Douglas PARTNERS

GROUNDED EXPERTISE

Report on Geotechnical Investigation

New Residential Dwelling

Lot 50, Bulman, NT

Prepared for Roper Gulf Regional Council

Project 230243.00

23 July 2024

Document History

Details

Project No.	230243.00
Document Title	Report on geotechnical investigation
Site Address	Lot 50, Bulman, NT
Report Prepared For	Roper Gulf Regional Council
Filename	230243.00.R.001.Rev0

Status and Review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Paul Southwell	Scott McFarlane	23 July 2024

Distribution of Copies

Status	Issued to
Revision 0	Belinda McArthur, Roper Gulf Regional Council

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	Paul Southwell	23 July 2024
Reviewer		23 July 2024

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Report on Geotechnical Investigation
New Residential Dwelling
Lot 50, Bulman, NT

1. Introduction

This report presents the results of a geotechnical investigation undertaken for proposed residential dwelling on part of Lot 50, Bulman, NT. The investigation was commissioned in an email dated 19 June 2024 by Perupkar Singh of Turner & Townsend Pty Ltd on behalf of Roper Gulf Regional Council and was undertaken in accordance with Douglas' proposal 230243.00.P.001.Rev0 dated 17 June 2024.

It is understood that the proposed development consists of a single storey, two bedroom demountable dwelling with shared kitchen, living and laundry space. The dwelling will be built on the rear of Lot 50, which currently has a dwelling situated on the front (northern) portion. Details of the proposed building loads and finished levels are not known at the time of writing this proposal, however footing loads are expected to be relatively light with footings designed in accordance with AS 2870 where possible.

Geotechnical investigation was required to provide information on the subsurface and groundwater conditions at the site, and comments on the following:

- Site preparation and earthworks requirements;
- Site classification to AS 2870 (2011);
- Suitable footing system options, foundation design parameters, including allowable bearing pressures and estimated settlements for shallow footings, and end bearing and shaft adhesion for short bored piles (founding within the depth of investigation); and
- Identify anticipated construction difficulties and provide possible solutions (if encountered).

The investigation included the drilling of two boreholes and dynamic cone penetrometer (DCP) testing. The details of the field work are presented in this report, together with comments and recommendations on the items listed above.

2. Site Description and Geology

Lot 50 is located within the southern portion of Bulman, situated approximately 240 km east northeast of Katherine (refer Drawing 1 in Appendix A). Lot 50 is bounded by sealed roads to the east and north, an existing residence to the northwest and undeveloped land to the southwest and south.

The site slopes down gently to the northwest from steeper rock ridges to the south. At the time of the investigation, an existing dwelling was located on the northern portion of the site, and a garden shed was located in the central east. The area of the proposed dwelling, located within the southern half of Lot 50 (Lot 50B on Drawing 1), was covered by grass with scattered Eucalypt trees spread throughout. The lot was surrounded by a high chain wire fence. Figure 1 shows the site conditions at the time of investigation.

Figure 1: View looking northwest across the site towards the existing dwelling.

Reference to the Mount Marumba 1:250 000 Geological Series map (Sheet SE53-06) and explanatory notes indicates that Bulman is located close to the boundary between two geological units, being the early Proterozoic aged Dook Creek Formation comprising dolomitic siltstone and sandstone, dolostone, siltstone and quartz sandstone, and the Derim Derim Dolerite of the same age. The fieldwork encountered generally gravelly soils underlain by sandstone, indicating that Lot 50 is more likely to be underlain by the Dook Creek Formation.

3. Field Work

3.1 Field Work Methods

Field work for this investigation was carried out on 16 July 2024 and comprised the drilling of two boreholes (designated Bores 1 and 2). The test locations are shown on Drawing 1 in Appendix A. Given access difficulties due to dangerous dogs within Lot 50, the test bores were drilled adjacent to the southern (Bore 1) and western (Bore 2) boundaries of the site.

The bores were drilled to auger refusal at 0.4 m and 0.8 m depth using a skid steer fitted with a 300 m diameter short flight auger attachment. The boreholes were drilled, logged, and sampled by a senior associate from Douglas. Following the completion of logging and sampling, the boreholes were checked for groundwater ingress before being backfilled with spoil and compacted using hand tools.

Dynamic cone penetrometer tests (DCPs) were carried out in accordance with AS1289.6.3.1 from the ground surface, adjacent to or progressively within the boreholes. Blow counts were recorded for each 100 mm penetration, with DCP refusal defined as greater than 15 blows per 100 mm penetration.

The test locations were recorded using a handheld GPS unit with a typical horizontal accuracy of about 5 m, and were also measure relative to the lot boundaries, as shown in Drawing 1. Survey information was not available at the time of reporting, therefore surface levels at the test locations were unable to be recorded.

3.2 Field Work Results

Ground conditions encountered in the bores are summarised below. Detailed logs of each borehole are presented on the log sheets in Appendix B, together with notes explaining classification methods and descriptive terms used in their preparation.

Very dense silty cobbly gravel was encountered in both bores to 0.4 m depth and was underlain by very dense clayey gravelly sand in Bore 2 only. Auger refusal on probable sandstone bedrock then occurred at 0.4 m depth in Bore 1 and 0.8 m depth in Bore 2. Retrieval of intact rock chips to allow strength estimation was not possible in the bores, however, based on observation of rock outcrop near to the site, the sandstone underlying the site is likely to be of at least low strength.

Groundwater was not observed in either of the bores while they remained open. It should be noted that groundwater depths are affected by factors such as climatic conditions and soil permeability and will therefore vary significantly between the dry and wet seasons. Field work was undertaken in July, which is mid dry season.

4. Laboratory Testing

Given the granular nature of the soils encountered in the bores, laboratory testing for site classification purposes was not deemed necessary.

5. Comments

5.1 Appreciation of Ground Conditions

The subsurface encountered during the field work comprised very dense granular soils to 0.4 m and 0.8 m depth overlying sandstone estimated to be of at least low strength. Groundwater was not encountered while the bores remained open, however, it is considered likely that shallow perched groundwater may be present at the interface between the soils and underlying sandstone during the wet season.

Based on the results of this investigation, the site is assessed as being suitable for the proposed use from a geotechnical perspective. Few difficulties are foreseen for construction of the dwelling at the site from a geotechnical perspective, provided that shallow footings are adopted, and all site preparation and construction is carried out well into the dry season.

Shallow footings founded within the very dense granular soils or on rock are recommended as the most appropriate footing system for the proposed structures at the site (refer Section 5.4). Due to the presence of cobbly soils and shallow sandstone at the site, which would hinder the drilling of shallow bored piles unless large equipment is used and the piles are cased (which is unlikely to be economically feasible), the adoption of bored piles is not recommended. Therefore, bored piles have not been discussed further in this report.

5.2 Site Preparation and Earthworks

Site preparation and earthworks carried out for the placement of any fill at the site or in areas of proposed pavements should be in accordance with the following guidelines:

- Strip to design subgrade level or remove all topsoil and vegetation from areas to receive fill (whichever is deeper), noting that no organic topsoil was encountered in the bores. If any uncontrolled fill is encountered, it may be left in areas of proposed buildings, provided all footings found on the underlying natural soils. Any tree roots and stumps larger than about 20 mm in diameter should be grubbed out at this stage.
- Rip and homogenise the subgrade to a depth of at least 250 mm, then adjust to optimum moisture content (OMC). It is possible that the exposed foundation soils will be soft in places and cause heaving under earthmoving machinery if earthworks commence during or soon after the wet season, when moisture content levels will be elevated. For this reason, it is recommended that site preparation and exposure of the foundation soils occur in the dry season when conditions are favourable, and drying out of the exposed foundation soils will permit them to be prepared for construction of the pavement subgrades.
- Roll the exposed surface with at least six passes of a minimum 12 tonne deadweight roller (or as large as practicable), with a final test roll pass accompanied by careful visual inspection. The stripped surface should be compacted to 95% modified compaction. The surface should not exhibit excessive deformation or springing under test roll. Any unstable zones that do not improve after further compaction or treatment should be excavated and replaced with compacted approved fill. The extent of treatment is best assessed at the time of construction, but large areas of excavation are not recommended to exceed 300 mm depth without geotechnical advice to assess other options. Test rolling should be witnessed by a suitably experienced geotechnical professional and a hold point put on the placement of fill until the stripped surface is approved.
- Place and compact granular low reactive fill in horizontal layers up to 250 mm loose thickness. In confined working areas or in situations where compaction may be difficult to achieve, thinner layers would be required. Recommended compaction requirements for fill are presented below.

Purpose	Minimum Dry Density Ratio
Building Footprints	98% Standard
Footing support	100% Standard
Pavement Subgrade	95% Modified

- Maintain moisture contents for fill exhibiting clay-like properties within 2% of OMC until pavements are constructed.

5.3 Site Classification

Site classification of foundation soil reactivity applies to residential buildings up to two-storeys and to other buildings of similar size, loading and flexibility as defined in accordance with AS 2870 (2011), and would apply to this project.

Based on the results of the field work, which encountered granular soils over relatively shallow bedrock, a characteristic surface movement (y_s) of less than 20 mm has been calculated for the site, corresponding to a site classification of Class S for this site in its current condition.

If fill exhibiting clay like properties is used to raise site levels, then the effect on site classification would depend on the reactivity of the material and the thickness of fill placed under the building footprints, and would need to be assessed once these factors are known.

The effects of possible trees near the proposed building envelopes have not been assessed in this site classification, and the building designer should refer to AS 2870 (2011) in this regard.

It should be noted that the above estimate of y_s does not take into account settlement induced by footing loading of the foundation soils (discussed in Section 5.4).

If other 'abnormal' soil moisture conditions are experienced at the site, the ground movements would be larger than those estimated above which would typically require more extensive foundation works to avoid adverse foundation performance. Abnormal soil moisture conditions are defined in AS 2870, and relevant conditions for the site comprise:

- Unusual moisture caused by drains, channels, ponds, dams or tanks;
- Growth of trees too close to a structure (albeit unlikely);
- Lack of maintenance of site drainage; and
- Leaks or drain outlets of air conditioning units.

With respect to the design of footings within areas of abnormal moisture, alternative solutions could comprise moisture conditioning and replacement under engineering supervision (information on the potential extent of affected soil is given in AS 2870) or founding below the depth of the affected soils.

5.4 High Level Footings

Conventional pad, strip and thickened edge or internal beam footings founding in the very dense granular soils or on low strength or stronger sandstone below 0.3 m depth would be suitable for the proposed buildings and could be designed based on an allowable bearing pressure of 100 kPa.

Settlements for pad footings up to 2 m wide or strip footings / beams up to 0.5 m wide, founded as above are estimated to be less than 10 mm.

All footing excavations should be inspected by a geotechnical engineer and tested, if necessary, to confirm that the materials exposed at founding level are suitable for the proposed building loads. If, during inspection, it is apparent that the foundation soils are different from those

described in this report, then further geotechnical assessment must be carried out, and possibly a review made of the allowable bearing pressure, founding depth or footing width.

6. References

AS 2870. (2011). *Residential Slabs and Footings.* Standards Australia.

AS 3798. (2007). *Guidelines on Earthworks for Commercial and Residential Developments.* Standards Australia.

CCAA. (2008). *TN61, Articulated Walling.* Technical Note 61, 3rd Edition: Cement Concrete & Aggregates Australia.

7. Limitations

Douglas Partners Pty Ltd (Douglas) has prepared this report for this project at Lot 50, Bulman, NT in line with Douglas' proposal dated 17 June 2024 and acceptance received from Perupkar Singh of Turner & Townsend Pty Ltd on behalf of Roper Gulf Regional Council dated 19 June 2024. The work was carried out under Douglas' Engagement Terms.

This report is provided for the exclusive use of Turner & Townsend and Roper Gulf Regional Council 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 Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas 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 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 Douglas' field testing has been completed.

Douglas' advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by Douglas 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.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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. Douglas 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 Douglas. This is because this report has been written as advice and opinion rather than instructions for construction.

Appendix A

About this Report

Drawing 1 - Site and Test Location Plan

About this Report

November 2023

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.

continued next page

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.

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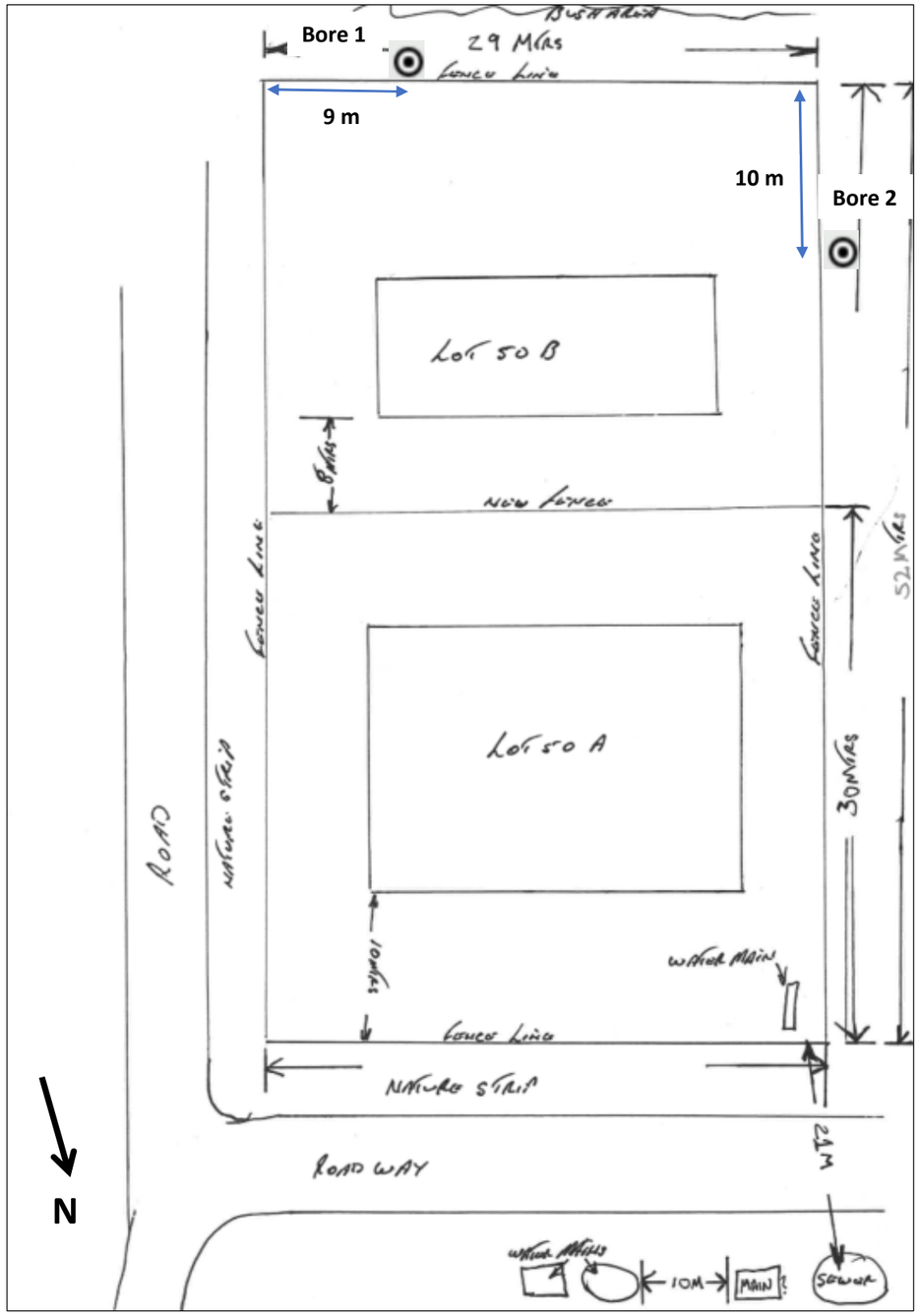
LOCALITY PLAN

NOTES:

1. Drawing supplied by client. Locality plan adapted from Google Maps.
2. Scale as shown

LEGEND:

◎ Bore Location and Number



Douglas PARTNERS GROUNDED EXPERTISE	Project No. 230243.00	Drawing 1 - Site and Test Location Plan
	Date: 23 July 2024	Proposed Dwelling, Lot 50, Bulman, NT
		Client: Roper Gulf Regional Council

Appendix B

About this Report

Terminology, Symbols and Abbreviations

Soil Descriptions

Sampling, Testing and Excavation Methodology

Results of Field Work

Terminology, Symbols and Abbreviations

November 2023

Introduction to Terminology, Symbols and Abbreviations

Douglas Partners' reports, investigation logs, and other correspondence may use terminology which has quantitative or qualitative connotations. To remove ambiguity or uncertainty surrounding the use of such terms, the following sets of notes pages may be attached Douglas Partners' reports, depending on the work performed and conditions encountered:

- Soil Descriptions;
- Rock Descriptions; and
- Sampling, insitu testing, and drilling methodologies

In addition to these pages, the following notes generally apply to most documents.

Abbreviation Codes

Site conditions may also be presented in a number of different formats, such as investigation logs, field mapping, or as a written summary. In some of these formats textual or symbolic terminology may be presented using textual abbreviation codes or graphic symbols, and, where commonly used, these are listed alongside the terminology definition. For ease of identification in these note pages, textual codes are presented in these notes in the following style XW. Code usage conforms with the following guidelines:

- Textual codes are case insensitive, although herein they are generally presented in upper case; and
- Textual codes are contextual (i.e. the same or similar combinations of characters may be used in different contexts with different meanings (for example `PL` is used for plastic limit in the context of soil moisture condition, as well as in `PL(A)` for point load test result in the testing results column)).

Data Integrity Codes

Subsurface investigation data recorded by Douglas Partners is generally managed in a highly structured database environment, where records "span" between a top and bottom depth interval. Depth interval "gaps" between records are considered to introduce ambiguity, and, where appropriate, our practice guidelines may require contiguous data sets. Recording meaningful data is not always appropriate (for example assigning a "strength" to a concrete pavement) and the following codes may be used to maintain contiguity in such circumstances.

Term	Description	Abbreviation Code
Core loss	No core recovery	KL
Unknown	Information was not available to allow classification of the property. For example, when auguring in loose, saturated sand auger cuttings may not be returned.	UK
No data	Information required to allow classification of the property was not available. For example if drilling is commenced from the base of a hole predrilled by others	ND
Not Applicable	Derivation of the properties not appropriate or beyond the scope of the investigation. For example providing a description of the strength of a concrete pavement	NA

Graphic Symbols

Douglas Partners' logs contain a "graphic" column which provides a pictorial representation of the basic composition of the material. The symbols used are directly representing the material name stated in the adjacent "Description of Strata" column, and as such no specific graphic symbology legend has been provided in these notes.

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Soil Descriptions

Terminology
Symbols
Abbreviations

March 2024

Introduction

All materials which are not considered to be "in-situ rock" are described in general accordance with the soil description model of AS 1726-2017 Part 6.1.3, and can be broken down into the following description structure:

The "classification" comprises a two character "group symbol" providing a general summary of dominant soil characteristics. The "name" summarises the particle sizes within the soil which most influence its behaviour. The detailed description presents more information about composition, condition, structure, and origin of the soil.

Classification, naming and description of soils require the relative proportion of particles of different sizes within the whole soil mixture to be considered.

Particle size designation and Behaviour Model

Solid particles within a soil are differentiated on the basis of size.

The engineering behaviour properties of a soil can subsequently be modelled to be either "fine grained" (also known as "cohesive" behaviour) or "coarse grained" ("non cohesive" behaviour), depending on the relative proportion of fine or coarse fractions in the soil mixture.

Particle Size Designation	Particle Size (mm)	Behaviour Model	
		Behaviour	Approximate Dry Mass
Boulder	>200	Excluded from particle behaviour model as "oversize"	
Cobble	63 - 200		
Gravel[1]	2.36 - 63	Coarse	>65%
Sand[1]	0.075 - 2.36		
Silt	0.002 - 0.075	Fine	>35%
Clay	<0.002		

[1] – refer grain size subdivision descriptions below

The behaviour model boundaries defined above are not precise, and the material behaviour should be assumed from the name given to the material (which considers the particle fraction which dominates the behaviour, refer "component proportions" below), rather than strict observance of the proportions of particle sizes. For example, if a material is named a "Sandy CLAY", this is indicative that the material exhibits fine grained behaviour, even if the dry mass of coarse grained material may exceed 65%.

Component proportions

The relative proportion of the dry mass of each particle size fraction is assessed to be a "primary", "secondary", or "minor" component of the soil mixture, depending on its influence over the soil behaviour.

Component Proportion Designation	Definition[1]	Relative Proportion	
		In Fine Grained Soil	In Coarse Grained Soil
Primary	The component (particle size designation, refer above) which dominates the engineering behaviour of the soil	The clay/silt component with the greater proportion	The sand/gravel component with the greater proportion
Secondary	Any component which is not the primary, but is significant to the engineering properties of the soil	Any component with greater than 30% proportion	Any granular component with greater than 30%; or Any fine component with greater than 12%
Minor[2]	Present in the soil, but not significant to its engineering properties	All other components	All other components

[1] As defined in AS1726-2017 6.1.4.4

[2] In the detailed material description, minor components are split into two further sub-categories. Refer "identification of minor components" below.

Composite Materials

In certain situations, a lithology description may describe more than one material, for example, collectively describing a layer of interbedded sand and clay. In such a scenario, the two materials would be described independently, with the names preceded or followed by a statement describing the arrangement by which the materials co-exist. For example, "INTERBEDDED Silty CLAY AND SAND".

Soil Descriptions

Classification

The soil classification comprises a two character group symbol. The first character identifies the primary component. The second character identifies either the grading or presence of fines in a coarse grained soil, or the plasticity in a fine grained soil. Refer AS1726-2017 6.1.6 for further clarification.

Soil Name

For most soils, the name is derived with the primary component included as the noun (in upper case), preceded by any secondary components stated in an adjective form. In this way, the soil name also describes the general composition and indicates the dominant behaviour of the material.

Component [1]	Prominence in Soil Name
Primary	Noun (eg "CLAY")
Secondary	Adjective modifier (eg "Sandy")
Minor	No influence

[1] – for determination of component proportions, refer component proportions on previous page

For materials which cannot be disaggregated, or which are not comprised of rock or mineral fragments, the names "ORGANIC MATTER" or "ARTIFICIAL MATERIAL" may be used, in accordance with AS1726-2017 Table 14.

Commercial or colloquial names are not used for the soil name where a component derived name is possible (for example "Gravelly SAND" rather than "CRACKER DUST").

Materials of "fill" or "topsoil" origin are generally assigned a name derived from the primary/secondary component (where appropriate). In log descriptions this is preceded by uppercase "FILL" or "TOPSOIL". Origin uncertainty is indicated in the description by the characters (?), with the degree of uncertainty described (using the terms "probably" or "possibly" in the origin column, or at the end of the description).

Identification of minor components

Minor components are identified in the soil description immediately following the soil name. The minor component fraction is usually preceded with a term indicating the relative proportion of the component.

Minor Component Proportion Term	Relative Proportion	
	In Fine Grained Soil	In Coarse Grained Soil
With	All fractions: 15-30%	Clay/silt: 5-12% sand/gravel: 15-30%
Trace	All fractions: 0-15%	Clay/silt: 0-5% sand/gravel: 0-15%

The terms "with" and "trace" generally apply only to gravel or fine particle fractions. Where cobbles/boulders are encountered in minor proportions (generally less than about 12%) the term "occasional" may be used. This term describes the sporadic distribution of the material within the confines of the investigation excavation only, and there may be considerable variation in proportion over a wider area which is difficult to factually characterise due to the relative size of the particles and the investigation methods.

Soil Composition

Plasticity

Descriptive Term	Laboratory liquid limit range	
	Silt	Clay
Non-plastic materials	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35 and ≤50
High plasticity	>50	>50

Note, Plasticity descriptions generally describe the plasticity behaviour of the whole of the fine grained soil, not individual fine grained fractions.

Grain Size

Type		Particle size (mm)
Gravel	Coarse	19 - 63
	Medium	6.7 - 19
	Fine	2.36 – 6.7
Sand	Coarse	0.6 - 2.36
	Medium	0.21 - 0.6
	Fine	0.075 - 0.21

Grading

Grading Term	Particle size (mm)
Well	A good representation of all particle sizes
Poorly	An excess or deficiency of particular sizes within the specified range
Uniformly	Essentially of one size
Gap	A deficiency of a particular size or size range within the total range

Note, AS1726-2017 provides terminology for additional attributes not listed here.

Soil Condition

Moisture

The moisture condition of soils is assessed relative to the plastic limit for fine grained soils, while for coarse grained soils it is assessed based on the appearance and feel of the material. The moisture condition of a material is considered to be independent of stratigraphy (although commonly these are related), and this data is presented in its own column on logs.

Applicability	Term	Tactile Assessment	Abbreviation code
Fine	Dry of plastic limit	Hard and friable or powdery	w<PL
	Near plastic limit	Can be moulded	w=PL
	Wet of plastic limit	Water residue remains on hands when handling	w>PL
	Near liquid limit	"oozes" when agitated	w=LL
	Wet of liquid limit	"oozes"	w>LL
Coarse	Dry	Non-cohesive and free running	D
	Moist	Feels cool, darkened in colour, particles may stick together	M
	Wet	Feels cool, darkened in colour, particles may stick together, free water forms when handling	W

The abbreviation code NDF, meaning "not-assessable due to drilling fluid use" may also be used.

Note, observations relating to free ground water or drilling fluids are provided independent of soil moisture condition.

Consistency/Density/Compaction/Cementation/Extremely Weathered Material

These concepts give an indication of how the material may respond to applied forces (when considered in conjunction with other attributes of the soil). This behaviour can vary independent of the composition of the material, and on logs these are described in an independent column and are generally mutually exclusive (i.e it is inappropriate to describe both consistency and compaction at the same time). The method by which the behaviour is described depends on the behaviour model and other characteristics of the soil as follows:

- In fine grained soils, the "consistency" describes the ease with which the soil can be remoulded, and is generally correlated against the materials undrained shear strength;
- In granular materials, the relative density describes how tightly packed the particles are, and is generally correlated against the density index;
- In anthropogenically modified materials, the compaction of the material is described qualitatively;
- In cemented soils (both natural and anthropogenic), the cemented "strength" is described qualitatively, relative to the difficulty with which the material is disaggregated; and
- In soils of extremely weathered material origin, the engineering behaviour may be governed by relic rock features, and expected behaviour needs to be assessed based the overall material description.

Quantitative engineering performance of these materials may be determined by laboratory testing or estimated by correlated field tests (for example penetration or shear vane testing). In some cases, performance may be assessed by tactile or other subjective methods, in which case investigation logs will show the estimated value enclosed in round brackets, for example (VS).

Consistency (fine grained soils)

Consistency Term	Tactile Assessment	Undrained Shear Strength (kPa)	Abbreviation Code
Very soft	Extrudes between fingers when squeezed	<12	VS
Soft	Mouldable with light finger pressure	>12 - ≤25	S
Firm	Mouldable with strong finger pressure	>25 - ≤50	F
Stiff	Cannot be moulded by fingers	>50 - ≤100	St
Very stiff	Indented by thumbnail	>100 - ≤200	VSt
Hard	Indented by thumbnail with difficulty	>200	H
Friable	Easily crumbled or broken into small pieces by hand	-	Fr

Relative Density (coarse grained soils)

Relative Density Term	Density Index	Abbreviation Code
Very loose	<15	VL
Loose	>15 - ≤35	L
Medium dense	>35 - ≤65	MD
Dense	>65 - ≤85	D
Very dense	>85	VD

Note, tactile assessment of relative density is difficult, and generally requires penetration testing, hence a tactile assessment guide is not provided.

Compaction (anthropogenically modified soil)

Compaction Term	Abbreviation Code
Well compacted	WC
Poorly compacted	PC
Moderately compacted	MC
Variably compacted	VC

Cementation (natural and anthropogenic)

Cementation Term	Abbreviation Code
Moderately cemented	MOD
Weakly cemented	WEK

Extremely Weathered Material

AS1726-2017 considers weathered material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. less than very low strength rock). These materials may be identified as "extremely weathered material" in reports and by the abbreviation code XWM on log sheets. This identification is not correlated to any specific qualitative or quantitative behaviour, and the engineering properties of this material must therefore be assessed according to engineering principles with reference to any relic rock structure, fabric, or texture described in the description.

Soil Origin

Term	Description	Abbreviation Code
Residual	Derived from in-situ weathering of the underlying rock	RS
Extremely weathered material	Formed from in-situ weathering of geological formations. Has strength of less than 'very low' as per as1726 but retains the structure or fabric of the parent rock.	XWM
Alluvial	Deposited by streams and rivers	ALV
Fluvial	Deposited by channel fill and overbank (natural levee, crevasse splay or flood basin)	FLV
Estuarine	Deposited in coastal estuaries	EST
Marine	Deposited in a marine environment	MAR
Lacustrine	Deposited in freshwater lakes	LAC
Aeolian	Carried and deposited by wind	AEO
Colluvial	Soil and rock debris transported down slopes by gravity	COL
Slopewash	Thin layers of soil and rock debris gradually and slowly deposited by gravity and possibly water	SW
Topsoil	Mantle of surface soil, often with high levels of organic material	TOP
Fill	Any material which has been moved by man	FILL
Littoral	Deposited on the lake or seashore	LIT
Unidentifiable	Not able to be identified	UID

Cobbles and Boulders

The presence of particles considered to be "oversize" may be described using one of the following strategies:

- Oversize encountered in a minor proportion (when considered relative to the wider area) are noted in the soil description; or
- Where a significant proportion of oversize is encountered, the cobbles/boulders are described independent of the soil description, in a similar manner to composite soils (described above) but qualified with "MIXTURE OF".

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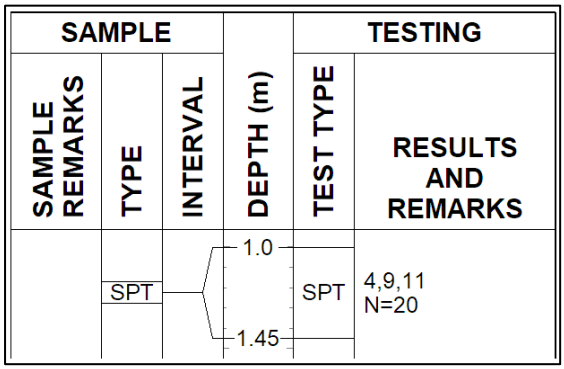
Sampling, Testing and Excavation Methodology

Terminology
Symbols
Abbreviations

March 2024

Sampling and Testing

A record of samples retained, and field testing performed is usually shown on a Douglas Partners' log with samples appearing to the left of a depth scale, and selected field and laboratory testing (including results, where relevant) appearing to the right of the scale, as illustrated below:



Sampling

The type or intended purpose for which a sample was taken is indicated by the following abbreviation codes.

Sample Type	Code
Auger sample	A
Acid Sulfate sample	ASS
Bulk sample	B
Core sample	C
Disturbed sample	D
Environmental sample	ES
Gas sample	G
Piston sample	P
Sample from SPT test	SPT
Undisturbed tube sample	U[1]
Water sample	W
Material Sample	MT
Core sample for unconfined compressive strength testing	UCS

[1] – numeric suffixes indicate tube diameter/width in mm

The above codes only indicate that a sample was retained, and not that testing was scheduled or performed.

Field and Laboratory Testing

A record that field and laboratory testing was performed is indicated by the following abbreviation codes.

Test Type	Code
Pocket penetrometer (kPa)	PP
Photo ionisation detector (ppm)	PID
Standard Penetration Test x/y =x blows for y mm penetration HB = hammer bouncing HW = fell under weight of hammer	SPT
Shear vane (kPa)	V
Unconfined compressive strength, (MPa)	UCS

Field and laboratory testing (continued)

Test Type	Code
Point load test, (MPa), axial (A), diametric (D), irregular (I)	PLT(_)
Dynamic cone penetrometer, followed by blow count penetration increment in mm (cone tip, generally in accordance with AS1289.6.3.2)	DCP/150
Perth sand penetrometer, followed by blow count penetration increment in mm (flat tip, generally in accordance with AS1289.6.3.3)	PSP/150

Groundwater Observations

▷	seepage/inflow
▽	standing or observed water level
NFGWO	no free groundwater observed
OBS	observations obscured by drilling fluids

Drilling or Excavation Methods/Tools

The drilling/excavation methods used to perform the investigation may be shown either in a dedicated column down the left-hand edge of the log, or stated in the log footer. In some circumstances abbreviation codes may be used.

Method	Abbreviation Code
Direct Push	DP
Solid flight auger. Suffixes: /T = tungsten carbide tip, /V = v-shaped tip	AD[1]
Air Track	AT
Diatube	DT[1]
Hand auger	HA[1]
Hand tools (unspecified)	HAND
Existing exposure	X
Hollow flight auger	HSA[1]
HQ coring	HQ3
HMLC series coring	HMLC
NMLC series coring	NMLC
NQ coring	NQ3
PQ coring	PQ3
Predrilled	PD
Push tube	PT[1]
Ripping tyne/ripper	R
Rock roller	RR[1]
Rock breaker/hydraulic hammer	EH
Sonic drilling	SON[1]
Mud/blade bucket	MB[1]
Toothed bucket	TB[1]
Vibrocore	VC[1]
Vacuum excavation	VE
Wash bore (unspecified bit type)	WB[1]

[1] – numeric suffixes indicate tool diameter/width in mm

Douglas PARTNERS

BOREHOLE LOG

CLIENT: roper gulf regional council
PROJECT: New Residential Dwelling
LOCATION: Lot 50 Bulman, NT

SURFACE LEVEL:
COORDINATE: E:427680.0, N:8489100.0
DATUM/GRID: MGA2020 Zone 53
DIP/AZIMUTH: 90°/---°

LOCATION ID: 1
PROJECT No: 230243.00
DATE: 16/07/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
			Silty Cobbly GRAVEL (GM): grey-brown; fine to coarse, sub-angular to angular; low plasticity silt; sub-angular to angular, argallite and sandstone cobbles.		COL	VD	D					DCP9/100	5 10 15 /50
			Borehole discontinued at 0.40m depth. Refusal on probable low strength sandstone bedrock.										

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Bobcat S160 skid steer
METHOD: 300 mm diameter auger
REMARKS: No free groundwater encountered.

OPERATOR: Mimal Rangers

LOGGED: PSS
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

BOREHOLE LOG

CLIENT: roper gulf regional council
PROJECT: New Residential Dwelling
LOCATION: Lot 50 Bulman, NT

SURFACE LEVEL:
COORDINATE: E:427659.0, N:8489117.0
DATUM/GRID: MGA2020 Zone 53
DIP/AZIMUTH: 90°/---°

LOCATION ID: 2
PROJECT No: 230243.00
DATE: 16/07/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
			Silty Cobbly GRAVEL (GM): grey-brown; fine to coarse, sub-angular to angular; low plasticity silt; sub-angular to angular, sandstone cobbles.		COL	VD	D					DCP9/100	5 10 15 22
		0.40	Clayey Gravelly SAND (GC): red-brown; fine to coarse; low plasticity clay; fine to coarse, sub-angular to angular gravel.		RS	VD	D						21
			Borehole discontinued at 0.80m depth. Refusal on probable low strength sandstone bedrock.										

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Bobcat S160 skid steer
METHOD: 300 mm diameter auger
REMARKS: No free groundwater encounterd.

OPERATOR: Mimal Rangers

LOGGED: PSS
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions