

#### **GEOTECHNICAL INVESTIGATION REPORT**

#### 56-58 BEANE STREET, GOSFORD NSW, 2250

PREPARED FOR ROOT PARTNERSHIPS PTY LTD

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## **1 INTRODUCTION**

Consulting Earth Scientists Pty Ltd (CES) was commissioned by Root Partnerships Pty Ltd (the Client) to undertake a geotechnical investigation for a proposed residential development at 56-58 Beane Street, Gosford NSW (formally defined as Lot 31 and 32 of Deposited Plan (DP) 1591), herein referred to as the Site. This report should be read in conjunction with the environmental investigation report (Document Reference: CES181201-RPS-AB, dated 17 January 2019).

CES understands that the development is to include a 7 to 8 storey residential building with a single basement carpark, the excavation required for the basement is assumed to be 3 to 4 m below the existing Site level at the time of the investigation.

The purpose of the geotechnical investigation was to assess the subsurface ground conditions at the Site and provide information and recommendations in relation to the following:

- An assessment of the engineering properties of the materials encountered;
- Site and subgrade preparation;
- Excavation conditions and support, including:
  - Excavatability;
  - Permanent and temporary batter slopes;
  - Shoring systems and design parameters; and
  - Support and retention requirements.
- Groundwater issues (if identified);
- Foundations, including:
  - Footing systems;
  - Allowable and ultimate bearing pressures; and



- o Likely settlements.
- Geotechnical constraints identified during the Site investigation.

The scope of works covered in this report has been undertaken in accordance with CES proposal (Document Reference: CES181201-RPS-AA) dated 13 December 2018.

## **2** SITE INFORMATION

#### 2.1 SITE LOCATION AND SITE DESCRIPTION

The Site is located at 56-58 Beane Street, Gosford, NSW, within the Central Coast Council Local Government Area (LGA) and comprises two lots, identified as Lots 31 and 32, Section 4 in Deposited Plan (DP) 1591. The Site location is indicated in Figure 1.

The Site covers an area of approximately 0.12 hectares and is roughly rectangular in outline. The Site gently slopes to the northwest (typically <3% slope) and was observed to have shallow surface depressions where stormwater had ponded due to rainfall. The Site is at an elevation of between approximately 20 m to 24 m AHD. At the time of this investigation, the Site was vacant and was being used as a car park.

Existing developments on adjoining land in close proximity to the planned development include the adjacent roads of Beane Street and Gertrude Street to the south and east, a car park to the west, and a two-storey residential building to the north.

## 2.2 REGIONAL GEOLOGY

A review of the Gosford Lake Macquarie Sheet 9131/9231 1:100000 geological map indicates that the Site is underlain by Mid -Triassic Interbedded Laminite (Rnt) shale and quartz to lithic quartz sandstone, and minor red claystone of the Narrabeen Group.

The 1:250000 geological map from the NSW Department of Industry, Resources & Energy (presented in the *Lotsearch* report included in the environmental investigation) indicates that the Site is underlain by Quaternary undifferentiated alluvial deposits; sand, silt, clay and gravel; some residual and colluvial deposits, including some channel, levee, lacustrine, floodplain and swamp deposits.



#### 2.3 ACID SULFATE SOILS

With reference to the Gosford Acid Sulphate Soils Risk Map (Department of Natural Resources (CJ Murphy, 1997, Edition 2, 1:25,000), the Site is situated in an area of no known occurrence of Acid Sulfate soils: "Acid sulfate soils are not known or expected to occur in these environments."

The State Environmental Planning Policy (Gosford City Centre) 2018 indicates the Site is situated on Class 5 land, which indicates that an Acid Sulfate Soils Management Plan is required for:

• Works within 500 metres of adjacent Class 1, 2, 3, or 4 land that is below 5 metres AHD and by which the water table is likely to be lowered below 1 metre AHD on adjacent Class 1, 2, 3 or 4 land, present an environmental risk.

It is noted that no Class 1, 2, 3, or 4 land is located within 500 m of the Site and the Site is situated at 20 m to 24 m AHD. Field screening was completed during the borehole drilling and sampling for Acid Sulfate Soils (ASS) and Potential Acid Sulfate Soils (PASS) and the results of field screening are summarised in Section 4 of this report.

## **3** FIELDWORK PROGRAMME

#### **3.1 BOREHOLE DRILLING**

Fieldwork was carried out from 18 to 20 December 2018. Boreholes were drilled to obtain geotechnical and environmental information over the Site. The drilling was undertaken by a specialist drilling subcontractor (Numac Drilling Pty Ltd) using a Geoprobe 205, track mounted drilling rig. A Geo-Environmental Engineer from CES was present full-time on Site during the fieldwork programme to log the material recovered from drilling in accordance with AS 1726-2017 *Geotechnical site investigations*, record groundwater observations and collect samples. Selected samples were taken from the boreholes and dispatched to a NATA accredited laboratory for testing. More information on sample locations are provided in the environmental investigation report (CES Document Reference: CES181201-RPS-AB, dated 17 January 2019).

Six (6) boreholes were drilled as part of the joint environmental and geotechnical fieldwork programme. The boreholes were drilled to the depths shown in Table 1.

The boreholes were advanced through soil using V-Bit augering techniques. Standard Penetration Tests (SPTs) were conducted at regular intervals to assess soil strength/density and obtain samples for logging.



Borehole BH04 was advanced in rock using diamond rotary coring techniques for approximately 4.5 m.

Table 1 provides a summary of borehole locations and termination depths. The borehole coordinates were determined using a hand-held GPS and have not been surveyed.

Borehole	Easting	Northing	Termination Depth (m)
BH01	333483	6248226	8.45
BH02	333482	6248212	8.0
BH03	333498	6248210	8.0
BH04	333503	6248224	14.9
BH05	333473	6248201	8.0
BH06	333488	6248217	8.0

 Table 1: A Summary of Borehole Locations and Depths

#### 3.2 ACID SULFATE SOIL FIELD SCREENING

Field screening for acid sulfate soils was undertaken by a CES Geo-Environmental Engineer during the drilling. Samples for screening were collected from the SPT tubes and the auger arisings at approximately 0.5 m depth intervals in Boreholes BH01 to BH04 (inclusive). The field screening was carried out in accordance with recommendations outlined in the NSW Government *Acid Sulfate Soil Manual* (ASSMAC, 1998). The ASSMAC field screening includes measurement of soil pH initially as collected in the field at the time of sampling (pH<sub>F</sub>) and following addition of peroxide (30% hydrogen peroxide), indicated as pH<sub>FOX</sub>, and documenting visible reactions. The results of the field screening are summarised in Section 4 of this report.

## **4 RESULTS OF THE INVESTIGATION**

#### 4.1 SUMMARY OF SUBSURFACE CONDITIONS

An inferred geotechnical model has been prepared for the Site based on the results of the geotechnical boreholes. The inferred geotechnical model is presented in Table 2. The depths of the various strata are based on the depths encountered at the borehole locations and may be



different at other parts of the Site. Detailed descriptions and depths of materials encountered are presented on the borehole logs included in Appendix A.

It should be noted that the depths provided in this table relate to the ground level at the time of the current geotechnical investigation (December 2018).

Geotechnical Unit	Approximate Depth to Top of Unit (m)	Approximate Thickness (m)	Typical Description
Unit 1: Topsoil/Fill	Ground Level	0.3 to 2.2	<ul> <li>TOPSOIL: Silty sand, fine to medium with trace roots and organics, dark grey, typically moist, observed only in west portion of Site at BH05 and BH06.</li> <li>FILL: Predominantly Sand and clayey Sand, fine, pale brown/yellow and dark brown, with trace amounts of brick, concrete and tile fragments, typically dry.</li> <li>Sandy Clay, low plasticity, pale orange to dark grey at BH05 only.</li> </ul>
Unit 2: Alluvium <sup>2</sup>	0.3 to 2.2	10	Predominantly sandy Clay and Clay, low to medium plasticity, pale yellow/brown and mottled dark orange/yellow, dark orange/pale grey, mottled pale orange/brown/grey. Sand is fine. Typically stiff to hard and with a moisture content approximately equal to plastic limit. Includes clayey Sand, fine to medium, mottled dark orange/pale brown, pale grey/dark orange, pale yellow/orange. Typically medium dense and moist. Soils contain trace carbonaceous organics, black, decomposing.

 Table 2: Inferred Geotechnical Model



Geotechnical Unit	Approximate Depth to Top of Unit (m)	Approximate Thickness (m)	Typical Description		
Unit 3: Sandstone <sup>1,2</sup> (Class V)	10.3	4.1	SANDSTONE: medium to coarse grained, pale grey, low to high but typically medium strength, moderately to slightly weathered with seams of highly weathered very low to low strength. Defects consisting of joints, bedding plane parting, crushed seam and extremely weathered seams were observed at spacings typically less than 200 mm.		
Unit 4: Sandstone <sup>1,2</sup> (Class III)	14.4	Not Proven	SANDSTONE: medium grained, pale grey, medium strength, slightly to moderately weathered. Occasional carbonaceous laminations throughout rock. Joints were observed at a spacing typically greater than 600 mm.		

Notes:

<sup>1</sup>Rock is classified in accordance with Pells et al. 1998 (Foundation on Shale and Sandstone in the Sydney Region, Australian Geomechanics Journal) which classifies rock depending upon strength, fracturing and weak seams. <sup>2</sup> Rock was observed in Borehole BH04 only, and the depth to rock and condition of rock should be considered a preliminary approximation as conditions may vary beyond the borehole location.

#### 4.2 GROUNDWATER OBSERVATIONS

Groundwater inflows were observed during drilling of the geotechnical boreholes. The standing groundwater depth was measured following completion of each borehole taking consecutive depth measurements until three consecutive measurements indicated that the water depths stabilised. This typically occurred within less than an hour upon completion of the boreholes. A summary of the standing groundwater depths is presented in Table 3.

The standing groundwater depths shown were recorded during the investigation and may vary over time due to other factors such as seasonal fluctuations and rainfall events.



Borehole ID	Approximate Standing Groundwater Depth Below Existing Ground Level (m)
BH01	7.5
BH02	7.8
BH03	7.8
BH04	8.9
BH05	6.8
BH06	Not Encountered

Table 5. Summary of Standing Groundwater Observations	Table	3:	Summarv	of Standing	Groundwater	Observations
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#### 4.3 ACID SULFATE SOIL FIELD SCREENING RESULTS

A total of 55 samples were collected from four boreholes for acid sulfate soil field screening, and results are summarised in Appendix B. The tabulated results include measurement of pH initially as collected in the field at the time of sampling (pH<sub>F</sub>), following addition of peroxide (30% hydrogen peroxide), pH<sub>FOX</sub>, and documenting visible reactions.

Field screening results with  $pH_F$  less than 4 indicates the actual presence of ASS. None of the samples screened recorded  $pH_F$  less than 4, indicating that actual ASS are unlikely to be present on the Site.

Indicators of PASS during field peroxide test screening are summarised below:

- Observed reaction upon addition of peroxide;
- Change in temperature;
- A pH change (lowering) of greater than 2 pH units when compared with field pH; and
- Final pH of less than 4.

The results of the field screening, review of available published information and the soil descriptions and observations made during the fieldworks do not indicate the presence of Actual Acid Sulfate Soils or Potential Acid Sulfate Soils at the site.



## **5 DISCUSSION AND RECOMMENDATIONS**

#### 5.1 MATERIAL ENGINEERING PROPERTIES AND EARTHWORKS

Topsoil/uncontrolled fill and other unsuitable materials observed in the Unit 1: Topsoil/Fill and any other soils with high organic or silt content, or otherwise geotechnically unsuitable materials, should be stripped from the Site area to be developed, as in their current condition, these materials are not suitable for providing an adequate foundation or subgrade. Topsoil should be stockpiled for re-instatement of landscaped areas requiring re-vegetation subject to horticultural assessment. Where trees are required to be removed, stumps should be grubbed out and root systems cleared. Uncontrolled fill soil may be reused as fill at the Site if necessary, provided it meets the requirements for suitable geotechnical material and is replaced and recompacted in accordance with the engineering specification presented herein.

Trafficability of the Unit 2: Alluvium should remain reasonable at the moisture content and stiffness observed during drilling. It is not anticipated that the groundwater table will be encountered during excavation of the single level basement carpark; however, exposed excavations should be laid out in a manner that allows for removal of water that may pond during rainfall events, such as trenches or drains or pumping from locally excavated sumps to avoid rainfall ponding in excavations. The Unit 2: Alluvium may become unstable where these soils experience a significant increase in moisture content.

Should additional filling be required, the nominated areas should be filled using suitable geotechnical material obtained from excavations on the Site or imported fill material. Suitable geotechnical material is a fill that is capable of being compacted to form a homogeneous mass capable of supporting the proposed structure and/or associated elements which does not contain the following unsuitable materials:

- Organic soils such as topsoil, severely root affected subsoils and peat;
- Imported material not assessed as Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM) or materials not subject to a General or Specific Resource Recovery Exception as approved by the NSW Office of Environment and Heritage. Imported fill should be accompanied by documentation adequately demonstrating the material's compliance with the exemption conditions.
- Materials containing substances which can be dissolved or leached out in the presence of moisture, or which undergo volume change or loss of strength when disturbed and exposed to moisture;



- Silts or materials that have the deleterious engineering properties of silt;
- Fill which contains wood, metal, plastic, boulders or other deleterious material;
- Loose, soft, wet or unstable soil or rock;
- Any material deemed unsuitable by the geotechnical practitioner.

Suitable geotechnical material or fill should be placed in near horizontal layers of uniform thickness placed systematically across the fill area. The fill should be placed in layers no greater than 150 mm compacted thickness and compacted as follows to a minimum 98% Standard Maximum Dry Density (SMDD) within  $\pm 2$  % of Optimum Moisture Content (OMC). For fill within 500 mm of slabs or pavements, this should be compacted to a minimum 100% SMDD within  $\pm 2$  % of OMC.

Subgrade preparation and the placement of fill at the Site should be carried out under Level 1 Supervision as defined in AS 3798-2007 *Guidelines on earthworks for commercial and residential developments*.

Erosion and sediment controls should be implemented during any earthworks operations in accordance with the requirements of the Landcom Publication "Managing Urban Stormwater: Soils and Construction".

The earthworks for the project will require inspection by experienced geotechnical practitioner during excavation and construction as defined in AS 3798-2007 *Guidelines on earthworks for commercial and residential developments*.

## 5.2 EXCAVATION CHARACTERISTICS

It is understood by CES that the proposed building will be constructed with a single basement excavated to approximately 3 m to 4 m depth. Both the Unit 1: Topsoil/Fill and Unit 2: Alluvium is likely to be encountered during the basement excavation. Conventional plant such as bulldozers, hydraulic excavators and backhoes should be adequate for excavation of the Unit 1: Topsoil/Fill and the Unit 2: Alluvium.

Contractors should be required to examine borehole records to make their own assessment of excavation plant and production rates.



#### 5.3 PERMANENT AND TEMPORARY BATTER SLOPES

For excavations of 3 m to 4 m depth, the Unit 2: Alluvium observed during drilling should stand at 1.5 horizontal to 1 vertical (1.5H:1V) for unsupported temporary batter slopes and 2H:1V for unsupported permanent batter slopes. Permanent batter slopes should be protected by dense rooted vegetation or shotcrete to mitigate erosion.

Engineered retaining solutions including shoring, sheet piling or trench boxes should be considered if:

- A batter steeper than recommended above is required.
- Excavations are anticipated to impact upon the zone of loading influence of neighbouring structures or developments, which is the zone from which neighbouring structures and developments derive support from the adjacent ground. For the proposed 3 m to 4 m basement excavation at the Site, as a general preliminary indication, the zone of loading influence would be expected to be a distance of approximately 4 m from the planned excavation.
- Surcharge loading is applied to slopes and batters for example from neighbouring structures, roads, machinery or storage of materials on site.

A suitably qualified and experienced geotechnical practitioner should be consulted prior to design and installation of any engineering retaining solution and assess the suitability of the solution. To assist in the design of shoring or retaining walls, geotechnical design parameters are provided in the following sections of this report.

#### 5.4 FOOTINGS AND DESIGN PARAMETERS

#### 5.4.1 General Foundation Considerations

Deep footings (piles) are likely the most feasible option for the planned residential building. In consideration of this, it is recommended that once the pile locations and approximate depths are determined, additional boreholes are drilled to confirm ground conditions. Ground conditions may vary beyond the location of the borehole that was drilled into rock at the Site.



#### 5.4.2 Strip or Pad Footings

Strip or pad footings for lightly loaded and flexible structures may be constructed on Unit 2: Alluvium. Exposed materials in footing excavations should be assessed by a suitably qualified and experienced geotechnical engineer prior to blinding and construction of the footings.

The bearing capacity of a pad or strip footing constructed in the Unit 2: Alluvium will be dependent on the geometry of the footing. In order to limit the settlements, it is suggested that a factor of safety of 3 be applied to the ultimate bearing capacity calculated for a particular footing geometry. The location of the groundwater table relative to the founding level must be taken into consideration when calculating the allowable bearing capacity and corresponding settlements. As a preliminarily indication, the maximum allowable bearing pressure should be limited to 100 kPa where footings are constructed near the existing surface elevation and 150 kPa where footings are constructed at basement level in the Unit 2: Alluvium.

All footings for the same structure should be founded on strata of similar stiffness and reactivity to minimize the risk of differential movements, with articulation provided where appropriate. Further review and analysis of bearing capacities and settlements should be carried out once the bulk excavation levels and design loads become available.

Alternatively, a raft slab foundation may be considered. The modulus of subgrade reaction value will need to be assessed based on the design working load and size of the loaded area. Structure settlements may be assessed once loading and elevation of such developments are known.

#### 5.4.3 Driven piles

Large-displacement conventional driven piles such as driven precast piles and driven cast-in situ piles can provide high shaft and end bearing resistances; however, noise and vibration associated with driven pile installation will need to be considered to evaluate the impacts on the surrounding properties, structures, utilities and residents. If deemed suitable from a construction noise and vibration perspective, driven precast reinforced concrete piles could be considered. Such piles could be founded in the Unit 3: Sandstone (Class V). Piles should be driven at least 5 pile diameters into the founding stratum

The design ultimate geotechnical strength of a driven pile or pile group should be determined as described in AS 2159 – 2009 *Piling-Design and installation* by considering factors including negative friction, soil swelling, cyclic loading and earthquake loading. The pile should be designed



by consideration of serviceability requirements including settlement, lateral deflection and rotation such that they are within the appropriate limit to the structure and its intended use.

The serviceability limit state (SLS) allowable load bearing capacity should consider the ultimate limit state (ULS) of unit end bearing resistance, ULS of unit shaft resistance and allowable settlement.

As a preliminary guide, piles designed using the limit state or working stress approach could be proportioned using the geotechnical parameters provided in **Error! Reference source not found.**.

Geotechnical Unit	Unit End Bearing Resistance (kPa)	Unit Shaft Resistance (kPa)
Unit 1: Topsoil/Fill	Not Applicable	Not Applicable
Unit 2: Alluvium	150	30
Unit 3: Sandstone (Class V)	9,000	90
Unit 4: Sandstone (Class III)	20,000	Not Applicable

Table 4: Recommended Ultimate Limit State (ULS) Design Parameters for Driven Piles

A geotechnical reduction factor ( $\phi_g$ ) of 0.5 should be adopted in accordance with AS 2159-2009 for preliminary design.

#### 5.4.4 Bored or CFA Piles

Open bored piles or continuous flight auger piles could be adopted for the planned residential building. It would be expected that using appropriate capacity piling rigs, the piles should be able to penetrate into the Unit 3: Sandstone (Class V) and the Unit 4: Sandstone (Class III). Allowable design parameters for bored piles are provided in Table 5. The use of the recommended allowable bearing pressures would be expected to result in pile settlement of about 1% of pile diameters (ultimate bearing values occur at large settlements greater than approximately 5% of the minimum footing dimension).



During construction, an experienced geotechnical engineer should observe boring of the piles in order to confirm that the foundation conditions and pile footing elevations are suitable and consistent with adopted design parameters.

Geotechnical Unit	Ultimate Bearing Pressures (kPa) <sup>1</sup>	Allowable Bearing Pressures (kPa) <sup>1</sup>	Ultimate Pile Adhesion (kPa) <sup>1,2</sup>	Typical Efield (kPa) <sup>1,3</sup>
Unit 3: Sandstone (Class V)	3,000	1,000	150	50
Unit 4: Sandstone (Class III)	20,000	4,000	800	350

**Table 5: Preliminary Bored Pile Design Parameters** 

Notes:

<sup>1</sup>Rock was only encountered in Borehole BH04 and the depth and condition of rock should be considered a preliminary approximation as conditions may vary beyond the borehole location.

 $^{2}$ Shaft adhesion should only be assumed where piles have a minimum embedment of at least 3 pile diameters into the nominated stratum with a properly cleaned rough socket (at least grooves of depth 1 mm to 4 mm and width greater than 5 mm spacing of 50 mm to 200 mm).

<sup>3</sup>For uplift capacity, the shaft adhesion value should be multiplied by a geotechnical reduction factor ( $\phi_g$ ) of 0.5. In addition to shaft adhesion, the uplift capacity should be checked for a cone pull-out failure mode assuming a cone angle of 90° considering the submerged weight of the soil or rock and adopting a factor of safety of 1.0 against pull-out.

Open bored piles may require temporary liners to provide bore wall stability through the Unit 1: Topsoil/Fill and the Unit 2: Alluvium or where groundwater is encountered. Piles should be cleaned, dewatered and concreted without delay to prevent softening of the pile base.

#### 5.5 DESIGN PARAMETERS FOR SHORING OR RETAINING WALLS

The geotechnical parameters for design of shoring or retaining walls have been derived from the results of the boreholes and SPT records along with engineering experience and published values that are typical for the Sydney region. The design parameters are summarised in Table 6.



Geotechnical Unit	γ (kN/m³)	Cu (kPa)	c' (kPa)	φ' (°)	E Elastic Modulus (MPa)	V (Poisson's ratio)	Ka <sup>1</sup>	Kp
Unit 1: Topsoil/Fill	20		0	24			0.4	2.4
Unit 2: Alluvium (Sandy clay, clay and clayey sand)	20	100	5	26 (0 for undrained)	20	0.3	0.4	2.5

 Table 6: Design Parameters for Shoring or Retaining Walls

Notes:

<sup>1</sup>Use of the active earth pressure coefficient ( $K_a$ ) requires that there will be sufficient deflection of the retaining system during construction to reach active conditions. If lateral deflections are inhibited, the at-rest earth pressure coefficient ( $K_o$ ) should be used. A  $K_o$  value of 0.6 may be used for both the Unit1: Topsoil/Fill and Unit 2: Alluvium.

The design values given are based on level ground behind the wall and do not include any surcharge loads that may be imposed near the top of the retaining system/wall, such as vehicle loads. All surcharge loading should be taken into consideration in the retaining system/wall design.

#### 5.5.1 Soil Nails

The ultimate bond stresses provided in Table 7 may be adopted for soil nails with the provision that the nails are proof loaded to at least 1.5 times their design working load. The parameters recommended in this section are based on engineering experience and published values that are typical for the Sydney region. It is recommended the suitability of these parameters be confirmed by the geotechnical practitioner by observation of conditions encountered during construction and the results of the recommended proof-load testing.

Table 7:	Recommended	<b>Ultimate Bond</b>	<b>Stress for</b>	Soil Nails
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Geotechnical Unit	Ultimate Bond Stress (kPa)
Unit 1: Topsoil/Fill	Not Applicable
Unit 2: Alluvium (Sandy clay, clay and clayey sand)	40



## 5.6 SEISMICITY

A Hazard Factor (Z) of 0.08 is appropriate for the development site, which is assigned sub-soil class  $C_e$  in accordance with Australian Standard AS1170.4 – 2007 Structural Design Actions – Part 4: Earthquake Actions in Australia.

## 5.7 **RECOMMENDATIONS**

Rock was observed in Borehole BH04 only and the depth and condition of the rock should be considered a preliminary approximation as conditions may vary beyond the borehole location. It is recommended that additional boreholes be completed once planned footing locations and depths are known and prior to construction, to enable better delineation of the depth to rock and condition of the rock at the Site.

## **6 GEOTECHNICAL CONSTRAINTS**

The following geotechnical constraints were identified during this geotechnical investigation.

- The depth to groundwater measured in the boreholes at the Site during the fieldwork is anticipated to be below the planned bulk excavation depth for the basement. However, augering below groundwater during pile installation without adequate shoring or lining may result in cave-in and sloughing of the adjacent ground.
- The close proximity of the neighbouring roads and pavements, buildings and underground services may be affected by excavation and construction activities at the Site. This may include, if adequate management and mitigation measures are not implemented, the potential for adverse impacts from noise, vibration and ground movement associated with the excavation and construction works.

## 7 LIMITATIONS OF THIS REPORT

This report has been prepared for use by the client who commissioned the works in accordance with the project brief and based on information provided by the client. The advice contained in this report relates only to the current project and all results, conclusions and recommendations should be reviewed by a competent person with experience in geotechnical and environmental investigations before being used for any other purpose. Consulting Earth Scientists Pty Ltd (CES) accepts no liability for use or interpretation by any person or body other than the client. This report



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It should be noted that boreholes were drilled within the site during the investigation. Therefore, the geotechnical model was inferred only and may not fully represent the accuracy of the overall ground conditions across the site. Spatial variability in ground conditions within the site can occur even at very small distances between any two bore holes. Excavation for footing bases and other purposes will confirm the likelihood of such ground variability.

This report does not provide a complete assessment of the geotechnical or environmental status of the site and is limited to the scope defined therein. Should information become available regarding conditions at the site including previously unknown sources of contamination, CES reserves the right to review the report in the context of the additional information.

## 8 REFERENCES

- Landcom publication, 2004. *Managing Urban Stormwater: Soils and Construction*. Fourth Edition, NSW Government.
- Standards Australia, 2007. AS3798-2007 Guidelines on Earthworks for Commercial and Residential Developments.
- Standards Australia, 1996. AS2870-1996 Residential Slabs and Footings Construction.
- Standards Australia, 2009. AS2159-2009 Piling Design and Installation.



FIGURES

CES Document Reference: CES181201-RPS-AC



# FIGURE 1: SITE LOCATION PLAN





# FIGURE 2: BOREHOLE LOCATION PLAN





# APPENDICES



# **APPENDIX A: GEOTECHNICAL BOREHOLE LOGS**

# **Borelog Symbols and Notes**



#### Suite 3, Level 1•55 Grandview Street• Pymble NSW 2073 Telephone: 02 88569 2200 • Fax: 02 9983 0582 •

DRILLIN	NG INFORMATION:	Ounc	Telephone: 02 88569 2200 • Fax: 02 9983 05		
Support		Method		Water	
None	No support provided	HA	HAND AUGER	$\supset$	Inflow of water
Mud	Drilling mud used	RA	ROTARY AIR	$\triangleleft$	Water Loss
NQ	NQ size drilling pipe (69.9 mm ODia)	ADV	Auger 'V'-STEEL BIT	S S	Water Level during drilling / excavation
HQ	HQ size drilling pipe (88.9 mm ODia)	ADTC	Auger 'TUNGSTEN-CARBIDE' BIT	Ŧ	Stabilised Water Level
PQ	PQ size drilling pipe (139.9mm ODia)	NMLC	DIAMOND CORING		

#### SAMPLING:

Sample ID	Type	D	Small Disturbed Sample
ddmmyy-01-SM Date-Sample Number-Initials of Sampler		U50	Undisturbed 50mm dia. tube sample
		в	Bulk Disturbed Sample
Note : Sample Depth is indicated by horizontal lines which define the start and end depths		PT	Geoprobe Push Tube Sample in
		J	Environmental Sample collected in a laboratory supplied glass jar
		SPT	SPT Split Tube Sampler

#### FIELD TESTS:

Standard	Penetration Test (SPT)	Vane Shear
{2,3,4}	Number of blows per 150mm over a depth of 450mm	VS=30 Vane Shear Reading of 30 kPa
N = 7	SPT "N" number = sum of last two blow counts	Pocket Penetromenter
#R	Refusal. SPT not able to penetrate	PP=100 Pocket Penetrometer Reading of 100 kPa (unless in notated column)
HB	Hammer Bouncing	6 · · · · · · · · · · · · · · · · · · ·

#### SYMBOLS:



#### NATURAL ROCK DEFECTS:

Description	Description Order:												
Fracture Type	racture Type, Orientation, Roughness, Shape, Infill, Other												
Fracture Typ	De	Shape		Infilling									
JT	Joint	PLN	Planar	CN	Clean								
PT	Bedding Plane Parting	CU	Curved	SN	Stained								
SS	Sheared Surface	UN	Undulating	VN	Veneer								
SZ	Sheared Zone	ST	Stepped	СО	Coating								
SSM	Sheared Seam	IR	Irregular										
CS	Crushed Seam												
IS	Infilled Seam												
EWS	Extremely Weathered Seam	Roughness											
		VR	Very Rough	Others									
Orientation		RF	Rough	DIS	Discontinuous								
JT <u>75</u>	75 degrees from Horizontal	SO	Smooth	TI	Tight								
VT	Vertical	POL	Polished	HW	Highly Weathered								
HZ (or 0o)	Horizontal	SLK	Slickensided										

Project I Client: Project: Location	D: 1:		CES18 Root Pa Enviror 56-58 F	1201- artners nment Beane	RPS ships Pty Ltd al and Geotechnical Site Inve Street, Gosford NSW	on 2 PH:	Jones Bay Whar 6-32 Pirrama Road, Pyr (02) 8569 2200 FAX www.consul	SULTING TH NTISTS f 19-21, Suite 55 mont NSW 2009 (c (02) 9552 4399 tingearth.com.au	LOG BH	<b>ID:</b> [01 et: 1 of 3	
X-Coord	:		346153		Date Con	mmenc	ed:	18/12/2018	Logg	ed by: H	JN
Y-Coord	: Flovo	tion	630080	6	Date Con Hole Dia	mplete	d: (mm):	18/12/2018	Chec	ked by: M	K
Drilling Inf	forme	tion	( <b>K.</b> L) .			meter	().	Samplas		Tosts	
	(tr							-		eter	n) (n
Depth (mBGL)	Method (Suppo	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environments Sample ID	SPT	Soil Penetrome (kPa)	Photo-Ionisati Detector (ppr
0.0					FILL: SAND, fine grained, pale brown/yellow. Trace brick and tile fragments.		D	0.5m to 0.6m	0.5m to 0.95m (4.6.7) N=13	-	0m to 0.5m = 0.0
				CL	Sandy CLAY: Low plasticity, pale	VSt	MC=PI		{4,0,7} IN=15		-
					yellow/brown. Sand is fine grained and angular.					0.95m PP>600kPa	- - - 1
									1m to 1.45m {7,8,10} N=18		-
+					Becoming mottled dark orange/yellow.					1.45m PP>600kPa	-
-									1.5m to 1.95m {6,10,14} N=24		1.5m to 1.6m =
								1.8m to 1.9m	-	1.95m PP>600kPa	-
2.0									2m to 2.45m {12,13,12} N=25		2
										2.45m PP>600kPa	-
2.5 + + + + + + + + + + + + + + + + + + +				SC	Clayey SAND: Fine grained, pale yellow/orange. Trace gravels, fine grained, dark orange, rounded.	MD	М		2.5m to 2.95m {10,12,12} N=24		-
										2.95m PP>600kPa	-
3.0 +									3m to 3.45m {7,10,11} N=21		3m  to  3.1m =

Project ID:CES181201-Client:Root PartnerProject:EnvironmenLocation:56-58 Beane			CES18 Root Pa Enviror 56-58 F	1201-] artners nmenta Beane	01-RPS merships Pty Ltd nental and Geotechnical Site Investigation ane Street, Gosford NSW			LOGSULTING EARTH SCIENTISTS Jones Bay Wharf 19-21, Suite 55 26-32 Pirrama Road, Pyrmont NSW 2009 PH: (02) 8569 2200 FAX: (02) 9552 4399 www.consultingearth.com.au Sheet: 2			<b>ID:</b> [01 et: 2 of 3
X-Coord	l:		346153	r	Date Con	mmenc	ed:	18/12/2018	Logg	ed by: H	JN
Y-Coord Surface	1: Eleva	ation	630080 ( <b>R.L) :</b>	5	Date Col Hole Dia	mplete	a: (mm):	18/12/2018 125mm	Chec	ked by: M	K
Drilling In	nform	ation			LITHOLOGY		< ,	Samples		Tests	
Depth (mBGL)	Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)
3.5 — - - - - -								3.3m to 3.4m		3.45m PP>600kPa	
+ 4.0 - - 4.5 - - - 5.0	125mm V-Bit Auger								4m to 4.45m {8,9,11} N=20	4.45m PP>600kPa	4- - - - - - - - - - - - - - - - - - -
				CL	Sandy CLAY: Low plasticity, mottled dark orange/pale grey. Sand is fine grained, angular. Trace gravels, fine grained, pale grey and rounded.	VSt	MC=PI		6m to 6.45m {7,6,8} N=14	5.45m PP>600kPa	

Project Client: Project Locatio	ID: : on:		CES18 Root Pa Enviroi 56-58 I	1201-] artners nmenta Beane	RPS ships Pty Ltd al and Geotechnical Site Inves Street, Gosford NSW	on 2 PH:	CON EAR SCIE Jones Bay Wharf 6-32 Pirrama Road, Pyrr (02) 8569 2200 FAX www.consult	SULTING TH NTIS TS 19-21, Suite 55 mont NSW 2009 : (02) 9552 4399 tingearth.com.au	LOG BH	<b>ID:</b> [01 et: 3 of 3	
X-Coor	d:		346153		Date Cor	nmenc	ed:	18/12/2018	Logg	ed by: H	JN
Y-Coor	<b>Y-Coord:</b> 6300806			6	Date Cor	nplete	d:	18/12/2018	Chec	ked by: M	K
Surface	Elevation (R.L) :				Hole Dia	meter	(mm):	125mm			
Drilling I	nforma	tion			LITHOLOGY			Samples		Tests	
Depth (mBGL)	Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetromete (kPa)	Photo-Ionisatior Detector (ppm)
				SC CL	Clayey SAND: Fine to medium grained, mottled dark orange/pale brown. Trace gravels, fine grained, pale grey, rounded. Trace carbonaceous organics, black, decomposing. Becoming pale grey. Sandy CLAY: Low plasticity, mottled dark orange/pale grey. Sand is fine grained and angular. Trace carbonaceous organics, black, decomposing.	MD VSt	M MC=PI		7m to 7.45m {5,7,9} N=16 8m to 8.45m {6,8,9} N=17	6.45m PP>600kPa 7.45m PP>600kPa	7
	$\checkmark$									8.45m PP>600kPa	-
8.5 —					Borehole terminated at 8.45m depth. Target depth.						-
			L		<u>I</u>	<u> </u>	<u> </u>	1	1	1	<u> </u>

Project D Client: Project: Locatior	ID: n:		CES18 Root Pa Enviror 56-58 F	1201- artners nment Beane	RPS ships Pty Ltd al and Geotechnical Site Inve Street, Gosford NSW	on 20 PH:	Jones Bay Whar 6-32 Pirrama Road, Pyr (02) 8569 2200 FAX www.consul	SULTING TH INTIS TS f 19-21, Suite 55 mont NSW 2009 f: (02) 9552 4399 tingearth.com.au	LOG BH	<b>ID:</b> [ <b>02</b> et: 1 of 3	
X-Coord	:		346152Date Commenced				ed:	18/12/2018	Logg	ed by: H	JN
Y-Coord	: Flovo	tion	630079	1	Date Co Hole Dig	mplete	d: (mm):	18/12/2018	Chec	ked by: M	K
Drilling Int	form	ntion	(K.L) . 				().	Samples		Tosts	
Drining III	(tr							-		eter	n) (n
Depth (mBGL)	Method (Suppc	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environments Sample ID	SPT	Soil Penetrome (kPa)	Photo-Ionisati Detector (ppn
					FILL: SAND, fine grained pale brown/yellow. Trace brick and tile fragments, .		D	0.2m to 0.3m	-		0m to 0.5m = 0 0.0
0.5				CL	Sandy CLAY: Low plasticity, mottled pale orange/brown/grey. Sand is fine grained, angular. Trace carbonaceous organics, black, decomposing.	St	MC=PI		0.5m to 0.95m {6,6,8} N=14	0.95m PP>600kPa	
1.0 + + + 1.5						- H	-		1.5m to 1.95m	-	1
20					Moisture content decreasing.		MC <pi< th=""><th></th><th>{11,16,17} N=33</th><th>1.95m PP&gt;600kPa</th><th>0.0</th></pi<>		{11,16,17} N=33	1.95m PP>600kPa	0.0
2.5											
3.0									3m to 3.45m {9,18,16} N=34	-	$\frac{3m \text{ to } 3.1m}{0.0} =$

Project Client: Project: Location	ID: CES181201- Root Partner Environment a: 56-58 Beane			ES181201-RPS Root Partnerships Pty Ltd Environmental and Geotechnical Site Investigation 66-58 Beane Street, Gosford NSW			on PH:	CON EAR SCIE Jones Bay Whart 5-32 Pirrama Road, Pyr (02) 8569 2200 FAX WWW.consult	SULTING TH NTISTS 19-21, Suite 55 mont NSW 2009 (02) 9552 4399 ingearth.com.au	LOG BH	<b>ID:</b> <b>102</b> et: 2 of 3	
X-Coord	:	346152				Date Cor	nmenc	ed:	18/12/2018	Logg	ed by: H	JN V
Surface l	Surface Elevation (R.L) :					Hole Dia	meter (	ı: (mm):	12/2018 125mm	Check	keu by: M	ĸ
Drilling In	forma	ation			LITHOLOGY	Y			Samples		Tests	
Depth (mBGL)	Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle chan colour, moisture, secondar component	racteristics ry and minor	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)
											3.45m PP>600kPa	
    	125mm V-Bit Auger											- - 4 - - -
4.5					Moisture content increas	sing.	VSt	MC=PI		4.5m to 4.95m {11,12,11} N=23	4.95m PP>600kPa	4.5m to 4.6m =
5.0 — - - - -												5
5.5												
6.0 <u>+</u> + +									6m to 6.1m	6m to 6.45m {9,10,11} N=21		6 6m to 6.1m = 0.0

Project ID: Client: Project: Location:	CES1812 Root Part Environn 56-58 Be	201-R tnersh nental eane S	PS ips Pty Ltd and Geotechnical Site Inves treet, Gosford NSW	n 20 PH:	CON EAR SCIE Jones Bay Wharf 6-32 Pirrama Road, Pyrr (02) 8569 2200 FAX www.consult	SULTING TH NTISTS 19-21, Suite 55 nont NSW 2009 (02) 9552 4399 ingearth.com.au	LOG BH	<b>ID:</b> <b>02</b> et: 3 of 3	
X-Coord:	346152		Date Con	nmence	ed:	18/12/2018	Logg	ed by: H	JN
Y-Coord:	6300791		Date Con	npleted	l:	18/12/2018	Chec	ked by: M	К
Surface Elevatio	n (R.L) :		Hole Dia	meter (	(mm):	125mm			
Drilling Informatio	n		LITHOLOGY			Samples		Tests	
Depth (mBGL) Method (Support) Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetromete (kPa)	Photo-Ionisation Detector (ppm)
		SC SC	Clayey SAND: Fine to medium grained, dark orange to brown. Trace gravels, fine grained, pale grey, rounded. Trace carbonaceous organics, black, decomposing.	St MD	М		7.5m to 7.95m {4.5,6} N=11	6.45m PP>600kPa 7.95m PP>600kPa	
8.0	·/. ·/.								8

Project ID: Client: Project: Location:	-	CES18 Root Pa Enviror 56-58 E	1201-] artners nmenta Beane	RPS ships Pty Ltd al and Geotechnical Site Inves Street, Gosford NSW	stigatio	on 20 PH:	Jones Bay Wharf 6-32 Pirrama Road, Pyr (02) 8569 2200 FAX www.consult	SULTING TH NTISTS 19-21, Suite 55 mont NSW 2009 (02) 9552 4399 ingearth.com.au	LOG BH	<b>ID:</b> 03 et: 1 of 3
X-Coord:		346135		Date Cor	nmenc	ed:	18/12/2018	Logg	ed by: H	JN
Y-Coord: Surface Eleva	tion	630081 ( <b>R.L) :</b>	1	Date Cor Hole Dia	nplete meter	a: (mm):	18/12/2018 125mm	Chec	ked by: M	K
Drilling Informa	tion	() •		LITHOLOGY		():	Samples		Tests	
Depth (mBGL) Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)
			CL	FILL: SAND, fine grained pale brown/yellow. Trace concrete, brick and tile fragments, . Sandy CLAY: Low plasticity, dark orange. Sand is fine grained, angular. Trace carbonaceous organics, black, decomposing.	VSt	D MC=PI	0.1m to 0.2m	0.5m to 0.95m {4,4,3} N=7	0.95m PP>600kPa	0m to 0.5m = 0 0.0 1- 1- 1.5m to 1.6m = 0.0
				Becoming mottled orange/pale grey/brown.				3m to 3.45m {6,7,11} N=18		3m  to  3.1m =

Project Client: Project: Locatio	oject ID:CES18120ent:Root Partneoject:Environmecation:56-58 BearCoord:346135Coord:6300811			1201-] artners nmenta Beane	201-RPS tnerships Pty Ltd nental and Geotechnical Site Investigation eane Street, Gosford NSW Date Commenced:		n 2 PH:	Consol Tinc EARTH SCIENTISTS Jones Bay Wharf 19-21, Suite 55 26-32 Pirrama Road, Pyrmont NSW 2009 PH: (02) 8569 2200 FAX: (02) 9552 4399 www.consultingearth.com.au		LOG ID: BH03 Sheet: 2 of	
X-Coord	l:		346135		Date Con	nmenc	ed:	18/12/2018	Logg	ed by: H	JN
Y-Coord Surface	ı: Eleva	tion	( <b>R.L</b> ) :	1	Date Cor Hole Dia	npleteo meter (	1: (mm):	18/12/2018 125mm	Chec	ked by: M	K
Drilling In	form	ation	() ·		LITHOLOGY		().	Samples		Tests	
Depth (mBGL)	Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)
+ + + 3.5 + + + + 4.0 + + 4.0 + + + 5.0 + + 5.0 + + + 5.5 + + + + 5.5 + + + + 5.5 + + + +	125mm V-Bit Auger								4.5m to 4.95m {7,10,14} N=24	3.45m PP>600kPa 4.95m PP>600kPa	4.5m to 4.6m = 0.0 4.5m to 4.6m = - - - - - - - - - - - - -
				SC	Clayey SAND: Fine to medium grained, mottled pale grey/dark orange. Trace carbonaceous	MD	М		6m to 6.45m {6,7,7} N=14		6m to 6.1m = 0.0

Project Client: Project: Locatio	ID: n:		CES18 Root Pa Environ 56-58 H	1201-J artners nmenta Beane	RPS ships Pty Ltd al and Geotechnical Site Inve Street, Gosford NSW	stigatic	on 21 PH:	CON EAR SCIE Jones Bay Whar 6-32 Pirrama Road, Pyr (02) 8569 2200 FAX www.consul	SULTING TH NTISTS f 19-21, Suite 55 mont NSW 2009 : (02) 9552 4399 tingearth.com.au	LOG BH	<b>ID:</b> [03 et: 3 of 3
X-Coord Y-Coord Surface I	l: l: Eleva	tion	346135 630081 <b>(R.L) :</b>	1	Date Co Date Co Hole Dia	mmenc mpletee imeter	ed: d: (mm):	18/12/2018 18/12/2018 125mm	Logg Chec	ed by: H ked by: M	JN IK
Drilling In	forma	tion			LITHOLOGY			Samples		Tests	
Depth (mBGL)	Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)
				CL	organics, black, decomposing.  Sandy CLAY: Low plasticity, mottled pale grey/brown/orange. Sand is fine grained, angular.	VSt	MC=PI		7.5m to 7.95m {6,8,9} N=17	6.45m PP>600kPa 7.95m PP>600kPa	7.5m to 7.6m =

Project Client: Project: Locatio	ID: : n:		CES18 Root Pa Enviror 56-58 I	1201-1 artners nmenta Beane	RPS ships Pty Ltd al and Geotechnical Site Inve Street, Gosford NSW	stigatio	Dn 2 PH:	CON EAR SCIE Jones Bay Whar 6-32 Pirrama Road, Pyr (02) 8569 2200 FAX www.consul	SULTING TH NTIS TS 19-21, Suite 55 mont NSW 2009 c (02) 9552 4399 lingearth.com.au	LOG BH	<b>ID:</b> [ <b>04</b> et: 1 of 4
X-Coord Y-Coord	1: 1:		346131 630079	4	Date Co Date Co	mmenc mplete	ed: d:	18/12/2018 18/12/2018	Logg Chec	ed by: H ked by: M	JN K
Surface	Eleva	tion	(R.L) :		Hole Dia	meter	(mm):	125mm			
Drilling Ir	nforma	ntion			LITHOLOGY			Samples		Tests	
Depth (mBGL)	Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)
0.0	$\bigwedge$				FILL: SAND, fine grained pale brown/yellow. Trace concrete, brick and tile fragments, .		D	0.2m to 0.3m			0m to 0.5m = 0.0
0.5				CL	Sandy CLAY: Low plasticity, mottled pale orange/brown. Sand is fine grained, angular. Trace gravels, fine grained, dark grey, rounded.	VSt	MC <pi< th=""><th></th><th>0.5m to 0.95m {7,9,9} N=18</th><th></th><th></th></pi<>		0.5m to 0.95m {7,9,9} N=18		
										0.95m PP>600kPa	- - - -
+ + + + + + + + + + + + + + + + + + + +											-
1.5 <del></del> + + +						Н			1.5m to 1.95m {5,13,18} N=31	1.95m PP>600kPa	1.5m to 1.6m = 0.0
2.0											
2.5											
3.0 ++++++++++++++++++++++++++++++++++++									3m to 3.45m {9,14,16} N=30	-	3m to 3.1m =

Project Client: Project: Locatio	oject ID:CES181201-RPSent:Root Partnerships Pty Ltdoject:Environmental and Geotechnical Site Ircation:56-58 Beane Street, Gosford NSWCoord:346131Date					Site Inves	stigatic	on 2 PH:	Jones Bay What 6-32 Pirrama Road, Py (02) 8569 2200 FAX www.consu	SULTING TH INTISTS f 19-21, Suite 55 rmont NSW 2009 (c) 9552 4399 tingearth.com.au	LOG BH	<b>ID:</b> [04 et: 2 of 4
X-Coord	l:		346131			Date Cor	nmenc	ed:	18/12/2018	Logg	ed by: H	JN
Y-Coord Surface	ı: Eleva	tion	6300/94 ( <b>R.L</b> ):	4		Date Cor Hole Dia	npleteo meter (	1: (mm):	18/12/2018 125mm	Chec	ked by: M	۱K
Drilling In	form	tion			LITHOLOG	Y			Samples		Tests	
Depth (mBGL)	Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle chan colour, moisture, secondar component	racteristics ry and minor	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)
					Becoming mottled dork						3.45m PP>600kPa	
+ + 4.0 +					Becoming motiled dark orange/brown.			MC=PI				- - 4
+ + 4.5 + -					Trace carbonaceous org black, decomposing. Mo content increasing.	anics, jisture	VSt			4.5m to 4.95m {9,11,14} N=25	-	4.5m to 4.6m = 0.0
  5.0  	Smm V-Bit Auger										4.95m PP>600kPa	- - - - -
5.5 — - - - -	12											
6.0 + +										6m to 6.45m {6,7,8} N=15	-	6 6m to 6.1m = 0.0

Project ID: Client: Project: Location:	CES181201- Root Partner Environment 56-58 Beane	RPS ships Pty Ltd al and Geotechnical Street, Gosford NS	Site Investigati W	on 2 PH	CON EAR SCIE Jones Bay Wharf 26-32 Pirrama Road, Pyr : (02) 8569 2200 FAX www.consult	SULTING TH NTIS TS f 19-21, Suite 55 mont NSW 2009 : (02) 9552 4399 tingearth.com.au	LOG BH	<b>ID:</b> [04 et: 3 of 4
X-Coord:	346131		Date Commen	ced:	18/12/2018	Logg	ed by: H	JN
Y-Coord: Surface Elevation	6300794 n ( <b>R.L</b> ) :		Date Complete Hole Diameter	ed: (mm):	18/12/2018 125mm	Chec	ked by: M	K
Drilling Information	n	LITHOLOGY	Y	( )	Samples		Tests	
Depth (mBGL) Method (Support) Water	Symbol USCS Symbol	Description SOIL TYPE: plasticity or particle char colour, moisture, secondar component	consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		Becoming pale grey. Becoming dark orange.				7.5m to 7.95m {6,8,10} N=18	6.45m PP>600kPa	7
								9.

Project Client: Project: Location	ID: n: :		CES18 Root Pa Enviror 56-58 F 346131	1201-] artners nmenta Beane	RPS hips Pty Ltd al and Geotechnical Site Inv Street, Gosford NSW Date Co	estigatio	on PH: ed:	CON EAR Scie Jones Bay Whart 5-32 Pirrama Road, Pyr (02) 8569 2200 FAX. www.consult 18/12/2018	SULTING TH NTIS TS 19-21, Suite 55 mont NSW 2009 (02) 9552 4399 ingearth.com.au	LOG BH She	<b>ID:</b> <b>04</b> et: 4 of 4
Y-Coord	:		6300794	4	Date Co	omplete	1:	18/12/2018	Check	ked by: M	K
Surface	Elevat	ion	(R.L):		Hole D	ameter	(mm):	125mm			
Drilling In	forma	tion			LITHOLOGY			Samples		Tests	
Depth (mBGL)	Method (Support)	Water	Symbol	USCS Symbol	<b>Description</b> SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)
9.5	↓			СН	CLAY: High plasticity, pale orange. With some sand, fine to medium grained, angular. Auger refusal at 10.3m depth. Refer to core log.		MC>PI				- - - - - - - - - - - - - - - -

Project ID: Client: Project: Location: X-Coord: Y-Coord: Surface Eleva Drilling Inform	CES18 Root P Enviro 56-58 3461: 6300 ation (R.L) mation	artnersl nmenta Beane S 31 794	RPS nips Pty Ltd l and Geotechnical Site Investigati Street, Gosford NSW Date Commen Date Complet Hole Diameter LITHOLOGY	on aced: ed: r (mm	Jones Bay WH 26 - 32 Pirrama Road, I PH: (02) 8569 2200 F www.cor 20/12/2018 20/12/2018 ): 52	CONS EART SCIEN harf 19 - Pyrmont FAX: (02 nsultinge	ULT H 21, Su t, NSW 2) 9552 earth.cc	ING IS 2009 4399 om.au Logge Checl	Co ] ed by ced b	Drehole ID: BH04 Sheet: 1 of 2 : HJN y: D.L Defects
Depth (mBGL) Method (Suppor	% Coreloss Water	Symbol	Rock Description ROCK TYPE: grain characteristics, colour structure, minor components	Weathering	Estimated Strength MPa <sup>60</sup> <del>-</del>	(UC) SI MPa	RQD %	Spaci (m: ୧ ତ ବି	ing m) 000 0007	Description
10.5 - - - - - - - - - - - - - -			PQ Casing installed to 10.4m. 10.4m to 10.7m - Coreloss SANDSTONE: Coarse grained, pale grey, medium strength, slightly weathered. Approxiantely 5% gravels in matrix, fine grained, pale green and grey, rounded. Laminations 15 degrees to horizontal. Becoming stained dark orange and moderately weathered. Becoming high strength and slightly weathered Becoming moderately weathered.	SW MW SW MW			$\langle 50 25 \rangle$			10.87m {JT5, RF, PLN, CO (Clay, HPL, pale grey)} 11 - 11 - 11.67m to 11.69m {EWS (Sand, medium to coarse grained, pale orange, rounded)} 11.825m {PT15, RF, PLN, CN, HW} 11.99m {PT15, RF, PLN, CN} 11.99m {PT15, RF, PLN, CN} 11.99m {PT15, RF, PLN, CN} 12.57m {JT10, RF, ST, CN} 12.57m {JT10, RF, ST, CN} 13 -

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Project ID: Client: Project: Location:	CES18 Root Pa Enviror 56-58 F	1201-R artnersh nmenta Beane S	PS hips Pty Ltd l and Geotechnical Site Investigation Street, Gosford NSW	on	Jones Bay W 26 - 32 Pirrama Road PH: (02) 8569 2200 www.co	CONS EART SCIEN /harf 19 - , Pyrmon FAX: (0: onsulting	<b>SULTING</b> <b>TH</b> <b>NTIS TS</b> - 21, Suite 55 it, NSW 2009 2) 9552 4399 earth.com.au	Corehole ID: BH04 Sheet: 2 of 2
X-Coord: Y-Coord: Surface Elevat	34613 63007 ion (R.L):	51 794	Date Commen Date Complet Hole Diameter	ced: ed: r (mm	20/12/2018 20/12/2018 ): 52		Logg Check	ed by: HJN ked by: D.L
Drilling Informa	tion		LITHOLOGY				N	atural Defects
Depth (mBGL) Method (Support)	% Coreloss Water	Symbol	Rock Description ROCK TYPE: grain characteristics, colour structure, minor components	Weathering	$\begin{array}{c} \text{Estimated} \\ \text{Strength} \\ \text{MPa} \\ \overset{\text{FOD}}{10} \overset{\text{CO}}{10} \overset{\text{CO}}{10$	Is (50) MPa	RQD % (m) 200 %	ing m) Description
13.5			SANDSTONE: Medium grained, pale grey, low strength, highly weathered. Orange staining throughout matrix.	HW				13.66m to 13.7m (Joint spacing typically 20mm, JT10, RF, ST, CN)
14.0			Becoming very low strength and highly weathered. Carbonaceous laminations at 20-25mm spacing.				60	
14.5 -			Becoming medium strength and moderately weathered. Carbonaceous laminations not evident. With carbonaceous laminations at 30- 40mm spacing. Carbonaceous laminations not evident.	MW			→ [	
			Borehole terminated at 14.9m depth. Target					

Project Client: Project Locatio	ID: : n:		CES18 Root Pa Enviror 56-58 F	1201- artners nment Beane	RPS ships Pty Ltd al and Geotechnical Site Inves Street, Gosford NSW	stigatio	on 2 PH:	Lones Bay Whar 6-32 Pirrama Road, Pyu (02) 8569 2200 FAX www.consul	SULTING TH NTISTS f 19-21, Suite 55 mont NSW 2009 :: (02) 9552 4399 tingearth.com.au	LOG BH	ID: [05 et: 1 of 3
X-Coord	1:		346116		Date Con	nmenc	ed:	18/12/2018	Logg	ed by: H	JN
Y-Coord	l: Flove	tion	6300793	8	Date Con Holo Die	mpletee motor	d: (mm):	18/12/2018	Chec	ked by: M	K
Durilling L	LIEVA		( <b>K.</b> L) :			meter	(mm):	125mm		Teste	
Drilling Ir	110rma	ation			LITHOLOGY			Samples		1 ests	uo (t
Depth (mBGL)	Method (Suppo	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environmenta Sample ID	SPT	Soil Penetrome (kPa)	Photo-Ionisati Detector (ppm
0.0					TOPSOIL: Silty SAND, fine to medium grained, dark grey. Trace fine roots and organics.		М	0.5m to 0.6m	0.5m to 0.95m		0m to 0.5m = 0.0 - - -
+ + + 1.0 + + + + +					FILL: Sandy CLAY, low plasticity, pale orange. Sand is fine grained, angular.	-	MC=PI		{3,3,2} N=5	0.95m PP=250kPa	- - - 1 - -
1.5 - - - 2.0 - -					Becoming dark grey.			1.5m to 1.95m	1.5m to 1.95m {1,1,1} N=2	1.95m PP=200kPa	1.5m to 1.6m = 0.0
2.5				CI	CLAY: Medium plasticity, mottled dark orange/pale grey. With some sand, fine grained, angular. Trace carbonaceous organics, black, decomposing.	VSt			3m to 3.45m {5,7,8} N=15		

Project ID Client: Project: Location:	roject ID:CES181201-RPSlient:Root Partnerships Pty Ltdroject:Environmental and Geoteclocation:56-58 Beane Street, GosforCoord:346116Coord:6300708				Site Inves W	tigatio	n 24 PH:	CONSULTIN EARTH SCIENTIST Jones Bay Wharf 19-21, Sui 26-32 Pirrama Road, Pyrmont NSW PH: (02) 8569 2200 FAX: (02) 9552 www.consultingearth.co		LTING STS 1, Suite 55 NSW 2009 9552 4399 arth.com.au LOG ID: BH05 Sheet: 2 of	
X-Coord:		346116			Date Con	nmence	ed:	18/12/2018		ed by: H	JN
Surface Ele	evation	( <b>R.L</b> ):	5		Hole Dia	npieteu meter (	mm):	12/2018 125mm	Check	ked by: M	ĸ
Drilling Info	rmation			LITHOLOGY	Y			Samples		Tests	
Depth (mBGL)	Method (Support) Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle char colour, moisture, secondar component	acteristics y and minor	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)
										3.45m PP>600kPa	
4.0 — 4.0 +	——————————————————————————————————————		CL	Sandy CLAY: Low plas mottled orange/pale grey fine grained, angular. Tr carbonaceous organics, l decomposing.	ticity, y. Sand is ace black,						- - 4 - - -
+ 4.5 - - - -									4.5m to 4.95m {6,7,9} N=16	4.95m PP>600kPa	4.5m to 4.6m = 0.0
5.0 — — — — — —											5 - - -
5.5											
6.0 +   +   +									6m to 6.45m {7,10,13} N=23		6m to 6.1m =

Project Client: Project Locatio	ID: : on:		CES18 Root Pa Enviror 56-58 F	ES181201-RPS bot Partnerships Pty Ltd avironmental and Geotechnical Site Investigation -58 Beane Street, Gosford NSW 6116 Date Commenced: 00798 Date Completed:				n PH:	CON EAR SCIE Jones Bay Whard 6-32 Pirrama Road, Pyr (02) 8569 2200 FAX www.consult	SULTING TH NTIS TS 19-21, Suite 55 mont NSW 2009 c (02) 9552 4399 tingearth.com.au	LOG BH	<b>ID:</b> <b>105</b> et: 3 of 3
X-Coord	<b>d:</b>		346116			Date Con	nmence	ed:	18/12/2018	Logg	ed by: H	JN
Y-Coord	d:		630079	8		Date Con	npleted	l:	18/12/2018	Chec	ked by: M	К
Surface	Elevat	tion	(R.L):			Hole Dia	meter (	(mm):	125mm			
Drilling I	nforma	tion			LITHOLOGY	[			Samples		Tests	
Depth (mBGL)	Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle chara colour, moisture, secondary component	acteristics y and minor	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)
								1			6.45m PP>600kPa	-
6.5 —												-
+												-
		_										-
7.0 —												7—
-												_
+												-
7.5 —										7.5m to 7.95m	-	7.5m to 7.6m =
										N=23		
											7.95m PP>600kPa	-
												-
8.0					Borehole terminated Target depth.	at 8m depth.						8

Project ID: Client: Project: Location:			CES181201-RPS Root Partnerships Pty Ltd Environmental and Geotechnical Site Investigation 56-58 Beane Street, Gosford NSW					CONSULTING EARTH SCIENTISTS Jones Bay Wharf 19-21, Suite 55 26-32 Pirrama Road, Pyrmont NSW 2009 PH: (02) 8569 2200 FAX: (02) 9552 4399 www.consultingearth.com.au			<b>ID:</b> [ <b>06</b> et: 1 of 3	
X-Coord	l:		346120	2	Date Con	ed:	18/12/2018	Logg	ed by: H	JN		
Y-Coord Surface	ı: Eleva	tion	6300810 ( <b>R.L</b> ) :	J	Date Co Hole Dia	mplete meter	a: (mm):	18/12/2018 125mm	Chec	ked by: M	IK.	
Drilling In	form	ation	() •		LITHOLOGY	HOLOGY Samples Tests						
Depth (mBGL)	Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)	
				CL	component         TOPSOIL: Silty SAND, fine to medium grained, dark grey. Trace fine roots and organics.         FILL: Clayey SAND, fine grained, dark brown. Trace brick.         Becoming pale orange.         Becoming dark brown.         Becoming dark brown.         Becoming very dark grey, high organic content.         Sandy CLAY: Low plasticity, mottled pale orange/brown/grey.         Sand is fine grained, angular. Trace carbonaceous organics, black, decomposing.	St	M MC=PI	0.5m to 0.6m	0.5m to 0.95m {11,4,2} N=6		0m to 0.5m = 0.0 - - - - - - - - - - - - - - - - - -	
3.0 — +									3m to 3.45m {5,7,6} N=13	-	3m to 3.1m =	

Project ID: Client: Project: Location:			CES18 Root Pa Enviroi 56-58 I	1201-J artners nmenta Beane	RPS ships Pty Ltd al and Geotechnical Site Inves Street, Gosford NSW	stigatic	n 2 PH:	Consulting EARTH SCIENTISTS Jones Bay Wharf 19-21, Suite 55 26-32 Pirrama Road, Pyrmont NSW 2009 PH: (02) 8569 2200 FAX: (02) 9552 4399 www.consultingearth.com.au						
X-Coord	1:		346120	_	Date Con	nmenc	ed:	I:         18/12/2018         Logged by:         HJN           18/12/2018         Club Llub         MK						
Y-Coord	i: Eleva	tion	630081 (RL)・	0	Date Co Hole Dia	mpleteo meter (	1: (mm)•	18/12/2018 125mm	Chec	ced by: MK				
Drilling In	form	ation					().	Samples		Tests				
Drining II	(tr								Londer		n) (n			
Depth (mBGL)	Depth (mBGL) Method (Suppo Water		Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environment Sample ID	SPT	Soil Penetrom (kPa)	Photo-Ionisat Detector (pp1			
+ + + - 3.5 + + + + 4.0 + + 4.0 + + + 5.0 + + + 5.5 + + + + 5.5 + + + + + + 5.5 + + + +	125mm V-Bit Auger					VSt			4.5m to 4.95m {7,8,9} N=17	3.45m PP=350kPa 4.95m PP>600kPa	4.5m to 4.6m = 0.0			
6.0 — + +				СН	CLAY: Medium plasticity, mottled dark orange/pale grey. With some sand, fine grained, angular.	St			6m to 6.45m {4,6,8} N=14	-	6 6m to 6.1m = 0.0			

Project ID: Client: Project: Location:			CES181201-RPS Root Partnerships Pty Ltd Environmental and Geotechnical Site Investigation 56-58 Beane Street, Gosford NSW 346120 Date Commenced: 18/12/2018 Logged by:					LOG BH She	<b>ID:</b> [ <b>06</b> et: 3 of 3 JN			
Y-Coor	d:		630081	0	Date Con	nplete	1:	18/12/2018	Chec	ked by: M	K	
Surface	Eleva	tion	(R.L):		Hole Dia	meter	(mm):	125mm		·		
Drilling I	nforma	tion			LITHOLOGY			Samples Tests				
Depth (mBGL)	Depth (mBGL)		Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Environmental Sample ID	SPT	Soil Penetrometer (kPa)	Photo-Ionisation Detector (ppm)	
				CL	Sandy CLAY: Low plasticity, mottled pale orange/grey/brown. Sand is fine grained, angular. Trace gravels, dark grey, fine grained, rounded. Trace carbonaceous organics, black, decomposing.	VSt			7.5m to 7.95m {5,8,10} N=18	6.45m PP>600kPa 7.95m PP>600kPa	7	
8.0	, in the second				Borehole terminated at 8m depth. Target depth.						8	



# APPENDIX B: ACID SULFATE SOILS FIELD SCREENING RESULTS



	Dept	h (m)		рНг	(Oxids	PHFOX	РНFOX ion in 30% Hydrogen Peroxide Efferve- scence PH (See Note 1) (PHF-PHFOX) a 1.6 a 0.6 a 0.6 a 0.0 a 0.2 a 0.2 a 0.2 a 0.2 a 0.2			
					(Oxiu	Peroxide)	liyurogen			
Sample Location	Тор	Bottom	Soil Description	pH in 1:5	рН	Efferve- scence	pH Change			
	(m)	(m)		distilled water	FOX	(See Note 1)	(PHF-PHFOX)			
	0.6	0.7	Sandy Clay	6.7	5.1	а	1.6			
	1.3	1.4	Sandy Clay	5.8	5.2	а	0.6			
	2.2	2.3	Sandy Clay	4.5	4.5	а	0.0			
	3.2	3.3	Clayey Sand	5.1	4.6	а	0.5			
BH01	4.0	4.1	Clayey Sand	5.0	4.8	а	0.2			
	4.6	4.7	Clayey Sand	4.7	4.5	а	0.2			
	5.0	5.1	Clayey Sand	4.5	4.5	а	0.0			
	6.0	6.1	Sandy Clay	4.7	4.5	а	0.2			
	7.0	7.1	Clayey Sand	4.2	4.2	а	0.0			
	0.5	0.6	Sandy Clay	5.2	5.1	а	0.1			
	1.0	1.1	Sandy Clay	5.2	4.0	а	1.2			
	1.5	1.6	Sandy Clay	5.1	4.6	а	0.5			
	2.0	2.1	Sandy Clay	4.6	4.1	а	0.5			
DU02	2.5	2.6	Sandy Clay	4.8	4.6	а	0.2			
ВП02	3.0	3.1	Sandy Clay	4.5	4.5	а	0.0			
	3.5	3.6	Sandy Clay	4.8	4.0	b	0.8			
	4.0	4.1	Sandy Clay	4.7	4.4	а	0.3			
	4.5	4.6	Sandy Clay	4.8	4.8	a	0			
	5.0	5.1	Sandy Clay	5.1	4.1	a	1			

CES Document Reference: CES181201-RPS-AC



	Dept	h (m)		рН <sub>F</sub>	(Oxida	PHFOX ation in 30%	PHFOX         ONOTO         A         A         A         A         A         A         A         A         A         A         A         A         A         A         A         A <t< th=""></t<>		
Sample Location	Тор	Bottom	Soil Description	pH in 1:5	рН	Efferve- scence	pH Change		
	(m)	(m)		distilled water	FOX	(See Note 1)	(PHF-PHFOX)		
	5.5	5.6	Sandy Clay	5.1	4	b	1.1		
	6.0	6.1	Sandy Clay	5.1	4.6	а	0.5		
BH02	6.5	6.6	Sandy Clay	5.1	3.9	b	1.2		
(Continued)	7.0	7.1	Sandy Clay	4.6	3.5	а	1.1		
	7.5	7.6	Clayey Sand	5.6	5.3	а	0.3		
	7.9	8.0	Clayey Sand	5.8	5.3	а	0.5		
	0.5	0.6	Fill: Sand	5.9	5.9	а	0		
	1.0	1.1	Sandy Clay	6.3	5.6	а	0.7		
	1.5	1.6	Sandy Clay	5.5	4.5	а	1		
	2.0	2.1	Sandy Clay	5.8	4.3	а	1.5		
	2.5	2.6	Sandy Clay	5.2	4	а	1.2		
	3.0	3.1	Sandy Clay	5.2	4.2	а	1		
BH03	3.5	3.6	Sandy Clay	4.9	4.2	а	0.7		
	4.0	4.1	Sandy Clay	5.1	4.1	а	1		
	4.5	4.6	Sandy Clay	5.8	4.5	а	1.3		
	5.0	5.1	Sandy Clay	5.6	4.7	а	0.9		
	5.5	5.6	Sandy Clay	5.6	4.4	а	1.2		
	6.0	6.1	Clayey Sand	6	5.2	a	0.8		
	6.5	6.6	Clayey Sand	6.2	5.8	a	0.4		



		• ( )				PHFox		
	Dept	h (m)		PHF	(Oxida	ation in 30% I Peroxide)	PHFOX         ONOTE 1)       (PHF-PHFOX)         ONOTE 1)       (PHF-PHFOX)         ONOTE 1)       (PHF-PHFOX)         ONOTE 1)       ONOTE 1)         ONOTE 1)       ONOTE 1	
Sample Location	Тор	Bottom	Soil Description	pH in 1:5	рН	Efferve- scence	pH Change	
	(m)	(m)		distilled water	FOX	(See Note 1)	(PHF-PHFOX)	
BH03 (Continued)	7.0	7.1	Clayey Sand	5.8	4.2	b	1.6	
(Continued)	7.5	7.6	Sandy Clay	6	5.9	а	0.1	
	0.5	0.6	Sandy Clay	5.1	4.7	а	0.4	
	1.0	1.1	Sandy Clay	5.4	4.9	а	0.5	
	1.5	1.6	Sandy Clay	4.9	4	а	0.9	
	2.0	2.1	Sandy Clay	6	3.6	а	2.4	
	2.5	2.6	Sandy Clay	5	4.7	а	0.3	
	3.0	3.1	Sandy Clay	6.4	4.6	а	1.8	
	3.5	3.6	Sandy Clay	6	3.9	а	2.1	
BH04	4.0	4.1	Sandy Clay	5.8	4.2	а	1.6	
	4.5	4.6	Sandy Clay	5.7	4.6	а	1.1	
	5.0	5.1	Sandy Clay	5.2	4.7	а	0.5	
	5.5	5.6	Sandy Clay	5.6	4.6	а	1	
	6.0	6.1	Sandy Clay	5.7	4.5	а	1.2	
	6.5	6.6	Sandy Clay	5.5	4.7	а	0.8	
	7.0	7.1	Sandy Clay	5.2	4.3	а	0.9	
	7.5	7.6	Sandy Clay	5.2	4.1	а	1.1	
Note 1: - Obs c. Vigorous ef	erved reactio ffervescent r	on: a. No v eaction	isible effervescence	b. Slight to r	noderate e	effervescence		