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Report on
Unexpected Finds Protocol

Lake Cathie Public School Upgrade
1240 Ocean Drive, Lake Cathie

Prepared for
AW Edwards Pty Ltd

Project 89691.02
December 2019

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	89691.02	Document No.	R.003.Rev0
Document title	Report on Unexpected Finds Protocol Lake Cathie Public School Upgrade		
Site address	1240 Ocean Drive, Lake Cathie		
Report prepared for	AW Edwards Pty Ltd		
File name	89691.02.R.003.Rev0.Unexpected Finds Protocol		

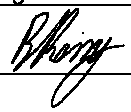
Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Jessica Paulsen	Brent Kerry	16 December 2019

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	0	Craig McIlveen, AW Edwards Pty Ltd

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		16 December 2019
Reviewer		16 December 2019

bsi. ISO 9001 Quality Management
FS 604853

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit 2, 32 Geebung Drive
Port Macquarie NSW 2444
PO Box 5463
Port Macquarie NSW 2444
Phone (02) 6581 5992

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Report on Unexpected Finds Protocol
Lake Cathie Public School Upgrade
1240 Ocean Drive, Lake Cathie

1. Introduction

This unexpected finds protocol (UFP) is for the Proposed Lake Cathie Public School Upgrade at 1240 Ocean Drive, Lake Cathie. The UFP was commissioned in an email dated 10 December 2019 by Craig McIlveen of AW Edwards Pty Ltd and was undertaken with reference to Douglas Partners Pty Ltd (DP) proposal PMQ190073.P.002.Rev0 dated 10 December 2019.

DP has previously prepared a report entitled *Report on Preliminary Site Investigation (PSI) for Contamination, Lake Cathie Primary School Expansion, 1240 Ocean Drive, Lake Cathie*, dated February 2019 (DP, 2019).

The PSI report (DP, 2019) concluded:

Based on the results of the preliminary investigation the site is considered to be suitable for the proposed development from a contamination perspective subject to the following being conducted:

- *Additional targeted testing of natural Serpentinite rock and associated residual soils is conducted to confirm the presence / absence of elevated chromium concentrations. Requirements for remediation / management (if any) would be confirmed following the additional investigation;*
- *Incorporation of unexpected finds protocols into the Construction Environmental Management Plan (CEMP) for the development given the presence of widespread fill of unknown origin; and*
- *If additional investigation identifies the presence of contamination requiring remediation / management, remediation and validation of the site would be required in accordance with a site specific remediation action plan (RAP) to be prepared for the site.*

This UFP is based on the results of the PSI (DP, 2019) and provides methods and strategies to manage unexpected finds of potential contamination, including serpentinite rock, during excavation and / or construction works.

2. Proposed Development

It is understood that the proposed development is to include 18 new teaching spaces which may include the construction of one and two storey structures as well as associated access roads and paved / concrete areas.

The site covers an area of approximately 3.73 ha and the proposed excavation depths are expected to be minimal for that required for shallow footings and installation of in-ground services.

Refer to Drawing 1 in Appendix B.

3. Site Information

3.1 Site Description

The school allotment is identified as 1240 Ocean Drive, Lake Cathie, described as Lot 2 DP1193553. The lot covers 3.73 ha and is an irregular shape, with the existing school infrastructure in the south-east half of the lot. The location of the proposed school expansion ('the site') is generally located in the central and eastern part of the overall school allotment as shown in Drawing 1, Appendix B. It is understood that the western portion of Lot 2 will not be affected except for removal of the existing access road.

The property is located on the eastern side of Ocean Drive and is bounded by a new collector road to the north and east and a new district sporting field development to the south.

At the time of the PSI (January 2019), a general fill pad had been constructed at the school property prior to construction of the existing school structures. It is understood that the fill was sourced from a local quarry. Observations made during the inspection (January 2019) are summarised below.

- The southern part of the school property had existing school buildings, vehicle pavements and concreted spaces. Landscaped gardens were also present adjacent to the vehicle pavements;
- The remaining parts of the school property generally had a good covering of mown grass within the central part and south western part of the site;
- The northern part of the site had over grown grass and semi mature trees, with the outside perimeter mown around the boundary of the school site. This area was fenced off from the remainder of the school site;
- A number of semi mature trees were planted along the western boundary
- An area north of the COLA near the western boundary had been recently turfed with grass, which is likely to be associated with the removal of the previous building;
- There were a number of small areas (less than 0.5 m in diameter) which appeared to have been recently topsoiled with the grass removed;

Surface soils where exposed comprised light brown / brown silty clay. No obvious signs of gross contamination (i.e. staining or odours) were observed during the inspection.

The existing area of the allotment to be further developed ('the site') is at approximate RL 9.5 m AHD in the north falling to RL 7.5 m AHD to the south, as shown on Drawing 1 in Appendix B.

An aerial image showing the existing structures at Lake Cathie Public School and the surrounding infrastructure is shown below in **Figure 1**. Small to medium trees have been planted around the north-east perimeter of the school and in the area of the existing car parks and access roads.

The site is currently zoned "R1 General Residential" under the current 2011 LEP.

Figure 1: Aerial image of Lake Cathie Public School and surrounds (Nearmap Image dated 23 October 2018)

3.2 Regional Geology and Acid Sulfate Soil Mapping

Reference to the 1:250,000 scale New South Wales state wide geology sheet indicates that the school allotment is underlain by Quaternary alluvium which consists of channel and floodplain alluvium deposits typically comprising gravel, sand, silt and clay. Karikeree Metadolerite is also mapped within the northern elevated parts of which typically comprises massive cleaved metadolerite.

Reference to the NSW Government "Mapping of naturally occurring asbestos in NSW – Known and potential for occurrence" indicates that the site is in close proximity to an area of "Geological units with Low asbestos potential'.

Reference to the Acid Sulfate Soil Risk Map published by the Department of Land and Water Conservation indicates that there is a low probability of occurrence of acid sulfate soils for soils at the depth of greater than 3 m below the natural ground surface within the alluvial sediments situated in the southern portion of the school property.

3.3 Hydrogeology

Groundwater at the site is expected to flow in a south easterly direction towards Duchess Gully and then towards the Pacific Ocean. Duchess Gully is considered to be the nearest environmentally sensitive receptor.

Review of available survey data for the site indicates that the ground surface at the site ranges from RL 9.5 m AHD in the north falling to RL 7.5 m AHD in the south.

3.4 Historical Review

The site history review completed as part of the PSI (DP, 2019) indicated the following:

- The majority of the site had been used for agricultural purposes since 1914 including potential market garden since 1956;
- Ocean Drive appeared similar to the current alignment in 1979;
- Construction of school buildings commenced in 2014;
- The Asbestos Register for the school indicated that asbestos was not used in construction of the school buildings.

4. Results of Previous Investigation

4.1 Scope

The scope of work completed for the PSI (DP, 2019) comprised a review of historical information for the site and a site walkover followed by drilling four boreholes. Selected soil samples were analysed. Results from previous investigations were also included in the PSI report (DP, 2019).

4.2 Results

A summary of the subsurface conditions encountered within the site are as follows. Logs are presented in Appendix C.

- Fill: Encountered in all bores (except Bore 104), from the surface to depths greater than 0.5 m and 1.9 m depth. Generally comprised silty clay fill (topsoil) over cobbly silty clay / cobbly clay fill with some gravel in the current investigation;
- Residual Soil: Encountered in Bores 101 and 104 beneath the fill to the bore terminations at 2.5 m and 1.6 m depth respectively except for Bore 104 as below. Generally comprising clay; and
- Weathered Siltstone: Encountered in Bore 104 from 1.5 m to bore termination at depth of 1.6 m.

The fill material appeared to be a quarry based overburden material which is consistent with the site history information provided for the school site.

Groundwater was not encountered in the bores during drilling. It should be noted that groundwater depths and ground moisture conditions are affected by factors such as climatic conditions and soil permeability and therefore vary with time. It is noted that the previous investigation completed in 2013 encountered groundwater at depths of 1.3 m to greater than 2.5 m.

There were no obvious indications of gross contamination within the exposed soils in the test locations (i.e. no obvious staining or odours).

The results of PID screening on soil samples are shown on the logs in Appendix C. PID screening indicated the absence of gross volatile hydrocarbon impact (PID <1 ppm) in the samples screened.

There was no visual or olfactory evidence (i.e. staining or odours) to suggest the presence of gross contamination within the soils investigated to the depths investigated (i.e. <2 m depth).

4.3 Conclusions

4.3.1 Contamination Status

The results of the site history review indicated the general absence of contaminating land uses for the site, other than historical use of the site for agricultural purposes, the presence of widespread fill and the potential for naturally occurring asbestos and elevated chromium within natural Serpentinite and associated residual soils.

All samples tested for the PSI and other previous investigations were below the relevant criteria for the health investigation and screening levels, and environmental investigation and screening levels for the adopted primary school land use.

All samples tested for the current investigation and previous investigation returned contaminant concentrations below the total petroleum hydrocarbon management limits.

It is noted that only limited testing of natural soils for asbestos has been conducted to date. In addition, Serpentinite was not identified during the current investigation, precluding asbestos identification testing. While the NSW Government naturally occurring asbestos website suggests the risk of naturally occurring asbestos on the site is considered to be low and limited testing of natural soils and Serpentinite on the school site to date indicate the absence of asbestos at laboratory reporting limits, it is therefore considered that the weathered bedrock investigated onsite does not contain naturally occurring asbestos.

No assessment of groundwater was undertaken for the PSI.

Based on the results of the preliminary investigation the site is considered to be suitable for the proposed development from a contamination perspective subject to the following being conducted:

- Additional targeted testing of natural Serpentinite rock and associated residual soils is conducted to confirm the presence / absence of elevated chromium concentrations. Requirements for remediation / management (if any) would be confirmed following the additional investigation;
- Incorporation of unexpected finds protocols into the Construction Environmental Management Plan (CEMP) for the development given the presence of widespread fill of unknown origin;
- If additional investigation identifies the presence of contamination requiring remediation / management, remediation and validation of the site would be required in accordance with a site specific remediation action plan (RAP) to be prepared for the site.

4.3.2 Preliminary Waste Classification

Based on the site historical information, site investigations and preliminary laboratory testing conducted for the previous investigations, the following waste classifications comments are provided:

4.3.2.1 Existing Fill

All of the samples tested within the site for the current and previous investigation returned contaminant concentrations below the maximum permissible concentrations to be classified as General Solid Waste (GSW) with reference to NSW EPA Waste Classification guidelines. The materials tested are also preliminary classified as 'General Solid Waste (non-putrescible)' for disposal to an appropriately licensed landfill, if required.

During excavation, it is recommended that appropriate inspections are conducted and if any materials are encountered that are different to the materials sampled and tested or exhibit signs of contamination (e.g. anthropogenic inclusions, fibro fragments, staining or odours), these should be appropriately segregated for further assessment. The handling, transport and disposal / re-use of the materials should be conducted in accordance with regulatory and statutory requirements.

4.3.2.2 Natural Soils

The contaminant concentrations within these samples of natural materials were below the maximum permissible concentrations for general solid waste. Only limited testing has been carried out on natural soils

Serpentinite rock has been previously encountered at the site and within nearby investigations. The site is mapped within an area comprising a "Low asbestos potential". There is a possibility that the serpentinite rock could be a potential source of naturally occurring asbestos and elevated chromium based on previous experience with these materials. Further investigation of the bedrock and associated residual soils to confirm the absence of asbestos and elevated chromium will be required if it is likely to be exposed during expansion activities.

Natural material won from site excavations (silty clay, clay) would likely satisfy the criteria for Virgin Excavated Natural Material (VENM). VENM materials can be re-used on another site in accordance with EPA guidelines.

Acid sulfate soil testing was not carried due to the "Low Risk of acid sulfate soils at depths greater than 3 m", however, further testing would be required to confirm the absence of acid sulfate soils (ASS) prior to removing from site.

Natural soils classified as ASS cannot be classified as VENM. In addition soils containing asbestos cannot be classified as VENM. As such further testing of natural bedrock and associated residual soils will be important if off-site disposal of natural soils / bedrock is required.

It is noted that the scope of testing was intended to provide a preliminary indication of contaminant concentrations and waste classification at nominated test locations.

5. Unexpected Finds Protocol

Given the site's history and the presence of fill and the potential for serpentinite rock to be present, there is a potential for unexpected contamination to be encountered in soil during construction works. The following protocol provides guidance on management of contamination not anticipated or known prior to commencement that may be encountered during construction works:

- Excavation, handling loading and transport of contaminated materials must be undertaken by a licensed contractor in accordance with the appropriate regulatory approvals and legislative requirements;
- The progress of site excavations during construction must be regularly inspected by the contractor and supervising environmental consultant during earthworks to confirm that soils exposed are consistent with those encountered in the PSI (DP, 2019). Potential soil contamination may include stained soils, odorous soils and soils containing anthropogenic materials such as asbestos containing materials (ACM) and naturally occurring asbestos (serpentinite);
- If potentially contaminated soils are identified (i.e. visual or olfactory indication of contamination), excavation of fill must cease immediately. The site foreman is to be promptly notified and the affected area closed off by the use of barrier fencing or tape and appropriate warning sign, without delay. . Warning signs shall be specific to the contamination encountered (where appropriate) and must comply with the Australian Standard 1319-1994 – Safety Signs for the Occupational Environment;
- The supervising environmental consultant is to assess the presence of contamination and determine the extent of investigation / remediation works to be undertaken (with reference to the relevant contaminated site guidelines). A report detailing this information must be compiled by the supervising environmental consultant and provided to the construction manager;
- The identified contamination must be managed / remediated as advised by the supervising environmental consultant. This may include segregation and removal of the impacted materials, and validation of the area;
- If the assessment of impacted materials indicates that the materials are not suitable to remain on-site, the materials must be classified by the supervising environmental consultant for disposal to an appropriately licensed landfill with reference to NSW EPA (2014). The preliminary waste classification provided in the PSI (DP, 2019) should be confirmed prior to off-site disposal;
- The licensed contractor is to load classified materials directly into appropriate trucks for transport and disposal to a licensed facility;
- All works should be undertaken by a contractor holding the appropriate licence and permits for the works in accordance with statutory and regulatory requirements;
- Documentary evidence, such as weighbridge dockets, of correct disposal is to be provided to the construction manager;
- Excavation / construction in the affected area cannot recommence until validation indicates the absence of contamination or appropriate management of contamination has occurred, based on the advice of the supervising environmental consultant. A written validation report is to be provided by the supervising environmental consultant that the area is safe to be accessed and worked; and
- Details of the incident are to be recorded in the site record system.

5.1 Reporting Requirements

A record of each unexpected find and remediation / management conducted must be maintained by the contractor and must include, but not be limited to the following details:

- Date;
- Location;
- Assessment and confirmation of the contamination status of soils (including results of testing);
- Assessment of remediation / management options;
- Record of remediation / management undertaken to address the identified contamination;
- Final report upon completion of validation presenting the results of the assessment and remediation / management conducted.

6. References

DP (2019), *Report on Preliminary Site Investigation (PSI) for Contamination, Lake Cathie Primary School Expansion, 1240 Ocean Drive, Lake Cathie*, dated February 2019, Douglas Partners Pty Ltd (DP, 2019) DP Ref.89691.01.R.001.Rev1.

NSW EPA (NSW EPA, 2014), *Waste Classification Guidelines, Part 1 – Classifying Waste, 2014.*

7. Limitations

Douglas Partners (DP) has prepared this Unexpected Finds Protocol report for the proposed upgrade at Lake Cathie Public School at 1240 Ocean Drive, Lake Cathie with reference to DP's proposal PMQ190073.P.002.Rev0 dated 10 December 2019 and acceptance received from Craig McIlveen of AW Edwards Pty Ltd dated 10 December 2019. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of AW Edwards Pty Ltd and Schreiber Hamilton Architecture Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and / or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site during previous investigations only at the specific sampling and / or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during previous investigations. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground

conditions across the site between and beyond the sampling and / or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Asbestos has not been detected by observation or by laboratory analysis, either on the surface of the site, or in fill materials at the test locations sampled and analysed. Although the sampling plan adopted for this investigation is considered appropriate to achieve the stated project objectives, there are necessarily parts of the site that have not been sampled and analysed. It is therefore considered possible that HBM, including asbestos, may be present in unobserved or untested parts of the site, between and beyond sampling locations, and hence no warranty can be given that asbestos is not present.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the environmental components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

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Appendix A

About This Report

About this Report

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Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

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

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

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

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

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

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

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawing 1 from Previous Investigation (89691.01)

Legend

- Approximate Borehole Location (Current Investigation)
- Approximate Hand Auger Location (Current Investigation)
- Approximate Test Pit (Previous Investigation Ref 8)
- Approximate Borehole Location (Previous Investigation Ref 8)
- Approximate CPT Location (Previous Investigation Ref 6)
- Approximate Test Pit Location (Previous Investigation Ref 6)
- Approximate Investigation (Site) Area
- Approximate Lot Boundary
- Approximate Fill Area
- 1m Surface Levels
- 0.25m surface levels
- Approximate Photo Location and Direction

0 5 10 15 20 25 m

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CLIENT: School Infrastructure NSW		TITLE: **Test Location Plan**
OFFICE: Port Macquarie	DRAWN BY: JRC	**Lake Cathie Primary School Expansion**
SCALE: 1:1250 @ A3	DATE: 12 February 2019	**1240 Ocean Drive, lake Cathie**

N

PROJECT:	89691.01
DRAWING No:	1
REVISION:	1

Appendix C

Notes on Descriptive Terms

Logs form Previous Investigations (101-104, 1-8 and 501-503)

Sampling Methods

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Sampling

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

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

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

  4,6,7
  N=13

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

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq \text{100 mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

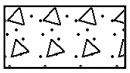
Symbols & Abbreviations

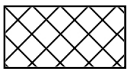
Graphic Symbols for Soil and Rock

General

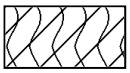

Asphalt


Road base

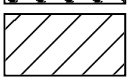

Concrete

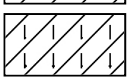

Filling

Soils

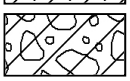

Topsoil

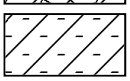

Peat

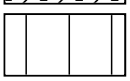

Clay


Silty clay

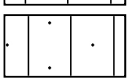

Sandy clay

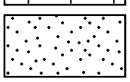

Gravelly clay

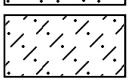

Shaly clay

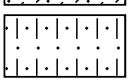

Silt


Clayey silt

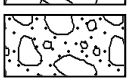

Sandy silt

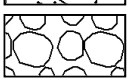

Sand


Clayey sand


Silty sand


Gravel

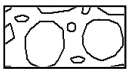

Sandy gravel


Cobbles, boulders

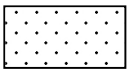

Talus

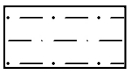
Sedimentary Rocks

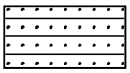

Boulder conglomerate

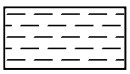

Conglomerate


Conglomeratic sandstone

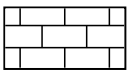

Sandstone


Siltstone

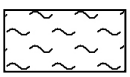

Laminite

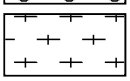

Mudstone, claystone, shale

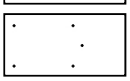

Coal


Limestone

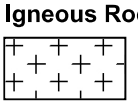
Metamorphic Rocks

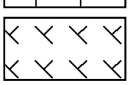

Slate, phyllite, schist


Gneiss

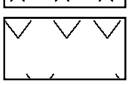

Quartzite

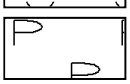
Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: School Infrastructure NSW
PROJECT: Lake Cathie Primary School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 7.5 AHD
EASTING: 483736
NORTHING: 6507299
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 89691.01
DATE: 31/1/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
7	0.15	FILLING (TOPSOIL) - Brown silty clay trace gravel and fine rootlets, M<Wp		A/E	0.1		PID<1		
		FILLING - Generally comprising brown cobbly clay filling trace gravel and sand, cobbles up to 250mm in size (gravel predominantly subangular, rough, 20mm - 60mm in size), M<Wp		A/E	0.5		PID<1		
	1			A/E	1.0		PID<1		1
6				A/E	1.5		PID<1		
	1.9	CLAY - Grey clay with trace medium grained sand, M>Wp							
	2			A/E	2.0		PID<1		2
5	2.5	Bore discontinued at 2.5m, limit of investigation		A/E	2.5		PID<1		

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: 100mm ϕ Solid Flight Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Coordinates recorded using Hand Held GPS and surface levels interpolated from survey plan by Land Dynamics Australia dated 31/05/2018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas CMG
Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: School Infrastructure NSW
PROJECT: Lake Cathie Primary School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 7.5 AHD
EASTING: 483630
NORTHING: 6507345
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 89691.01
DATE: 1/2/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
7	0.15	FILLING (TOPSOIL) - Generally comprising brown silty clay trace gravel, sand and fine rootlets, M<Wp		A/E	0.1		PID<1		
		FILLING - Generally comprising brown silty clay with some gravel trace medium grained sand (gravel predominantly subangular, rough, 10mm - 60mm in size), M<Wp							
	0.7	Bore discontinued at 0.7m, refusal on gravels		A/E	0.7		PID<1		
6	1								1
5	2								2

RIG: Hand Tools **DRILLER:** Hickman **LOGGED:** Hickman **CASING:**

TYPE OF BORING: 75mm ϕ Hand Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Coordinates recorded using Hand Held GPS and surface levels interpolated from survey plan by Land Dynamics Australia dated 31/05/2018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas CMG
Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: School Infrastructure NSW
PROJECT: Lake Cathie Primary School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 8.2 AHD
EASTING: 483672
NORTHING: 6507410
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 89691.01
DATE: 31/1/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
8	0.15	FILLING (TOPSOIL) - Brown silty sand trace fine rootlets, humid		A/E	0.1		PID<1		
		COBBLY CLAY - Light brown cobbly clay with some medium grained sand, cobbles up to 250mm in size, M<Wp							
	0.5	Bore discontinued at 0.5m, refusal		A/E	0.5		PID<1		
7	1								1
6	2								2

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: 100mm ϕ Solid Flight Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Coordinates recorded using Hand Held GPS and surface levels interpolated from survey plan by Land Dynamics Australia dated 31/05/2018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas CMG
Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: School Infrastructure NSW
PROJECT: Lake Cathie Primary School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 8.6 AHD
EASTING: 483583
NORTHING: 6507406
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 89691.01
DATE: 31/1/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
8	0.0	TOPSOIL - Grey silty sand trace fine rootlets, humid		A/E	0.1		PID<1		
	0.2	CLAY - Red brown clay trace medium grained sand and fine gravel (gravel predominantly subangular, smooth, 5mm - 15mm in size), M<Wp							
	0.4	CLAY - Yellow brown clay with trace silt, M>Wp		A/E	0.5		PID<1		
	1			A/E	1.0		PID<1		1
	1.5			A/E	1.5		PID<1		
7	1.6	SILTSTONE - Extremely low strength, extremely weathered, light brown siltstone							
		Bore discontinued at 1.6m, refusal on weathered rock							
	2								2
6									

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: 100mm ϕ Solid Flight Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Coordinates recorded using Hand Held GPS and surface levels interpolated from survey plan by Land Dynamics Australia dated 31/05/2018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas CMG
Geotechnics | Environment | Groundwater

TEST PIT LOG

CLIENT: Schreiber Hamilton Architecture Pty Ltd (SHAC)
PROJECT: Lake Cathie Public School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 9.2 AHD
EASTING: 483705
NORTHING: 6507444

PIT No: 1
PROJECT No: 89691.00
DATE: 16/6/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
9	0.2	FILLING (TOPSOIL) - Generally consisting of dark brown silty clay with a trace of fine rootlets (grass covered), M>Wp		D/E	0.1				
		FILLING - Generally consisting of light brown cobbly silty clay filling with some fine to coarse gravel, M<Wp		D/E	0.5				
				B					
				D/E	0.8		pp = 300 QA2		
	0.9				0.9				
8	1	CLAY - Firm to stiff, yellow brown, medium to high plasticity clay with a trace of silt, M>Wp			1.0				1
				U50					
	1.5				1.4				
		SERPENTINITE - Extremely low strength, extremely weathered, green grey serpentinite with very low to low strength bands		D	1.6				
7	2			D	2.0				2
				D	2.1				
	2.3			D	2.3				
		Pit discontinued at 2.3m, refusal on weathered rock							
6	3								3
5	4								4

RIG: Excavator 4.5 tonne 450mm bucket to 2.1m then solid flight auger

LOGGED: Hickman

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MGA95, Zone 56J Datum, Surface levels interpolated from Detail Survey Plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas CMG
Geotechnics | Environment | Groundwater

TEST PIT LOG

CLIENT: Schreiber Hamilton Architecture Pty Ltd (SHAC)
PROJECT: Lake Cathie Public School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 8.5 AHD
EASTING: 483700
NORTHING: 6507420

PIT No: 2
PROJECT No: 89691.00
DATE: 16/6/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
8	0.15	FILLING (TOPSOIL) - Generally consisting of dark brown silty clay with a trace of fine rootlets (grass covered), M>Wp		D/E	0.1				
		FILLING - Generally consisting of light brown cobbly silty clay filling with some fine subangular gravel, M<Wp		D/E	0.5				
7	1.2	CLAY - Stiff, yellow brown, medium to high plasticity clay with a trace of silt, M>Wp		D	1.5		pp = 250		
6				D	2.0		pp = 200-150		
5				D	2.5		pp = 100-150		
4	3.0	Pit discontinued at 3.0m, limit of investigation							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3, 4

RIG: Excavator 4.5 tonne 450mm bucket to 2.1m then solid flight auger
LOGGED: Hickman
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MGA95, Zone 56J Datum, Surface levels interpolated from Detail Survey Plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas CMG
Geotechnics | Environment | Groundwater

TEST PIT LOG

CLIENT: Schreiber Hamilton Architecture Pty Ltd (SHAC)
PROJECT: Lake Cathie Public School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 8.4 AHD
EASTING: 483665
NORTHING: 6507434

PIT No: 3
PROJECT No: 89691.00
DATE: 16/6/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
									5 10 15 20
		FILLING (TOPSOIL) - Generally consisting of dark brown silty clay with a trace of fine rootlets (grass covered), M>Wp		D/E	0.1				
	0.25	FILLING - Generally consisting of light brown cobbly silty clay filling with some subangular gravel, M=Wp		D/E	0.5				
8									
	1.0	CLAY - Very stiff, light grey mottled brown, medium plasticity clay with a trace of sand and fine subangular gravel, M>Wp			1.0		pp = 300		1
7		From 1.5m, some fine subangular gravel and becoming stiff			1.5				
	1.9	CLAY - Stiff, yellow/brown, medium to high plasticity clay with a trace of silt, M>Wp			2.0		pp = 100-150		2
6									
	3.0	Pit discontinued at 3.0m, limit of investigation			3.0		pp = 150		3
5									
									4
4									

RIG: Excavator 4.5 tonne 450mm bucket to 2.1m then solid flight auger

LOGGED: Hickman

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MGA95, Zone 56J Datum, Surface levels interpolated from Detail Survey Plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Schreiber Hamilton Architecture Pty Ltd (SHAC)
PROJECT: Lake Cathie Public School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 8.1 AHD
EASTING: 483676
NORTHING: 6507396

PIT No: 4
PROJECT No: 89691.00
DATE: 16/6/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
8	0.2	FILLING (TOPSOIL) - Generally consisting of dark brown silty clay with a trace of fine rootlets (grass covered), M>Wp		D/E	0.15		QA1		
		FILLING - Generally consisting of light brown cobbly silty clay filling with some fine to coarse gravel, M<Wp		D	0.5				
				B	0.9				
7	1.1	CLAY - Stiff, yellow brown, medium to high plasticity clay with a trace of silt, M>Wp		D	1.0				
				U50	1.1				
				D	1.5		pp = 250		
6	1.65	SILTY CLAY - Very stiff, light grey mottled brown silty clay with a trace of fine ironstone gravel, M>Wp		D	2.0		pp = 250		
5				D	3.0		pp = 250-300		
4				D	4.0		pp = 200-250		
	5.0	Pit discontinued at 5.0m, limit of investigation		D	5.0		pp = 300		

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3, 4, 5; >>

RIG: Excavator 4.5 tonne 450mm bucket to 2.5m then solid flight auger

LOGGED: Hickman

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MGA95, Zone 56J Datum, Surface levels interpolated from Detail Survey Plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Schreiber Hamilton Architecture Pty Ltd (SHAC)
PROJECT: Lake Cathie Public School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 8.0 AHD
EASTING: 483692
NORTHING: 6507385

PIT No: 5
PROJECT No: 89691.00
DATE: 16/6/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
8	0.1	FILLING (TOPSOIL) - Generally consisting of dark brown silty clay with a trace of fine rootlets (grass covered), M>Wp		D/E	0.2				
		FILLING - Generally consisting of light brown cobbly silty clay filling with some fine to coarse gravel, M>Wp		D	0.5				
7	1			D	1.0				1
	1.2	Pit discontinued at 1.2m, refusal on cobbles within filling							
6	2								2
5	3								3
4	4								4

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; >>

RIG: Excavator 4.5 tonne 450mm bucket

LOGGED: Hickman

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MGA95, Zone 56J Datum, Surface levels interpolated from Detail Survey Plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Schreiber Hamilton Architecture Pty Ltd (SHAC)
PROJECT: Lake Cathie Public School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 7.6 AHD
EASTING: 483660
NORTHING: 6507332

PIT No: 6
PROJECT No: 89691.00
DATE: 16/6/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		FILLING (TOPSOIL) - Brown silty sand, moist		D	0.1				
	0.3	FILLING - Generally consisting of light brown cobbly silty clay filling with some fine to coarse gravel, M>Wp							
7	1			D	1.0				1
	1.1	CLAY - Stiff, yellow brown, medium to high plasticity clay with a trace of silt, M>Wp							
6				D	1.5		pp = 150		
	2			D	2.0		pp = 200		2
5		From 2.5m, trace of fine subangular ironstone gravel, M>Wp							
	3			D	3.0		pp = 150-200		3
	3.0	Pit discontinued at 3.0m, limit of investigation							
4	4								4
3									

RIG: Solid flight auger 300mm diameter

LOGGED: Hickman

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Test pit located in garden bed, MGA95, Zone 56J Datum, Surface levels interpolated from Detail Survey Plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Schreiber Hamilton Architecture Pty Ltd (SHAC)
PROJECT: Lake Cathie Public School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 7.5 AHD
EASTING: 483683
NORTHING: 6507304

PIT No: 7
PROJECT No: 89691.00
DATE: 16/6/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.15	FILLING (TOPSOIL) - Generally consisting of dark brown silty clay with a trace of fine rootlets (grass covered), M>Wp		D/E	0.1				
		FILLING - Generally consisting of light brown cobbly silty clay filling with some fine to coarse gravel, M<Wp		D/E	0.5				
				B					
					0.8				
		From 0.9m, M>Wp		D	1.0				
	1.6	SILTY CLAY - Firm to stiff, dark brown, low to medium plasticity and grey silty clay, M>Wp		D	1.7		pp = 100		
	1.85	CLAY - Stiff, brown, medium plasticity clay, M>Wp		D	2.0		pp = 150		
		From 2.2m, becoming light grey with a trace of silt, M>Wp							
	2.8	GRAVELLY CLAY - Very stiff, light grey mottled red brown, medium plasticity, fine to medium grained subangular gravelly clay, M>Wp		D	3.0		pp = 200		
	3.1	CLAY - Very stiff, yellow brown, medium to high plasticity clay, M>Wp		D	3.5		pp = 150-200		
				D	4.5		pp = 200		
	5.0	Pit discontinued at 5.0m, limit of investigation							

RIG: Excavator 4.5 tonne 450mm bucket to 2.5m then solid flight auger

LOGGED: Hickman

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MGA95, Zone 56J Datum, Surface levels interpolated from Detail Survey Plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas CMG
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TEST PIT LOG

CLIENT: Schreiber Hamilton Architecture Pty Ltd (SHAC)
PROJECT: Lake Cathie Public School Upgrade
LOCATION: 1240 Ocean Drive, Lake Cathie

SURFACE LEVEL: 8.4 AHD
EASTING: 483748
NORTHING: 6507396

PIT No: 8
PROJECT No: 89691.00
DATE: 16/6/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.05	FILLING (TOPSOIL) - Generally consisting of dark brown silty clay with a trace of fine rootlets (grass covered), M>Wp		D/E	0.1				
		FILLING - Generally consisting of light brown cobbly silty clay filling with some fine to coarse gravel, M>Wp From 0.4m, M<Wp			0.4				
				D/E B	0.5				
					0.8				
				D	1.0				
	1.2	CLAY - Stiff, yellow brown, medium to high plasticity clay with a trace of silt, M>Wp			1.3				
				B					
				D	1.5		pp = 300		
				D	2.0		pp = 150		
	2.6	SILTY CLAY - Very stiff, light grey mottled brown, medium plasticity silty clay, M=Wp							
				D	3.0		pp = 300		
	3.1	SERPENTINITE - Extremely low strength, extremely weathered, green grey serpentinite with very low to low strength bands							
	3.2	Pit discontinued at 3.2m, refusal on weathered rock							

RIG: Excavator 4.5 tonne 450mm bucket to 2.5m then solid flight auger

LOGGED: Hickman

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MGA95, Zone 56J Datum, Surface levels interpolated from Detail Survey Plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: [redacted]
PROJECT: [redacted]
LOCATION: Ocean Drive, Bonny Hills

SURFACE LEVEL: 8.0 AHD
EASTING: 483745
NORTHING: 6507419

PIT No: 501
PROJECT No: 49971
DATE: 15/10/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
8		TOPSOIL - Light grey silt topsoil with trace clay and some rootlets, humid							
	0.15	CLAY - Very stiff, orange-brown, slightly gravelly clay with subrounded gravel up to 10mm in size with some silt, M>Wp		A,pp	0.3		350 kPa		
	0.5	CLAY - Stiff, orange brown clay with some silt, trace fine grained sand with trace rootlets, M>Wp		A	0.5				
				pp	0.6		150-200 kPa		
				V	0.65		50 kPa		
	0.8	SILTY CLAY - Stiff, green grey silty clay with trace fine grained sand, M>Wp		A,V	0.85		38 kPa		
				pp	0.9		150 kPa		
7	1	From 1.3m, with some subrounded quartz gravel up to 20mm in size							1
	1.7	SERPENTENITE - Extremely low strength, extremely weathered, green grey serpentenite with very low to low strength sands							
	1.9	Pit discontinued at 1.9m, limit of investigation							
6	2								2

RIG: Case 58 Super Le, 7 tonne, backhoe with 600mm tiger tooth bucket **LOGGED:** West **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Hand held GPS, ±10m

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: [redacted]
PROJECT: [redacted]
LOCATION: Ocean Drive, Bonny Hills

SURFACE LEVEL: 7.4 AHD
EASTING: 483672
NORTHING: 6507398

PIT No: 502
PROJECT No: 49971
DATE: 15/10/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.2	TOPSOIL - Light grey silt topsoil with trace clay and some rootlets, humid							
		CLAY - Very stiff, grey brown clay, slightly silty, M>Wp		pp	0.3		350 kPa		
7	0.4	CLAY - Very stiff, orange brown clay with some silt, M>Wp		A,pp	0.5		250 kPa		
	0.6	CLAY - Stiff, green grey clay, trace silt, M>Wp							
	1			A,pp	1.2		150-180 kPa		1
6		From 1.5m, with some subrounded gravel up to 20mm in size		A,pp	1.7		150-160 kPa		
	1.8	GRAVELLY CLAY - Stiff, grey mottled red brown gravelly clay with subrounded quartz gravel up to 20mm in size							
	2 2.0	Pit discontinued at 2.0m, limit of investigation		D	2.0				2
5									

RIG: Case 58 Super Le, 7 tonne, backhoe with 600mm tiger tooth bucket **LOGGED:** West **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Hand held GPS, ±10m

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: [redacted]
PROJECT:
LOCATION: Ocean Drive, Bonny Hills

SURFACE LEVEL: 6.7 AHD
EASTING: 483647
NORTHING: 6507322

PIT No: 503
PROJECT No: 49971
DATE: 15/10/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - Light grey silt topsoil with trace clay and some rootlets, humid							
		CLAY - Very stiff, dark brown clay, slightly silty, M>Wp		pp	0.2		350 kPa		
	0.35	CLAY - Stiff, orange brown clay with trace silt, M>Wp		A,pp	0.5		150 kPa		
6		From 0.6m, grey brown mottled orange brown							
	1								1
				A,pp	1.3		150-170 kPa		
5		From 1.8m, with some serpentenite cobbles		D,pp	1.9		190 kPa		
	2 2.0	SERPENTENITE - Extremely low strength, extremely weathered, grey brown serpentinite							2
	2.1	Pit discontinued at 2.1m, limit of investigation							
4									

Dynamic Penetrometer Test (blows per 150mm): 5 10 15 20

RIG: Case 58 Super Le, 7 tonne, backhoe with 600mm tiger tooth bucket **LOGGED:** West **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Hand held GPS, ±10m

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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