

RGS31546.1-AB

26 July 2018

Garrard Building Pty Ltd
PO Box 538
YAMBA NSW 2464

Attention: Neil Garrard

Dear Neil

**RE: Proposed Residential Development – 52-54 Miles Street, Yamba NSW
Preliminary Geotechnical Assessment**

1 INTRODUCTION

Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken a geotechnical assessment for a development that is proposed to be constructed at 52-54 Miles Street, Yamba NSW (Lots 46 and 47 DP751395).

The proposed development is understood to involve large scale earthworks to raise the site levels to at least RL3m AHD (fill depths of generally 1.5 to 2m) which will allow the site to be subdivided for residential development. Specific details such as final fill depths, the type of fill material or the proposed lot layout have not yet been provided. It has been assumed that either single or double storey residential structures are likely to be constructed at the site following earthworks.

The purpose of the work as presented herein was to provide comments and recommendations on the following:

- Subsurface profile including depth of topsoil, presence of marine clays or silts, and groundwater level (where encountered) in the upper approximately 1m of the subsurface profile;
- Thickness of unsuitable materials (including topsoil, silt deposits or low strength marine clays, etc.) that would require stripping prior to fill placement;
- Preliminary earthworks recommendations; and
- In-situ permeability for stormwater infiltration pond design (design to be undertaken by others).



2 METHODOLOGY

Field work for the assessment was undertaken by a Geotechnical Engineer on 26 June 2018 and included:

- Observation of site features and surrounding features relevant to the geotechnical conditions of the site;
- Eleven test pits (TP1 to TP11) with a 2 tonne excavator to depths of between 1 and 1.35m;
- Dynamic Cone Penetrometer (DCP) testing adjacent to selected test pits; and
- In-situ falling head permeability testing adjacent to TP5 and TP7.

Engineering logs of the test pits and the in-situ permeability test result sheets are attached. The locations of the test pits are illustrated on Figure 1 and were measured with a hand held GPS. The test locations were nominated by Paul Paskins of Mortons Urban Solutions.

3 SITE CONDITIONS

3.1 Surface Conditions

The approximately 42ha rectangular site is bound by Miles Street to the north, Carrs Drive to the west, Golding Street to the east, and by rural-residential lots and bushland to the south. An aerial photograph that illustrates the site location and site setting is shown below.



Site location and setting is illustrated on the NSW Government 'Six Maps'. The approximate boundary of the site is shown by a red box

The site is located within a region characterised by low lying sand flats with localised swamp deposits in lower lying areas and depressions across the site. The provided survey indicates that site levels are generally between about RL1.0 to 1.4m (AHD) with lower lying depressions and drainage lines having elevations of between about 0.5 to 1.0m. The intermittent drainage lines drain to both the northeast towards the Clarence River and to the southwest towards Oyster Channel. In addition to the drainage lines, surface waters were observed to be ponding in a number of lower



areas across the site and the extents of the larger areas are estimated approximately on Figure 1. These areas were untrafficable on the day of the site investigation. Smaller untrafficable areas were also scattered across the site in localised depressions.

Two residential dwellings are located in the northeast of the site. Typical site photographs are presented below.



Looking west from the southeast corner of the site. Groups of trees are scattered across this area.



Looking south across the northwest portion of the site. This area was trafficable



A row of trees can be seen which are located on the edge of a drainage line in the southwest of the site that drains into Oyster Channel



Looking north from the central portion of the site at open farmland. Lower lying depressions were untrafficable.



Untrafficable boggy ground near the central portion of the southern boundary



Surface water ponding in the southwest portion of the site



A row of trees is present on the edge of a drainage line in the southwest of the site. Water was present within the drainage line



Looking south along the eastern site boundary. Boggy areas were encountered in lower lying portions of the site.

3.2 Subsurface Conditions

The 1:25,000 Yamba Quaternary Geology Map indicates that the site is predominantly underlain by a Holocene tidal-delta flat that comprises marine sand, silt, clay, shell and gravel. The lower lying drainage lines that are located at the site are underlain by a Holocene saline swamp that comprises organic mud, peat, clay, silt and sand, that overlies the tidal-delta flat outline above.

The subsurface conditions encountered within the test pits are summarised in Table 1. Test pit logs and photographs of each of the test pits are attached.



Table 1: Summary of Subsurface Conditions Encountered in Test Pits

Material Name	Material Description	Depth to Base of Material Layer (m)										
		TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8	TP9	TP10	TP11
Topsoil	Silty SAND, dark grey, higher organic content in the upper approximately 50mm.	0.2	0.25	--	--	0.25	0.2	0.25	--	--	0.25	0.2
	Sandy SILT was encountered in TP3 and TP9, and Sandy CLAY in TP4 and TP8			0.1	0.2				0.15	0.25		
Alluvial Clay	Silty CLAY, medium to high plasticity, firm	--	--	0.4	0.4	--	--	--	0.35	0.55	--	--
Alluvial Sand	SAND, fine to medium grained, medium dense to dense	≥1.1	≥1.2	≥1.1	≥1.1	≥1.3	≥1.0	≥1.2	≥1.3	≥1.3	≥1.1	≥1.3

Notes: -- indicates that the material was not encountered at the test location
 ≥ indicates that the base of the material layer was not encountered at the test location

Groundwater was encountered within all the test pits excavated during the investigation. Groundwater levels do fluctuate due to inclement weather, seasonal variations, tidal influences, or due to reasons that may not have been apparent at the time of the site investigation. A summary of the groundwater levels inflows encountered during the investigation is presented in Table 2.

Table 2: Summary of Groundwater Inflow Depths

Summary of Groundwater Inflow Depths (m)										
TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8	TP9	TP10	TP11
0.7	0.9	0.7	0.65	0.9	0.8	1.0	0.95	0.7	0.8	0.8

4 PROPOSED DEVELOPMENT

The proposed development is understood to involve raising the site level to above RL3m (AHD) and subdividing the approximately 42Ha site for residential development which will include the construction of roads, the installation of underground services and likely single and/or double storey residential dwellings.

Earthworks associated with the development will include the placement of generally between 1.5 to 2m of imported fill and at this stage it is understood that a source of fill material has not yet been confirmed. Two stormwater detention ponds are proposed at the site within the general vicinity of TP3 and TP5 and localised excavations (after fill placement) are likely to be required for the construction water/sewer services and the like.



5 SITE APPRECIATION & GEOTECHNICAL CONSTRAINTS

The site is generally underlain by 0.2 to 0.25m of sandy topsoil that overlies medium dense to dense sands. Alluvial clays were encountered within four of the eleven test pits to depths of between 0.35 and 0.55m and the overlying topsoil within these areas comprises clay and silt materials. The clay materials can be generalised as being located within or closely adjacent to the naturally lower lying areas of the site that are identified on Figure 1. Groundwater inflows were encountered within all eleven test pits at depths of between 0.65 and 1.0m.

Several geotechnical constraints have been identified during the assessment that will need to be addressed during the planning and design stages of the development as well as during construction. A summary of the identified constraints is presented below. Further details and recommendations are presented in subsequent sections of this report.

- The site is poorly drained. The test pit investigation was undertaken after a wet weather event and surface waters were present within lower lying areas of the site. Untrafficable 'boggy' areas were identified to be surrounding the surface waters and in isolated depressions that are scattered across the site. Initial site preparation works will be critical to improve drainage conditions during the initial stages of construction;
- Between 200 and 250mm of topsoil was generally encountered within the test pits that were excavated during the investigation. The topsoil was generally a Silty SAND material with a high organic content within the upper approximately 100mm. CLAY and SILT topsoil materials were encountered within four of the test pits that overlie low strength clays as discussed below;
- Firm normally consolidated clays were encountered within four of the eleven test pits excavated during the investigation. This material is likely to undergo both elastic and consolidation settlement during and following fill placement;
- The site investigation was undertaken with a small tracked excavator and the test pits were terminated within wet sands at depths of between 1 and 1.3m. Deeper investigations involving either boreholes or Cone Penetration Tests (CPTs) have not been undertaken and there is the potential for thick normally consolidated clay deposits to be located at depth. If present these layers would likely undergo consolidation settlement due to the surcharge load that is to be applied by the fill and the proposed structures both during and post construction; and
- Groundwater was encountered at depths of between 0.65 and 1.0m. Careful consideration will therefore be required during the planning of the initial fill placement and with the selection and maintenance of haul roads and high trafficked areas.

6 EARTHWORKS

6.1 Site Preparation

Surface waters and saturated 'boggy' ground is present over large portions of the site. The site is poorly drained and extended delays should be expected during the initial stages of earthworks during and after rainfall events and potentially after king tides. The implementation of good site drainage during the initial stages of the development will reduce the risk and extent of delays and will be essential for the successful completion of the initial earthworks stages at the site. The principle aim of the drainage is to promote controlled surface water run-off, reduce the velocity of flow and to reduce the potential for water to pond. During the initial stages of earthworks it may be necessary to construct localised sump points and swale drains to enable surface water to be



pumped and removed from the site. Given the size of the site and extent of works it may be necessary to construct multiple onsite sedimentation basin as part of the overall site erosion and sediment control plan.

Earthworks should be carefully planned and scheduled to maintain suitable cross-falls so as to promote controlled runoff of surface water. Adequate silt control and dissipation measures will need to be employed to reduce the potential for silt entering the storm water system to the south and west of the site. An earthworks management plan (EMP), including an erosion and sediment control plan should be prepared prior to site works commencing.

6.2 Stripping, Fill Placement & Compaction Control

6.2.1 Stripping Options

Site preparation works will therefore generally require the removal of vegetation including the stripping of all organic and root affected material. Any deleterious material or material that appears potentially contaminated should also be stripped and disposed of. These materials are not considered suitable for reuse as engineered fill and should be disposed of offsite, pending appropriate waste classification or exemption, or stockpiled on site where appropriate for later reuse in landscaping areas only.

Based on the results of the assessment and following discussions with you, two options are presented to address the required degree of stripping of unsuitable materials at the site:

Option 1 – Stripping of Organic Rich Materials & Alluvial Clays

This option involves stripping the upper organic rich topsoil and the underlying firm alluvial clay materials that were encountered to depths of up to 0.55m. Based on the results of the site investigation, areas of the site that are not underlain by shallow alluvial clay deposits are likely to require stripping of about 100mm of organic rich materials, however, thicker organic layers may be encountered between the test pit locations.

Option 1 is the preferred option as it removes the risk of consolidation settlement post construction of the shallow alluvial clay layers.

Option 2 – Stripping of organic rich materials only

This option includes stripping the upper organic rich topsoil materials that have an estimated thickness of about 100mm based on the result of the test pits, without removing the firm clay materials that were encountered within TP3, TP4, TP8 and TP9. Selection of this option will involve accepting the risk of differential settlements across the site due to the likely consolidation of the firm alluvial clay layer, however, the degree of risk could be reduced by undertaking regular monitoring of the surface height of the fill (relative to a fixed point outside of the site) over a period of months and potentially years after the completion of earthworks. If this option is selected then it is recommended that the extents of the firm alluvial clay layer which are likely to be identifiable following the initial stripping be recorded by a surveyor.



6.2.2 Fill Placement & Compaction Control

Where fill is required to raise the site to design levels for the placement of high level footings or pavements, following removal of topsoil and other unsuitable materials as discussed above the following outlines the recommended fill placement procedures:

- The site has a shallow water table and careful consideration will be required during the design of the earthworks program to reduce the potential for construction traffic to 'pump' water up into the shallow subgrade soils and the lower fill layers. It is therefore recommended that nominated haul routes be selected and an allowance be made for the placement of rock bridging layers within these areas. It is also recommended that only static compaction be used until at least 1.2m of fill has been placed;
- After unsuitable material has been stripped to expose the underlying alluvial soils (either Option 1 or Option 2 as outlined in Section 6.2.1), the exposed natural subgrade should be proof roll tested (with a large grader, loaded water cart or the like) in the presence of a suitably experienced geotechnical practitioner to highlight any soft, wet or excessively deflecting areas. Where these are encountered, it is recommended that a Geotechnical Engineer be engaged to provide advice regarding appropriate remedial measures and the required extents. Such measures will be dependent on the depth of the water table, the thickness and type of the low strength material, the depth of fill that is to be placed, and the end use of the area (i.e. supporting structures or pavements, etc.). Remedial measures may include:
 - Removing the low strength material and replacing with granular fill such as select fill, crushed concrete or pavement gravel (DGS40);
 - Rock bridging layers which would typically comprise about 400mm of very high strength clean angular no fines rock with a particle size of between about 50 and 150mm, or alternatively clean crushed concrete. The bridging layer should be fully wrapped in a heavy duty geofabric such as Bidim A34 or equivalent;
 - Placement of a 40kN biaxial or triaxial geogrid over the exposed material and covered with at least say 300mm of granular fill; and
 - A combination of some of the above measures.
- Due to the shallow water table it is recommended that two 300mm thick layers of clean granular fill be placed across the site to provide a suitable platform to aid in the placement of the overlying fill layers;
- If a rock bridging layer (wrapped in geofabric) or a geogrid layer is to be placed at the site (as discussed above) consideration should be given to the potential implications to future excavation of service trenches such as sewer/water etc.;
- 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 98% of standard compaction. Clay fill should be placed and maintained within $\pm 2\%$ of standard optimum moisture content. Unless non-reactive fill is used the surface movement characteristics may change significantly and the site classification should be revised;
- 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 95% standard compaction, with the upper 300mm of the subgrade being compacted to at least 100% SMDD. Clay fill should be placed and maintained within 2% of standard optimum moisture content; and



- Where filling is required on batters, the material should be over-placed, compacted, and then trimmed back to the required batter to ensure that compaction is achieved to edge of batter.

In accordance with AS3798-2007, it is recommended that Level 1 control be implemented for areas of the site that are filled to support structures, while areas of the site that are filled to support pavements should be filled under Level 2 supervision and testing. Level 1 control will be required to avoid the future residential lots being classified as Class 'P' sites in accordance with AS2870-2011 '*Residential Slabs and Footings*'.

6.2.3 Deep Consolidation Settlements

As discussed in Section 5, the preliminary geotechnical investigation presented herein was limited to a depth of 1.3m. The site is located within the Clarence coastal delta and is underlain by deep alluvial and marine deposits that extend to depths of up to at least about 30 to 40m. There is therefore a risk that normally consolidated marine clays underlie the site at depth which may undergo consolidation settlement due to the loads imposed by the fill and the residential structures.

The amount of consolidation settlement and the lateral extent and potential for deep seated differential settlements have not been assessed as part of this assessment and would require deep geotechnical investigations, laboratory testing and detailed analysis. Consolidation settlements would be expected to be induced during fill placement and may continue to occur for a number of months and potentially years after the completion of bulk earthworks at the site.

7 STORMWATER INFILTRATION

Two falling head infiltration tests were undertaken within the alluvial sands at the site. The locations of the tests are nominated on Figure 1 as TP5 and TP7. The testing indicated that the alluvial sands have an infiltration rate of between about 2×10^{-4} m/s and 7×10^{-4} m/s. Calculation sheets are attached.

The site is considered suitable for bioretention of stormwater and it is recommended that a design infiltration rate of 2×10^{-4} m/s be adopted.

8 LIMITATIONS

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical and pavement 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.

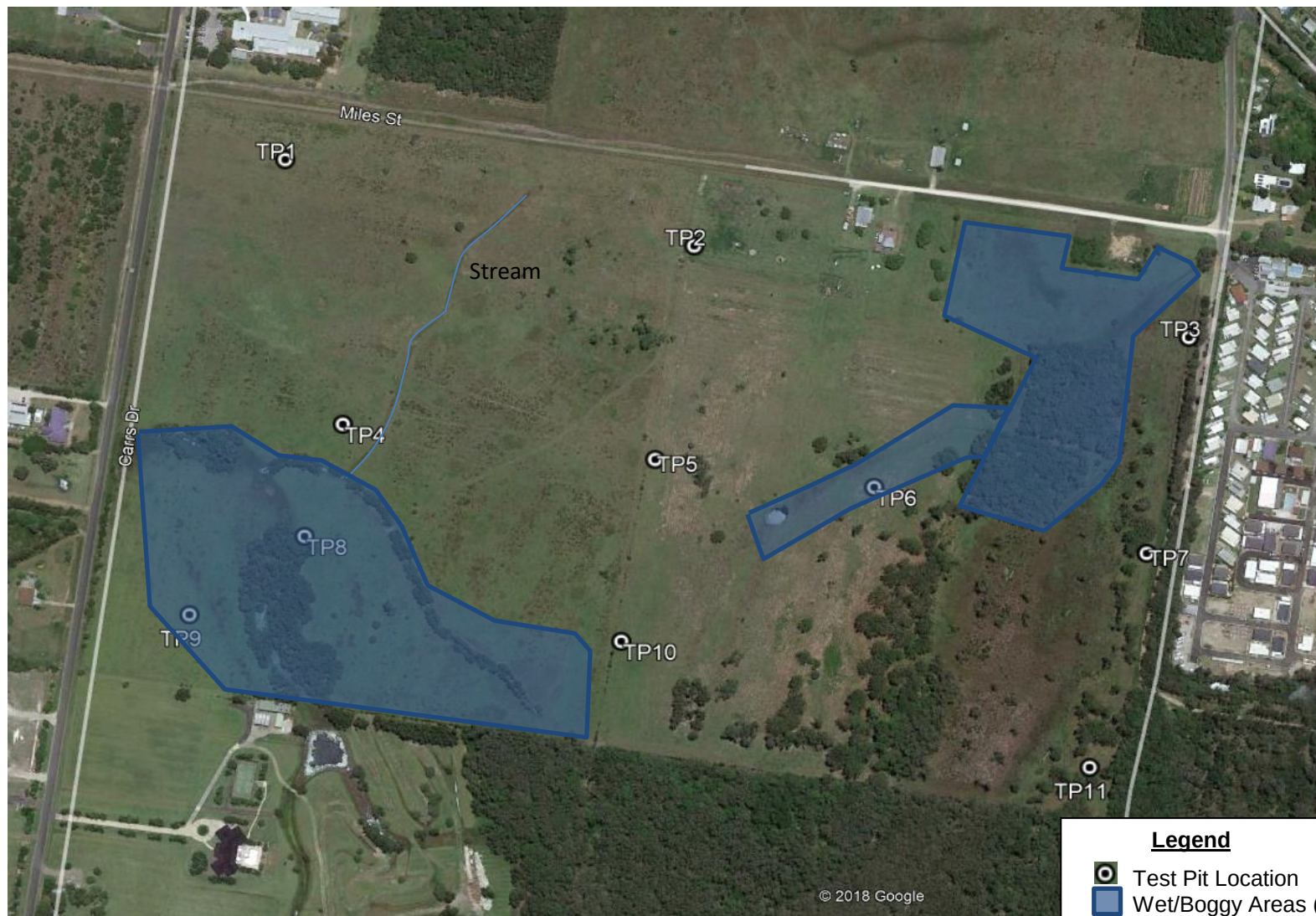
For and on behalf of

Regional Geotechnical Solutions Pty Ltd

Simon Keen

Senior Geotechnical Engineer

Attachments: Figure 1 – Test Pit Location Plans
 Test Pit Logs & Photographs



Legend

- Test Pit Location
- Wet/Boggy Areas (approx. Extents)

 REGIONAL GEOTECHNICAL SOLUTIONS	Client:	Garrard Building PTY LTD	Job No.	RGS31546.1
	Project:	Proposed Development 52-54 Miles Street Yamba NSW	Drawn By:	LD
			Date:	9-Jul-18
	Title:	Test Pit Location Plan	Drawing No.	FIGURE 1



ENGINEERING LOG - TEST PIT

CLIENT: Garrad Building Pty Ltd
PROJECT NAME: Proposed Development
SITE LOCATION: 52-54 Miles Street, Yamba
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP1
PAGE: 1 of 1
JOB NO: RGS31546.1
LOGGED BY: LD
DATE: 26/6/18

EQUIPMENT TYPE: 2t Excavator
TEST PIT LENGTH: 1.6 m
WIDTH: 0.3 m
EASTING: 532334 m
NORTHING: 6743389 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	
Excavator	2:09:00 PM			0.5		SM	TOPSOIL: Silty SAND, fine to medium grained, dark grey	M		DCP (0-1.7m)	1	TOPSOIL
											1	
						SP	SAND: Fine to medium grained, grey, some Silt	M	MD		2	ALLUVIAL SOIL
											3	
											3	
											3	
						SP	SAND: Fine to medium grained, pale grey				4	
								W			4	
						SP	SAND: Fine to medium grained, grey				4	
									D		6	
											6	
				1.5			Hole Terminated at 1.10 m				6	
											5	
											5	
											4	
											3	
											2	

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 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 _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	W _L	Liquid Limit
Gradational or transitional strata		Field Tests		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%



TP1 encountered 0.2m of topsoil overlying sand. Groundwater was encountered at 0.7m.



Excavated material from TP1

	Client:	Garrard Building Pty Ltd	Job No.	RGS31546.1
	Project:	Proposed Residential Development	Drawn By:	SK
		52-54 Miles Street, Yamba	Scale:	NTS
	Title:	Test Pit Photographs - TP1	Date:	26-Jul-18
			Drawing No.	

[illegible]



TP2 encountered 0.25m of topsoil overlying sand. Groundwater was encountered at 0.9m.



Excavated material from TP2



	Client:	Garrard Building Pty Ltd	Job No.	RGS31546.1
	Project:	Proposed Residential Development 52-54 Miles Street, Yamba	Drawn By:	SK
			Scale:	NTS
			Date:	26-Jul-18
	Title:	Test Pit Photographs - TP2	Drawing No.	



ENGINEERING LOG - TEST PIT

CLIENT: Garrad Building Pty Ltd
PROJECT NAME: Proposed Development
SITE LOCATION: 52-54 Miles Street, Yamba
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP3
PAGE: 1 of 1
JOB NO: RGS31546.1
LOGGED BY: LD
DATE: 26/6/18

EQUIPMENT TYPE: 2t Excavator
TEST PIT LENGTH: 1.6 m **WIDTH:** 0.3 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		
Excavator	1:30:00 PM			0.5		ML	TOPSOIL: Sandy SILT, low plasticity, dark brown	M > w _p		DCP (0-0.7m)	1	TOPSOIL	
						CH	Silty CLAY: Medium to high plasticity, grey, pale brown	M > w _p	F		3	ALLUVIAL SOIL	
											12		
											5		
						SM	Silty SAND: Fine to medium grained, grey	W	D	6			
										8			
						SP	SAND: Fine to medium grained, pale grey			10			
				1.0									
				1.10m			Hole Terminated at 1.10 m						
				1.5									
LEGEND:				Notes, Samples and Tests				Consistency		UCS (kPa)		Moisture Condition	
Water Water Level (Date and time shown) Water Inflow Water Outflow Strata Changes --- Gradational or transitional strata — Definitive or distinct strata change				U ₅₀ 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)				VS Very Soft S Soft F Firm St Stiff VSt Very Stiff H Hard Fb Friable		<25 25 - 50 50 - 100 100 - 200 200 - 400 >400		D Dry M Moist W Wet W _p Plastic Limit W _L Liquid Limit	
								Density V Very Loose L Loose MD Medium Dense D Dense VD Very Dense				Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85% Density Index 85 - 100%	



TP3 encountered 0.1m of topsoil overlying firm clay to 0.4m, overlying sand. Groundwater was encountered at 0.7m.



Excavated material from TP3

	Client:	Garrard Building Pty Ltd	Job No.	RG31546.1
	Project:	Proposed Residential Development	Drawn By:	SK
		52-54 Miles Street, Yamba	Scale:	NTS
	Title:	Test Pit Photographs - TP3	Date:	26-Jul-18
			Drawing No.	



ENGINEERING LOG - TEST PIT

CLIENT: Garrad Building Pty Ltd
PROJECT NAME: Proposed Development
SITE LOCATION: 52-54 Miles Street, Yamba
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP4
PAGE: 1 of 1
JOB NO: RGS31546.1
LOGGED BY: LD
DATE: 26/6/18

EQUIPMENT TYPE: 2t Excavator
TEST PIT LENGTH: 1.7 m
WIDTH: 0.3 m
EASTING: 532384 m
NORTHING: 6743163 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	
Excavator	2:40:00 PM			0.5		CL	TOPSOIL: Sandy CLAY, medium plasticity, dark grey	M > w _p				TOPSOIL
						CL	Sandy Silty CLAY: Medium plasticity, grey, brown, with trace coarse gravel	M < w _p	F	HP	100	ALLUVIAL SOIL
						SP	SAND: Fine to medium grained, pale grey, pale brown	M	MD	HP	90	
								W				
				1.0								
				1.5								
							Hole Terminated at 1.10 m					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 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 _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	W _L	Liquid Limit
Gradational or transitional strata		Field Tests		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%



TP4 encountered 0.2m of topsoil overlying firm clay to 0.4m, overlying sand. Groundwater was encountered at 0.65m.



Excavated material from TP4

	Client:	Garrard Building Pty Ltd	Job No.	RG31546.1
	Project:	Proposed Residential Development	Drawn By:	SK
		52-54 Miles Street, Yamba	Scale:	NTS
	Title:	Test Pit Photographs - TP4	Date:	26-Jul-18
			Drawing No.	



ENGINEERING LOG - TEST PIT

CLIENT: Garrad Building Pty Ltd
PROJECT NAME: Proposed Development
SITE LOCATION: 52-54 Miles Street, Yamba
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP5
PAGE: 1 of 1
JOB NO: RGS31546.1
LOGGED BY: LD
DATE: 26/6/18

EQUIPMENT TYPE: 2t Excavator
TEST PIT LENGTH: 2.0 m
WIDTH: 0.3 m
EASTING: 532634 m
NORTHING: 6743129 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	
Excavator	10:30:00 AM			0.25m		SM	TOPSOIL: Silty SAND, fine to medium grained, dark grey	M				TOPSOIL: GRASS
						SM	SAND: Fine to medium grained, grey, with some Silt	M	MD			ALLUVIAL SOIL
						SP	SAND: Fine to medium grained, pale grey, pale brown					
						SP	SAND: Fine to medium grained, grey, pale brown	W		D		
				1.0			Hole Terminated at 1.30 m					
				1.30m								
				1.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 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 _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	W _L	Liquid Limit
Gradational or transitional strata		Field Tests		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%	



TP5 encountered 0.25m of topsoil overlying sand. Groundwater was encountered at 0.9m.



Excavated material from TP5

	Client:	Garrard Building Pty Ltd	Job No.	RG31546.1
	Project:	Proposed Residential Development	Drawn By:	SK
		52-54 Miles Street, Yamba	Scale:	NTS
	Title:	Test Pit Photographs - TP5	Date:	26-Jul-18
			Drawing No.	



ENGINEERING LOG - TEST PIT

CLIENT: Garrad Building Pty Ltd
PROJECT NAME: Proposed Development
SITE LOCATION: 52-54 Miles Street, Yamba
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP6
PAGE: 1 of 1
JOB NO: RGS31546.1
LOGGED BY: LD
DATE: 26/6/18

EQUIPMENT TYPE: 2t Excavator
TEST PIT LENGTH: 1.7 m
WIDTH: 0.3 m
EASTING: 532813 m
NORTHING: 6743105 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		
Excavator	11:40:00 AM			<									

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 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 _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	W _L	Liquid Limit
Gradational or transitional strata		Field Tests		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%



TP6 encountered 0.2m of topsoil overlying sand. Groundwater was encountered at 0.8m.



Excavated material from TP6

	Client:	Garrard Building Pty Ltd	Job No.	RGS31546.1
	Project:	Proposed Residential Development	Drawn By:	SK
		52-54 Miles Street, Yamba	Scale:	NTS
	Title:	Test Pit Photographs - TP6	Date:	26-Jul-18
			Drawing No.	



ENGINEERING LOG - TEST PIT

CLIENT: Garrad Building Pty Ltd
PROJECT NAME: Proposed Development
SITE LOCATION: 52-54 Miles Street, Yamba
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP7
PAGE: 1 of 1
JOB NO: RGS31546.1
LOGGED BY: LD
DATE: 26/6/18

EQUIPMENT TYPE: 2t Excavator
TEST PIT LENGTH: 1.7 m
WIDTH: 0.3 m
EASTING: 533034 m
NORTHING: 6743047 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	
Excavator	12:50:00 PM			<								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 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 _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	W _L	Liquid Limit
Gradational or transitional strata		Field Tests		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%	



TP7 encountered 0.25m of topsoil overlying sand. Groundwater was encountered at 1m.



Excavated material from TP7

	Client:	Garrard Building Pty Ltd	Job No.	RGS31546.1
	Project:	Proposed Residential Development	Drawn By:	SK
		52-54 Miles Street, Yamba	Scale:	NTS
	Title:	Test Pit Photographs - TP7	Date:	26-Jul-18
			Drawing No.	



ENGINEERING LOG - TEST PIT

CLIENT: Garrad Building Pty Ltd
PROJECT NAME: Proposed Development
SITE LOCATION: 52-54 Miles Street, Yamba
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP8
PAGE: 1 of 1
JOB NO: RGS31546.1
LOGGED BY: LD
DATE: 26/6/18

EQUIPMENT TYPE: 2t Excavator
TEST PIT LENGTH: 1.6 m
WIDTH: 0.3 m
EASTING: 532348 m
NORTHING: 6743066 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	
Excavator						CL	TOPSOIL: Silty CLAY, medium plasticity, dark grey	M > w _p		HP	100	TOPSOIL: GRASS
							Silty CLAY: High plasticity, grey, mottled pale brown	M > w _p	F	HP	100	ALLUVIAL SOIL
							SAND: Fine to medium grained, pale grey, pale brown, with trace clay	M	MD			
							SAND: Fine to medium grained, grey	W				
							Hole Terminated at 1.30 m					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 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 _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	w _L	Liquid Limit
Gradational or transitional strata		Field Tests		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%	



TP8 encountered 0.15m of topsoil overlying firm clay to 0.35m, overlying sand. Groundwater was encountered at 0.95m.



Excavated material from TP8

	Client:	Garrard Building Pty Ltd	Job No.	RG31546.1
	Project:	Proposed Residential Development	Drawn By:	SK
		52-54 Miles Street, Yamba	Scale:	NTS
	Title:	Test Pit Photographs - TP8	Date:	26-Jul-18
			Drawing No.	



ENGINEERING LOG - TEST PIT

CLIENT: Garrad Building Pty Ltd
PROJECT NAME: Proposed Development
SITE LOCATION: 52-54 Miles Street, Yamba
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP9
PAGE: 1 of 1
JOB NO: RGS31546.1
LOGGED BY: LD
DATE: 26/6/18

EQUIPMENT TYPE: 2t Excavator
TEST PIT LENGTH: 1.6 m
WIDTH: 0.3 m
EASTING: 532256 m
NORTHING: 6742998 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	
Excavator	4:00:00 PM											

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
U₅₀ 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 _p Plastic Limit
VSt Very Stiff	200 - 400	W _L 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%	



TP9 encountered 0.25m of topsoil overlying firm clay to 0.55m, overlying sand. Groundwater was encountered at 0.7m.



Excavated material from TP9

	Client:	Garrard Building Pty Ltd	Job No.	RG31546.1
	Project:	Proposed Residential Development	Drawn By:	SK
		52-54 Miles Street, Yamba	Scale:	NTS
	Title:	Test Pit Photographs - TP9	Date:	26-Jul-18
			Drawing No.	



ENGINEERING LOG - TEST PIT

CLIENT: Garrad Building Pty Ltd
PROJECT NAME: Proposed Development
SITE LOCATION: 52-54 Miles Street, Yamba
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP10
PAGE: 1 of 1
JOB NO: RGS31546.1
LOGGED BY: LD
DATE: 26/6/18

EQUIPMENT TYPE: 2t Excavator
TEST PIT LENGTH: 2.0 m
WIDTH: 0.3 m
EASTING: 532605 m
NORTHING: 6742975 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	
Excavator	11:00:00 AM			0.25m		SM	TOPSOIL: Silty SAND, fine to medium grained, dark grey	M				TOPSOIL: GRASS
						SM	SAND: Fine to medium grained, grey, with some silt	M	MD			ALLUVIAL SOIL
						SP	SAND: Fine to medium grained, pale grey, pale brown					
						SP	SAND: Fine to medium grained, grey, pale brown	W				
				1.0			Hole Terminated at 1.10 m					
				1.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 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 _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	W _L	Liquid Limit
Gradational or transitional strata		Field Tests		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%	



TP10 encountered 0.25m of topsoil overlying sand. Groundwater was encountered at 0.8m.



Excavated material from TP10

	Client:	Garrard Building Pty Ltd	Job No.	RGS31546.1
	Project:	Proposed Residential Development	Drawn By:	SK
		52-54 Miles Street, Yamba	Scale:	NTS
	Title:	Test Pit Photographs - TP10	Date:	26-Jul-18
			Drawing No.	



ENGINEERING LOG - TEST PIT

CLIENT: Garrad Building Pty Ltd
PROJECT NAME: Proposed Development
SITE LOCATION: 52-54 Miles Street, Yamba
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP11
PAGE: 1 of 1
JOB NO: RGS31546.1
LOGGED BY: LD
DATE: 26/6/18

EQUIPMENT TYPE: 2t Excavator
TEST PIT LENGTH: 1.6 m
WIDTH: 0.3 m
EASTING: 532987 m
NORTHING: 6742868 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	
Excavator	1:10:00 PM											



TP11 encountered 0.2m of topsoil overlying sand. Groundwater was encountered at 0.8m.



Excavated material from TP11

	Client:	Garrard Building Pty Ltd	Job No.	RG31546.1
	Project:	Proposed Residential Development	Drawn By:	SK
		52-54 Miles Street, Yamba	Scale:	NTS
	Title:	Test Pit Photographs - TP11	Date:	26-Jul-18
			Drawing No.	

FALLING HEAD INFILTRATION TEST - CASED HOLE

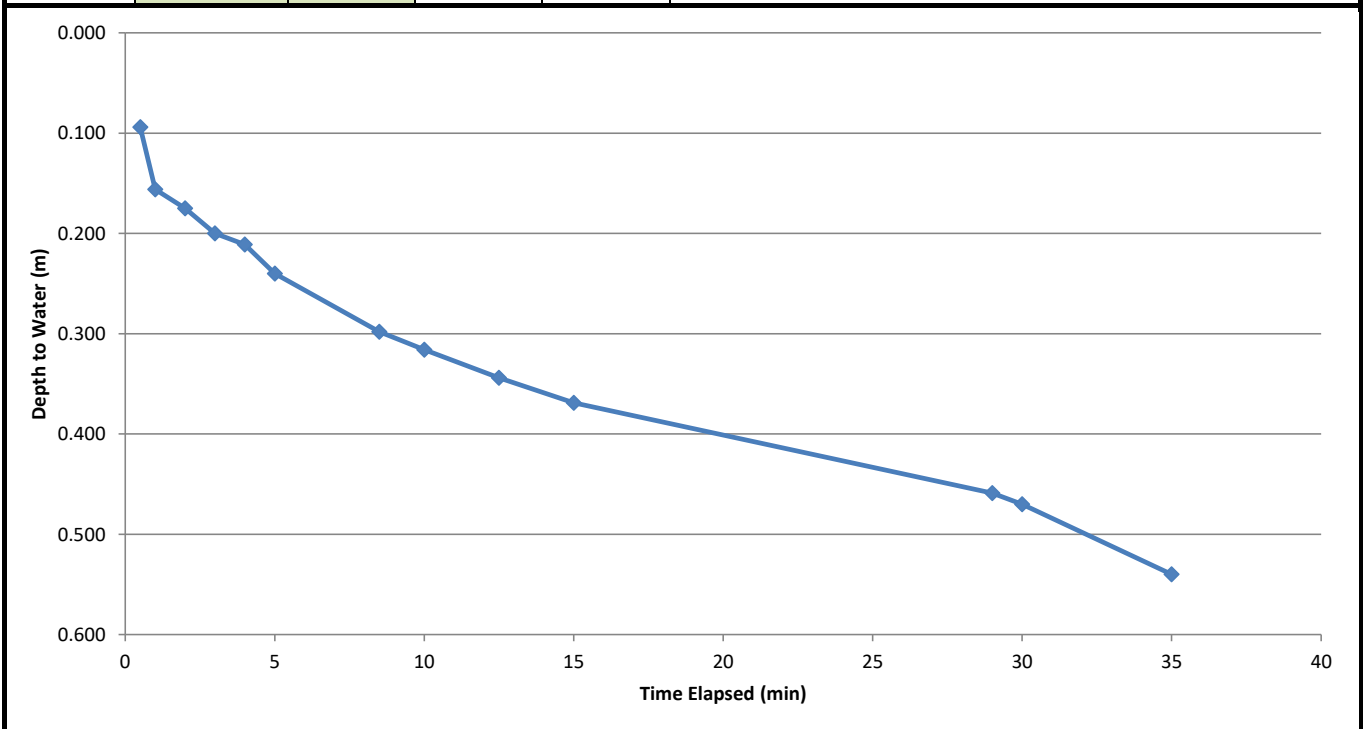
CLIENT: Garrard Building Pty Limited
PROJECT: Proposed Residential Development
LOCATION: 52-54 Miles Street, Yamba NSW

Job No.: RGS31546.1
Date: 26-Jun-18
By: LD



Test number:	TP5	Test Location:	Refer to Figure 1
Hole radius (m):	0.35	Surface RL:	Not measured
Hole depth(m):	0.54	Casing stickup(m):	0.00
Depth to water table (m):	Unknown	Water table RL(m)	Unknown

Reading	Time elapsed (min)	Depth to water (m)	Height of water (m)	Calculations
1	0.5	0.094	0.45	
2	1	0.156	0.38	<u>Constant loss time period:</u> Reading 1: 2 Time 1: 1 Height 1: 0.384 Reading 2: 7 Time 2: 8.5 Height 2: 0.702 Total time (min): 7.50 Total head loss (m): 0.318
3	2	0.175	0.83	
4	3	0.200	0.80	In situ Permeability: $K = \frac{(Height\ 2 - Height\ 1)}{(Time\ 2 - Time1)}$ K= 7.07E-04 m/sec (x 10m/sec)
5	4	0.211	0.79	
6	5	0.240	0.76	
7	8.5	0.298	0.70	
8	10	0.316	0.68	
9	12.5	0.344	0.66	
10	15	0.369	0.63	
11	29	0.459	0.54	
12	30	0.470	0.53	
13	35	0.540	0.46	
14				
15				



FALLING HEAD INFILTRATION TEST - CASED HOLE

CLIENT: Garrard Building Pty Limited
PROJECT: Proposed Residential Development
LOCATION: 52-54 Miles Street, Yamba NSW

Job No.: RGS31546.1
Date: 26-Jun-18
By: LD



Test number:	TP7	Test Location:	Refer to Figure 1
Hole radius (m):	0.35	Surface RL:	Not measured
Hole depth(m):	0.54	Casing stickup(m):	0.00
Depth to water table (m):	Unknown	Water table RL(m)	Unknown

Reading	Time elapsed (min)	Depth to water (m)	Height of water (m)	Calculations
1	0.5	0.040	0.50	
2	1	0.063	0.48	<u>Constant loss time period:</u> Reading 1: 7 Time 1: 5 Height 1: 0.348 Reading 2: 14 Time 2: 30 Height 2: 0.046 Total time (min): 25.00 Total head loss (m): -0.302
3	1.5	0.084	0.46	
4	2	0.099	0.44	In situ Permeability: $K = \frac{(Height\ 2 - Height\ 1)}{(Time\ 2 - Time1)}$ K= 2.01E-04 m/sec (x 10m/sec)
5	3	0.134	0.41	
6	4	0.165	0.38	
7	5	0.192	0.35	
8	7.5	0.234	0.31	
9	10	0.272	0.27	
10	15	0.343	0.20	
11	21	0.395	0.15	
12	24	0.434	0.11	
13	27	0.460	0.08	
14	30	0.494	0.05	
15				

