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs

# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S12**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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

*B. Cullen*

Approved Signatory: Brent Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 23/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S12

**Test Request No.:** RGS20337.1

**Sampling Method:** Sampled by Client

**Specification:** No Specification

**Location:** TP210 - (0.4 - 0.8m)

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

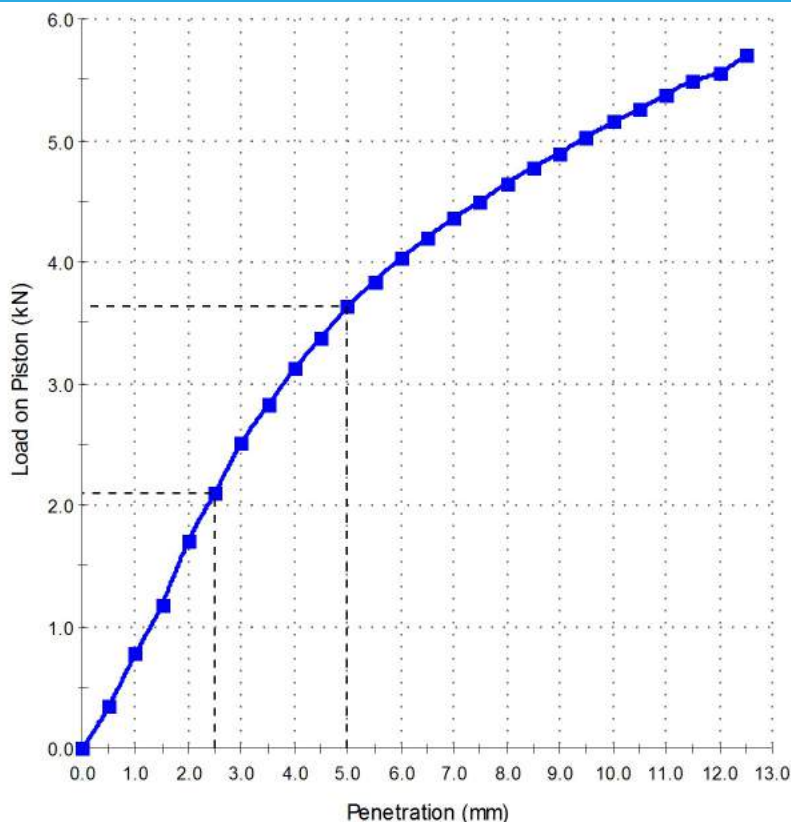
**Lot No.:** -

**Date Sampled:** 21/12/2017

**Source:** On-Site

**Material:** Clay

## Load vs Penetration



## Test Results

AS 1289.6.1.1

**CBR At 5.0mm (%):** **18**  
Maximum Dry Density (t/m³): 1.92  
Optimum Moisture Content (%): 14.4  
Dry Density before Soaking (t/m³): 1.93  
Density Ratio before Soaking (%): 100  
Moisture Content before Soaking (%): 13.9  
Moisture Ratio before Soaking (%): 96  
Dry Density after Soaking (t/m³): 1.92  
Density Ratio after Soaking (%): 100  
Swell (%): 0.5  
Moisture Content of Top 30mm (%): 16.8  
Moisture Content of Remaining Depth (%): 15.2  
Compactive Effort: Standard  
Surcharge Mass (kg): 4.50  
Period of Soaking (Days): 4  
Oversize Material: Excluded  
Oversize Material (%): 4.7

Moisture Content  
**Field Moisture Content (%):** 10.5

## Comments

Laboratory Density Ratio (LDR): 100.5% Laboratory Moisture Ratio (LMR): 96.5%

Method of establishing plasticity level: Visual Assessment

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs



# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S12**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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*B. Cullen*

Approved Signatory: Brent Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 23/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S12

**Lot No.:** -

**Test Request No.:** RGS20337.1

**Date Sampled:** 21/12/2017

**Sampling Method:** Sampled by Client

**Specification:** No Specification

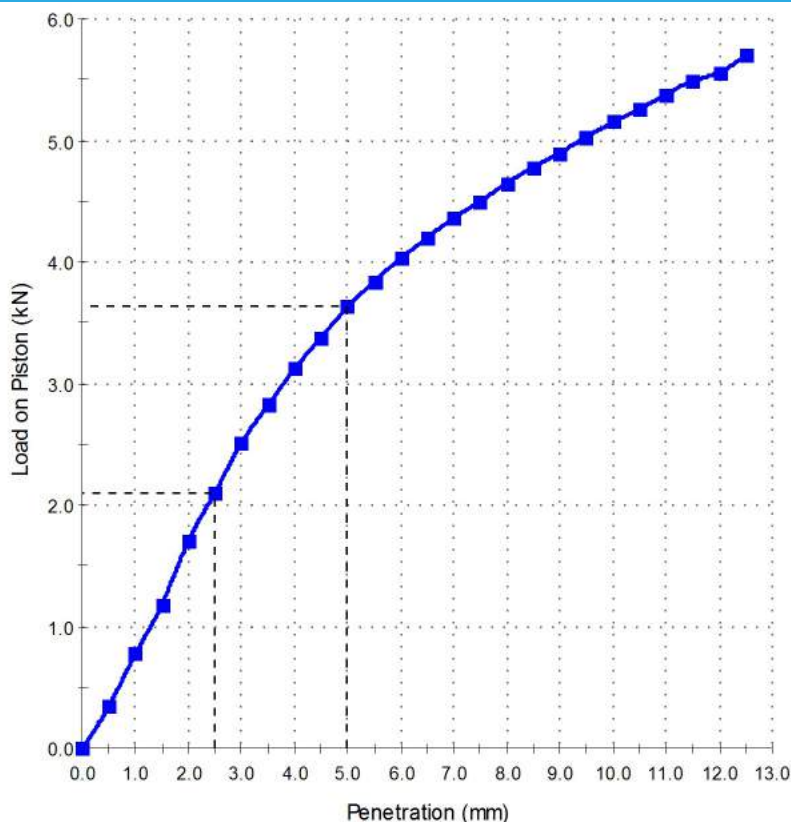
**Source:** On-Site

**Location:** TP210 - (0.4 - 0.8m)

**Material:** Clay

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

## Load vs Penetration



## Test Results

AS 1289.6.1.1

<b>CBR At 5.0mm (%):</b>	<b>18</b>
Maximum Dry Density (t/m <sup>3</sup> ):	1.92
Optimum Moisture Content (%):	14.4
Dry Density before Soaking (t/m <sup>3</sup> ):	1.93
Density Ratio before Soaking (%):	100
Moisture Content before Soaking (%):	13.9
Moisture Ratio before Soaking (%):	96
Dry Density after Soaking (t/m <sup>3</sup> ):	1.92
Density Ratio after Soaking (%):	100
Swell (%):	0.5
Moisture Content of Top 30mm (%):	16.8
Moisture Content of Remaining Depth (%):	15.2
Compactive Effort:	Standard
Surcharge Mass (kg):	4.50
Period of Soaking (Days):	4
Oversize Material:	Excluded
Oversize Material (%):	4.7

Moisture Content  
Field Moisture Content (%): 10.5

## Comments

Laboratory Density Ratio (LDR): 100.5% Laboratory Moisture Ratio (LMR): 96.5%

Method of establishing plasticity level: Visual Assessment

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs

# California Bearing Ratio Test Report

**Report No: CBR:NEW18W-0006--S13**
**Issue No: 1**

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



Accredited for compliance with ISO/IEC 17025 - Testing  
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Approved Signatory: Dane Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 24/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S13

**Test Request No.:** RGS20337.1

**Sampling Method:** Sampled by Client

**Specification:** No Specification

**Location:** TP212 - (0.5 - 0.9m)

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

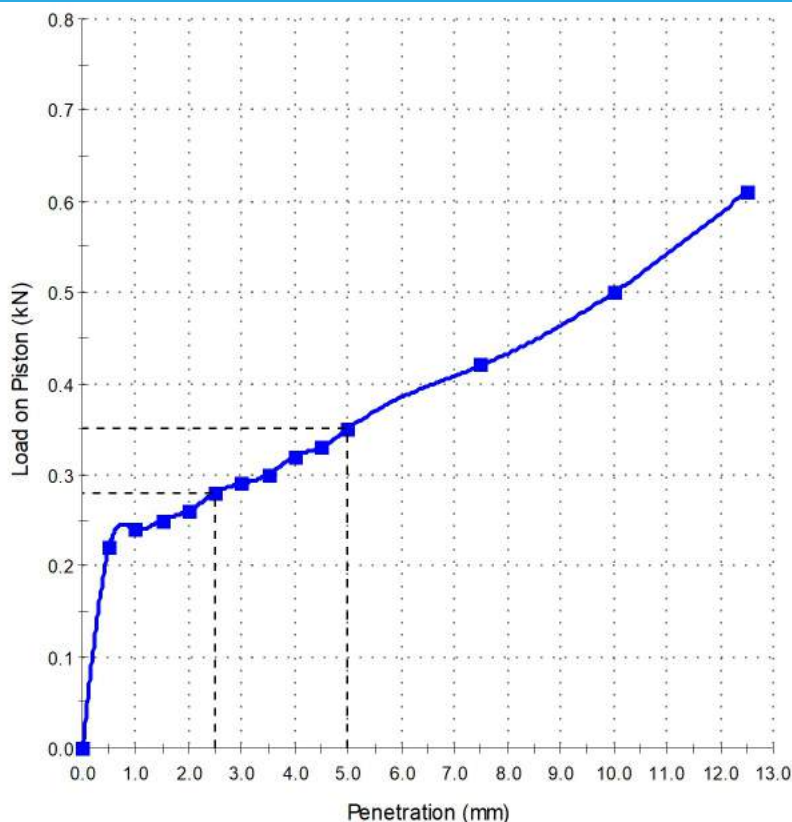
**Lot No.:** -

**Date Sampled:** 21/12/2017

**Source:** On-Site

**Material:** Clay

## Load vs Penetration



## Test Results

AS 1289.6.1.1

**CBR At 2.5mm (%):** **2.0**

Maximum Dry Density (t/m<sup>3</sup>): 1.52

Optimum Moisture Content (%): 27.9

Dry Density before Soaking (t/m<sup>3</sup>): 1.52

Density Ratio before Soaking (%): 100

Moisture Content before Soaking (%): 28.4

Moisture Ratio before Soaking (%): 101

Dry Density after Soaking (t/m<sup>3</sup>): 1.47

Density Ratio after Soaking (%): 96

Swell (%): 3.5

Moisture Content of Top 30mm (%): 43.3

Moisture Content of Remaining Depth (%): 30.8

Compactive Effort: Standard

Surcharge Mass (kg): 4.50

Period of Soaking (Days): 4

Oversize Material (%): 0.0

Moisture Content

Field Moisture Content (%): 32.8

## Comments

Laboratory Density Ratio (LDR): 99.5% Laboratory Moisture Ratio (LMR): 101.5%

Method of establishing plasticity level: Visual Assessment

Moisture Content Method Performed as Per AS1289.2.1.1.

Sample curing time: 48 hrs

**Report No: MAT:NEW18W-0006--S07**
**Issue No: 1**

# Material Test Report

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



Accredited for compliance with ISO/IEC 17025 - Testing

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards



Approved Signatory: Dane Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686

Date of Issue: 30/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S07  
**Sampling Method:** Sampled by Client  
**Date Sampled:** 21/12/2017  
**Source:** On-Site  
**Material:** Clay  
**Specification:** No Specification  
**Project Location:** Precinct A/B/C, Rainbow Beach, NSW  
**Lot. No** -  
**TRN** RGS20337.1  
**Sample Location:** TP206 - (0.4 - 0.9m)

## Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	72	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	53	

## Comments

N/A

**Report No: SSI:NEW18W-0006--S05**
**Issue No: 1**

# Shrink Swell Index Report

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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Approved Signatory: Dane Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 10/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S05

**Test Request No.:** RGS20337.1

**Material:** Clay

**Source:** On-Site

**Specification:** No Specification

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

**Sample Location:** TP205 - (0.2 - 0.7m)

**Borehole Number:** TP205

**Borehole Depth (m):** 0.2 - 0.7

**Client Sample ID:**

**Sampling Method:** Sampled by Client

**Date Sampled:** 21/12/2017

**Date Submitted:** 4/01/2018

## Swell Test

### AS 1289.7.1.1

**Swell on Saturation (%):** -0.8

**Moisture Content before (%):** 29.4

**Moisture Content after (%):** 35.5

**Est. Unc. Comp. Strength before (kPa):** 450

**Est. Unc. Comp. Strength after (kPa):** 180

## Shrink Test

### AS 1289.7.1.1

**Shrink on drying (%):** 5.9

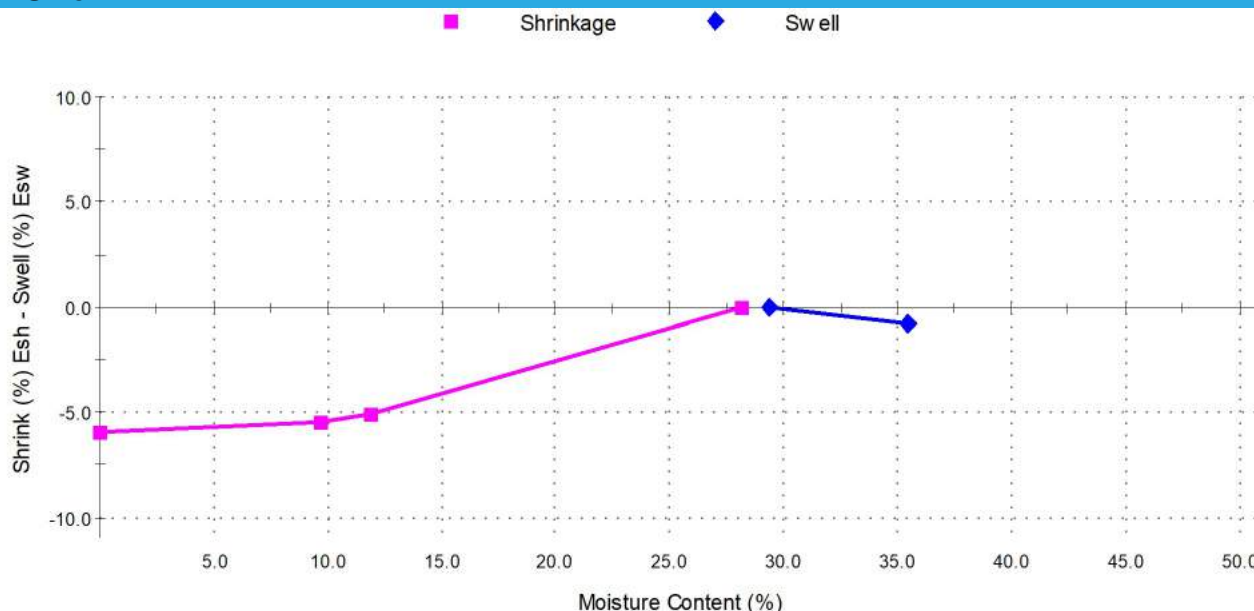
**Shrinkage Moisture Content (%):** 28.1

**Est. inert material (%):** 2%

**Crumbling during shrinkage:** Nil

**Cracking during shrinkage:** Minor

## Shrink Swell



**Shrink Swell Index - Iss (%): 3.3**

## Comments

**Report No: SSI:NEW18W-0006--S07**
**Issue No: 1**

# Shrink Swell Index Report

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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



Approved Signatory: Dane Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686

Date of Issue: 15/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S07

**Test Request No.:** RGS20337.1

**Material:** Clay

**Source:** On-Site

**Specification:** No Specification

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

**Sample Location:** TP206 - (0.4 - 0.9m)

**Borehole Number:** TP206

**Borehole Depth (m):** 0.4 - 0.9

**Client Sample ID:**

**Sampling Method:** Sampled by Client

**Date Sampled:** 21/12/2017

**Date Submitted:** 4/01/2018

## Swell Test

### AS 1289.7.1.1

**Swell on Saturation (%):** -0.1

**Moisture Content before (%):** 23.2

**Moisture Content after (%):** 24.2

**Est. Unc. Comp. Strength before (kPa):** 300

**Est. Unc. Comp. Strength after (kPa):** 270

## Shrink Test

### AS 1289.7.1.1

**Shrink on drying (%):** 3.8

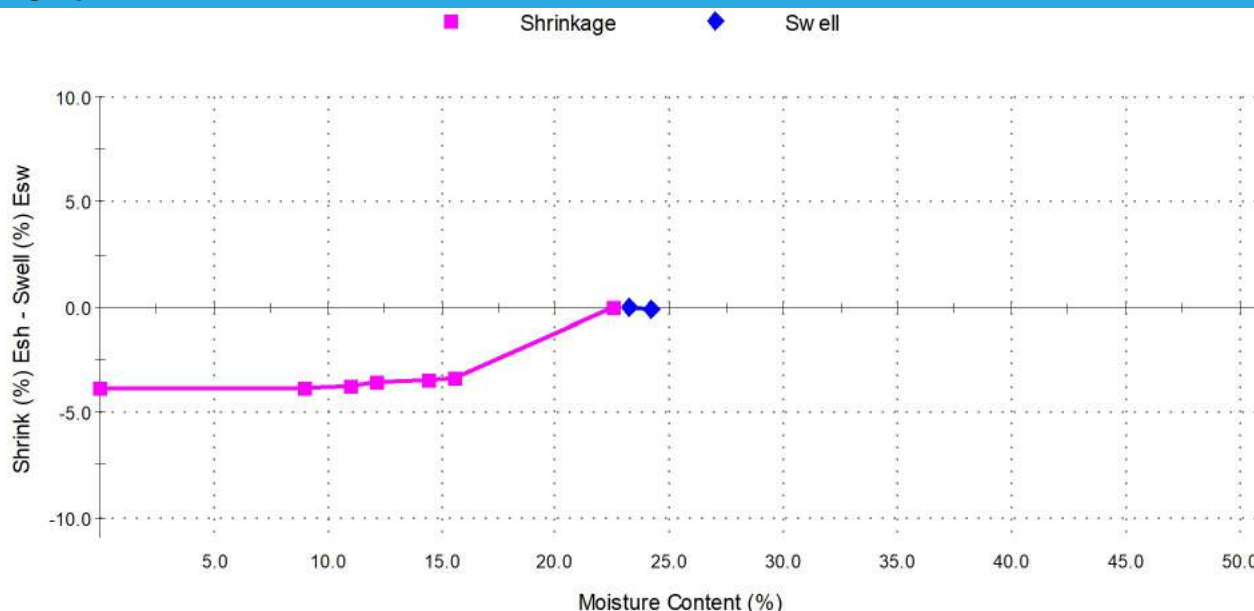
**Shrinkage Moisture Content (%):** 22.5

**Est. inert material (%):** 10%

**Crumbling during shrinkage:** Nil

**Cracking during shrinkage:** Moderate

## Shrink Swell



**Shrink Swell Index - Iss (%): 2.1**

## Comments

\* Shrink swell remoulded at approximately 98% SMDD & at OMC



**Report No: SSI:NEW18W-0006--S10**
**Issue No: 1**

# Shrink Swell Index Report

**Client:** Regional Geotechnical Solutions Pty Ltd  
44 Bent Street  
Wingham NSW 2429

**Principal:**

**Project No.:** MNC16P-0001

**Project Name:** Various Testing



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



Approved Signatory: Dane Cullen  
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686  
Date of Issue: 15/01/2018

## Sample Details

**Sample ID:** NEW18W-0006--S10

**Test Request No.:** RGS20337.1

**Material:** Clay

**Source:** On-Site

**Specification:** No Specification

**Project Location:** Precinct A/B/C, Rainbow Beach, NSW

**Sample Location:** TP209 - (0.4 - 0.8m)

**Borehole Number:** TP209

**Borehole Depth (m):** 0.4 - 0.8

**Client Sample ID:**

**Sampling Method:** Sampled by Client

**Date Sampled:** 21/12/2017

**Date Submitted:** 4/01/2018

## Swell Test

### AS 1289.7.1.1

**Swell on Saturation (%):** 0.4

**Moisture Content before (%):** 35.5

**Moisture Content after (%):** 38.3

**Est. Unc. Comp. Strength before (kPa):** 140

**Est. Unc. Comp. Strength after (kPa):** 90

## Shrink Test

### AS 1289.7.1.1

**Shrink on drying (%):** 8.7

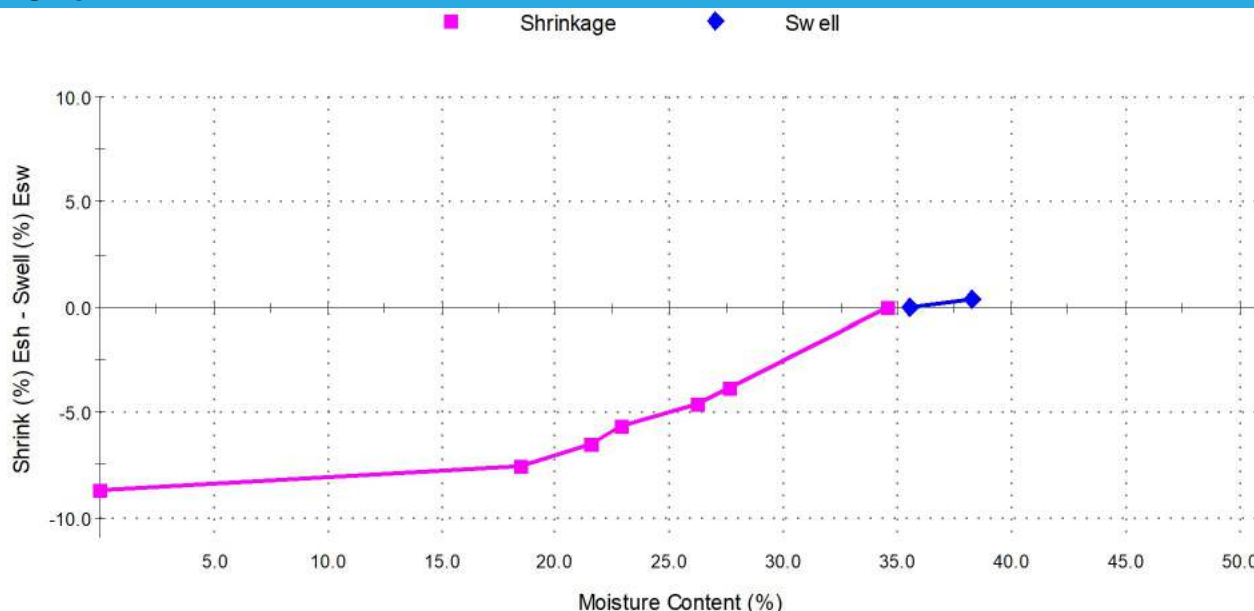
**Shrinkage Moisture Content (%):** 34.6

**Est. inert material (%):** 5%

**Crumbling during shrinkage:** Nil

**Cracking during shrinkage:** Minor

## Shrink Swell



**Shrink Swell Index - Iss (%): 4.9**

## Comments

\* Shrink swell remoulded at approximately 98% SMDD & at OMC



## **Appendix C**

### **Pavement Thickness Design Sheets**



## FLEXIBLE PAVEMENT THICKNESS DESIGN - Fill Embankment

**CLIENT:** King & Campbell  
**PROJECT:** Proposed Residential Development  
**LOCATION:** Precinct A, Rainbow Beach

**Job No.:** RGS20337.1



**Date:** 30-Jul-18

<b>ROAD NAME:</b>	<b>Road 1</b>	<b>Refer to drawing:</b>	Figure 1
<b>Chainage Interval (m):</b>	Fill Embankment	<b>Road classification ref:</b>	PMHC Aus-Spec
<b>Road Classification:</b>	Collector Road	<b>Design Traffic:</b>	1 x 10 <sup>6</sup> ESA
<b>Pavement Design Methodology</b>	Empirical with reference to Austroads Part 2		
<b>Subgrade Conditions</b>			
Expected subgrade:	Embankment fill on Alluvial Terrain B		
Adopted Subgrade CBR value:	7 - To be confirmed	Required subgrade compaction:	100% Standard Compaction
Potential construction or performance issues:	Trim surface to design subgrade level and grade subgrade towards road edge to assist drainage. Proof roll the exposed subgrade to highlight any loose, soft, wet, or heaving areas. Where such areas are identified they should be removed and replaced with approved granular fill. Compact and take CBR samples at subgrade level to confirm design CBR is appropriate. Place pavement layers as specified.		
<b>Pavement Design</b>			
<b>Recommended Pavement Layer Thickness:</b>		<b>Recommended Material requirements</b>	<b>Required Compaction</b>
Wearing course thickness (mm):	40	AC10 as Per Council requirements*	
Base thickness (mm):	140	DGB20 material complying to Hastings AUSPEC	98% Modified Compaction
Sub-base thickness (mm):	150	DGS20 or DGS40 complying to Hastings AUSPEC	95% Modified Compaction
Select thickness (mm):		CBR>15; PI<12; Max Particle size 100mm	100% Standard Compaction
Total thickness (mm):	330	*Note: AC layer to be underlain by primer. AC density testing required.	
<b>Definitions:</b>			
<b>Design traffic loading:</b>	The anticipated number of equivalent standard axles (ESA), as defined by AUSTROADS, in the design lane during the design life of the pavement.		
<b>Modified Compaction:</b>	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.2.1-2003 or equivalent.		
<b>Standard Compaction:</b>	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.1.1-2003 or equivalent.		
<b>Density Index:</b>	Minimum required Density Index AS1289 5.6.1-1998, defined as the ratio of field dry density determined by AS1289 5.3.1-2004 or equivalent to the laboratory values of maximum and minimum density obtained by AS1289 5.5.1-1998 or equivalent		
<b>Note:</b>	Pavement designs assume appropriate drainage is installed and maintained. Refer to Regional Geotechnical Solutions Report No. RGS20337.1-AS for recommendations regarding drainage.		

## FLEXIBLE PAVEMENT THICKNESS DESIGN - Weathered Rock

**CLIENT:** King & Campbell

**Job No.:** RGS20337.1

**PROJECT:** Proposed Residential Development

**LOCATION:** Precinct A, Rainbow Beach



**Date:** 30-Jul-18

ROAD NAME:	Road 10	Refer to drawing:	Figure 1
Chainage Interval (m):	Ch0 - 170m	Road classification ref:	PMHC Aus-Spec
Road Classification:	Collector Road	Design Traffic:	1 x 10 <sup>6</sup> ESA
Pavement Design Methodology	Empirical with reference to Austroads Part 2		
Subgrade Conditions			
Expected subgrade:	EW/HW Dolerite		
Adopted Subgrade CBR value:	10	Required subgrade compaction:	100% Standard Compaction
Potential construction or performance issues:	Trim surface to design subgrade level and rip and weathered rock to break up preferential drainage paths and recompact. Grade subgrade towards road edge to assist drainage. Proof roll the exposed subgrade to highlight any loose, soft, wet, or heaving areas. Where such areas are identified they should be removed and replaced with approved granular fill. ** Where yellow clay exposed, excavate to 300mm, or, weathered rock and replace with Select Fill. Compact and place pavement layers as specified.		
Pavement Design			
Recommended Pavement Layer Thickness:		Recommended Material requirements	Required Compaction
Wearing course thickness (mm):	40	AC10 as Per Council requirements*	
Base thickness (mm):	140	DGB20 material complying to Hastings AUSPEC	98% Modified Compaction
Sub-base thickness (mm):	150	DGS20 or DGS40 complying to Hastings AUSPEC	95% Modified Compaction
Select thickness (mm):		CBR>15; PI<12; Max Particle size 100mm	100% Standard Compaction
Total thickness (mm):	330	*Note: AC layer to be underlain by primer	
Definitions:			
Design traffic loading:	The anticipated number of equivalent standard axles (ESA), as defined by AUSTROADS, in the design lane during the design life of the pavement.		
Modified Compaction:	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.2.1-2003 or equivalent.		
Standard Compaction:	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.1.1-2003 or equivalent.		
Density Index:	Minimum required Density Index AS1289 5.6.1-1998, defined as the ratio of field dry density determined by AS1289 5.3.1-2004 or equivalent to the laboratory values of maximum and minimum density obtained by AS1289 5.5.1-1998 or equivalent		
Note:	Pavement designs assume appropriate drainage is installed and maintained. Refer to Regional Geotechnical Solutions Report No. RGS20337.1-AS for recommendations regarding drainage.		

## FLEXIBLE PAVEMENT THICKNESS DESIGN - Low CBR

**CLIENT:** King & Campbell  
**PROJECT:** Proposed Residential Development  
**LOCATION:** Precinct A, Rainbow Beach

**Job No.:** RGS20337.1



**Date:** 30-Jul-18

<b>ROAD NAME:</b>	<b>Road 10</b>	<b>Refer to drawing:</b>	Figure 1
<b>Chainage Interval (m):</b>	Ch170 - 215	<b>Road classification ref:</b>	PMHC Aus-Spec
<b>Road Classification:</b>	Collector Road	<b>Design Traffic:</b>	1 x 10 <sup>6</sup> ESA
<b>Pavement Design Methodology</b>	Empirical with reference to Austroads Part 2		
<b>Subgrade Conditions</b>			
Expected subgrade:	Residual/EW Dolerite		
Adopted Subgrade CBR value:	2	Required subgrade compaction:	100% Standard Compaction
Potential construction or performance issues:	Adopt a select layer at base of pavement to assist construction, reduce potential for shear failure, and reduce overall pavement thickness required. Trim surface to design subgrade level and dry back exposed surface. Assess need for additional improvement works. Grade subgrade towards road edge to assist drainage. Proof roll the exposed subgrade to highlight any loose, soft, wet, or heaving areas. Where such areas are identified they should be removed and replaced with approved granular fill. Place 300mm layer of Select Fill (CBR >15 and PI <12) to subgrade design. Compact and place pavement layers as specified.		
<b>Pavement Design</b>			
<b>Recommended Pavement Layer Thickness:</b>		<b>Recommended Material requirements</b>	<b>Required Compaction</b>
Wearing course thickness (mm):	40	AC10 as Per Council requirements*	
Base thickness (mm):	140	DGB20 material complying to Hastings AUSPEC	98% Modified Compaction
Sub-base thickness (mm):	150	DGS20 or DGS40 complying to Hastings AUSPEC	95% Modified Compaction
Select thickness (mm):	300	CBR >15; PI <12; Max Particle size 100mm	100% Standard Compaction
Total thickness (mm):	630	*Note: AC layer to be underlain by primer. AC density testing required.	
<b>Definitions:</b>			
<b>Design traffic loading:</b>	The anticipated number of equivalent standard axles (ESA), as defined by AUSTROADS, in the design lane during the design life of the pavement.		
<b>Modified Compaction:</b>	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.2.1-2003 or equivalent.		
<b>Standard Compaction:</b>	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.1.1-2003 or equivalent.		
<b>Density Index:</b>	Minimum required Density Index AS1289 5.6.1-1998, defined as the ratio of field dry density determined by AS1289 5.3.1-2004 or equivalent to the laboratory values of maximum and minimum density obtained by AS1289 5.5.1-1998 or equivalent		
<b>Note:</b>	Pavement designs assume appropriate drainage is installed and maintained. Refer to Regional Geotechnical Solutions Report No. RGS20337.1-AS for recommendations regarding drainage.		

## FLEXIBLE PAVEMENT THICKNESS DESIGN - Low CBR

**CLIENT:** King & Campbell  
**PROJECT:** Proposed Residential Development  
**LOCATION:** Precinct A, Rainbow Beach

**Job No.:** RGS20337.1



**Date:** 30-Jul-18

<b>ROAD NAME:</b>	Road 26 and 29		<b>Refer to drawing:</b>	Figure 1
<b>Chainage Interval (m):</b>	Residual Yellow Clay - Low CBR		<b>Road classification ref:</b>	PMHC Aus-Spec
<b>Road Classification:</b>	Local Street		<b>Design Traffic:</b>	5 x 10 <sup>5</sup> ESA
<b>Pavement Design Methodology</b>	Empirical with reference to Austroads Part 2			
<b>Subgrade Conditions</b>				
Expected subgrade:	Residual Clay - Terrain A			
Adopted Subgrade CBR value:	2	Required subgrade compaction:	100% Standard Compaction	
Potential construction or performance issues:	Adopt a select layer at base of pavement to assist construction, reduce potential for shear failure, and reduce overall pavement thickness required. Trim surface to design subgrade level and dry back exposed surface. Assess need for additional improvement works. Grade subgrade towards road edge to assist drainage. Proof roll the exposed subgrade to highlight any loose, soft, wet, or heaving areas. Where such areas are identified they should be removed and replaced with approved granular fill. Place 280mm layer of Select Fill (CBR >15 and PI <12) to subgrade design. Compact and place pavement layers as specified.			
<b>Pavement Design</b>				
<b>Recommended Pavement Layer Thickness:</b>		<b>Recommended Material requirements</b>	<b>Required Compaction</b>	
Wearing course thickness (mm):	30	AC10 as Per Council requirements*		
Base thickness (mm):	120	DGB20 material complying to Hastings AUSPEC	98% Modified Compaction	
Sub-base thickness (mm):	150	DGS20 or DGS40 complying to Hastings AUSPEC	95% Modified Compaction	
Select thickness (mm):	280	CBR >15; PI <12; Max Particle size 100mm	100% Standard Compaction	
Total thickness (mm):	580	*Note: AC layer to be underlain by primer. AC density testing required.		
<b>Definitions:</b>				
<b>Design traffic loading:</b>	The anticipated number of equivalent standard axles (ESA), as defined by AUSTROADS, in the design lane during the design life of the pavement.			
<b>Modified Compaction:</b>	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.2.1-2003 or equivalent.			
<b>Standard Compaction:</b>	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.1.1-2003 or equivalent.			
<b>Density Index:</b>	Minimum required Density Index AS1289 5.6.1-1998, defined as the ratio of field dry density determined by AS1289 5.3.1-2004 or equivalent to the laboratory values of maximum and minimum density obtained by AS1289 5.5.1-1998 or equivalent			
<b>Note:</b>	Pavement designs assume appropriate drainage is installed and maintained. Refer to Regional Geotechnical Solutions Report No. RGS20337.1-AS for recommendations regarding drainage.			

## FLEXIBLE PAVEMENT THICKNESS DESIGN - Fill Embankment

**CLIENT:** King & Campbell

**Job No.:** RGS20337.1

**PROJECT:** Proposed Residential Development

**LOCATION:** Precinct A, Rainbow Beach



**Date:** 30-Jul-18

<b>ROAD NAME:</b>	<b>Road 3, 25 and 26</b>	<b>Refer to drawing:</b>	<b>Figure 1</b>
<b>Chainage Interval (m):</b>	Fill Embankment	<b>Road classification ref:</b>	PMHC Aus-Spec
<b>Road Classification:</b>	Local Street	<b>Design Traffic:</b>	5 x 10 <sup>5</sup> ESA
<b>Pavement Design Methodology</b>	Empirical with reference to Austroads Part 2		
<b>Subgrade Conditions</b>			
Expected subgrade:	Embankment fill on Alluvial Terrain B		
Adopted Subgrade CBR value:	7 - To be confirmed	Required subgrade compaction:	100% Standard Compaction
Potential construction or performance issues:	Trim surface to design subgrade level and grade subgrade towards road edge to assist drainage. Proof roll the exposed subgrade to highlight any loose, soft, wet, or heaving areas. Where such areas are identified they should be removed and replaced with approved granular fill. Compact and take CBR samples at subgrade level to confirm design CBR is appropriate. Place pavement layers as specified.		
<b>Pavement Design</b>			
<b>Recommended Pavement Layer Thickness:</b>		<b>Recommended Material requirements</b>	<b>Required Compaction</b>
Wearing course thickness (mm):	30	AC10 as Per Council requirements*	
Base thickness (mm):	120	DGB20 material complying to Hastings AUSPEC	98% Modified Compaction
Sub-base thickness (mm):	150	DGS20 or DGS40 complying to Hastings AUSPEC	95% Modified Compaction
Select thickness (mm):		CBR>15; PI<12; Max Particle size 100mm	100% Standard Compaction
Total thickness (mm):	300	*Note: AC layer to be underlain by primer. AC density testing required.	
<b>Definitions:</b>			
<b>Design traffic loading:</b>	The anticipated number of equivalent standard axles (ESA), as defined by AUSTROADS, in the design lane during the design life of the pavement.		
<b>Modified Compaction:</b>	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.2.1-2003 or equivalent.		
<b>Standard Compaction:</b>	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.1.1-2003 or equivalent.		
<b>Density Index:</b>	Minimum required Density Index AS1289 5.6.1-1998, defined as the ratio of field dry density determined by AS1289 5.3.1-2004 or equivalent to the laboratory values of maximum and minimum density obtained by AS1289 5.5.1-1998 or equivalent		
<b>Note:</b>	Pavement designs assume appropriate drainage is installed and maintained. Refer to Regional Geotechnical Solutions Report No. RGS20337.1-AS for recommendations regarding drainage.		

## FLEXIBLE PAVEMENT THICKNESS DESIGN - Weathered Rock

**CLIENT:** King & Campbell

**Job No.:** RGS20337.1

**PROJECT:** Proposed Residential Development

**LOCATION:** Precinct A, Rainbow Beach



**Date:** 30-Jul-18

ROAD NAME:	Road 25 and 28	Refer to drawing:	Figure 1
Chainage Interval (m):	Weathered Rock	Road classification ref:	PMHC Aus-Spec
Road Classification:	Local Street	Design Traffic:	5 x 10 <sup>5</sup> ESA
Pavement Design Methodology	Empirical with reference to Austroads Part 2		
Subgrade Conditions			
Expected subgrade:	EW/HW Dolerite		
Adopted Subgrade CBR value:	10	Required subgrade compaction:	100% Standard Compaction
Potential construction or performance issues:	Trim surface to design subgrade level and rip and weathered rock to break up preferential drainage paths and recompact. Grade subgrade towards road edge to assist drainage. Proof roll the exposed subgrade to highlight any loose, soft, wet, or heaving areas. Where such areas are identified they should be removed and replaced with approved granular fill. ** Where yellow clay exposed, excavate to 300mm, or, weathered rock and replace with Select Fill. Compact and place pavement layers as specified.		
Pavement Design			
Recommended Pavement Layer Thickness:		Recommended Material requirements	Required Compaction
Wearing course thickness (mm):	30	AC10 as Per Council requirements*	
Base thickness (mm):	120	DGB20 material complying to Hastings AUSPEC	98% Modified Compaction
Sub-base thickness (mm):	150	DGS20 or DGS40 complying to Hastings AUSPEC	95% Modified Compaction
Select thickness (mm):		CBR>15; PI<12; Max Particle size 100mm	100% Standard Compaction
Total thickness (mm):	300	*Note: AC layer to be underlain by primer	
Definitions:			
Design traffic loading:	The anticipated number of equivalent standard axles (ESA), as defined by AUSTROADS, in the design lane during the design life of the pavement.		
Modified Compaction:	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.2.1-2003 or equivalent.		
Standard Compaction:	Minimum required dry density ratio (AS1289 5.4.1-2007) defined as the ratio of the calculated field dry density (AS1289 5.3.1-2004 or equivalent) to the maximum dry density obtained using AS1289 5.1.1-2003 or equivalent.		
Density Index:	Minimum required Density Index AS1289 5.6.1-1998, defined as the ratio of field dry density determined by AS1289 5.3.1-2004 or equivalent to the laboratory values of maximum and minimum density obtained by AS1289 5.5.1-1998 or equivalent		
Note:	Pavement designs assume appropriate drainage is installed and maintained. Refer to Regional Geotechnical Solutions Report No. RGS20337.1-AS for recommendations regarding drainage.		