Geotechnical Investigation Report

Redmond Place, Orange NSW

Landcom

15 May 2024

→ The Power of Commitment

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1. Introduction

1.1 Background

GHD understands that Landcom and Orange City Council have signed a Project Delivery Agreement for the purposes of delivering the Redmond Place project. The site is owned by Orange City Council and Landcom are taking the lead in preparing a planning proposal to amend the Orange Local Environmental Plan 2011 (LEP) to rezone the site for residential use in accordance with a prepared master plan.

The key objectives of the master plan are to:

– Supply – increase the supply of land to facilitate housing
– Diversity – promote housing diversity
– Affordability – increase the supply of land for affordable housing by delivering at least 20% of all residential dwellings for affordable housing
– Sustainability – develop a climate resilient, healthy, and inclusive place, at the forefront of environmental and social sustainability.

The staging strategy for this site is to be determined and will need to take into consideration infrastructure availability, delivery timing, placemaking, and entry point to the area from Mitchell Highway.

The urban design approach for the project focuses on socio-economic activation, innovative sustainability solutions and urban vibrancy through place-making. The master plan for the future new community of Redmond Place will be based on a landscape-led approach to urban design, informed by the unique qualities of the site and Connecting with Country principles. A thorough community and stakeholder engagement process, including community workshops, a Walk on Country, and indigenous stakeholder interview, will also inform the urban design process.

Landcom have engaged GHD Pty Ltd (GHD) to undertake a preliminary assessment of the site for environmental and geotechnical risks and constraints in support of their planning proposal submission.

1.2 Objectives and purpose of this report

The purpose of this report is to document the findings of the Preliminary Geotechnical Investigation.

The key objectives of the preliminary geotechnical investigation include:

– To undertake a combined Geotechnical and Environmental Field-Based Investigation, comprising intrusive investigations, insitu/laboratory testing and data collation.
– To provide Landcom with a preliminary understanding of potential geological/geotechnical issues of the proposed development area.
– To provide a preliminary Geotechnical Investigation Report (this report) that will support Landcom's planning proposal and provide information regarding the relevant geological, geotechnical specifications and risks for the project.

1.3 Limitations

This report: has been prepared by GHD for Landcom and may only be used and relied on by Landcom for the purpose agreed between GHD and Landcom as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Landcom arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report Revision. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

General notes relating to limitations of this report are included in Appendix A and should be read in conjunction with this report.

2. Scope of work

The scope of work for the preliminary geotechnical site investigation comprised the following:

- Preparation of site-specific health and safety documentation.
  - Collating a job safety and environmental analysis (JSEA) for the works, which provided a step-by-step assessment of the risks and mitigation measures to be utilised during the execution of the works.
  - Review of safe work method statements (SWMS) for all subcontractors and personnel involved during the execution of the field investigation.
  - Collation of daily pre-work assessments to identify 'new' risks and control measures identified during the works (using GHD's SMART App and form in the JSEA).
- Identifying and addressing regulatory requirements for the investigations to proceed
- Review of Before You Dig Australia (BYDA) documents and onsite non-intrusive utilities search with a qualified services locator to clear each test location for underground surfaces. Completion of permit to excavate.
- Subsurface investigation comprising:
  - Excavation of twenty-eight (28) test pits.
  - Dynamic cone penetrometer (DCP) testing adjacent to select test pits.
  - Full-time supervision on-site by a GHD Environmental Scientist, competent in geotechnical soil logging and sampling.
- Geotechnical laboratory testing of select soil samples collected from test pits.
- Preparation of this Geotechnical Investigation Report presenting the results of the preliminary investigation and provision of geotechnical advice in relation to the objectives outlined in Section 1.3 above.

3. Site Details

3.1 Site information

The Site is located on the southeast fringe of Orange, the largest city in the Central West Region. It is adjacent to the suburb of Glenroi, 4.4 km from Orange City Centre and approximately 3.2 km from Orange train station and indicated in Figure 1 below provided by Landcom (Source: OCULUS).

The Site has a significant frontage along Mitchell Highway (A32) which runs from east to west from the M4 Motorway in Greater Sydney connecting through Penrith, Katoomba, Bathurst to Orange.

The Site lies on the southern side of Redmond Place, bounded by Bathurst Road / Mitchell Highway (on the northeast), Lone Pine Avenue (on the west) and Dairy Creek Road to the south. It is surrounded by a mixture of land uses with low density residential to the west, retail and large format retail to the north, rural farmland to the south and east, as well as a kart racing track 250 m north of the Mitchell highway.

The Site is approximately 24.2 Ha in size and is currently vacant, except for a structure that previously housed an emergency services helicopter hangar.

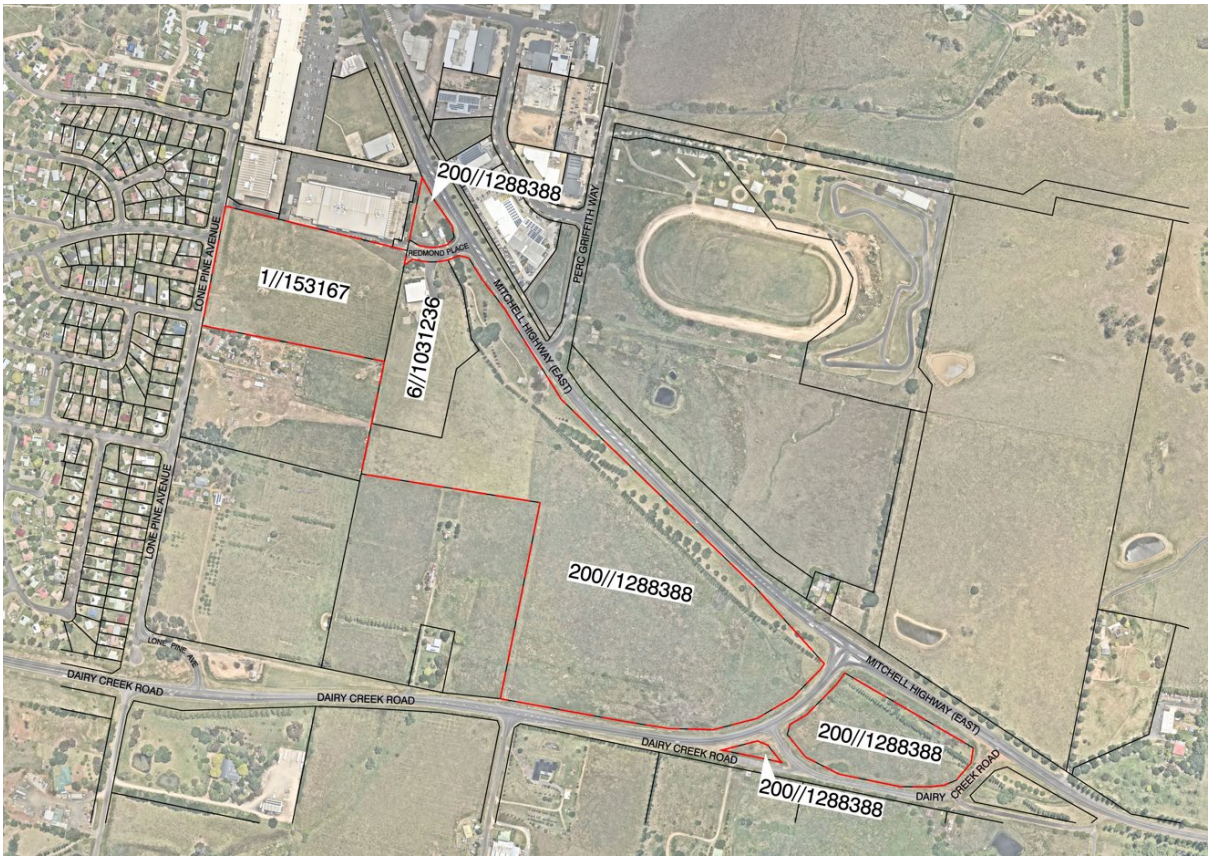

Figure 1 Site Locality Plan (Source: OCULUS via Landcom)

3.2 Site identification

The site currently comprises three lots as indicated in Table 1 below and shown in Appendix B, Figure 1.

Table 1 Site identification – Lot Details

Legal description	Address	Area
Lot 1 DP 153167	154 Lone Pine Avenue	4.10 ha
Lot 6 DP 1031236	3 Redmond Place	2.28 ha
Lot 200 DP 1288388	5255 Mitchell Highway	17.85 ha
	Total	**24.23 ha**

3.3 Environmental Setting

3.3.1 Site and topography

The following is a summary of the existing site, including surrounding landscapes, key relevant site features, and approximate elevation for the site is outlined below:

– Lot 1 DP 153167 (154 Lone Pine Avenue, Orange NSW): Situated within a paddock on northwestern portion of the Site, adjacent to Redmond Place and Lone Pine Avenue. Nearby site features include residential housing and a commercial lot. Approximate height of 903 m AHD.
– Lot 6 DP1031236 (3 Redmond Place, Orange NSW): Situated within a paddock within the northeastern portion of site, adjacent to Redmond Place and Mitchell Highway. Nearby site features include sporadic trees and vegetation following the highway and an aircraft hangar, with asphalted carpark, helipad and concrete bunding. Approximate height of 899 m AHD.
– Lot 200 DP 1288388 (5255 Mithcell Highway, Orange NSW): Situated within a paddock within the southeastern portion of site, adjacent to Dairy Creek Road and Mitchell Highway. Nearby site features include sporadic trees and vegetation following the highway, a small pond on the eastern boundary of the site and residential housing. Approximate height of 896 m AHD.

Elevation was assessed using the publicly available Elvis digital elevation model[1]. This elevation is an approximate for discussion only and is limited to the spatial resolution of the dataset, information on elevations should be obtained using survey.

3.3.2 Geology

Reference to the NSW Seamless Geology (Geological Survey of New South Wales, version 2024.02.05) via MinView indicates up to two geological units to be present within the project site and surrounding area. A geological fault named Lucknow Fault is situated approximately 750 m east of the easternmost section of the site.

Table 2 below provides as summary of the geological units applicable for each bridge location. An extract of the NSW surface geology for the area for the site are indicated in Figure 2 below.

Table 2 Summary of surface geology

Unit	Description
Conobalas Volcanics (NMcnc_o)	Thin alkaline to transitional basaltic lavas, domes and plugs capped by trachyte, minor volcaniclastic units and interbedded non-volcanogenic sediments
Oakdale Formation (Ocao)	Mafic volcanic sandstone; basalt, basaltic andesite, latite and intrusions emplaced as a lava. Volcaniclastic breccia and conglomerate, siltstone, shale, chert. Minor allochthonous limestone and calcareous sedimentary rocks.

[1] Source: https://elevation.fsdf.org.au/ Elvia Elevation and Depth Foundation Spatial Data, Intergovernmental Committee on Surveying and Mapping (ICSM)

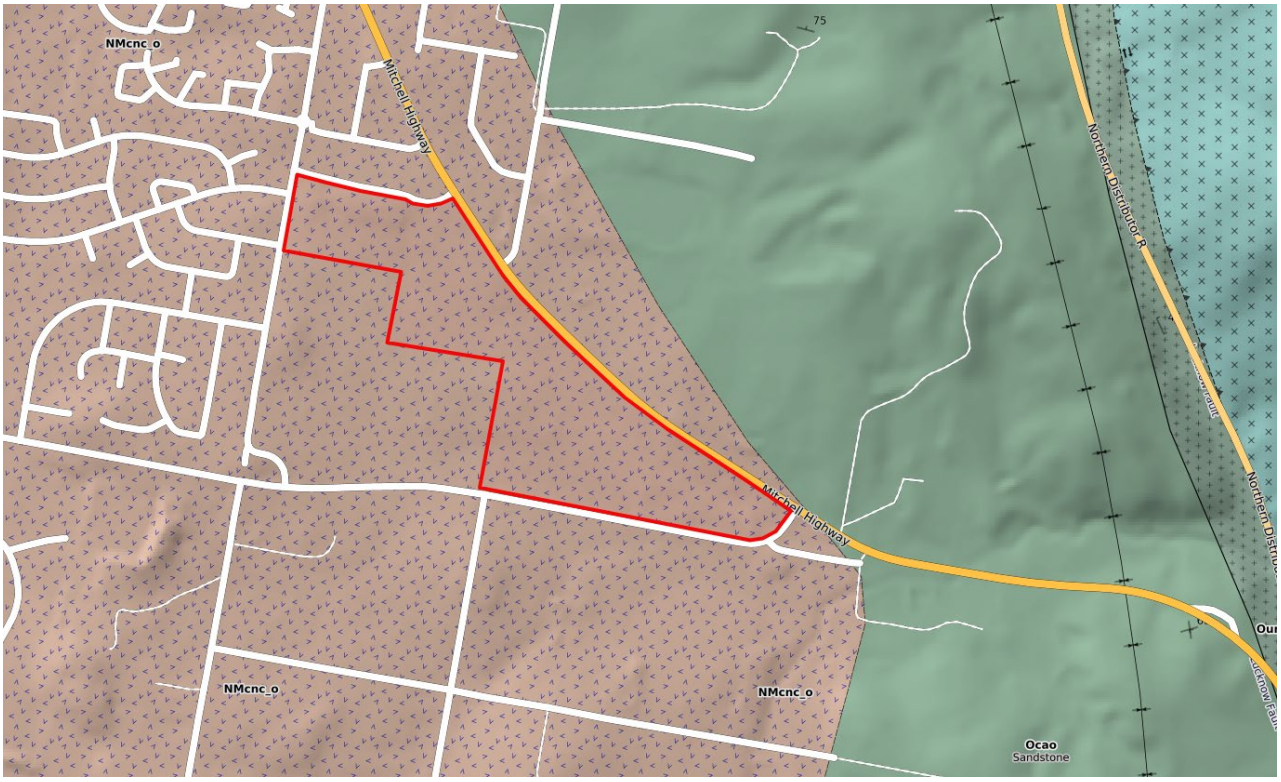

Figure 2 Surface geology and approximate extent of proposed site (red outline) (Source MinView – accessed April 2024).

3.3.3 Soil landscape

Reference to the of the Soil Landscape of Central and Eastern NSW (via eSPADE web map (v2.2)) indicated the site is within the North Orange (SI5508no) soil landscape group. Soils in the SI5508no group include Red Earths on upper slopes and shallow lithosols on crests and side slopes. Yellow Earths occur on lower slopes with brown solodic and yellow solodic Soils in drainage depressions. Soils on the site are expected to be dominated by Yellow Earths which comprise dark to dull brown fine sandy loam with a clear change to bright yellowish-brown loam fine sandy loam to clay loam.

An extract of the Soil Landscape of Central and Eastern NSW map is presented in Figure 3 below.

Figure 3 *Soil landscape occurrence at the site, the approximate location of the site (Source: eSPADE[2])*

3.3.4 Groundwater and surface water

No water sources are noted on site. However, there are several dams positioned on the eastern portion of Lot 200, one being directly on the boundary between Lot 200 and the adjacent property. The Spring Creek Reservoir is located 1,500 m southwest of the site.

A search of NSW Government Water NSW website identified one registered bore (GW042830) on site. An additional ten bores were identified within 500 m of the site. Information pertaining to the additional boreholes is presented in Table 3.

Table 3 *Summary of surrounding groundwater wells*

No.	Date drilled	Location	SWL (m)	Use
GW042830	1976	On-site	1.5	Stock, domestic, irrigation
GW028855	1968	360 m N	9.1	Irrigation
GW026490	1966	440 m N	-	Domestic, stock, irrigation
GW802773	2003	495 m N	-	Stock, domestic
GW038003	-	220 m S	3.9	Domestic
GW038004	1975	220 m S	0.3	Stock, domestic, irrigation
GW013117	1957	160 m S	7.3	Domestic, stock, general use
GW053977	1981	70 m N	-	Irrigation

[2] from espade.environment.nsw.gov.au © State of NSW and Department of Planning, Industry and Environment 2024.

No.	Date drilled	Location	SWL (m)	Use
GW037332	1972	260 m S	-	Stock, domestic, irrigation
GW807079	-	325 m E	-	-
GW019516	1962	310 m E	3.7	Stock, domestic

3.3.5 Acid sulphate soil

Reference to the Department of Planning, Housing and Infrastructure (DPHI) Acid Sulfate Soil mapping through eSPADE[3] web map (v2.2) on 14 March 2024 indicates the site and the immediate area around these locations (within 50 m) mapped as having no known occurrence of Acid Sulphate Soil (ASS).

3.3.6 Salinity

Reference to the DPHI Salinity mapping through eSPADE[2] web map (v2.2) on 15 March 2024 indicates the site and the immediate area around these locations (within 50 m) mapped as having no known occurrence of salinity.

3.4 Surrounding environment

Table 4 Summary of surrounding land use

Direction from investigation areas	Description
North	E3 (productivity support) The surrounding land to the north of Lot 1 DP153167 and Lot 6 DP1031236, contains several store commercial stores (Furniture stores and Supercheap Auto) within three large commercial buildings with carparks. Followed by Mitchell Highway and additional commercial buildings with businesses such as rental car and car dealerships.
East	RE2 (Private recreation) and C3 (Environmental management) The surrounding land to east comprises the Highlands Raceway to the north of Mitchell Highway and the site (RE2) and open space paddocks with minimal residential housing (C3)
South	C3 (Environmental management) The southern portion of the surrounding area contains open paddocks predominantly covered by grass, along with minimal residential housing.
West	R2 (Low density residential) E1 (Local centre) R1 (General residential) and RE1 (Public recreation). Lone Pine Avenue sits on the western boarder of the site, followed by low density residential housing and several public recreation spaces.

[3] from eSPADE.environment.nsw.gov.au © State of NSW and Department of Planning, Industry and Environment 2024.

4. Geotechnical Investigation

4.1 Field investigation

The field investigation was undertaken between 28 February to 1 March 2024.

Prior to the commencement of the intrusive geotechnical investigation a Before You Dig Australia (BYDA) search was undertaken to assess the potential location of underground assets to the proposed investigation locations. Each borehole location was then scanned for underground services by a suitably qualified service locator engaged by GHD. A site layout plan showing the approximate location of the test pits at the site is presented on Figure 2, Appendix B.

Test pits TP01 to TP28 were excavated using a 3-tonne excavator with a toothed bucket, the test pits were excavated to the target termination depth (3.0 m bgl) or refusal. GHD had originally proposed to complete thirty test pits at the site however access constraints (saturated soils) in the southeast corner of the site (western side of Dairy Creek Road) meant two locations could not be complete.

Dynamic Cone Penetrometer (DCP) testing was carried out adjacent to select test pit locations to a depth of 2.0 m to assess soil density or consistency and to further assess soil properties at the test pit locations.

A GHD engineering geologist was onsite full-time during fieldwork to log the subsurface conditions and collect, process, label, and store soil samples for testing.

Soil and rock samples were then labelled and despatched to GHD's NATA accredited laboratory in Artarmon for laboratory testing. Samples were selected for laboratory testing comprising:

– Twenty-two (22) Moisture content tests on select soil samples used
– Fifteen (15) Atterberg Limits tests on soil samples to assess soil plasticity and estimated reactivity of residual soils, and to assess estimated soil parameters for design of the proposed infrastructure.
– Six (6) Linear Shrinkage – Determine reactivity and assist in site classification.
– One (1) shrink swell index
– Eleven (11) Particle Size Distribution (PSD) (sieve method)
– Four (4) PSD (hydrometer method)
– Six (6) Emerson class tests to assess the dispersive potential of the soils at the Site.
– Six (6) Aggressivity suite to assess influence on adopted footing/pile design
– Three (3) Compaction (Std – 100%)
– Three (3) California Bearing Ratio (CBR) tests to assess the potential for material reuse at the site.

Approximate coordinates of the test pit locations were recorded by the GHD engineering geologist using a handheld Global Positioning System (GPS) device with an accuracy of +/- 5m.

The logging was carried out in general accordance with Australian Standard AS 1726-2017 Geotechnical site investigations. GHD Standard Sheets with guidance notes for the engineering logs are provided in Appendix A . Engineering logs of the test pits are presented in Appendix C. Test pit details are summarised below in Table 5.

Table 5 Summary of test pit details

Test Pit ID	Latitude (°)	Longitude (°)	Position of test pit	Depth (m bgl)	Termination	Date completed
TP01	-33.303664°	149.118186°	North-west portion of the site, within Lot 1 DP 153167	1.5	Refusal on HW rock	28/02/2024
TP02	-33.303234°	149.118379°	North-west portion of the site, within Lot 1 DP 153167	1.5	Refusal on HW rock	28/02/2024
TP03	-33.302676°	149.118532°	North-west portion of the site, within Lot 1 DP 153167	2.75	Refusal on HW rock	28/02/2024

Test Pit ID	Latitude (°)	Longitude (°)	Position of test pit	Depth (m bgl)	Termination	Date completed
TP04	-33.303230°	149.118925°	North-west portion of the site, within Lot 1 DP 153167	1.2	Refusal on HW rock	28/02/2024
TP05	-33.303622°	149.118761°	North-west portion of the site, within Lot 1 DP 153167	1.4	Refusal on HW rock.	28/02/2024
TP06	-33.303436°	149.119318°	North-west portion of the site, within Lot 1 DP 153167	1.1	Refusal on HW rock	28/02/2024
TP07	-33.302904°	149.119510°	North-west portion of the site, within Lot 1 DP 1531672	2.20	Refusal on HW rock	28/02/2024
TP08	-33.303978°	149.120123°	North-west portion of the site, within Lot 1 DP 153167	3.0	Target Depth	28/02/2024
TP09	-33.303556°	149.120435°	North-west portion of the site, within Lot 1 DP 153167	1.7	Refusal on HW rock.	28/02/2024
TP10	-33.303140°	149.120372°	North-west portion of the site, within Lot 1 DP 153167	3.0	Target Depth	28/02/2024
TP11	-33.303590°	149.120864°	Northern portion of Lot 6 DP1031236	2.4	Refusal on suspected HW rock	28/02/2024
TP12	-33.303943°	149.121053°	Northern portion of Lot 6 DP1031236	2.3	Refusal on suspected HW rock	28/02/2024
TP13	-33.304564°	149.121196°	Northern portion of Lot 6 DP1031236	2.3	Refusal on HW rock.	28/02/2024
TP14	-33.304648°	149.121948°	Northern portion of Lot 6 DP1031236	3.0	Target Depth	28/02/2024
TP15	-33.305160°	149.121786°	Northern portion of Lot 200 DP 1288388	2.3	Refusal on suspected HW rock	28/02/2024
TP16	-33.305294°	149.122354°	Northern portion of Lot 200 DP 1288388	3.0	Target Depth	28/02/2024
TP17	-33.305437°	149.123213°	Northern portion of Lot 200 DP 1288388	2.8	Refusal on HW rock	28/02/2024
TP18	-33.306445°	149.123398°	Northern portion of Lot 200 DP 1288388	3.0	Target Depth	28/02/2024
TP19	-33.305913°	149.123872°	Eastern portion of Lot 200 DP 1288388	1.5	Refusal on HW rock	28/02/2024
TP20	-33.307682°	149.122847°	Eastern portion of Lot 200 DP 1288388	1.5	Refusal on HW rock	28/02/2024
TP21	-33.307051°	149.129084°	Southwestern portion of Lot 200 DP 1288388	1.9	Refusal on HW rock	28/02/2024
TP22	-33.307152°	149.123733°	Southwestern portion of Lot 200 DP 1288388	2.0	Refusal on HW rock	28/02/2024
TP23	-33.306775°	149.124333°	Southwestern portion of Lot 200 DP 1288388	3.0	Target Depth	28/02/2024
TP24	-33.307492°	149.124438°	Southeastern portion of Lot 200 DP 1288388	3.0	Target Depth	28/02/2024
TP25	-33.307797°	149.125402°	Southern portion of Lot 200 DP 1288388	1.7	Refusal on HW rock	28/02/2024
TP26	-33.308430°	149.125052°	Southern portion of Lot 200 DP 1288388	3.0	Target Depth	28/02/2024

Test Pit ID	Latitude (°)	Longitude (°)	Position of test pit	Depth (m bgl)	Termination	Date completed
TP27	-33.308369°	149.125574°	Southeastern portion of Lot 200 DP 1288388	1.5	Refusal on HW rock	28/02/2024
TP28	-33.307408°	149.125898°	Southern portion of Lot 200 DP 1288388	1.9	Refusal on HW rock	28/02/2024

4.2 Laboratory testing

The geotechnical test methods and number of tests undertaken for this investigation are listed in Table 6 below.

Table 6 Laboratory test methods and scheduled quantities

Test	Test Method	Quantity
Moisture Content	AS 1289.2.1.1	22
Atterberg Limits	AS1289.3.1.1,.3.2.1 & 3.3.3	15
Linear Shrinkage	AS1289.3.4.1	8
Shrink Swell index	AS1289.7.1.1	1
PSD – Sieve method	AS1289.3.6.1	11
PSD – Hydrometer method	AS1289.3.6.3	4
Emerson Crumb Test	AS1289.3.8.1	6
Aggressivity (pH, Cl, SO_4, EC, Resistivity)	AS2159-2009 – Aggressivity Suite Soil (Envirolab)	6
Standard Compaction	AS1289.5.1.1	3
California Bearing Ratio (4-day soak)	AS1289.6.1.1	3

5. Results

5.1 Summary of historic aerial photographs

As part of the Preliminary Site Investigation (PSI) (GHD Reference: 12627900-REP-01, dated 05/04/2024) being carried out concurrently by GHD, a review of historic aerial photographs was carried out. Below is a summary of key observations that may influence the geotechnical conditions and constraints of the site.

– The Site has undergone several stages of notable change throughout the historical aerial imagery.
– Three lots have predominantly remained as vacant open land, with the exception for the construction and removal of various infrastructure across the Site.
– The earliest available imagery is 1954, which outlines the site to contain a residential house within the southeastern and northeastern portions of Lot 200 and orchid rows within Lot 1.
– Throughout the timeline, various small changes have occurred with stockpiles of soil and potential waste occurring intermittently, particularly within Lot 1 DP153167 and the southern portion of Lot 200.
– The most notable change occurring on the Site is the emplacement of fill material observed within the 2003 aerial imagery. This is believed to be associated with the construction of the commercial lot located on the northern boundary of Lot 1 DP153167. Within this period, the addition of the hangar and helipad occurred as well.
– Between 2020 and 2021, an extension to the current sealed road (Dairy Creek Rd) was placed running east to west through the southeastern portion of Lot 200. In addition to the sealed road, small changes were noted within the northern and southern portion of the immediate surrounding area of the road. It is believed that these areas were utilised as laydown areas associated with the construction of the extension.

5.2 Site inspection

As part of the PSI, a site inspection was carried out prior to the intrusive investigation. Below is a summary of key observations that may influence the geotechnical conditions and constraints of the site.

Lot 1 DP153167:

– Lot 1 DP153167 was rectangular shaped paddock that was approximately 41,500 m^2.
– The surface area consisted of a combination of bare soul, gravels, and patchy grass.
– Two stockpiles were noted within the southwestern quadrant of the lot. The larger stockpile consisted of waste material such metal sheeting, wire, concrete, tyres, corrugated iron, PVC piping and potential asbestos containing material. The second stockpile consisted of crusher dust. It was noted that evidence of stockpile relocation was evident throughout the lot, with certain areas containing remnants of past stockpiles (bare soil).
– The northern portion of the lot showed signs of fill placement, believed to be associated with the development of the commercial lot north of the Site.
– The general gradient of the lot sloped towards the southwest, however, the northern portion of the lot was noted to be raised and uneven. Large boulders within the northeastern quadrant were noted on the surface.

Lot 6 DP1031236:

– Lot 6 was a roughly rectangular shaped paddock and aircraft hangar that covered approximately 42,000 m^2.
– The surface area was noted to be covered by asphalt and concrete within the northern quadrant (where the hangar is situated) and cut grass within the central southern areas.
– Boulders, potentially serpentinite, were observed in the southwestern corner of Lot 6 adjacent property. The boulders do not appear to be in-situ and were potentially imported to site and associated with the construction of an internal residential access road.
– An Above Ground Storage Tank (AST) bunded area was noted within the northwestern quadrant, which was accompanied by an additional two concreted areas. Oily water was noted within the bunded area during the inspection. One noted to be a helipad, with two shipping containers.

– Fire hydrant infrastructure was observed to be adjacent to the helipad. Surficial storm water drains were evident in the south and southeastern area of the lot.
– The general gradient of the site was relatively flat, however, towards the southern portion of the lot, it began to slope southeast.

Lot 200 DP 1288388:

– Lot 200 was noted to be inaccessible at the time of the site inspection, however the following was noted.
– Free flowing water was observed in the drainage line flowing west to east from the culverts along Dairy Creek Road.
– Drainage lines were also observed exiting Lot 200, flowing to the east, inferred surface water flow to south and south east towards the large drainage pipes that run beneath Dairy Creek Rd.

5.3 Site conditions at the time of investigation

A summary of key observation made at the time of the intrusive investigations included:

– The site was predominantly grass covered with the height of grass varying across the three lots.
  - Lot 1 and Lot 6 were noted to be cut, where the surface was easily visible.
  - Lot 200, located within the southeastern portion of the site was noted to be covered by overgrown grass, ground surface was not visible.
– With the exception of the southeastern corner of Lot 200, the site was dry and surficial water was not observed. Due to rainfall on 29th February 2024, the southeastern corner of Lot 200 was considered inaccessible by vehicle, which resulted in test pits TP29 and TP30 not being carried out.
– One small pond of water was observed on the southeastern portion of Lot 200, on the boundary of Mitchell Highway. At the time of the investigation the pond was noted to be at capacity of water.
– Three hardstand surfaces were noted in Lot 6, on the southwestern corner of the hanger, the hardstand furthest west was noted to be bunded.
– Drainage lines from Lot 6 were noted to run downslope from the area of the hangar and helipad. At the time of the investigation no water was observed to run freely through the drainage lines.

Key photographs of the site conditions mentioned above are included in Table 7 overleaf. The current site layout is presented in Figure 1, Appendix B.

Table 7 Site Observation Photographs – 30 January and 1 March 2024

Photo 1 *Looking north towards the northern boundary of the site, note neighbouring light industrial buildings built up compared to the surrounding land (photo dated: 30/01/2024).*

Photo 2 *Looking south towards the southern boundary of Lot 1 (photo dated: 30/01/2024)*

Photo 3 *Looking south towards the southern boundary of Lot 1 (photo dated: 30/01/2024)*

Photo 4 *Overview of boulders observed in western portion of Lot 1 (photo dated 30/1/2024)*

Photo 5 *Looking southeast towards the central portion of Lot 6 (photo dated: 30/01/2024).*

Photo 6 *Looking southeast towards the southeastern portion of Lot 6 (photo dated: 30/01/2024).*

Table 6 Site Observation Photographs – 30 January and 1 March 2024 (continued)

Photo 7 *Looking south, overview of the eastern portion of Lot 6, Adjacent to Mitchell Highway (photo dated 30/01/2024)*

Photo 8 *Culvert noted within the southern boundary of Lot 200, adjacent to Dairy Creek Road (photo dated 30/01/2024)*

Photo 9 *Looking north, overview of northern portion of Lot 200 (phot dated 30/01/2024)*

Photo 10 *View central portion of Lot 200, facing southeast, note thick grass and reeds indicative of wet ground conditions (photo dated 1/03/2024)*

Photo 11 *Overview of southeastern portion of Lot 200, facing east (photo dated 01/03/2024)*

Photo 12 *Overview of southwestern portion of Lot 200, facing west (photo dated 01/03/2024)*

5.4 Subsurface conditions

A summary of the soil and rock units encountered in the test pit locations is presented in Table 8. Engineering logs of the test pits are presented in Appendix C. Photographs of test pits are presented in Appendix D.

Table 8 Soil and rock units encountered in the test locations

Unit	Unit Description	Depth to top of unit (m bgl)	Test locations
Topsoil	Clayey SILT, low to medium plasticity, light brown, with rounded to sub-rounded gravel and rootlets	Surface	TP01 to TP03, TP05, TP06, TP09, TP10 and TP12 to TP28
Fill	Silty CLAY, low plasticity, brown, with fine to coarse sub-rounded to rounded gravel, trace fine to coarse grained sand, trace cobble sized rock fragments	Surface	TP03, TP04, TP07 and TP11
Residual	Silty CLAY or Clayey SILT: low to medium plasticity, brown, mottled grey, with fine to coarse grained sand, trace fine to coarse angular to sub angular gravel, iron staining	0.20 – 1.95*	All locations
Extremely weathered rock	Recovered as: Silty CLAY or Gravelly CLAY, low to medium plasticity, firm to very stiff, angular to sub-angular gravel fine to coarse gravel, fine to coarse grained sand	0.7 to 2.75*	TP01 to TP15, TP17 to TP24, TP26 to TP28

Table notes: * = Depth to top of unit may vary significantly between locations due to changes in the surface elevation between test pit locations.

5.4.1 Groundwater

Groundwater inflow was recorded at three test pit locations (TP20, TP21, and TP25) at 1.5, 1.7 and 1.9 m bgl respectively. The test pits were noted to be within the low-lying portions of the site. It should be noted groundwater conditions and depths will vary depending on seasonal weather patterns.

5.4.2 Dynamic Cone Penetrometer testing

DCP testing was completed adjacent to select test pits and are presented on the engineering logs in Appendix C. A summary of soil consistency for depth intervals at each test location as interpreted from the DCP results are indicated in Table 9.

Table 9 Summary of DCP test results

DCP	Depth Interval				
	Soft	Firm	Stiff	Very Stiff	Hard
TP01	-	-	0.3 – 0.7	0.1 – 0.2 & 0.8 – 0.9	0.0 – 0.1 & 1.0 – 1.4
TP02	-	-	1.3 – 1.6	0.4, 0.7 – 1.2 & 1.6	0.0 – 0.3 & 0.5 – 0.7 & 1.7
TP03	1.2 – 1.3	0.9 – 1.1 1.7- 2.0	0.2 – 0.8, 1.3 – 1.6 & 2.0 - 2.2	0.0-0.2 & 2.2-2.3	1.3-1.7 & 2.3 - 2.4
TP06	-	-	0.6	0 - 0.6	0.7 – 1.1
TP10	-	0.4 – 0.5	0.0 - 0.3 & 0.6 – 1.3	-	-
TP11	-	-	0.0 - 1.1	1.1-1.5	1.5-1.7
TP12	-	-	0.0 -1.0	1.0 to 1.3	1.3-1.4
TP13	-	0.2 – 0.4	0.0 – 0.2 & 0.4 – 0.7	-	-
TP14		0.0 - 0.5	1.0 – 1.1	0.5 – 0.9 & 1.1 – 1.2	1.2 - 1.3

DCP	Depth Interval				
	Soft	Firm	Stiff	Very Stiff	Hard
TP15	-	-	0.0 – 0.5 & 0.6 – 1.0	0.5 - 0.6 & 1.0 - 1.1	1.1 - 1.2
TP16	-	-	0.0 – 0.7	0.7 – 1.2	1.2 - 1.3
TP17	-	-	0.0 – 0.5	0.5 – 0.7, 0.8 – 0.9 & 1.0 -1.8	0.7 – 0.8, 0.9 - 1.0
TP18	-	0.0 – 0.9	0.9 - 1.0 & 1.1 – 1.6	1.0 - 1.1 & 1.6 – 1.8	-
TP19	-	0.0 – 0.4	0.4 - 0.5	0.5 - 1.0	1.0 - 1.1
TP20	0.0 - 0.1	0.1 – 0.5	0.5 - 0.9	0.9 – 1.2	1.2 -1.3
TP21	-	0.0 – 0.6	0.6 – 1.0	-	1.0 – 1.2
TP22	-	-	0.0 – 0.7	0.7 – 0.9	0.9 – 1.0
TP23	-	0.0 – 0.3	0.3 -0.7	0.7 – 0.8	0.8 - 0.9
TP24	-	0.0 – 0.7	0.7 – 1.1 & 1.3 – 1.8	1.1 - 1.3	-
TP25	-	0.0 – 0.3	0.3 – 0.8 & 1.3	0.8 – 1.2 & 1.4	-
TP26	-	0.2	0.1 – 0.2 & 0.4 – 0.5	0.5 – 0.6	0.6 – 0.7
TP27	-	0.0 – 0.4	0.4 – 0.5	0.5 – 0.8	0.8 - 1.0
TP28	-	0.3 – 0.9	0.0 – 0.3 & 0.9 – 1.2	1.2 – 1.6	-

5.5 Geotechnical laboratory testing

All geotechnical soil samples were sent to GHD's NATA accredited laboratory at Artarmon for temporary storage and geotechnical laboratory testing. All geotechnical samples are outlined below in Table 10.

The results of geotechnical laboratory testing for select soil samples from the test pits are summarised in Table 11 to Table 17, with laboratory test results attached in Appendix E.

Table 10 Geotechnical sample register

Location	Depth (m)
TP01	0.5 – 1.50
TP03	0.20 – 0.50
TP03	1.0 – 1.2
TP03	2.01 – 2.10
TP07	1.0 – 1.10
TP08	1.0 1.10
TP08	2.50 – 2.60
TP10	0.50 – 0.60
TP11	0.50 – 1.00
TP14	1.00 – 1.50
TP15	0.50 – 1.00
TP17	0.50 – 1.00
TP17	2.00 – 2.50
TP19	0.50 – 0.75
TP21	0.50 – 1.00

Location	Depth (m)
TP22	0.50 – 1.00
TP23	0.60 – 1.00
TP23	2.00 – 2.50
TP26	0.50 – 1.00
TP28	1.00 -1.50

5.5.1 Moisture content

Moisture content results of the tested samples are summarised in Table 11 below.

Table 11 Moisture content (%)

Test Pit ID	Depth	Moisture content (%)
TP01	0.50 - 1.50	12.6
TP03	1.00 - 1.20	11.5
TP03	2.01 - 2.10	16.6
TP06	0.50 - 0.60	10.4
TP07	1.00 - 1.10	15.9
TP08	1.00 - 1.10	10.1
TP08	2.50 - 2.60	20.8
TP10	0.50 - 0.60	17.1
TP11	0.50 - 1.00	18.6
TP13	0.50 - 1.00	16.9[1]
TP14	1.00 - 1.50	18.8
TP15	0.50-1.00	17.4
TP17	0.50-1.00	18
TP17	2.00-2.50	23.3
TP19	0.50 - 0.75	14.2
TP21	0.50-1.00	23.6
TP22	0.50-1.00	19.4
TP23	0.60-1.00	20
TP23	2.00 - 2.50	27.7
TP24	0.20-0.50	21.1
TP26	0.50 - 1.00	14.2
TP27	0.50 - 1.00	20.1
TP28	1.00 - 1.50	22.1

Table Note

1 'Initial Swell Moisture Content' result taken from the Shrink-Swell Index test

5.5.2 Particle size distribution

Particle size distribution (PSD) testing with both sieve and hydrometer methods was carried out on suitable soils samples and the results of these tests are summarised in Table 12 and Table 13 below.

Table 12 Summary of PSD (sieve) test results

Borehole ID	Depth range (m)	Passing 2.36 mm (%)	Passing 1.18 mm (%)	Passing 600 µm (%)	Passing 425 µm (%)	Passing 300 µm (%)	Passing 150 µm (%)	Passing 75 µm (%)
TP03	2.01 – 2.1	95	94	93	92	92	91	90
TP06	0.5 – 0.6	77	75	73	72	72	71	70.2
TP08	2.5 – 2.6	98	98	97	97	97	97	96
TP11	0.5 – 1.0	99	99	98	97	97	95	94
TP14	1.0 – 1.5	85	81	77	76	74	72	70.4
TP15	0.5 – 1.0	99	98	96	95	95	94	92.9
TP17	2.0 – 2.5	96	92	88	87	85	82	79.8
TP19	0.5 – 0.75	92	85	80	78	76	73	70.3
TP23	2.0 – 2.3	98	96	93	91	88	81	75
TP26	0.5 – 1.0	54	42	36	35	34	32	31.4
TP27	0.5 – 1.0	75	66	61	60	59	58	56.8

The PSD results indicate that majority of the samples had more than 50% material passing through 75 µm sieve, indicating that majority of the soils at the site consist of fine-grained silt/clay with smaller percentages of coarser grained material. This is consistent with the logs.

Table 13 Summary of PSD (hydrometer) test results

Borehole ID	Depth range (m)	Passing 0.075 mm (%)	Passing 0.02 mm (%)	Passing 0.006 mm (%)	Passing 0.002 mm (%)
TP03	2.01 – 2.	90	52	40	33
TP08	2.5 – 2.6	96	60	44	37
TP11	0.5 – 1.0	94	50	26	16
TP23	2.0 – 2.5	75	51	39	26

5.5.3 Atterberg limits, linear shrinkage

The results for the samples submitted for Atterberg Limits and Linear Shrinkage testing are presented in Table 14. A plot of the plasticity based on these results is presented in Figure 4.

Table 14 Summary of Atterberg limits and linear shrinkage laboratory test results

Sample ID	Depth range (m bgl)	Moisture (%)	Soil unit	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)
TP01	0.0 to 1.5	12.5	Topsoil/Residual	47	19	28	12.5
TP03	1.0 to 1.2	-	Residual	64	28	36	15.5
TP03	2.0 to 2.10	-	Residual	38	24	14	-
TP06	0.5 to 0.6	10.4	Residual	35	14	21	9.0
TP07	1.0 to 1.10	17.8	Residual	47	23	24	15.0
TP08	2.5 to 2.6	-	Residual	43	15	28	-

Sample ID	Depth range (m bgl)	Moisture (%)	Soil unit	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)
TP11	0.5 to 1.0	18.6	Residual	24	16	8	-
TP14	1.0 to 1.5	18.8	Residual	48	16	32	-
TP15	0.5 to 1.0	17.4	Residual	51	16	35	8.0
TP17	2.0 to 2.5	23.3	Residual	61	20	41	-
TP19	0.5 to 0.75	14.2	Residual	39	17	22	10.5
TP23	2.0 to 2.5	20	Residual	42	22	20	
TP24	0.2 to 0.5	21.1	Residual	18	16	2	1.0
TP26	0.5 to 1.0	14.2	Residual	31	16	15	-
TP27	0.5 to 1.0	20.1	Residual	36	17	19	8.5

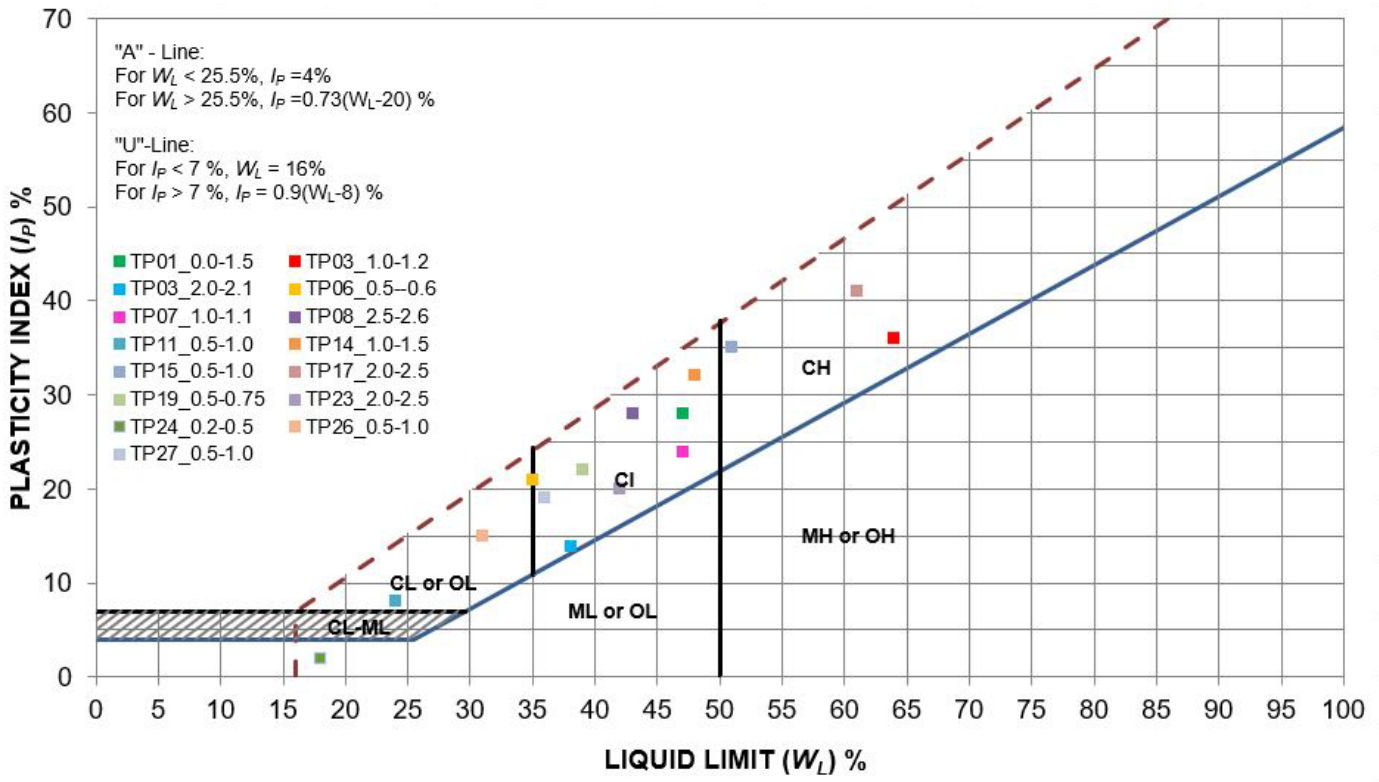

Figure 4 *Plot of Plasticity, based on Atterberg limits of tested samples*

Atterberg Limits test results indicate the clay content of the soils tested is of low to high plasticity and in turn would generally be classified as 'CL, CI or CH' or inorganic clays of low to high plasticity and includes gravelly clays, sandy clays & silty clays. Most samples were of medium plasticity. This is relatively consistent with the field description.

5.5.4 Shrink Swell testing

The results for the sample (TP13_0.5-1.0) submitted for Shrink Swell testing reported a Shrink-Swell Index of 1.4%.

5.5.5 Emerson classification number

Emerson Class number testing has been carried out on select soil samples. The results of the Emerson Class testing are summarised in Table 15 below.

Table 15 Summary of Emerson Class Laboratory Test Results

Sample ID	Depth range (m bgl)	Consistency/ Density	Unit	Emerson Class number
TP03	1.00 to 1.20	Stiff	Residual	3
TP06	0.50 to 0.60	Very stiff	Residual	6
TP11	0.50 to 1.00	Soft to firm	Residual	3
TP22	0.50 to 1.00	Soft to hard	Topsoil/Residual	6
TP24	0.20 to 0.50	Soft	Topsoil/Residual	3
TP27	0.50 to 1.00	Firm to hard	Residual	6

Generally, the results indicated the soil samples from the residual soil were found to have little dispersion potential:

– Emerson class numbers of '3' indicates the soil dispersion when remoulded at water content equal to field capacity and immersed immediately in water.
– Emerson class of '6' indicates soil flocculation in a 1:5 aggregate to water suspension (carbonate or gypsum is absent).

5.5.6 Soil aggressivity test results

Soil aggressivity testing was carried out on suitable soils samples and the results of these tests are summarised in Table 16 below.

Table 16 Summary of soil aggressivity test results

Borehole ID	Soil/rock unit	Sample Depth (m)	Chloride (mg/kg)	Conductivity (uS/cm)	pH	Sulphate (mg/kg)	Resistivity (ohm/cm)*
TP03	Residual	1.00-1.20	<10	36	6.5	20	28,000
TP06	Residual	0.50-0.60	<10	42	6.5	29	24,000
TP11	Residual	0.50-1.00	<10	53	6.3	<10	19,000
TP22	Residual	0.50-1.00	<10	43	5.4	10	23,000
TP24	Residual	0.20-0.50	<10	30	5.6	<10	33,000
TP27	Residual	0.50-1.00	<10	90	6.3	20	11,000

5.5.7 California Bearing Ratio

California Bearing Ration (CBR) testing was carried out on suitable soils samples and the results of these tests are summarised in Table 17 below.

Table 17 Summary of CBR test results

Location ID	Soil unit	Sample Depth (m)	Standard Maximum Dry Density – SMDD (t/m3)	Standard Optimum Moisture Content – SOMC (%)	4-day soaked CBR (%)
TP10	Residual	1.0 to 1.70	1.72	16.9	8.0
TP16	Residual	0.5 to 1.0	1.40	31.0	7.0
TP25	Residual	0.5 to 1.0	1.82	15.6	9.0

The CBR laboratory test results indicate that the residual soils (subgrade material) have a CBR values between 7.0 and 9.0%.

5.6 Summary

The preliminary geotechnical investigation indicated a consistent soil profile across the site, comprising topsoil underlain by residual silty clay soils which graded to weathered rock, with an increase in consistency with depth.

Depth to rock was shallowest within the northwestern portion of the site (Lot 1 DP 153167), which was within the upper gradient of the site. Depth to rock was deeper within the low-lying southwestern portion of the site (Lot 200 DP 1288388). An assessment of the underlying rock could not be carried out during this preliminary investigation with test pit refusal on the extremely weather bedrock. No core drilling was undertaken in this investigation.

Groundwater strikes were recorded within three test pits within the southeastern portion of the Site, these locations were noted to be within the lower gradient of site and where surface soils were noted to be soft underfoot.

Laboratory results indicate the residual clay to be predominately medium to high plasticity clays, with moderate to high soil reactivity. The topsoil and residual soils were found to have some dispersive potential. Residual soils were confirmed to be predominantly of fine-grained silt/clay based on PSD and hydrometer test results, smaller percentages of sand and gravel were recorded within the residual and extremely weathered samples, consistent with the geotechnical logs.

The site elevation ranged from approximately 905 m AHD in the northwest corner of the site to 885 m AHD in the southeast corner of the site. Higher elevated areas of the northwest corner of site (Lot 1 DP153167) were observed to have good drainage in comparison to the lower elevated areas to the southeast (Lot 200 DP1288388). The central sections of the site and easternmost sections around Gateway Park Dairy Creek Wetland were observed to received surface water drainage due to their elevation relative to nearby surrounding land. The drainage in these areas was observed to be poor and slow to drain during rainfall events like that observed on the 29 March 2024 when undertaking the investigation.

The highly weathered rock (dark grey in colour) is estimated to be low to medium strength (based on field estimates) with some defects noted.

The NSW geological mapped geology indicated that the site is underlain by the Conobalas Volcanics. Residual soil profiles grading into weathered volcanic rock (basalt/trachyte) is consistent with our field investigation for ground conditions encountered.

6. Discussion and recommendations

6.1 Site classification

GHD understand the current master plan development for the proposed infrastructure (lots and roads) is a preliminary plan and further work is required. Future earthworks in relation to the construction of this infrastructure may result in site regrading including placement of fill, and cuts that may affect the final site classification in accordance with Australian Standard AS2870-2011 *Residential Slabs and Footings*. The site classifications provided here are based on the ground levels and subsurface conditions encountered at the time of this investigation.

As discussed in Section 5.4, fill was encountered at the test locations TP03, TP04, TP07 and TP08. Firm to hard residual cohesive soils were encountered below the topsoil at depths of 0.2 to 3.0 m bgl, which then graded to extremely weathered rock which was observed as a silty clay.

Based on the laboratory test results for the collected soil samples, the natural clay soils encountered beneath the topsoil are of low to high plasticity, with the majority of samples tested having medium plasticity. The clay soils are considered plastic and are likely to exhibit moderate to high reactivity with changes in moisture.

Final site levels for building platforms are not known, and wet ground conditions exist over the lower elevated parts of the site.

The preliminary site classifications determined for the site are for shallow footings in accordance with AS2870-2011 '*Residential Slabs and Footings'*:

– For areas with a natural soil profile (consisting of topsoil overlying residual clays), a preliminary site classification of **class M** would apply.
– For areas where uncontrolled fill is located (such as locations TP03, TP04, TP07 and TP08), a preliminary site classification of **class P** would apply.

Class M refers to sites with moderately reactive clay or silt sites, which may experience moderate ground movement from the moisture changes.

Class P refers to sites where uncontrolled fill is >0.4 m (soil types other than sand) or due to observed unstable ground conditions, abnormal moisture conditions or soft soils. Limited testing data for the fill soils would suggest they are comparable to the surrounding/underlying natural soils, however the observed fill depth of 1.95 to 2.0 m would make it a class P.

Site classification is generally only applicable to residential and commercial buildings up to two levels, and therefore it is assumed for the proposed building developments, that the site classifications adopted will only apply to single or two storey buildings with similar floor loads.

The site classification for individual building sites should be re-assessed following any site regrading earthworks to prepare building platforms.

6.2 Building footings

Recommended geotechnical parameters for the design of footings for the proposed development and minor structures are provided in the following sections.

6.2.1 Shallow footings

For minor structures founded at or near the current ground surface, shallow footing systems such as a raft slab or grid of strip footings may be suitable. It is assumed the buildings proposed under the current master plan will be single storey and generally of light construction.

For preliminary design purposes the recommended design parameters for high level footings founded in stiff residual soils or very stiff/hard extremely weathered rock are summarised in Table 18.

Table 18 Summary of proposed preliminary geotechnical parameters for shallow footings.

Unit	Effective Elastic Modulus E' (MPa)	Allowable Bearing Capacity (kPa)
Firm to stiff - residual	15	80
Stiff - residual	20	120
Very stiff to hard - extremely weathered volcanic sandstone/basalt/trachyte.	45	250

The allowable bearing capacities tabulated in Table 18 apply to footings terminated uniformly in the respective residual soil unit and assume that the soils are not water affected.

6.2.2 Bored and Continuous Flight Auger Piles

For any other structures with heavy or concentrated loads or structures sensitive to differential settlement, bored Continuous Flight Auger (CFA) piles socketed into the underlying high strength weathered rock will be appropriate. In addition to providing uniform support for proposed structures.

Pile support would provide a more robust design solution given the likely variable moisture conditions across the site and potential for fluctuations in groundwater levels across the site. This section provides general advice and recommendations in relation to pile design and provides rock parameters for pile design.

For pile foundations, AS 2159-2009 requires that the ultimate design geotechnical strength is not less than the design action effect. The design geotechnical strength is calculated as the ultimate geotechnical strength multiplied by a geotechnical strength reduction factor.

Based on the assessment of the above factors and assumptions, an Average Risk Rating (ARR) for the design of piles terminated in the highly weathered bedrock may be adopted.

Based on Table 4.3.2 (C) of AS 2159-2009, an ARR of 3.0 to 3.5 is defined as moderate to high risk. The basic geotechnical strength reduction factor (ϕ_g) for single isolated piles (low redundancy system) founded into the weathered bedrock profile within the site is assessed to be 0.48. The geotechnical strength reduction factor may be increased if geotechnical supervision and pile testing is undertaken during construction.

Spacing of piles within a pile group should generally not be less than 2.5 times the pile diameters unless a comprehensive assessment of group interaction is undertaken and as a result it is confirmed this does not adversely affect the overall pile group. A cone pull-out mode of failure shall be considered where appropriate for single piles.

For piles subject to uplift loads, the geotechnical design strength shall be modified by multiplying by a factor of 0.8 in addition to the geotechnical strength reduction factor assuming good construction practice is upheld where cleanliness and roughness of rock sockets can be confirmed during construction. Where cleanliness and roughness cannot be confirmed, a reduction factor of 0.5 should be adopted in accordance with guidance by Pells (1998).

Inspection of the foundation conditions and pile excavations, or CFA pile installation shall be undertaken by experienced geotechnical engineer to confirm the founding conditions and above values. All bored pile excavations should be kept free of fall-ins and ponded water. The proposed piling methodology must consider equipment suitable for drilling into the described subsurface conditions and account for locally coarser alluvial materials (e.g. cobbles) and high to very high strength rock.

No assessment of rock type or strength testing was carried out in this preliminary investigation, with test locations restricted to test pits to refusal and no boreholes with rock coring. With no visual observations of rock condition or strength testing carried out of rock, estimated preliminary parameters are provided in Table 19. The proposed parameters are based on desk study information only that the site is underlain by Conobalas Volcanics comprising basalt/trachyte. For future works it is recommended an assessment of rock condition be done with geotechnical boreholes, rock coring and laboratory strength testing.

Table 19 Summary of proposed preliminary geotechnical parameters for pile foundations.

Unit	Description	Ultimate End Bearing (MPa)[1]	Rock Mass Elastic Modulus (MPa)	Ultimate shaft adhesion kPa
Rock - volcanic sandstone/basalt/trachyte.	HW rock	3-5	50-200	150[2]

Table Notes:
HW = highly weathered
1 – At ultimate bearing pressure, large settlements greater than 5% of the minimum foundation dimensions are expected.
2 – Based on sandstone class V proposed by Pells (2018)

The selection of the footing system will depend on the final soil/rock profile, the building loads and load distribution, and sensitivity of the structures to settlement. In selecting the appropriate footing system, we recommend the building footings supporting heavy or concentrated loads including column loads, wall loads, or high floor loads be founded into competent rock.

6.2.3 Durability

Soil or groundwater can cause chemical reactions that result in damage to buried concrete and steel structures. The exposure classifications for this site have been assessed in accordance with AS3600- 2018 *'Concrete Structures*' and AS 2159-2009 *'Piling Design and installation'*. The assessment is based on the aggressivity test results as presented in Table 16. The assessment of minimum concrete cover depends on the exposure classification and characteristic strength of the concrete. The soils tested in the upper 3.0 m are considered soil condition B.

The laboratory tests returned values that indicate the on average the residual soil are considered classification A1. The soil tested is calculated to be non-aggressive to concrete and non-aggressive for steel, based on measured electrical conductivity and resistivity. For a 50-year design life, cast in place concrete piles must provide for a minimum concrete strength of 32 MPa with a minimum cover to reinforcement of 45 mm.

6.2.4 Subsoil classification – earthquake risk

With reference to Section 4.2 of AS 1170.4-2007 for determining site sub-soil classification, the site classification will vary based on the underlying geology encountered at different areas of the site. Based on the subsurface profiles observed from the test pits undertaken as part of this geotechnical investigation:

– The majority of the locations were observed to be shallow soil and residual soil profiles overlying the Conobalas Volcanics and would be classified as Class C_e.
– For some locations where very soft soils were observed (southeast portion of site), with estimated undrained shear strength (su) less than 12.5 kPa, a classification of D_e may be applicable, however these soils were noted to be limited in their depth and frequency. For future investigations it is recommended additional strength testing of the soils be carried out.

Areas with deeper soil profiles or soft soil may be present at the site where contact between geological units has occurred such as intrusive geological dykes or faults. If zones of deep soil or soft soil are encountered differing in characteristic from that encountered as part of this investigation, they should be further assessed by a geotechnical engineer and classification of earthquake risk may need to be updated for these areas.

An assessment of rock strength could allow for some areas of the site to reclassified for earthquake risk.

6.3 General site access and trafficability

Most of the of site soils have sufficient bearing capacity to support tracked earthmoving equipment, however rubber tyred equipment may experience difficulty with trafficability, particularly during or following prolonged periods of heavy rain and also if operating around the dams and creek area of the site where existing wet to saturated surface soils were observed.

Earthworks for the formation of roads and building platforms should be carried out in accordance with project specifications, or as a minimum in accordance with AS3798-2007 *Guidelines on Earthworks for Commercial and Residential Developments*.

6.4 Material re-use potential

It is anticipated that earthworks required for the site will typically be associated with stripping topsoil, preparation of building platforms, foundation excavations, pavements, services installations, and landscaping.

Topsoil should be stockpiled separately and may be reused for landscaping purposes subject to the findings of the waste classification and contamination status of this material.

Based on anticipated site levels it is likely that the excavated clay materials (residual and XW rock) may be suitable for reuse as general fill following drying back to within 2% of optimum moisture content, screening of coarse material and removal of any unsuitable materials such as organic soils or large cobble sized rocks.

This assumes the material is excavated natural material (ENM) and there is no obvious signs of anthropogenic materials or visual/olfactory evidence of contamination. In the event anthropogenics or obvious contamination a waste classification assessment may be required to assess potential reuse on site or disposal offsite.

6.5 Compaction requirements for structural fill

As there is limited availability of structural fill onsite, we expect that structural fill, where required, will be imported to site.

Structural fill, where required, should be placed and compacted in 200 mm compacted thickness layers in accordance with AS3798-2007 to at least 98% of Standard Maximum Dry Density (SMDD) at a moisture content within +/- 2% of Standard Optimum Moisture Content.

For the upper 300 mm of fill placed within roads and under building floor slabs, structural fill should be compacted to 100% of SMDD. If fill is to be placed close to existing structures or sensitive services, then it should be placed and compacted in layers without vibration unless otherwise advised by the geotechnical engineer.

6.6 Excavation conditions and earthworks

Bulk excavations will likely be in the residual/extremely weathered soil profile below the topsoil. This material is expected to be readily excavated by backhoe or small excavator (>5 t). The highly weathered rock should be readily excavated by a 20t excavator.

6.7 Subsoil drainage – access roads and paved areas

Subsoil drainage should be implemented to provide effective drainage of pavements and subgrades for access roads and other paved areas where sufficient fall to stormwater drainage pits can be achieved. Subsoil drains along roads or within carpark areas should be in good contact with the pavement subbase, and any granular select subgrade where required.

Generally, subsoil drains will comprise a 100 mm slotted PVC pipe (Ag Pipe) surrounded by 20 mm clean aggregate, with the entire drain wrapped in a geotextile fabric (for example Bidim A34 or equivalent). All subsoil drains should fall at a minimum 1% grade to dedicated drainage pits or suitable open drainage channels.

6.8 Preliminary CBR value for pavement design

The general site will be subject to ground improvement works and local excavations and filling. Three CBR tests were carried out on typical samples of the residual soil profile at depths of 0.5 to 1.7 m, with results ranging between 7.0 to 9.0%. The final subgrade CBR will depend on the actual exposed subgrade conditions.

An assessment of inferred CBR value based on DCP results at the same sample locations/depth indicated CBR values of 8.0 to 23.0. These CBR values have been calculated from DCP data based on general correlations published within *"Guide to Pavement Technology Part 2: Pavement Structural Design" (Austroads, 2010)*. Values

are applicable to fine grained cohesive soil only. CBR correlation is material specific and may commonly be influenced by moisture content variation or the presence of gravels.

For this preliminary assessment the recommendations on the design subgrade CBR is based on the clay residual or extremely weathered soil encountered throughout the site. For preliminary pavement design purposes, we recommend adopting a preliminary design CBR of 6% as soils with lower CBR values may be encountered based on the borehole information.

6.8.1 Pavement subgrade notes

Where engineered select fill is required to replace any unsuitable subgrade material, fill placement will need to be carried out under onsite guidance from the Geotechnical Inspection and Testing Authority (GITA) appointed to the project to ensure the fill material is appropriate for use (e.g. free of cobbles/boulders, topsoil and deleterious materials) and is uniformly compacted as outlined above. For these areas, select fill material should satisfy the following requirements:

– Placed under the guidance of the GITA to the requirements of Level 1 of AS3798-2007.
– Free from contamination and deleterious matter such as root or plant matter or topsoil.
– Maximum particle size of 50 mm and contain sufficient fines to achieve compaction.
– Be a well graded, readily compactable and placed at a moisture content close to optimum, based on Standard Compaction.
– Tested to validate the assumed design subgrade CBR.
– Assessed and approved by an experienced geotechnical engineer at the source or the borrow area prior to delivery to site.

6.8.2 General compaction requirements

Following satisfactory performance of the exposed subgrade under proof rolling using a 12 tonne smooth drum roller without vibration, and receipt of subsequent satisfactory density test results, place and compact approved pavement material to the compaction requirements outlined in Table 20. Pavement materials should be placed in layers not exceeding 200 mm compacted thickness.

Compaction should be carried out using a 12 tonne smooth drum roller without vibration, for locations near buildings and potentially sensitive underground services that may exist or be constructed prior to pavement works.

Table 20 Minimum compaction requirements for pavement construction

Description	Compaction requirements	Moisture requirements[1]
Base – DGB20	Minimum 98% Modified MDD	-2% to 0% of OMC
Subbase – DGS40	Minimum 95% Modified MDD	-2% to 0% of OMC
Subgrade or General Fill Zone (top 300 mm)	Minimum 100% Standard MDD	-2% to 0% of OMC
General Fill Zone (deeper than 300 mm below top of subgrade)	Minimum 98% Standard MDD	-2% to 0% of OMC

Note: [1] – Negative means dry of optimum moisture content, MDD = Maximum Dry Density OMC = Optimum Moisture Content

7. References

– Colquhoun, G.P., Hughes, K.S., Deyssing, L., Ballard, J.C., Folkes, C.B, Phillips, G., Troedson, A.L. & Fitzherbert, J.A. 2021. *New South Wales Seamless Geology dataset*, version v2024.02.05 [Digital Dataset]. Geological Survey of New South Wales, Department of Regional NSW, Maitland.
– AS1726-2017 – Geotechnical Site Investigation
– AS 2159-2009 – Piling – Design and installation
– AS2870-2011 – Residential Slabs and Footings
– AS3600-2018 – Concrete Structures
– AS3798-2007 – Guidelines for earthworks for commercial and residential developments.

Appendices

Appendix A

GHD Standard Guidance Notes

GENERAL NOTES

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The report contains the results of a geotechnical investigation or study conducted for a specific purpose and client. The results may not be used or relied on by other parties, or used for other purposes, as they may contain neither adequate nor appropriate information. In particular, the investigation does not cover contamination issues unless specifically required to do so by the client.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the report are excluded unless they are expressly stated to apply in the report.

TEST HOLE LOGGING

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where test information is available (field and/or laboratory results). The test hole logs include both factual data and inferred information. Moreover, the location of test holes should be considered approximate, unless noted otherwise (refer report). Reference should also be made to the relevant standard sheets for the explanation of logging procedures (Soil and Rock Descriptions, Core Log Sheet Notes etc.).

GROUNDWATER

Unless otherwise indicated, the water depths presented on the test hole logs are the depths of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater depth may differ from this recorded depth depending on material permeabilities (i.e. depending on response time of the measuring instrument). Further, variations of this depth could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities such as a change is ground surface level. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate surveys, instrumentation techniques and monitoring programmes.

INTERPRETATION OF RESULTS

The discussion or recommendations contained within this report normally are based on a site evaluation from discrete test hole data, often with only approximate locations (e.g. GPS). Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in ground conditions do occur in the natural environment, particularly between discrete test hole locations or available observation sites. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural processes.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed or reported should be referred to GHD for appropriate assessment and comment.

GEOTECHNICAL VERIFICATION

Verification of the geotechnical assumptions and/or model is an integral part of the design process - investigation, construction verification, and performance monitoring. Variability is a feature of the natural environment and, in many instances, verification of soil or rock quality, or foundation levels, is required. There may be a requirement to extend foundation depths, to modify a foundation system and/or to conduct monitoring as a result of this natural variability. Allowance for verification by appropriate geotechnical personnel must be recognised and programmed for construction.

FOUNDATIONS

Where referred to in the report, the soil or rock quality, or the recommended depth of any foundation (piles, caissons, footings etc.) is an engineering estimate. The estimate is influenced, and perhaps limited, by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The material quality and/or foundation depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications should provide for variations in the final depth, depending upon the ground conditions at each point of support, and allow for geotechnical verification.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in our geotechnical report, or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions must include at least all of the relevant test hole and test data, together with the appropriate Standard Description sheets and remarks made in the written report of a factual or descriptive nature.

Ref: DS5.5.1 Issue 0 Date: 05/10/2018

GLOSSARY OF SYMBOLS

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This standard sheet should be read in conjunction with all test hole log sheets and any idealised geological sections prepared for the investigation report.

GENERAL

Symbol	Description	Symbol	Description
D	Disturbed Sample	R	Rising Head Permeability Test
B	Bulk Sample	F	Falling Head Permeability Test
U(50)	Undisturbed Sampled (suffixed by sample size or tube diameter in mm if applicable)	PBT	Plate Bearing Test
CS	Core Sample (suffixed by diameter in mm)		Water Inflow (make)
ES	Soil sample for environmental sampling		Water Outflow (loss)
PID	Photoionisation Detector		Temporary Water Level
SPT	Standard Penetration Test (with blows per 0.15m)		Final Water Level
N	SPT Value		Point Load Test (axial)
HB/HW	SPT Hammer Bouncing/Hammer Weight		Point Load Test (diametric)
PP/HP	Pocket/Hand Penetrometer (suffixed by value kPa)	PL	Point Load (kPa)
PK	Packer Test (kPa)	IMP	Impression Device Test
PZ	Piezometer Installation	PM	Pressuremeter Test
SV/VS	Shear Vane Test (suffixed by value in kPa)		

SOIL SYMBOLS

Main Components				Minor Components			
	SAND		FILL		sandy		vegetation, roots
	GRAVEL		SILT		gravelly		silty
	CLAY		TOPSOIL		clayey	*Note: Natural soils are generally a combination of constituents, e.g. sandy CLAY*	

ROCK SYMBOLS

Sedimentary						Igneous			
	SANDSTONE		SILTSTONE		CONGLOMERATE		GRANITIC ROCK		IGNEOUS DYKE
	CLAYSTONE		SHALE		COAL		BASALTIC ROCK		

Note: Additional rock symbols may be allocated for a particular project

NATURAL DEFECTS *(Coding)*

Defect Type		Orientation					
Jt	Joint	For vertical non-oriented core ... “Dip” angle (eg. 5°) measured relative to horizontal.					
Pt	Parting	For inclined non-oriented core ... “Angle” measured relative to core axis.					
SS	Sheared Surface	For inclined oriented core ... “Dip” angle and “Dip Direction” angle (eg. 45°/225° mag.).					
WSm	Weathered Seam	**Orientation (con’t)**		**Roughness**		**Coating**	
SSm	Sheared Seam	VT	Vertical	Pol	Polished	Cn	Clean
CSm	Crushed Seam	HZ or 0°	Horizontal	So	Smooth	Sn	Stained
ISm	Infilled Seam	d / °	Degrees	Rf	Rough	Ve	Veneer
SZ	Sheared Zone			VR	Very Rough	Co	Coating
VN	Vein			Slk	Slickensided		
Shape				**Infilling / Common Materials**			
Pln	Planar	St	Stepped	CLAY	Clay	Mi	Micaceous
Cu	Curved	Ir	Irregular	Ca	Calcite	Mn	Manganese
Un	Undulating	Dis	Discontinuous	X	Carbonaceous	Py	Pyrite
Others				Kt	Chlorite	Qz	Quartz
OP	Open	CL	Closed	Ti	Tight	Fe	Iron Oxide	MU	Unidentified Mineral

Ref: DS6.5.3 Rev 1 Date : 25/09/2019

SOIL DESCRIPTION AND CLASSIFICATION

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Soil is described in general accordance with Australian Standard AS 1726-2017 (Geotechnical Site Investigations) in terms of visual and tactile properties, with potential refinement by laboratory testing. AS 1726 defines soil as particulate materials that occur in the ground and can be disaggregated or remoulded by hand in air or water without prior soaking. Classification of the soil is undertaken following description.

SOIL DESCRIPTION

The soil description includes a) Composition, b) Condition, c) Structure, d) Origin and e) Additional observations. 'FILL', 'TOPSOIL' or a 'MIXTURE OF SOIL AND COBBLES / BOULDERS' (with dominant fraction first) is denoted at the start of a soil description where applicable.

a) Soil Composition (soil name, colour, plasticity or particle characteristics, secondary and then minor components)

Soil Name: A soil is termed a *coarse grained soil* where the dry mass of sand and gravel particles exceeds 65% of the total. Soils with more than 35% fines (silt or clay particles) are termed *fine grained soils*. The soil name is made up of the primary soil component (in BLOCK letters), prefixed by applicable secondary component qualifiers. Minor components are applied as a qualifiers to the soil name (using the words 'with' or 'trace').

Particles are differentiated on the basis of size. 'Boulders' and 'cobbles' are outside the soil particle range, though their presence (and proportions) is noted. While individual particles may be designated as silt or clay based on grain size, fine grained soils are characterised as silt or clay based on tactile behaviour or Atterberg Limits, and not the relative composition of silt or clay sized particles.

Colour: The prominent colour is noted, followed by (spotted, mottled, streaked etc.) then secondary colours as applicable. Roughly equally proportioned colours are prefixed by (spotted, mottled, streaked etc.). Colour is described in its moist condition, though both wet and dry colours may also be provided if appropriate.

Plasticity: Fine grained soils are designated within standard ranges of plasticity based on tactile assessment or laboratory assessment of the Liquid Limit.

Particle Characteristics: The particle shape, particle distribution and particle size range within a coarse grained soil is described using standard terms. Particle composition may be described using rock or mineral names, with specific terms for carbonate soils.

Secondary and Minor Components: The primary soil is described and modified by secondary and minor components, with assessed ranges as tabulated.

Carbonate Soils: Carbonate content can be assessed by use of dilute '10%' HCl solution. Resulting clear sustained effervescence is interpreted as a *Carbonate soil* (approximately >50% carbonate), while weak or sporadic effervescence indicates *Calcareous soil* (< 50% carbonate). No effervescence is interpreted as a non-calcareous soil.

Organic and Peat Soils: Where identified, organic content is noted. *Organic soil* (2% to 25% organic matter) is usually identified by colour (usually dark grey/black) and odour (i.e. 'mouldy' or hydrogen sulphide odour). *Peat* (>25% organic matter) is identified by a spongy feel and fibrous texture. Peat soils' decomposition may be described as '*fibrous*' (little / no decomposition), '*pseudo-fibrous*' (moderate decomposition) or '*amorphous*' (full decomposition).

Fraction	Components		Particle Size (mm)
Oversize	BOULDERS		> 200
	COBBLES		63 - 200
Coarse grained soil particles	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
Fine grained soil particles	SILT		0.002 - 0.075
	CLAY		< 0.002

Plasticity Terms (Fine Grained Soils)		Laboratory Liquid Limit Range
Silt	**Clay**	
N/A	N/A	(Non Plastic)
Low Plasticity	*Low Plasticity*	≤ 35%
	Medium Plasticity	> 35% and ≤ 50%
High Plasticity	*High Plasticity*	> 50%

Particle Distribution Terms (Coarse Grained Soils)	
Well graded	good representation of all particle sizes
Poorly graded	one or more intermediate sizes poorly represented
Gap graded	one or more intermediate sizes absent
Uniform	essentially of one size

Particle Shape Terms (Coarse Grained Soils)		
Rounded	*Sub-angular*	*Flaky or Platy*
Sub-rounded	*Angular*	*Elongated*

Secondary and Minor Components for Coarse Grained Soils			
Fines (%)	**Modifier** (as applicable)	**Accessory coarse (%)**	**Modifier** (as applicable)
≤ 5	*'trace silt / clay'*	≤ 15	*'trace sand / gravel'*
> 5, ≤ 12	*'with clay / silt'*	> 15, ≤ 30	*'with sand / gravel'*
> 12	*prefix 'silty / clayey'*	> 30	*prefix 'gravelly / sandy'*

Secondary and Minor Components for Fine Grained Soils	
% Coarse	**Modifier** (as applicable)
≤ 15	add *"trace sand / gravel"*
> 15, ≤ 30	add *"with sand / gravel"*
> 30	prefix soil *"sandy / gravelly"*

Ref: DS6.5.1.1 Rev 0 Date: 2/03/2018

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b) Soil Condition (moisture, relative density or consistency)

Moisture: Fine grained soils are described relative to plastic or liquid limits, while coarse grained soils are assessed based on appearance and feel. The observation of seepage or free water is noted on the test hole logs.

Moisture - Coarse Grained Soils

Term		Tactile Properties
Dry	*('D')*	Non-cohesive, free running
Moist	*('M')*	Feels cool, darkened colour, tends to stick together
Wet	*('W')*	Feels cool, darkened colour, tends to stick together, free water forms when handling

Moisture - Fine Grained Soils

Term		Tactile Properties
Moist, dry of plastic limit	*('w < PL')*	Hard and friable or powdery
Moist, near plastic limit	*('w ≈ PL')*	Can be moulded
Moist, wet of plastic limit	*('w > PL')*	Weakened, free water forms on hands with handling
Wet, near liquid limit	*('w ≈ LL')*	Highly weakened, tends to flow when tapped
Wet, wet of liquid limit	*('w > LL')*	Liquid consistency, soil flows

Relative Density (Non Cohesive Soils): The Density Index is inherently difficult to assess by visual or tactile means, and is normally assessed by penetration testing (e.g. SPT, DCP, PSP or CPT) with published correlations. Assessment may be affected by moisture and *in situ* stress conditions. Density Index assessment may be refined by combination of *in situ* density testing and laboratory reference maximum and minimum density ranges.

Consistency (Cohesive Soils): May be assessed by direct measurement (shear vane, CPT etc.), or approximate tactile correlations. Cohesive soils include fine grained soils, and coarse grained soils with sufficient fine grained components to induce cohesive behaviour. A 'design shear strength' must consider the mode of testing, the *in situ* moisture content and potential for variations of moisture which may affect the shear strength.

Relative Density (Non-Cohesive Soils)

Term and (Symbol)		Density Index (%)
Very Loose	*(VL)*	≤ 15
Loose	*(L)*	> 15 and ≤ 35
Medium Dense	*(MD)*	> 35 and ≤ 65
Dense	*(D)*	> 65 and ≤ 85
Very Dense	*(VD)*	> 85

Consistency assessment can be influenced by moisture variation.

Consistency (Cohesive Soils)

Term and (Symbol)		Tactile Properties	Undrained Shear Strength
Very Soft	*(VS)*	Extrudes between fingers when squeezed	< 12 kPa
Soft	*(S)*	Can be moulded by light finger pressure	12 - 25 kPa
Firm	*(F)*	Can be moulded by strong finger pressure	25 - 50 kPa
Stiff	*(St)*	Cannot be moulded by fingers	50 - 100 kPa
Very Stiff	*(VSt)*	Can be indented by thumb nail	100 - 200 kPa
Hard	*(H)*	Can be indented with difficulty by thumb nail	> 200 kPa
Friable	*(Fr)*	Easily crumbled or broken into small pieces by hand	-

c) Structure (zoning, defects, cementing)

Zoning: The *in situ* zoning is described using the terms below. *'Intermixed'* may be used for an irregular arrangement.

'layer' (a continuous zone across the exposed sample)

'lens' (a discontinuous layer with lenticular shape)

'pocket' (an irregular inclusion of different material).

'interbedded' or *"interlaminated'* (alternating soil types)

Defects: Described using terms below, with dimension orientation and spacing described where practical.

'parting' (an open or closed surface or crack sub parallel to layering with little / no tensile strength - open or closed)

'fissure' (as per a parting, though not parallel or sub parallel to layering – may include desiccation cracks)

'sheared seam' (zone of sub parallel near planar closely spaced intersecting smooth or slickensided fissures dividing the mass into lenticular or wedge shaped blocks)

'sheared surface' (a near planar, curved or undulating smooth, polished or slickensided surface, indicative of displacement)

'softened zone' (in clayey soils, usually adjacent to a defect with associated higher moisture content)

'tube' (tubular cavity, singly or one of a large number, often formed from root holes, animal burrows or tunnel erosion)

'tube cast' (an infilled tube – infill may vary from uncemented through to cemented or have rock properties)

'infilled seam' (sheet like soil body cutting through the soil mass, formed by infilling of open defects)

Cementation: Soils may be cemented by various substances (e.g. iron oxides and hydroxides, silica, calcium carbonate, gypsum), and the cementing agent shall be identified if practical. Cemented soils are described as:

'weakly cemented'	easily disaggregated by hand in air or water
'moderately cemented'	effort required to disaggregate the soil by hand in air or water

Materials extending beyond '*moderately cemented'* are encompassed within the rock strength range. Where consistent cementation throughout a soil mass is identified as a duricrust, it is described in accordance with duricrust rock descriptors. Where alternate descriptors of cementation development are applied for consistency with regional practices or geology, or client requirements, these are outlined separately.

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d) Origin

An interpretation is provided based on observations of landform, geology and fabric, and may further include assignment of a stratigraphic unit. The use of terms 'possibly' or 'probably' indicates a higher degree of uncertainty regarding the assessed origin or stratigraphic unit. Typical origin descriptors include:

Residual	Formed directly from in situ weathering with no visible structure or fabric of the parent soil or rock.
Extremely weathered	Formed directly from in situ weathering, with remnant and/or fabric from the parent rock.
Alluvial	Deposited by streams and rivers (may be applied more generically as transported by water).
Estuarine	Deposited in coastal estuaries, including sediments from inflowing rivers, streams, and tidal currents.
Marine	Deposited in a marine environment.
Lacustrine	Deposited in freshwater lakes.
Aeolian	Transported by wind.
Colluvial and Slopewash	Soil and rock debris transported down slopes by gravity (with or without assistance of water). Colluvium is typically applied to thicker / localised deposits, and slopewash for thinner / widespread deposits.
TOPSOIL	Surficial soil, typically with high levels of organic material. Topsoils buried by other transported soils are termed *'remnant topsoil'*. Tree roots within otherwise unaltered soil does not characterise topsoil.
FILL	Any material which has been placed by anthropogenic processes (i.e. human activity).

e) Additional Observations

Additional observations may be included to supplement the soil description. Additional observations may consist of notations relating to soil characteristics (odour, contamination, colour changes with time), inferred geology (with delineation of soil horizons or geological time scale) or notes on sampling and testing application (including the reliability, recovery, representativeness, or condition of samples or test conditions and limitations). If the material is assessed to be not representative, terms such as 'poor recovery', 'non-intact', 'recovered as' or 'probably' are applied.

SOIL CLASSIFICATION

Classification allocates the material within distinct soil groups assigned a two character Group Symbol:

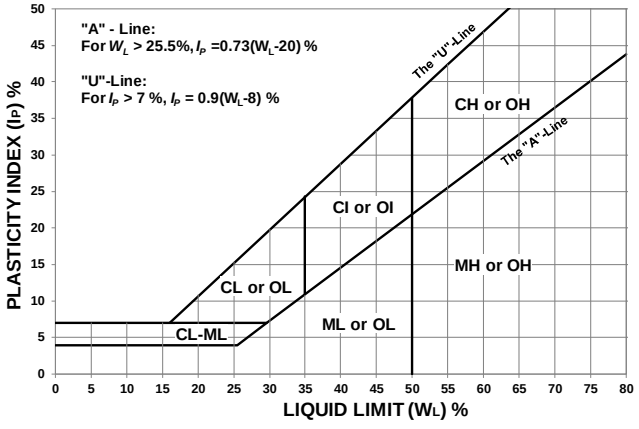
Coarse Grained Soils (sand and gravel: more than 65% of soil coarser than 0.075 mm)		
Major Division	**Group Symbol**	**Soil Group**
GRAVEL (more than half of the coarse fraction is > 2.36 mm)	GW	GRAVEL, well graded
	GP	GRAVEL, poorly graded
	GM	Silty GRAVEL
	GC	Clayey GRAVEL
SAND (more than half of the coarse fraction is < 2.36 mm)	SW	SAND, well graded
	SP	SAND, poorly graded
	SM	Silty SAND
	SC	Clayey SAND

Fine Grained Soils (silt and clay: more than 35% of soil finer than 0.075 mm)		
Major division	**Group Symbol**	**Soil Group**
SILT and CLAY (low to medium plasticity)	ML	SILT, low plasticity
	CL	CLAY, low plasticity
	CI	CLAY, medium plasticity
	OL	Organic SILT
SILT and CLAY (high plasticity)	MH	SILT, high plasticity
	CH	CLAY, high plasticity
	OH	Organic CLAY / SILT
Highly Organic	Pt	PEAT

Coarse grained soils with fines contents between 5% and 12% are provided a dual classification comprising the two group symbols separated by a dash, e.g. for a poorly graded gravel with between 5% and 12% silt fines (poorly graded 'GRAVEL with silt'), the classification is GP-GM.

For the purpose of classification, *poorly graded, uniform,* or *gap graded* soils are all designated as poorly graded. Soils that are dominated by boulders or cobbles are described separately and are not classified.

Classification is routinely undertaken based on tactile assessment with the soil description. Refinement of soil classification may be applied using laboratory assessment, including particle size distribution and Atterberg Limits. Atterberg Limits testing is applied to the sample portion finer than 0.425 mm. Fine grained soil components are assessed on the basis of regions defined within the Modified Casagrande Chart.



ROCK DESCRIPTION AND CLASSIFICATION

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Rock is described in general accordance with Australian Standard AS 1726-2017 (Geotechnical site investigations) in terms of visual and tactile properties, with potential refinement by laboratory testing. AS 1726 defines rock as any aggregate of minerals and/or organic materials that cannot be disaggregated by hand in air or water without prior soaking. The rock description and classification distinguishes between rock material, defects, structure and rock mass.

ROCK DESCRIPTION AND CLASSIFICATION

a) Description of rock material (rock name, grain size and type, colour, texture and fabric, inclusions or minor components, moisture content and durability)

Rock Name: Simple rock names are used to provide a reasonable engineering description rather than a precise geological classification. The rock name is chosen on the basis of origin, with common types summarised below. Additional, non-exhaustive, terminology is included in AS 1726. Rock names not described within AS 1726 may be adopted, with geological characteristics typically noted within accompanying text.

<table>
<tr><th rowspan="2">Grain Size (mm)</th><th colspan="4">Sedimentary</th><th colspan="2">Metamorphic</th><th colspan="3">Igneous</th></tr>
<tr><th colspan="2">Clastic or Detrital</th><th colspan="2">Carbonate</th><th rowspan="2">Pyroclastic</th><th rowspan="2">Foliated</th><th rowspan="2">Non-Foliated</th><th rowspan="2">Felsic</th><th rowspan="2">↔</th><th rowspan="2">Mafic</th></tr>
<tr><th colspan="2"></th><th>Low Porosity</th><th>Porous</th></tr>
<tr><td>>2.0</td><td colspan="2">CONGLOMERATE
(rounded grains in a finer matrix)

BRECCIA
(angular or irregular fragments in a finer matrix)</td><td rowspan="4">LIMESTONE
(Predominantly $CaCO_3$)

or

DOLOMITE
(Predominantly $CaMgCO_3$)</td><td>CALCIRUDITE</td><td>AGGLOMERATE
(rounded grains in a finer matrix)

VOLCANIC BRECCIA
(angular fragments in a finer matrix)</td><td>GNEISS</td><td>MARBLE
(carbonate)

QUARTZITE</td><td>GRANITE</td><td>DIORITE</td><td>GABBRO</td></tr>
<tr><td>2.0-0.06</td><td colspan="2">SANDSTONE</td><td>CALCARENITE</td><td>TUFF</td><td>SCHIST</td><td rowspan="3">SERPENTINITE

HORNFELS</td><td>MICRO-GRANITE</td><td>MICRO-DIORITE</td><td>DOLERITE</td></tr>
<tr><td>0.06-0.002</td><td rowspan="2">MUDSTONE
(silt and clay)</td><td>SILTSTONE
(mostly silt)</td><td>CALCISILTITE</td><td rowspan="2">Fine grained TUFF</td><td rowspan="2">PHYLLITE or SLATE</td><td rowspan="2">RHYOLITE</td><td rowspan="2">ANDESITE</td><td rowspan="2">BASALT</td></tr>
<tr><td><0.002</td><td>CLAYSTONE
(mostly clay)</td><td>CALCILUTITE</td></tr>
</table>

Reproduced with modification from Tables 15, 16 and 17, Clause 6.2.3.1, AS 1726-2017, Geotechnical site investigations.

Grain size: For rocks with predominantly sand sized grains the dominant or average grain size is described as follows:

Rock type	Coarse grained	Medium grained	Fine grained
Sedimentary rocks	Mainly 0.6 mm to 2 mm	Mainly 0.2 mm to 0.6 mm	Mainly 0.06 mm (just visible) to 0.2 mm
Igneous and metamorphic rocks	Mainly >2 mm	Mainly 0.06 mm to 2 mm	Mainly <0.6 mm (just visible)

Colour assists in rock identification and interpolation. Rock colour is generally described in a *"moist"* condition, using simple terms (e.g. grey, brown, etc.) and modified as necessary by *"pale"*, *"dark"*, or *"mottled"*. Borderline colours may be described as a combination of these colours (e.g. red-brown).

Texture refers to the arrangement of, or the relationship between, the component grains or crystals (e.g. porphyritic, crystalline or amorphous).

Fabric refers to visible grain arrangement along a preferential orientation or a layering. Fabric may be noted as *"indistinct"* (little effect on strength) or *"distinct"* (rock breaks more easily parallel to the fabric). Common terms include *"massive"* or *"flow banding"* (igneous), *"foliation"* or *"cleavage"* (metamorphic). Sedimentary layering is described as *"bedding"* or (where thickness < 20 mm) *"lamination"*. The typical orientation, spacing or thickness of these structural features can be described directly in millimetres and metres. Further quantification of bedding thickness applied by GHD is as follows:

Bedding Term	Thickness
Very thickly bedded	>2 m
Thickly bedded	0.6 to 2 m
Medium bedded	0.2 to 0.6 m
Thinly bedded	60 to 200 mm
Very thinly bedded	20 to 60 mm
Laminated	6 to 20 mm
Thinly laminated	<6 mm

Features, Inclusions and Minor Components are typically only described when those features could influence the engineering behaviour of the rock. Described features may include: gas bubbles in igneous rocks; veins of quartz, calcite or other minerals; pyrite crystals and nodules or bands of ironstone or carbonate; cross bedding in sandstone; clast or matrix support in conglomerates and breccia.

Moisture content may be described by the feel and appearance of the rock, as follows: *"dry"* (looks and feels dry), *"moist"* (feels cool, darkened in colour, but no water is visible on the surface), or *"wet"* (feels cool, darkened in colour, water film or droplets visible on the surface). The moisture content of rock cored with water may not represent in situ conditions.

Durability of rock samples is noted where there is an observed tendency of samples to crack, breakdown in water or otherwise deteriorate with exposure.

Ref: DS6.5.2.1 Issue 2.0 Date: 01/08/2019

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b) Classification of the rock material condition (strength, weathering and/or alteration)

Estimated Strength refers to the rock material and not the rock mass. The strength is defined in terms of uniaxial compressive strength (UCS), though is typically estimated by either tactile assessment or Point Load Strength Index ($Is_{(50)}$) (measured perpendicular to planar anisotropy). A correlation between $Is_{(50)}$ and UCS is adopted for classification, though is not intended for design purposes without appropriate supporting assessment. A field guide follows:

Term and (Symbol)		UCS (MPa)	$Is_{(50)}$ (MPa)	Field Guide
Very Low	*(VL)*	0.6 – 2	0.03 - 0.1	Material crumbles under firm blows with sharp end of geological pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm thick can be broken by finger pressure.
Low	*(L)*	2 - 6	0.1 - 0.3	Easily scored with knife; indentations 1 to 3 mm show in the specimen with firm blows of a geological pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	*(M)*	6 - 20	0.3 - 1.0	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
High	*(H)*	20 - 60	1 - 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken by a geological pick with a single firm blow; rock rings under hammer.
Very High	*(VH)*	60 - 200	3 -10	Hand specimen breaks with geological pick after more than one blow; rock rings under hammer.
Extremely High	*(EH)*	>200	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Based on Table 19, Clause 6.2.4.1, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

Material with strength less than *"very low"* is described using soil characteristics, with the presence of an original rock texture or fabric noted if relevant.

Weathering and Alteration: The process of weathering involves physical and chemical changes to the rock resulting from exposure near the earth's surface. A subjective scale for weathering is applied as follows:

Weathering Term and (Symbol)		Description
Residual Soil	*(RS)*	Material has weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely Weathered	*(XW)*	Material has weathered to such an extent that it has soil properties. Mass structure, material texture and fabric of original rock are still visible.
Highly Weathered	*(HW)*	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately Weathered	*(MW)*	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly Weathered	*(SW)*	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	*(Fr)*	Rock shows no sign of decomposition of individual minerals or colour changes.

Modified based on Table 20, Clause 6.2.4.2, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

Where physical and chemical changes to the rock are caused by hot gases or liquids at depth, the process is called alteration. Unlike weathering, the distribution of altered material may occur at any depth and show no relationship to topography. Where alteration minerals are identified the terms *"extremely altered" (XA)*, *"highly altered" (HA)*, *"moderately altered" (MA)* and *"slightly altered" (SA)* can be used to describe the physical and chemical changes described above.

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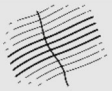
c) Description of defects (defect type, orientation, roughness and shape, coatings and composition of seams, spacing, length, openness and thickness, block shape)

Defects often control the overall engineering behaviour of a rock mass. AS 1726 defines a defect as “a discontinuity, fracture, break or void in the material or materials across which there is little or no tensile strength”. Describing the type, character and distribution of natural defects is an essential part of the description of many rock masses.

Commonly described characteristics of defects within a rock mass include type, orientation, roughness and shape, coatings and composition of seams, aperture, persistence, spacing and block shape.

The degree of detail required for defect descriptions depends on project requirements. All defects judged of engineering significance for the site and project are described individually. Where appropriate, generalised descriptions for less significant, or multiple similar, defects can be provided for delineated parts of rock core or exposures. A general description of delineated defect sets is provided when sufficient orientation data is available.

Defect Type is described using the terms summarised below. On core logs, only natural defects across which the core is discontinuous are described (i.e. inferred artificial fractures such as drill breaks are excluded). Incipient defects are described using the relevant texture or fabric terms. Healed defects (those that have been re-cemented by minerals such as chlorite or calcite) are described using the prefix “healed” (e.g. healed joint).

Type and (Symbol)		Description	Diagram
Parting	(Pt)	A surface or crack across which the rock has little or no tensile strength. Parallel or sub-parallel to layering (e.g. bedding) or a planar anisotropy in the rock material (e.g. cleavage). May be open or closed.	
Joint	(Jt)	A surface or crack with no apparent shear displacement and across which the rock has little or no tensile strength, but which is not parallel or subparallel to layering or to planar anisotropy in the rock material. May be open or closed.	
Sheared Surface	(SS)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided and which shows evidence of shear displacement.	
Sheared Zone	(SZ)	Zone of rock material with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
Sheared Seam	(SSm)	Seam of soil material with roughly parallel almost planar boundaries, composed of soil materials with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
Crushed Seam	(CSm)	Seam of soil material with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock material which may be more weathered than the host rock. The seam has soil properties.	
Infilled Seam	(ISm)	Seam of soil material usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1 mm thick may be described as a veneer or coating on a joint surface.	
Extremely Weathered Seam	(WSm)	Seam of soil material, often with gradational boundaries. Formed by weathering of the rock material in place.	

Modified based on Table 22, Clause 6.2.5.2, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

Defect Orientation is recorded as the “dip” (maximum angle of the mean plane, measured from horizontal) and the “dip direction” (azimuth of the dip, measured clockwise from true north). Dip and dip direction is expressed in degrees, with two-digit and three-digit numbers respectively, separated by a slash (e.g. 45/090). For vertical boreholes, the defect dip is measured as the acute angle from horizontal. Rock core extracted from vertical boreholes is generally not oriented, so the dip direction cannot be directly measured. For non-oriented inclined boreholes, a defect “alpha” (α) angle is measured as the acute angle from the core axis. For vertical and non-oriented inclined boreholes, the dip direction can sometimes be estimated from the relationship of the defect to a well-defined site structure such as fabric. For oriented inclined boreholes, the measurement of the defect orientation is carried out and recorded in a form suited to the particular device being used and later processed to report true dip and dip direction.

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Roughness and Shape of the defect surface combine to have significant influence on shear strength. Standard descriptions and abbreviations include:

Roughness and (Symbol)		Description
Very Rough	(VR)	Many large surface irregularities (amplitude generally more than 1 mm). Feels like, or coarser than very coarse sand paper.
Rough	(Rf)	Many small surface irregularities (amplitude generally less than 1 mm). Feels like fine to coarse sand paper.
Smooth	(So)	Smooth to touch. Few or no surface irregularities.
Polished	(Pol)	Shiny smooth surface.
Slickensided	(Slk)	Grooved or striated surface, usually polished.

Shape and (Symbol)		Description
Planar	(Pln	The defect does not vary in orientation.
Curved	(Cu)	The defect has a gradual change in orientation.
Undulating	(Un)	The defect has a wavy surface.
Stepped	(St)	The defect has one or more well defined steps.
Irregular	(Ir)	The defect has many sharp changes of orientation.

Although the surface roughness of defects can be described at small (10-100 mm) scales of observation, the overall shape of the defect surface can usually be observed only at medium (0.1-1 m) and large (>1 m) scale.

Where it is necessary to assess the shear strength of a defect, observations are generally made at multiple scales. Surface roughness may also be characterised by using the joint roughness coefficient (JRC) profiles established by Barton and Choubey (1977). Where large-scale observations are possible, further measurement of defect "waviness" (angle of the asperities relative to the overall dip angle of the plane) is made.

Coatings and Composition of Seams: Many defects have surface coatings, which can affect their shear strength. Standard descriptions include:

Coating and (Symbol)		Description
Clean	(Cn)	No visible coating.
Stained	(Sn)	No visible coating but surfaces are discoloured.
Veneer	(Ve)	A visible coating of soil or mineral substance, but too thin to be measured may be patchy.
Coating	(Co)	A visible coating up to 1 mm thick. Soil material greater than 1 mm thick is described using defect terms (e.g. infilled seam). Rock material greater than 1 mm thick is described as a vein (Vn).

Common Minerals and (Symbol)	
Clay	(CLAY)
Calcite	(Ca)
Carbonaceous	(X)
Chlorite	(Kt)
Iron Oxide	(Fe)
Micaceous	(Mi)
Manganese	(Mn)
Pyrite	(Py)
Quartz	(Qz)

The composition of seams are described using soil description terms as given on the SOIL DESCRIPTION AND CLASSIFICATION Standard Sheet. Where possible the mineralogy of coatings is identified. Common mineral coatings include:

Aperture: Defects across which there is little or no tensile strength can be either *"open"* (*Op*) or *"closed"* (*Cl*). For rock core, the width of the "open" defect is measured whilst still in the core barrel splits. The descriptor *"tight"* (*Ti*) can only apply to healed or incipient defects (i.e. veins, foliation, etc.).

Persistence and Spacing of defects is described directly in millimetres and metres. If the measurement of defect persistence is limited by the extent of the exposure, the end conditions are noted (i.e. 0, 1 or 2 defect ends observed). The spacing between defects of similar orientation (i.e. within a specific defect set) is recorded when possible.

The frequency of defects within rock core can be measured as either: the spacing between successive defects; or the "Fracture Index", which is the number of defects per metre of core.

Spacing Term	Thickness
Very wide	>2 m
Wide	0.6 to 2 m
Medium	0.2 to 0.6 m
Closely	60 to 200 mm
Very closely	20 to 60 mm
Extremely closely	6 to 20 mm

Block Shape: Where it is considered significant, block shape can be described using the subjective terms as follows:

Block Shape	Description
Polyhedral	Irregular discontinuities without arrangement into distinct sets, and of small persistence.
Tabular	One dominant set of parallel discontinuities, for example bedding planes, with other non-continuous joints; thickness of blocks much less than length or width.
Prismatic	Two dominant sets of discontinuities, approximately orthogonal and parallel, with a third irregular set; thickness of blocks much less than length or width.
Equidimensional	Three dominant sets of discontinuities, approximately orthogonal, with occasional irregular joints, giving equidimensional blocks.
Rhomboidal	Three (or more) dominant, mutually oblique, sets of joints giving oblique-shaped, equidimensional blocks.
Columnar	Several, usually more than three sets of continuous, parallel joints usually crossed by irregular joints; lengths much greater than other dimensions.

Modified based on Table 23, Clause 6.2.5.7, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

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d) Interpreted stratigraphic unit

Stratigraphic units may be interpreted and reported, in accordance with The Australian Stratigraphic Units Database (ASUD). The terms *"possibly"* or *"probably"* indicate increased uncertainty in this interpretation.

e) Geological structure

After describing the rock material and defects, an interpretation of the nature and configuration of rock mass defects may be presented in logs, charts, 2D sections and 3D models (e.g. dipping strata, folds, unconformities, weathering profiles, defect sets, geological faults, etc.).

PARAMETERS RELATED TO CORE DRILLING

Drill Depth and Core Loss: Drilling intervals are shown on GHD Core Log Sheets by depth increments and horizontal marker lines.

"Core loss", or its inverse "total core recovery" (TCR), is measured as a percentage of the core run. If the location of the core loss is known, or strongly suspected, it is shown in a region of the column bounded by dashed horizontal lines. If unknown, core loss is assigned to the bottom of a core run.

Rock Quality Designation (RQD), described by Deere et al. (1989), may be recorded on GHD Core Log Sheets.

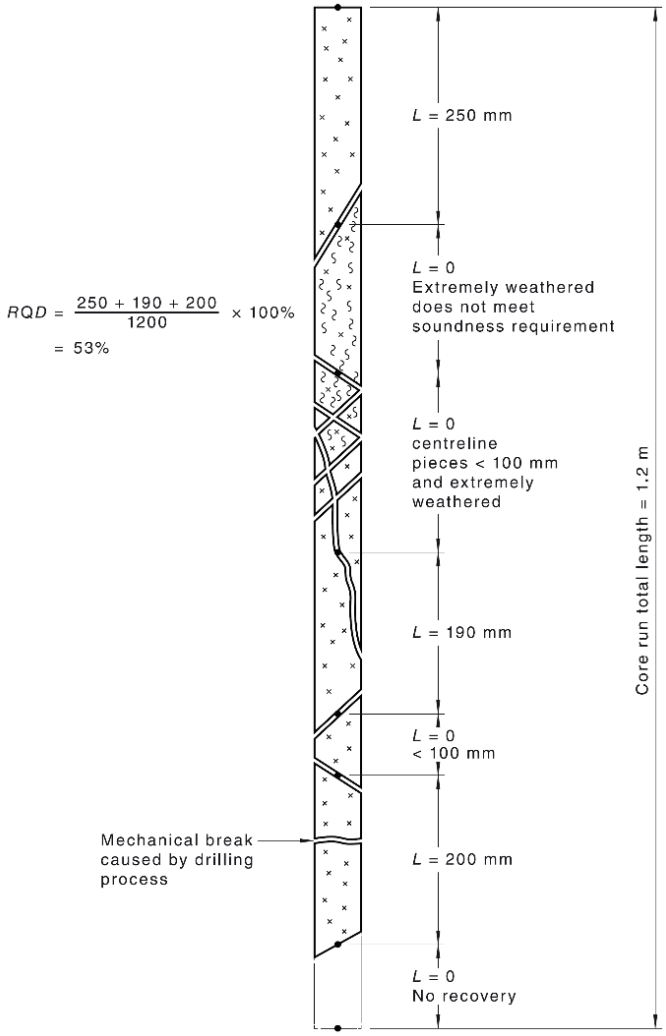
For certain projects, such as tunnelling or underground mining investigations, rock mass ratings or classifications can be required as part of the design process. The RQD forms a component of these rock mass ratings and provides a quantitative estimate of rock mass quality from rock core logs.

The rock core must be "N" sized (nominally 50 mm) or greater for derivation of RQD. The RQD is expressed as a percentage of intact rock core (excluding residual soil and extremely weathered rock) greater than 100 mm in length over the total selected core length.

Deere et al. (1989) recommends measuring lengths of core along the centreline, as shown right.

RQD is expressed as:

$$RQD = \frac{\sum Length\ of\ sound\ core\ pieces > 100\ mm\ in\ length}{Length\ of\ core\ run}\ x\ 100\%$$



RQD measurement procedure
(reproduced from Figure 13, Clause 6.2.9.4, AS 1726-2017, Geotechnical site investigations)

ROCK MASS CLASSIFICATION

Rock mass classification schemes may be used to represent the engineering characteristics of a rock mass. A large variety of classification schemes have been developed by various authors, ranging from simple to complex. All of the schemes are limited in their application and many rock mass classification systems assume that the rock mass is isotropic, which is rarely the case.

References

STANDARDS AUSTRALIA (2017). AS 1726-2017. GEOTECHNICAL SITE INVESTIGATIONS.
BARTON, N. AND CHOUBEY, V. (1977). THE SHEAR STRENGTH OF ROCK JOINTS IN THEORY AND PRACTICE. ROCK MECHANICS 10, 1-54. SPRINGER.
DEERE, D.U. AND DEERE, D.W. (1989). ROCK QUALITY DESIGNATION (RQD) AFTER TWENTY YEARS. CONTRACT REPORT GL-89-1. ARMY CORPS OF ENGINEERS. WASHINGTON DC, 1989.

LABORATORY TESTING

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GENERAL

Samples extracted during the fieldwork stage of a site investigation may be “disturbed” or “undisturbed” (as generally indicated on the test hole logs) depending upon the nature and purpose of the sample as well as the method of extraction, transportation, extrusion and testing. This aspect should be taken into account when assessing test results, which must of necessity, reflect the effects of such disturbance.

All soil properties (as measured by laboratory testing) exhibit inherent variability and thus a certain statistical number of tests is required in order to predict an average property with any degree of confidence. The site variability of soil strata, future changes in moisture and other conditions and the discrete sampling positions must also be considered when assessing the representative nature of the laboratory programme.

Certain laboratory test results provide interpreted soil properties as derived by conventional mathematical procedures. The applicability of such properties to engineering design must be assessed with due regard to the site, sample condition, procedure and project in hand.

TESTING

Laboratory testing is normally carried out in accordance with Australian Standard AS 1289 as amended, or in NSW, Roads and Maritime Services (RMS) standards when specified. The routine Australian Standard tests are as follows:

Moisture Content	AS1289 2.1.1	
Liquid Limit	AS1289 3.1.1	collectively known as Atterberg Limits
Plastic Limit	AS1289 3.2.1	
Plasticity Index	AS1289 3.3.1	
Linear Shrinkage	AS1289 3.4.1	
Particle Density	AS1289 3.5.1	
Particle Size Distribution	AS1289 3.6.1, 3.6.2 and 3.6.3	
Emerson Class Number	AS1289 3.8.1	collectively, Dispersive Classification
Percent Dispersion	AS1289 3.8.2	
Pinhole Dispersion Classification	AS1289 3.8.3	
Hole Erosion (HE)	GHD Method	
No Erosion Filter (NEF)	GHD Method	
Organic Matter	AS1289 4.1.1	
Sulphate Content	AS1289 4.2.1	
pH Value	AS1289 4.3.1	
Resistivity	AS1289 4.4.1	
Standard Compaction	AS1289 5.1.1	
Modified Compaction	AS1289 5.2.1	
Dry Density Ratio	AS1289 5.4.1	
Minimum Density	AS1289 5.5.1	
Density Index	AS1289 5.6.1	
California Bearing Ratio	AS1289 6.1.1 and 6.1.2	
Shear Box	AS1289 6.2.2	
Undrained Triaxial Shear	AS1289 6.4.1 and 6.4.2	
One Dimensional Consolidation	AS1289 6.6.1	
Permeability Testing	AS1289 6.7.1, 6.7.2 and 6.7.3	

Where tests are used which are not covered by appropriate standard procedures, details are given in the report.

LABORATORIES

Our Australian laboratories are NATA accredited to AS ISO / IEC17025 for the listed tests.

The oedometer, triaxial and shear box equipment are fully automated for continuous operation using computer controlled data acquisition, processing and plotting systems.

Ref: DS5.5.2 Issue 0 Date: 05/10/2018

CONE PENETRATION (CPT/CPTU) TESTING

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SCOPE

The Cone Penetration Test (CPT) comprises the measurement of soil resistance in response to a steel cone pushed into the ground at a constant rate. The CPTU (or piezo cone) test involves sophisticated equipment yet is simple in operation and provides rapid, almost continuous traces of soil response, with good repeatability.

The CPT/CPTU test is commonly employed as a means of extrapolation of discrete borehole data for a particular site. The interpretation of CPT and CPTU results without appropriate borehole data correlation must be considered for guide purposes only and should not be used in isolation for detailed design.

EQUIPMENT AND METHOD

The steel cone consists of a 37 mm diameter, 60° cone, hydraulically pushed vertically down into the soil profile. The piezo probe includes the measurement of cone resistance (q_c), friction sleeve (f_s), inclinometer and pore pressure (u) whilst the friction cone used for CPT testing includes cone resistance and friction sleeve readings only. The porous element of the piezo cone is situated on the cylindrical shaft immediately behind the cone. The rate of penetration for both cones is approximately 20 mm/sec with readings taken usually at 20 mm intervals throughout the profile.

The CPTU test is typically initiated by inserting the pre-saturated probe into a pre-drilled hole below the ground water table. The probe is then permitted to achieve temperature stabilisation prior to conducting the penetration test.

The CPT/CPTU readings are measured using load cells and strain gauges set in the probe. The signals from these gauges are transmitted to an analogue/digital converter. The digitised data is then recorded and stored on a lap-top computer for later analysis. In particular, data reduction includes processing of the q_c results recorded with the piezo cone to total resistance (q_t) values using the corresponding pore pressure value in accordance with published procedures.

The piezo cone can also be used to perform pore pressure dissipation measurements at selected test levels to determine the localised lateral drainage characteristics of the subsoil. Depending on the rate of dissipation, the excess pore pressure is recorded during the dissipation test until a nominated degree of dissipation is achieved.

The cone penetration test is terminated once the probe reaches refusal, when the rods behind the probe cannot be advanced further due to resistance developed along the rods or when the force required to advance the rods exceeds the capacity of the testing vehicle or frame. The probe is then withdrawn from the ground and the readings corrected to take into account effects of the temperature variation at depth.

INTERPRETATION

The CPT and CPTU results can be used to assess the soil profile at specific test locations and to estimate soil strength and consolidation characteristics. As mentioned previously, such interpretations are generally performed in association with discrete borehole data.

In particular, the interpretations must take account of the soil type (and consequent drainage conditions), soil strength, sensitivity and stress history (i.e. normally or over-consolidated). Details of these are beyond the scope of this explanation sheet.

Ref: 5.4.4 Issue 0 Date: 05/10/2018

DYNAMIC CONE PENETROMETER (DCP) TESTING

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SCOPE

The Dynamic Cone Penetrometer (DCP) test comprises the measurement of the soil resistance to a steel rod driven into the ground by a dropped weight.

The DCP test is a simple manual test used in both sandy and clayey soils. The test is a measure of the shear strength of the soil at relatively shallow depth.

EQUIPMENT AND METHOD

A general description of the dynamic penetrometer apparatus used by our firm is presented in Australian Standard AS 1289.6.3.2. The equipment utilises a 9 kg sliding weight with a drop height of 510 mm. It is fitted with a conical tip. The equipment can be adjusted for a fall of 600 mm and use of a blunt tip in accordance with AS 1289.6.3.3.

The test data are generally recorded as the number of blows (n) per 50 mm of penetration. For specific applications (such as pavement investigations), the data may be collected in the reverse form, i.e. as mm per blow. The results are presented either in tabular or graphic form for reporting purposes.

INTERPRETATION

The interpretation of the DCP results is generally based on the assumption that the measured resistance is a function of soil strength. A profile of soil strength (cohesive soils) or density index (cohesionless soils) can thus be established. The test often can be used to qualitatively indicate the presence of soft or loose zones within a soil profile.

The energy of the system per unit area is similar to that of the larger Standard Penetration Test (SPT). Thus, the common relationships of SPT and other parameters can be used as a means of estimating soil properties, after appropriate site specific consideration. The interpretations from the test are approximate only, and this is particularly pertinent to sand profiles where the magnitude of confinement stress is important in the assessment of the results.

Interpretation of the DCP penetration rate at depth must be conducted with due regard to rod friction effects. In particular, care must be exercised with soft clay profiles where rod resistance may have an unconservative impact on the results. Care must also be exercised with soil profiles containing larger particles such as gravels and cobbles where penetration rate can be affected if the DCP tip strikes or glances off such particles.

In-situ California Bearing Ratio (CBR) values of clay soil subgrades are sometimes interpreted directly from DCP test results for use in road pavement design. In this case, the correlation between DCP and CBR based on that published in AUSTROADS Pavement Structural Design guide (AGPT02-17 Part 2) may be applied. This correlation should be verified by site specific laboratory testing, where appropriate. In addition, the effects of moisture content variations (in-situ versus design conditions) must be considered, as the DCP test only reflects the shear strength of the soil at the time of testing. Further information can be found in AUSTROADS Geotechnical Investigation and Design guide (AGRD07-08 Part 7).

Ref: DS5.4.3 Rev 0 Date: 05/10/2018

REACTIVE SOILS SITE MANAGEMENT PRECAUTIONS

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These precautions are considered supplementary to any structural and/or foundation design measures for the subject building, and are intended for distribution to the prospective building owner / occupier.

Reactive clays are prone to heave/shrink movements with changes in soil moisture content due to natural or artificial means. The basic design philosophy employed for the building is to provide a foundation/superstructure adequate to accommodate ground movements due to extreme seasonal moisture changes only. The possibility of other abnormal and/or localised moisture changes (the cause of most building distress) has been assumed to be controlled by the following site management procedures.

In particular, leaking plumbing or blocked drains should be repaired promptly and site grading maintained to prevent ponding near foundations. Garden watering, particularly by fixed systems, should be controlled carefully to avoid gross over-watering. On the other hand, proper garden maintenance should produce year round uniform moisture conditions.

Trees and shrubs can cause a substantial drying of the clay soil profile and associated shrinking of reactive clays. This effect is most likely to result in damage when added to the drying from a drought or a long dry spell. The problem can be avoided by planting trees at substantial distances from the building. The distance depends upon the species, soil conditions, and site classification.

Problems during droughts can be minimised by extensive pruning (thus reducing water demand) and/or providing trees with adequate water. This watering can be achieved by boreholes or trenches dug well into the clay between the tree and the footing. To avoid settlement problems, the holes or trenches should not be too close to the footing and should be filled with compacted screenings. The installation of root barriers is another option. Frequent moderate watering during dry periods also should assist in minimising the extraction of excessive moisture from beneath the foundation of the building by trees and other vegetation as well as the environmental effects.

This action should also be immediately undertaken by the owner / occupier if brickwork cracking due to tree drying is noticed. Most reactive clay failures can be avoided or the effects minimised by controlling the combined drying effects of trees and drought.

The owner / occupier should also appreciate that on reactive clays it is virtually impossible to design an economic foundation system which will totally prevent movement. Some minor aesthetic cracking, while undesirable, will occur in a significant proportion of houses. In addition, some minor problems should be expected with jamming of windows and doors, especially during the settling-in period or following a major drought, and such repairs should be regarded as part of normal building maintenance. Even significant masonry cracking with widths over 5mm usually has little influence on the function of the wall and presents an aesthetic problem. Just as it is difficult to design an immovable footing system, it is almost impossible to provide remedial measures that will prevent further movements if distress does occur. Consequently, extreme remedial measures should not be undertaken for minor problems.

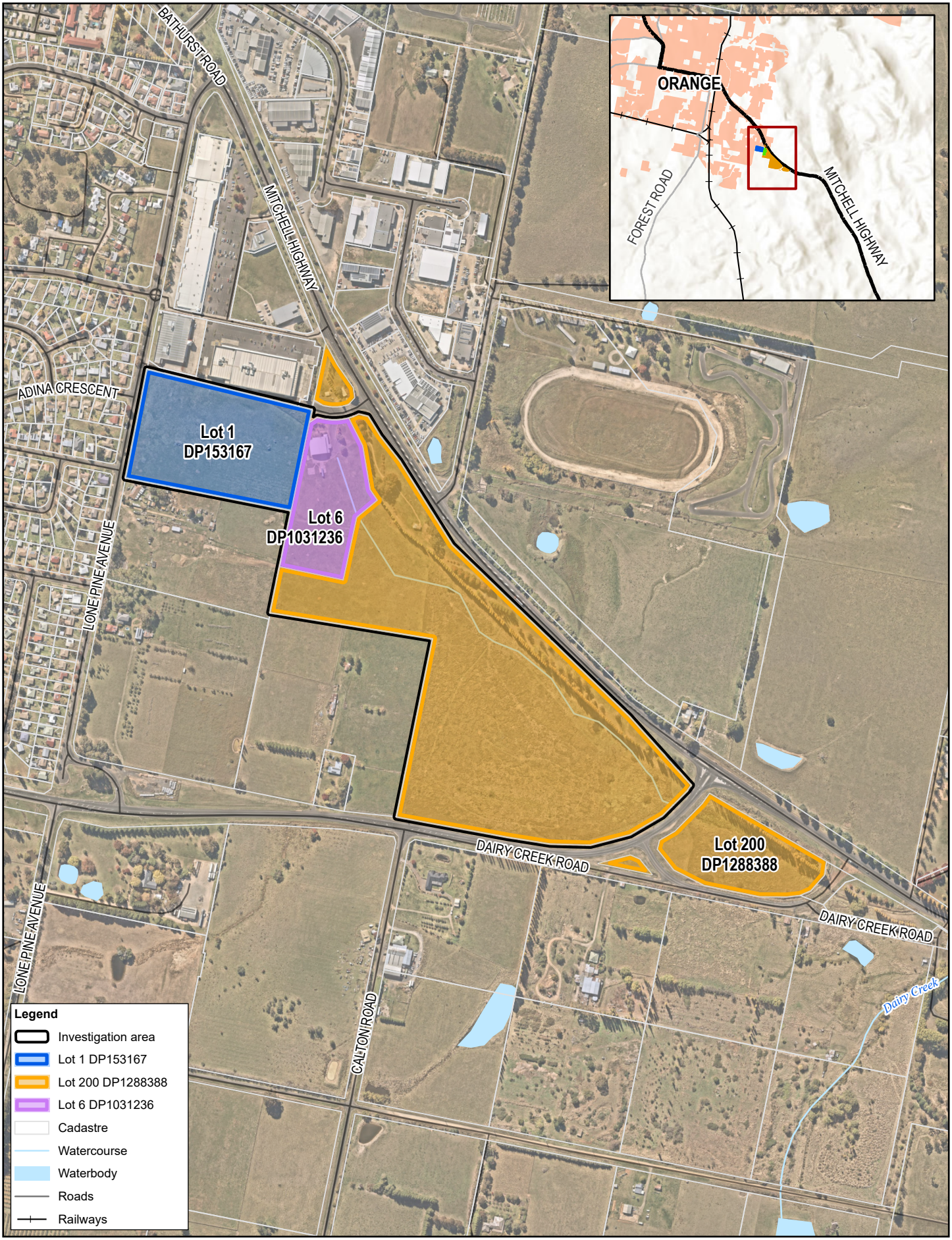
Advice on these matters is addressed in Australian Standard AS2870 “Residential slabs and footings”. In particular the designer, owner and occupier are referred to Appendix B “Foundation Performance and Maintenance” in AS2870.

Useful information for homeowners can also be found in CSIRO Building Technology File BTF 18-2011 “Foundation Maintenance and Footing Performance: A Homeowner’s Guide”, available through CSIRO Publishing.

Ref: DS5.4.1 Rev 0 Date: 04/10/2018

Appendix B

Figures



Paper Size ISO A4

0 50 100 150 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 55

N

GHD

Landcom
Geotechnical Investigation

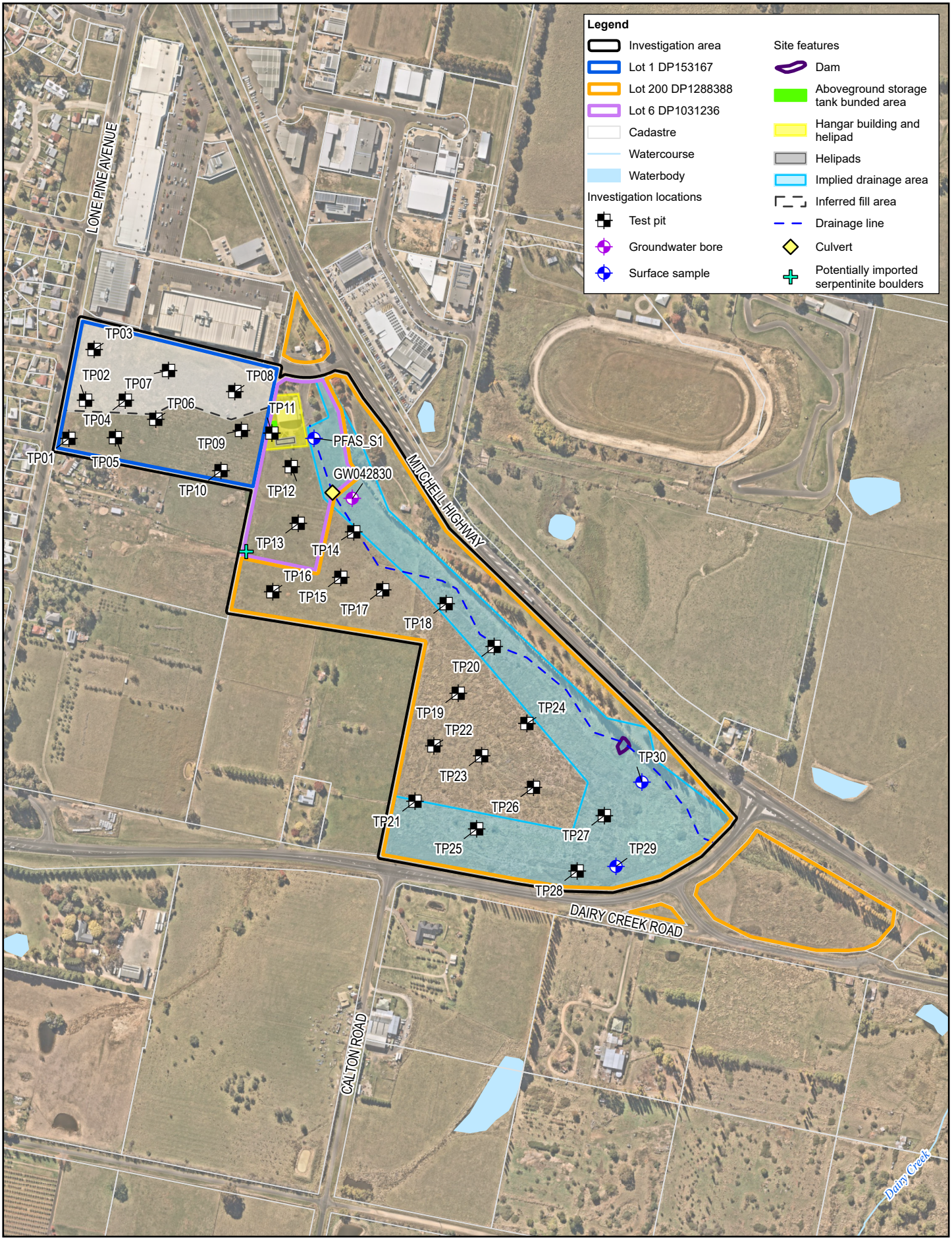
Overall site layout

Project No. **12627900**
Revision No. **0**
Date **14/03/2024**

FIGURE 1

\\ghdnet\ghd\AU\Sydney\Projects\21\12627900\GIS\Maps\Deliverables\12627900_PSI_A.aprx
Print date: 10 May 2024 - 14:19

Data source: NSWSS: Road, Cadastre, Hydrology, 2024; World Hillshade: Esri, Geoscience Australia, NASA, NGA, USGS
Nearmap WMS Server: World Hillshade: Esri, Geoscience Australia, NASA, NGA, USGS
Nearmap WMS Server: . Created by: pfernandes



Paper Size ISO A4

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 55

N

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Landcom
Geotechnical Investigation

Investigation locations

Project No. **12627900**
Revision No. **0**
Date **28/03/2024**

FIGURE 2

\\ghdnet\ghd\AU\Sydney\Projects\21\12627900\GIS\Maps\Deliverables\12627900_PSI_A.aprx
Print date: 10 May 2024 - 14:18

Data source: GHD: Test Pits, 2014; NSWSS: Road, Cadastre, Hydrology, 2024; Nearmap WMS Server: . Created by: pfernandes

Appendix C

Geotechnical Test Pit Logs with DCPs

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP01

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** MAG
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 28/02/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
		ES			-	[TOPSOIL]: Clayey SILT: low plasticity, light brown, trace organic matter (rootlets).	w < PL	L-MD		18	0.00m, PP=6.0kPa PID=0.40ppm
			0.30							9	
						Clayey SILT: light brown, trace fine to coarse grained sand (residual).	M	D		4	0.30m, PP=N/A PID=0.50ppm
		ES								4	
										3	
	Nil									3	
										5	
										16	
1		B				From 0.90m, trace fine, angular to sub-angular gravel (ironstones).				10	
										25	
										28	
						1.20m, becoming light brown/ white, iron staining.				17	
										20	
			1.40							23	
			1.50		CL	Silty CLAY: low plasticity, brown, with fine to coarse grained sand, fine to coarse, angular to sub-angular gravel, iron staining, weathered ironstone (extremely weathered rock).	w = PL	VSt - H	End of probe at 1.40m		1.40m, PP=N/A
2						End of Test pit at 1.5 metres. Refusal on HW rock.					
3											

Note: * indicates signatures on original issue of log or last revision of log

See standard sheets for details of abbreviations & basis of descriptions

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Job No. 12627900

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP02

SHEET 1 **OF** 1

Position: Refer to test location plan **Surface RL:** N/A **Processed:** MAG

Method of Exploration: 3.5T Excavator + Track **Hole Size:** 0.3m x 2.0m **Checked:** JM

Date: 28/02/24 **Logged by:** SH **Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
		ES			-	[TOPSOIL]: Clayey SILT: low plasticity, light brown, trace organic matter (rootlets).	w < PL	VSt - H		22 28 18 9	0.00m, PID=0.60ppm
			0.50					VSt		18	
		ES			CL-Cl	Silty CLAY: low to medium plasticity, brown/orange, trace fine to coarse, angular to sub-angular gravel (ironstones) (residual).	w ≈ PL	VSt - H		20 20 10 10	0.50m, PID=0.70ppm
	Nil							St - VSt		8	
1		ES	1.00		Cl	Gravelly CLAY: medium plasticity, fine to coarse, angular to sub-angular gravel, trace fine to coarse grained sand, trace ironstones (extremely weathered rock).	w ≈ PL	St		12 11 5 5	1.0m, PID=0.70ppm
		ES	1.50					VSt		5	1.50m, PID=0.50ppm
						End of Test pit at 1.5 metres. Refusal on HW rock.			End of probe at 1.70m	13 20	
2											
3											

Note: * indicates signatures on original issue of log or last revision of log

GEO_TEST PIT_DCP100/40_AS1726 2017_12627900 REDMAN PLACE ORANGE.GPJ_GHD_GEO_TEMPLATE 2.00.GDT 2/5/24

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP03

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** MAG
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 28/02/24	**Logged by:** MH/SH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
		ES+GEO			-	[FILL]: Silty CLAY: low plasticity, brown, with fine to coarse, sub-rounded to rounded gravel, trace fine to coarse grained sand, trace organic matter (rootlets).	w = PL	St		12	0.00m, PID=0.40ppm
										5	
										6	
										7	
		ES+GEO								6	
								F - St		4	
										4	
						0.75m, trace ironstones.				8	0.75m, PID=0.20ppm
								F		3	
1										2	
		ES+GEO FD1/FD2								3	
										2	
										2	1.25m, PID=0.30ppm
	Nil									5	
								F - St		7	
										17	
								F		2	
										3	
			1.95							3	
2					CI	Silty CLAY: medium plasticity, brown, with fine to sub-rounded ironstones, trace fine to coarse grained sand (residual grading to extremely weathered rock).	w = PL	St - VSt		4	2.00m, PP=1.00kPa
		ES+GEO								5	
										7	
										12	
									End of probe at 2.40m	20	
						2.50m, iron staining with ironstone inclusions, with grey mottling.					2.50m, PP=1.00kPa
		ES+GEO									
			2.75								
3						End of Test pit at 2.75 metres. Target Depth.					

Note: * indicates signatures on original issue of log or last revision of log

GEO_TEST PIT_DCP100/40_AS1726 2017_12627900 REDMAN PLACE ORANGE.GPJ_GHD_GEO_TEMPLATE 2.00.GDT 2/5/24

See standard sheets for details of abbreviations & basis of descriptions

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP04

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** MAG
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 28/2/2024	**Logged by:** SH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description [COBBLES / BOULDERS / FILL / TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: Grain size, colour, fabric and texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Note: * indicates signatures on original issue of log or last revision of log Comments Observations
		ES + FD3			-	[FILL]: Silty CLAY: low plasticity, light brown, well rounded, >40% cobbles (quartz), trace sub-rounded to rounded gravel, trace fine to coarse grained sand, rootlets.	w ≈ PL	St MD	0.00m, PP=2.00kPa PID=0.40ppm
			0.50						
	Nil	ES			CI	Silty CLAY: medium plasticity, orange/brown, with fine, sub-angular to sub-rounded gravel (ironstones), rootlets (residual grading to extremely weathered rock).	w ≈ PL	St	0.50m, PP=1.00kPa PID=0.40ppm
1		ES				1.00m, weathered ironstone gravels, light brown, >50%, iron staining.	W	St - VSt	1.00m, PID=0.50ppm
			1.20			End of test pit at 1.2 metres Refusal on HW rock			
2									
3									

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP05

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** MAG
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 28/2/2024	**Logged by:** SH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	Comments Observations
		ES			-	[TOPSOIL]: Silty CLAY: light brown, rootlets.	w < PL	St	0.00m, PP=N/A PID=0.20ppm
			0.50						
	Nil	ES			Cl	Silty CLAY: medium plasticity, orange (residual).	w < PL	St	0.50m, PP=1.50kPa PID=0.50ppm
1			1.00						
		ES			Cl	Silty CLAY: medium plasticity, brown, orange, with fine to coarse sub-angular to sub-rounded gravel (ironstones), trace fine to coarse grained sand, weathered ironstone gravel inclusions, >=40% (residual grading to extremely weathered rock).	w = PL	St - VSt	1.00m, PP=N/A PID=0.10ppm
			1.40			End of test pit at 1.4 metres Refusal on HW rock			
2									
3									

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP06

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** MAG
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 28/02/24	**Logged by:** SH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
		ES			-	[TOPSOIL]: Silty CLAY: light brown, rootlets, charcoal inclusions between <5mm to >=15mm, <1%.	w < PL	St - VSt		9	0.00m, PP=N/a PID=0.30ppm
			0.30							8	
										7	
					CI	Silty CLAY: medium plasticity, pale yellow/brown, ironstone gravels inclusions <10%, trace fine to coarse, sub-angular to sub-rounded gravel (ironstones), trace fine to coarse grained sand (residual).	w < PL	VSt		13	0.30m, PP=N/A PID=0.30ppm
	Nil	ES								18	
										17	
										5	
										15	
										12	
			1.00							17	
1		ES	1.10		CI	Silty CLAY: medium plasticity, trace fine to coarse, sub-angular to sub-rounded gravel (ironstones), trace fine to coarse grained sand, weathered ironstone (residual grading to extremely weathered rock).	w < PL	VSt to H	End of probe at 1.10m	20	1.00m, PP=6.0kPa PID=0.40ppm
						End of Test pit at 1.1 metres. Refusal on HW rock.					
2											
3											

Note: * indicates signatures on original issue of log or last revision of log

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP07

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** MAG
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 28/2/2024	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	Comments Observations
		ES+GEO			-	[FILL]: Silty CLAY: medium plasticity, brown.	w < PL	St-VSt	0.00m, PP=N/A PID=0.30ppm
		ES+GEO				0.60m, becoming light brown.			0.50m, PID=0.50ppm
1	Nil	ES+GEO	1.00		-	[FILL]: Silty CLAY: medium plasticity, brown, rootlets.	w ≈ PL	St	1.00m, PP= N/A PID=0.30ppm
2		ES+GEO	2.00 2.20		CI	Silty CLAY: medium plasticity, brown, mottled grey/ light brown, with fine to coarse, sub-angular to sub-rounded gravel (ironstones), trace fine to coarse grained sand.	w ≈ PL	S-F	2.00m, PP=1.0kPa PID=0.50ppm
						End of test pit at 2.2 metres Refusal on HW rock		VSt - H	
3									

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Job No. 12627900

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP08

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** MAG
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 28/2/2024	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description [COBBLES / BOULDERS / FILL / TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: Grain size, colour, fabric and texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Note: * indicates signatures on original issue of log or last revision of log Comments Observations
1	Nil	ES+GEO			-	[FILL]: Silty CLAY: medium plasticity, brown, with rootlets and trace iron staining.	w ≈ PL	S-F	0.00m, PID=0.30ppm
		FD4 + FD5							
		ES+GEO							0.50m, PID=0.40ppm
		ES+GEO							1.00m, PID=0.10ppm
2		ES+GEO	1.95		CI	Silty CLAY: medium plasticity, grey, with organics, tree roots and grass, slight organic odour (residual).	w ≈ PL	F	1.95m, PP=3.35kPa PID=0.40ppm
		ES+GEO	2.35		CI	Silty CLAY: medium plasticity, green, mottled grey, with decaying organics, slight organic odour (residual).	w ≈ PL	St	2.35m, PP=30.0kPa PID=0.50ppm
3		ES+GEO	2.75		CI-CH	Silty CLAY: medium to high plasticity, brown mottled grey orange, iron staining, weathered ironstone (residual grading to extremely weathered rock).	w ≈ PL	St	2.75m, PP=N/A PID=0.30ppm
			3.00			End of test pit at 3 metres Target Depth			

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP09

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** MAG
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 28/2/2024	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	Comments Observations
						[COBBLES / BOULDERS / FILL / TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: Grain size, colour, fabric and texture, inclusions or minor components, durability, strength, weathering / alteration, defects			Note: * indicates signatures on original issue of log or last revision of log
		ES+GEO			-	[TOPSOIL]: Clayey SILT: medium plasticity, brown, with rootlets in topsoil.	w ≈ PL	MD	0.00m, PID=0.60ppm
			0.30						
		ES+GEO			CI	Silty CLAY: medium plasticity, light brown, with iron staining (residual).	w ≈ PL	S-F	0.30m, PID=0.50ppm
			0.80						
1	Nil	ES+GEO			CL-CI	Silty CLAY: low to medium plasticity, grey, mottled brown/orange, iron staining, weathered ironstone (residual).	w ≈ PL	VSt	1.00m, PID=0.40ppm
			1.35						
		GEO			CI	Silty CLAY: medium plasticity, brown, mottled grey/orange, iron staining with weathered ironstone (residual grading to extremely weathered rock).	w ≈ PL	S-F	1.35m, PID=0.30ppm
			1.70					VSt - H	
2						End of test pit at 1.7 metres Refusal on HW rock			
3									

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Job No. 12627900

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP10

SHEET 1 **OF** 1

Position:	Refer to test location plan	**Surface RL:**	N/A	**Processed:**	MAG
Method of Exploration:	3.5T Excavator + Track	**Hole Size:**	0.3m x 2.0m	**Checked:**	JM
Date:	28/02/24	**Logged by:**	SH	**Date:**	28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
		ES			-	[TOPSOIL]: Silty CLAY: light brown, rootlets.	w ≈ PL	F - St		4 4 6 2 2	0.00m, PID=0.50ppm
			0.50								
		ES			Cl	Silty CLAY: medium plasticity, light brown/yellow, rootlets (residual).	w ≈ PL	F - St		4 4 5 4 4	0.50m, PID=0.40ppm
1		ES				1.00m, becoming yellow orange.				5 5 5 7 5 6	1.00m, PID=0.50ppm
									End of probe at 1.60m		
			1.95								1.90m, PID=0.30ppm
2		ES			Cl	CLAY: medium plasticity, mottled orange/grey (residual).	w < PL	St			
			2.50								2.50m, PID=0.30ppm
					Cl	Silty CLAY: medium plasticity, light brown/brown, rootlets (residual grading to extremely weathered rock).	w < PL	St			
		ES	3.00								
3						End of Test pit at 3 metres. Target Depth.					

Note: * indicates signatures on original issue of log or last revision of log

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Job No. 12627900

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP11

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 29/02/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
						Note: * indicates signatures on original issue of log or last revision of log					
		ES+GEO +PFAS	0.25		-	[TOPSOIL/FILL]: Clayey SILT: no plasticity, brown, with sub-angular to angular roadbase, with fine to medium grained sand.	w = PL	F		7 5	0.0mm, PP=N/A PID=0.4ppm
					Cl	Silty CLAY: medium plasticity, brown, with orange mottling and rootlets (residual).	w = PL	S		4 3	0.25m, PP=1.0kPa
			0.55		Cl	Silty CLAY: medium plasticity, light brown, with fine grained sand (residual).	w = PL	S-F		5 3	0.50m, PP=1.5kPa PID=0.5ppm
		ES+GEO								3 3	
1										3 5	
	Nil							St		5 11	
		ES+GEO								12 13	
			1.40		Cl	Silty CLAY: medium plasticity, brown with grey mottling (residual).	w = PL	St		10 17	1.4m, PP=3.5ppm
									End of probe at 1.70m	20	
2		ES+GEO									2.00m, PID=0.6ppm
			2.35								
			2.40		Cl	Silty CLAY: medium plasticity, brown with mottled grey (extremely weathered rock).	w = PL	VSt - H			Hard excavation
						End of Test pit at 2.4 metres. Refusal on HW rock.					
3											

See standard sheets for details of abbreviations & basis of descriptions

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12627900

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP12

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 29/02/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
					-	[TOPSOIL]: Clayey SILT: brown, with rootlets.	M	S		4	0.00m, PP=N/A PID=0.3ppm
		ES+GEO+PFAS +FD1+FD2	0.25		CL	Silty CLAY: low plasticity, brown/orange, moist, with rootlets and with grey mottling (residual).	w = PL	F		3 2 4 4	0.50m, PP=N/A PID=0.3ppm
		ES+GEO	0.70		CL	Silty CLAY: low plasticity, grey with mottled brown/orange, with fine to coarse grained angular to sub-angular gravel (ironstones) (residual).	w = PL	F		4 5 6 5	
1	Nil	ES+GEO						St		7 8 10 12	1.00m, PP=N/A PID=0.5ppm
			2.00		CL	Silty CLAY: low plasticity, grey with mottled brown/orange, with fine to coarse grained to sub-angular gravel (ironstones) (extremely weathered rock).	w = PL	VSt - H	End of probe at 1.40m	20	Hard excavation
2			2.30			End of Test pit at 2.3 metres. Refusal on HW rock.		VSt			
3											

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GEO_TEST PIT_DCP100/40_AS1726 2017_12627900 REDMAN PLACE ORANGE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 2/5/24

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP13

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 29/02/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
					-	[TOPSOIL]: Clayey SILT: low plasticity, light brown, with rootlets.	w < PL	F		4	0.00m, PP=N/A PID=0.5ppm
		ES+GEO +PFAS	0.25		CI	Silty CLAY: medium plasticity, brown (residual).	w < PL	S-F		5 3	0.25m, PP=N/A PID=0.3ppm
			0.50		CI	Silty CLAY: medium plasticity, brown with mottled grey (residual).	w = PL	F		2 4	0.50m, PP=2.0kPa
1	Nil	ES+GEO +PFAS							End of probe at 0.70m	5 8	
			1.80		CI	Silty CLAY: medium plasticity, brown with mottled grey (grading to weathered rock).	w = PL	VSt - H			Very hard excavation
2		ES+GEO									2.00m, PP=3.5kPa
			2.80			End of Test pit at 2.8 metres. Refusal.					
3											

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP14

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 29/02/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
					-	[TOPSOIL]: Clayey SILT: low plasticity, light brown, with rootlets.	w = PL	MD		3	0.00m, PID=0.4ppm
		ES+GEO	0.15		Cl	Silty CLAY: medium plasticity, brown (residual).	w = PL	F - St		3 2 3 5	
		ES+GEO	0.90		Cl	Silty CLAY: medium plasticity, grey with brown mottling, with iron staining (residual).	w = PL	St - VSt		8 13 12 6	0.50m, PID=0.5ppm
1	Nil	ES+GEO	1.75		Cl	Silty CLAY: medium plasticity, brown, green patches, with grey mottling, trace fine to coarse grained sand, fine to coarse, angular to sub-angular gravel (residual grading to extremely weathered rock).	w = PL	St - VSt	End of probe at 1.30m	6 8 12 22	1.00m, PID=0.5ppm
2		ES ES+GEO	3.00			End of Test pit at 3 metres. Target Depth.					
3											

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP15

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 29/02/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
					-	[TOPSOIL]: Clayey SILT: low plasticity, brown, with rootlets and organics.	w = PL	MD		5 7 6	0.00m, PID=0.6ppm
		ES+GEO	0.35		CL	Silty CLAY: low plasticity, brown, with fine to medium grained sand.	w = PL	F - St		4 7 8	0.50m, PID=0.4ppm
		ES+GEO	0.90		CL	Silty CLAY: low plasticity, grey with mottled brown/orange, with iron staining and trace fine to coarse grained sand, fine to coarse, angular to sub-angular gravel (residual).	w = PL	S - VSt		6 5 4 4 10	1.00m, PID=0.3ppm
1	Nil	ES+GEO	1.80		CL	Silty CLAY: low plasticity, grey with mottled brown/orange, with iron staining and trace fine to coarse grained sand, fine to coarse, angular to sub-angular gravel (extremely weathered rock).	w = PL	S - VSt	End of probe at 1.20m	20	
2		ES+GEO	2.30			End of Test pit at 2.3 metres. Refusal on HW rock.		VSt - H			
3											

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP16

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 29/02/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
					-	[TOPSOIL]: Clayey SILT: low plasticity, light brown, with rootlets and organics.	w = PL	F - St		7 5	0.00m, PP=N/A PID=0.3ppm
			0.20		CI	Silty CLAY: medium plasticity, red, with fine to coarse, sub-angular to angular gravel (ironstone) (residual).	w < PL	St		3 3	PP=N/A
		ES+GEO								5 5	
		ES+GEO						VSt		10 14	
1			1.00		CI	Silty CLAY: medium plasticity, red (residual).	w < PL	VSt		10 12	1.00m, PID=0.6ppm
		ES+GEO	1.40		CI	Silty CLAY: medium plasticity, red with grey mottling (residual).	w = PL	F - St	End of probe at 1.30m	14 12 20	
	Nil	GEO									
2											
			3.00			End of Test pit at 3 metres. Target Depth.					
3											

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP17

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 29/02/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
					-	[TOPSOIL]: Clayey SILT: low plasticity, brown, with rootlets, one fragment of glass.	w ≃ PL	-		5	0.00m, PID=0.5ppm
		ES+GEO	0.25		CI	Silty CLAY: medium plasticity, light brown, trace fine to coarse, sub-angular to angular, trace fine to coarse grained sand, with iron staining (residual).	w < PL	St - VSt		5 4 7 10	0.50m, PID=0.5ppm
		ES+GEO								13 18 17	
1	Nil		0.90		CL	Silty CLAY: low plasticity, brown with mottled grey, trace fine to coarse gravel, angular to sub-angular, trace fine to coarse grained sand, iron staining (residual).	w ≃ PL	VSt		18 13 14 13 11 10 13 9 12 12	
			1.85		CI	Silty CLAY: medium plasticity, grey with mottled orange/brown, with iron staining, weathered rock, with fine to medium grained sand (residual grading to extremely weathered rock).	w = PL	St	End of probe at 1.80m		1.85m, PID=0.3ppm
2		ES+GEO									
		ES+GEO	2.80			2.7m, high plasticity clay, becoming high clay content and high moisture.	w > PL	VSt - H			
3						End of Test pit at 2.8 metres. Refusal.					

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP18

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 29/02/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
		ES+GEO			-	[TOPSOIL]: Clayey SILT: light brown, with rootlets and organics.	w ≈ PL	S		2	0.00m, PP=N/A PID=0.4ppm
			0.20		Cl	Silty CLAY: medium plasticity, light brown mottled orange, with iron staining (residual).	w ≈ PL	S - F		2	
		ES+GEO								3	0.50m, PID=0.5ppm
										2	
										2	
										4	
										1	
1			1.00		Cl	Silty CLAY: medium plasticity, pale brown mottled light brown/orange, trace fine to coarse, angular to sub-angular gravel, trace fine to coarse grained sand, iron staining (residual).	w ≈ PL	St		4	1.00m, PP=1.0kPa
		GEO								13	
										6	
										4	
										4	
	Nil							VSt		6	
										7	
										8	
										10	
									End of probe at 1.80m		
2			2.10		Cl	Silty CLAY: medium plasticity, orange with mottled grey, with fine grained sand (residual).	w ≈ PL	S - F			2.10m, PID=2.0ppm
		GEO									
			2.65		Cl	Silty CLAY: medium plasticity, grey with mottled orange, with weathered rock (residual grading to extremely weathered rock).	w ≈ PL	St - VSt			2.65m, PP=3.5kPa PID=0.6ppm
		ES+GEO									
3			3.00			End of Test pit at 3 metres. Target Depth.					

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP19

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 29/02/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
		ES+GEO			-	[TOPSOIL]: Clayey SILT: low plasticity, dark brown, with organics.	w = PL	S - F		2 2	0.00m, PP=N/A PID=0.9ppm
			0.30		CL	Silty CLAY: low plasticity, reddish-brown, with fine to coarse, angular to sub-angular gravel (ironstones), trace fine to coarse grained sand (residual).	w = PL	St - VSt		3 3	
		ES+GEO								6 10	0.50m, PP=N/A PID=0.2ppm
			0.70		CL	Silty CLAY: low plasticity, reddish-brown with grey mottling, with extremely weathered rock, trace fine to coarse, angular to sub-angular gravel, trace fine to coarse grained sand (residual grading to extremely weathered rock).	w = PL	St - VSt		10 14	
1	Nil									11 14	1.00m, PP=N/A
		ES+GEO	1.50						End of probe at 1.10m	20	
						End of Test pit at 1.5 metres. Refusal on HW rock.					
2											
3											

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP20

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 29/02/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
		ES+GEO			-	[TOPSOIL]: Silty CLAY: medium to high plasticity, grey, mottled brown, with rootlets.	w ≈ PL	S-F		0	0.00m, PP=1.0kPa PID=0.4ppm
			0.25		CI	Silty CLAY: medium plasticity, brown with grey mottling, with fine grained sand (residual).	w ≈ PL	S		1	
										1	
										1	
										3	
		ES+GEO						St		3	0.50m, PP=1.5kPa PID=0.5ppm
										4	
										3	
										6	
1								VSt - H		8	
						1.0m, increased moisture.	w > PL			10	
										16	
										23	
			1.35		CI	Silty CLAY: medium plasticity, brown with grey mottling, with fine grained sand (extremely weathered rock).	w > PL	VSt - H	End of probe at 1.30m		
			1.50			End of Test pit at 1.5 metres. Refusal on HW rock.					
2											
3											

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Comments Observations

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Job No. 12627900

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP21

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 01/03/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
		ES+GEO			-	[TOPSOIL]: Silty CLAY: medium to high plasticity, brownish grey with brown mottling, with rootlets and organics.	w = PL	S		1	0.00m, PP=0.5kPa PID=0.3ppm
			0.27							1	0.15m, PP=0.3kPa PID=0.3ppm
		ES+GEO			CI-CH	Silty CLAY: medium to high plasticity, brown with grey mottling (residual).	w = PL	S-F		1	
			0.60							1	
		ES+GEO			CI	Silty CLAY: medium plasticity, grey with mottled brown, with angular to sub-angular ironstone (residual).	w > PL	F		1	0.60m, PP=0.5kPa PID=0.2ppm
1										3	
								VSt - H		3	
			1.20							2	
		ES+GEO			CI	Silty CLAY: medium plasticity, reddish-brown, with fine to coarse, angular to sub-angular gravel, trace fine to coarse grained sand (residual grading to extremely weathered rock).	w > PL	F	End of probe at 1.20m	5	1.20m, PP=0.5kPa
										19	
		ES+GEO								21	
			1.90					VSt - H			
2						End of Test pit at 1.9 metres. Refusal on HW rock.					
3											

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GEO_TEST PIT_DCP100/40_AS1726 2017_12627900 REDMAN PLACE ORANGE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 2/5/24

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP22

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 01/03/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
		ES+GEO			-	[TOPSOIL]: Clayey SILT: low plasticity, dark brown, with rootlets.	M	MD		6 5 4 4	0.00m, PP=N/A PID=0.8ppm
			0.45		CL	Silty CLAY: low plasticity, reddish-brown (residual).	w = PL	VSt		4 3 7 12 12 21	0.50m, PP=2.0kPa PID=0.6ppm
1	Nil	ES+GEO							End of probe at 1.00m		
			1.60								1.50m, PP=4.0kPa
		ES+GEO				Silty CLAY: reddish-brown, mottled grey, with extremely weathered rock (residual grading to extremely weathered rock).	w = PL	St - VSt			
2			2.00			End of Test pit at 2 metres. Refusal on HW rock.		VSt - H			
3											

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TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP23

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 01/03/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
					-	[TOPSOIL]: Silty CLAY: low to medium plasticity, brown, with rootlets.	w = PL	S - F		3	0.00m, PP=N/A PID=0.6ppm
			0.15		CL	Silty CLAY: low plasticity, reddish-brown, with angular to sub-angular ironstone (residual).	w = PL	F - St		3 3 6 6 5 7	0.15m, PP=N/A
		ES									
		ES+GEO	0.80		CL	Silty CLAY: low plasticity, reddish-brown, with highly weathered rock (laterite?), angular, coarse (>20mm), 60%, with fine to coarse, angular to sub-angular gravel, trace fine to coarse grained sand, trace cobble size, rounded rock (residual).	w = PL	VSt	End of probe at 0.90m	16 20	
1			1.20		Cl	Silty CLAY: medium plasticity, pale brown with orange/grey mottling, with sub-angular to angular weathered rock and iron staining (residual grading to extremely weathered rock).	w = PL	VSt - H			1.20m, PP=2.5kPa PID=0.9ppm
	Nil										
2		ES+GEO									
3			3.00			End of Test pit at 3 metres. Target Depth.					

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Job No. 12627900

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP24

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 01/03/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
					-	[TOPSOIL]: Silty CLAY: medium plasticity, dark brown, with rootlets.	w = PL	VS		1 1	0.00m, PP=0.5kPa PID=0.7ppm
			0.20		CI	Silty CLAY: medium plasticity, brown, with rootlets (residual).	w = PL	VS		1 1 1 1 1 1	
		ES+GEO +PD7+PD8									
			0.60		CI	Silty CLAY: medium plasticity, grey, with highly weathered rock, 10-70mm, 60%, with fine to coarse, angular to sub-angular gravel, trace fine to coarse grained sand, trace cobble sized rock (residual).	w > PL	S - F		1 3 4	0.60m, PP=N/A PID=0.4ppm
		ES+GEO	0.90			Silty CLAY: orange with mottled grey, with fine to coarse, angular to sub-angular gravel, trace fine to coarse grained sand, with iron staining, weathered rock (residual grading to extremely weathered rock).	w = PL	St		7 5 15 8	0.90m, PP=1.5kPa PID=0.4ppm
1		ES+GEO						F - St		5 3 2 3 4	
	Nil								End of probe at 1.80m		
2											
		GEO									
			3.00			End of Test pit at 3 metres. Target Depth.					
3											

Note: * indicates signatures on original issue of log or last revision of log

See standard sheets for details of abbreviations & basis of descriptions

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12627900

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP25

SHEET 1 **OF** 1

Position: Refer to test location plan	**Surface RL:** N/A	**Processed:** AJET
Method of Exploration: 3.5T Excavator + Track	**Hole Size:** 0.3m x 2.0m	**Checked:** JM
Date: 01/03/24	**Logged by:** MH	**Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
					-	[TOPSOIL]: Silty CLAY: low to medium plasticity, light brown with orange mottling, moist.	w = PL	S		1	
		ES+GEO	0.15		CI-CH	Silty CLAY: medium to high plasticity, light brown with orange mottling, with angular weathered rock (residual).	w = PL	S - F		2 2 5 6	0.15m, PP=1.0kPa PID=0.5ppm
			0.50		CI-CH	Silty CLAY: medium to high plasticity, grey with orange mottling (residual).	w > PL	F - St		6 4 8 8 8	0.50m, PP=1.5kPa PID=0.5ppm
1		ES+GEO	1.15		CI-CH	Silty CLAY: medium to high plasticity, brown with orange mottling (residual).	w > PL	St - VSt	End of probe at 1.40m	15 11 6 9	1.15m, PP=4.0kPa
			1.70			End of Test pit at 1.7 metres. Refusal on HW rock.		VSt - H			
2											
3											

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12627900

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP26

SHEET 1 **OF** 1

Position: Refer to test location plan | **Surface RL:** N/A | **Processed:** AJET

Method of Exploration: 3.5T Excavator + Track | **Hole Size:** 0.3m x 2.0m | **Checked:** JM

Date: 01/03/24 | **Logged by:** MH | **Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
					-	[TOPSOIL]: Silty CLAY: no to medium plasticity, brown, with rootlets.	w = PL	S - F		3	0.00m, PP=N/A PID=0.6ppm
			0.15		CL	Silty CLAY: low plasticity, reddish-brown, with angular to sub-angular ironstone (residual).	w = PL	F		4	0.15m, PP=N/A
		ES						St - VSt		2	
										3	
										5	
										10	
		ES+GEO	0.80						End of probe at 0.70m	20	
					CL	Silty CLAY: low plasticity, reddish-brown, with fine to coarse, angular to sub-angular gravel, trace fine to coarse grained sand, trace cobble size, rounded rock (residual).	w = PL	VSt			0.80m, Layer rounded boulder Hard excavation
1			1.10								
					CI	Silty CLAY: medium plasticity, pale brown with orange/grey mottling, with fine to coarse, angular to sub-angular gravel, trace fine to coarse grained sand, iron staining (residual grading to extremely weathered rock).	w = PL	VSt			1.10m, PP=2.5kPa PID=0.9ppm
	Nil										
2		ES+GEO									
			3.00								
3						End of Test pit at 3 metres. Target Depth.					

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12627900

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP27

SHEET 1 **OF** 1

Position: Refer to test location plan **Surface RL:** N/A **Processed:** AJET

Method of Exploration: 3.5T Excavator + Track **Hole Size:** 0.3m x 2.0m **Checked:** JM

Date: 01/03/24 **Logged by:** MH **Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
		ES+GEO	0.30		-	[TOPSOIL]: Silty CLAY: medium plasticity, reddish-brown.	w = PL	S - F		2 3 2	0.00m, PP=N/A
	Nil	ES+GEO	0.85		CL	Silty CLAY: low plasticity, reddish-brown, with rounded to sub-rounded ironstone (residual).	w = PL	F - St VSt		3 7 11 16 12	0.30m, PP=1.5kPa
1		ES+GEO	1.50		CI	Silty CLAY: medium plasticity, brown, with weathered rock, angular (5-30/50mm), with fine to coarse, angular to sub-angular gravel, trace fine to coarse grained sand (residual grading to extremely weathered rock).	w = PL	H	End of probe at 1.00m	18 20	0.85m, Hard excavation
						End of Test pit at 1.5 metres. Refusal on HW rock.					
2											
3											

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Job No. 12627900

TEST PIT LOG SHEET

Client: Landcom

Project: Geotechnical Investigation Report

Location: Redmond Place, Orange NSW

HOLE No. TP28

SHEET 1 **OF** 1

Position: Refer to test location plan **Surface RL:** N/A **Processed:** AJET

Method of Exploration: 3.5T Excavator + Track **Hole Size:** 0.3m x 2.0m **Checked:** JM

Date: 01/03/24 **Logged by:** MH **Date:** 28/03/2024

Scale (m)	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Material Description	Moisture Condition	Consistency / Density Index	DCP Test Results blows per 100mm (0 20 40)	Recorded Blows	Comments Observations
					-	[TOPSOIL]: Silty CLAY: low to medium plasticity, brown with mottled grey.	w = PL	F-St		4 7	0.00m, PP=2.5kPa
			0.20								
		ES+GEO			Cl	Silty CLAY: medium plasticity, grey with slight orange mottling (residual).	w = PL	S-F		3 2	0.20m, PP=N/A
			0.40								
					Cl-CH	Silty CLAY: medium to high plasticity, brown/orange with grey mottling (residual).	w = PL	S		3 2	0.40m, PP=0.5kPa
			0.65								
		ES+GEO			Cl	Silty CLAY: medium plasticity, grey with orange mottling (residual).	w = PL	S		3 2 7	
1	Nil									5 6	
		ES+GEO						VSt		5 9 10 11 11	
			1.70						End of probe at 1.60m		
		ES+GEO			Cl	Silty CLAY: medium plasticity, grey with orange mottling, with fine to coarse, angular to sub-angular gravel, trace fine to coarse grained sand, with extremely weathered rock, angular to rounded (residual grading to extremely weathered rock).	w = PL	VSt - H			
			1.90			End of Test pit at 1.9 metres. Refusal.					
2											
3											

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Comments Observations

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12627900

Appendix D

Test Pit Photographs

TP01 - 1 Depth Range: 0.00 m

TP01 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 28/03/2024
		CHECKED: M Hurley	DATE: 28/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP01 1/1

TP02 - 1 Depth Range: 0.00 m

TP02 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 28/03/2024
		CHECKED: M Hurley	DATE: 28/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP02 1/1

TP03 - 1 Depth Range: 0.00 m

TP03 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 28/03/2024
		CHECKED: M Hurley	DATE: 28/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP03 1/1

TP04 - 1 Depth Range: 0.00 m

TP04 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 28/03/2024
		CHECKED: M Hurley	DATE: 28/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP04 1/1

TP05 - 1 Depth Range: 0.00 m

TP05 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 28/03/2024
		CHECKED: M Hurley	DATE: 28/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP05 1/1

TP06 - 1 Depth Range: 0.00 m

TP06 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 28/03/2024
		CHECKED: M Hurley	DATE: 28/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP06 1/1

TP07 - 1 Depth Range: 0.00 m

TP07 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 28/03/2024
		CHECKED: M Hurley	DATE: 28/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP07 1/1

TP08 - 1 Depth Range: 0.00 m

TP08 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 28/03/2024
		CHECKED: M Hurley	DATE: 28/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP08 1/1

TP09 - 1 Depth Range: 0.00 m

TP09 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 28/03/2024
		CHECKED: M Hurley	DATE: 28/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP09 1/1

TP10 - 1 Depth Range: 0.00 m

TP10 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN H Warr	DATE 28/03/2024
		CHECKED M Hurley	DATE 28/03/2024
		SCALE Not To Scale	A4
		PROJECT No 12627900	FIGURE No TP10 1/1

TP11 - 1 Depth Range: 0.00 m

TP11 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP11 1/1

TP12 - 1 Depth Range: 0.00 m

TP12 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP12 1/1

TP13 - 1 Depth Range: 0.00 m

TP13 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP13 1/1

TP14 - 1 Depth Range: 0.00 m

TP14 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP14 1/1

TP15 - 1 Depth Range: 0.00 m

TP15 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP15 1/1

TP16 - 1 Depth Range: 0.00 m

TP16 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP16 1/1

TP17 - 1 Depth Range: 0.00 m

TP17 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN H Warr	DATE 26/03/2024
		CHECKED M Hurley	DATE 26/03/2024
		SCALE Not To Scale	A4
		PROJECT No 12627900	FIGURE No TP17 1/1

TP18 - 2 Depth Range: 0.00 m

	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP18 1/1

TP19 - 1 Depth Range: 0.00 m

TP19 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP19 1/1

TP24 - Depth Range: 0.00 - 3.0 m

TP24 - 2 Depth Range: 0.00 - 3.0 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP24 1/1

TP21 - 1 Depth Range: 0.00 m

TP21 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP21 1/1

TP22 - 1 Depth Range: 0.00 m

TP22 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP22 1/1

TP23 - 1 Depth Range: 0.00 m

TP23 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP23 1/1

TP24 - Depth Range: 0.00 - 3.0 m

TP24 - 2 Depth Range: 0.00 - 3.0 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP24 1/1

TP25 - 1 Depth Range: 0.00 m

TP25 - 2 Depth Range: 0.00 m

Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN H Warr	DATE 26/03/2024	
	CHECKED M Hurley	DATE 26/03/2024	
	SCALE Not To Scale		A4
	PROJECT No 12627900	FIGURE No TP25 1/1	

TP26 - 1 Depth Range: 0.00 m

TP26 - 2 Depth Range: 0.00 m

GHD

Landcom
Geotechnical Investigation Report
Redmond Place Orange NSW
Test Pit Photographs

DRAWN	H Warr	DATE	26/03/2024
CHECKED	M Hurley	DATE	26/03/2024
SCALE	Not To Scale		A4
PROJECT No	12627900	FIGURE No	TP26 1/1

TP27 - 1 Depth Range: 0.00 m

TP27 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP27 1/1

TP28 - 1 Depth Range: 0.00 m

TP28 - 2 Depth Range: 0.00 m

GHD	Landcom Geotechnical Investigation Report Redmond Place Orange NSW Test Pit Photographs	DRAWN: H Warr	DATE: 26/03/2024
		CHECKED: M Hurley	DATE: 26/03/2024
		SCALE: Not To Scale	A4
		PROJECT No: 12627900	FIGURE No: TP28 1/1

Appendix E

Laboratory Reports

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 346974

Client Details

Client	GHD Pty Ltd
Attention	David Brooke
Address	57-63 Herbert Street, Artarmon, NSW, 2064

Sample Details

Your Reference	**12627900, Redmond Place Geotechnical&Enviro. Inves**
Number of Samples	6 Soil
Date samples received	20/03/2024
Date completed instructions received	20/03/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	27/03/2024
Date of Issue	27/03/2024

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By
Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		346974-1	346974-2	346974-3	346974-4	346974-5
Your Reference	UNITS	TP03	TP06	TP11	TP22	TP24
Depth		1.00-1.20	0.50-0.60	0.50-1.00	0.50-1.00	0.20-0.50
Date Sampled		28/02/2024	28/02/2024	29/02/2024	01/03/2024	01/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	22/03/2024	22/03/2024	22/03/2024	22/03/2024	22/03/2024
Date analysed	-	22/03/2024	22/03/2024	22/03/2024	22/03/2024	22/03/2024
pH 1:5 soil:water	pH Units	6.5	6.5	6.3	5.4	5.6
Electrical Conductivity 1:5 soil:water	µS/cm	36	42	53	43	30
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	20	29	<10	10	<10

Misc Inorg - Soil		
Our Reference		346974-6
Your Reference	UNITS	TP27
Depth		0.50-1.00
Date Sampled		01/03/2024
Type of sample		Soil
Date prepared	-	22/03/2024
Date analysed	-	22/03/2024
pH 1:5 soil:water	pH Units	6.3
Electrical Conductivity 1:5 soil:water	µS/cm	90
Chloride, Cl 1:5 soil:water	mg/kg	<10
Sulphate, SO4 1:5 soil:water	mg/kg	20

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			22/03/2024	6	22/03/2024	22/03/2024		22/03/2024	[NT]
Date analysed	-			22/03/2024	6	22/03/2024	22/03/2024		22/03/2024	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	6	6.3	6.2	2	100	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	6	90	110	20	99	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	6	<10	<10	0	108	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	6	20	21	5	109	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

Samples received in good order: Holding time exceedance

CHAIN OF CUSTODY

Laboratory:	GHD Artarmon	Date Issued: 15/3/24	Results Required By:
Laboratory Address:	Unit 5 / 43 Herbert Street Artarmon NSW		Electronic Format: EXCEL
Laboratory Quote Number:		Laboratory Ph: 9462 4860	Electronic Format: PDF
GHD Job Number:	12627900	Laboratory Fax:	Total Number of Samples: 6
Project Name:	Redmond Place Geotechnical & Environmental Investigation		

Sheet 1 of 1

GHD Contact:	David Brooke	Contact Ph:	9462 4860	Email:	david.brooke@ghd.com

	Sample #	Sample Depth (m)	Date Sampled	Material type / field description	Tests: Aggressivity (pH, Cl, SO4, EC)							Hazard Potential	Sample Container (Type & Size)
1	TP03	1.00-1.20	28/2/24	Soil	✓								
2	TP06	0.50-0.60	28/2/24	Soil	✓								
3	TP11	0.50-1.00	29/2/24	Soil	✓								
4	TP22	0.50-1.00	1/3/24	Soil	✓								
5	TP24	0.20-0.50	1/3/24	Soil	✓								
6	TP27	0.50-1.00	1/3/24	Soil	✓								

ENVIROLAB

Enviro/ab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 346974

Date Received: 20/3/24
Time Received: 1400
Received By: OW
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by:			Comments:
Name	Signature	Date	
A. MUNOZ		15/3/24	

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2400460
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0088-01
Date Sampled	28/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Pl, Gl Orange NSW
	Sandy SILT or CLAY brown
BH / TP No.	TP01
Depth (m)	0.50 - 1.50

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	12.6	
Date Tested		14/03/2024	

Comments

N/A

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2400461
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0088-02
Date Sampled	28/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Pl, Gl Orange NSW
	Sandy CLAY brown
BH / TP No.	TP03
Depth (m)	1.00 - 1.20

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	11.5	
Date Tested		14/03/2024	
Emerson Class Number	AS 1289.3.8.1	3	
Soil Description		Sandy CLAY: brown	
Type of Water		Distilled	
Temperature of Water (°C)		22	
Date Tested		22/03/2024	

Comments

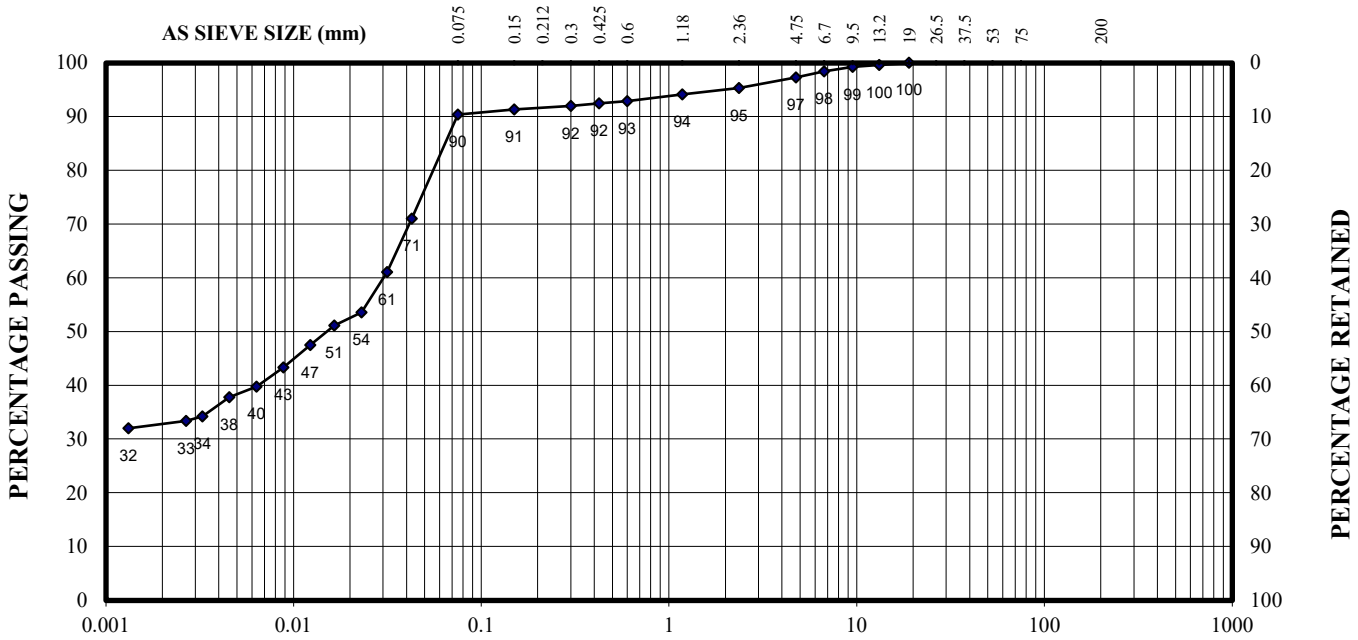
N/A

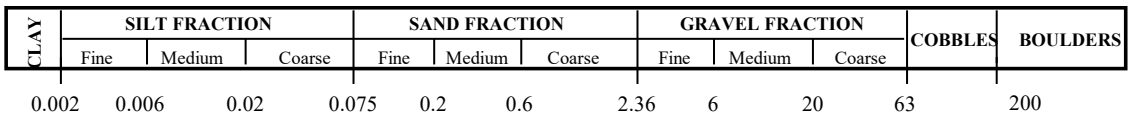
SOIL CLASSIFICATION REPORT

Trial Hole:	TP03
Depth (m):	2.01-2.10
Sample No:	SYD24-0088-03

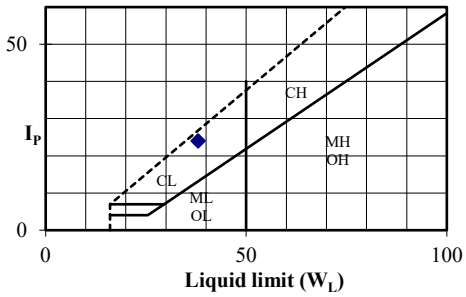
Client: Landcom
Project: Redmond Place GI
Location: Orange, NSW

Sample Id.:
Sample History: Sampled by GHD Geotech





PARTICLE SIZE (mm)



TEST METHODS
Particle size AS1289.3.6.3

OTHER TESTS AS1289.3.1.1
AS1289.3.2.1 AS1289.3.3.1 AS1289.3.5.1

GRADING
$C_u = D_{60} / D_{10} =$ not determinable
$C_c = D_{30}^2 / (D_{10} \times D_{60}) =$ not determinable

PARTICLE DENSITY 2.586 (measured)

PRE-TREATMENT HYDROMETER N/A

TEST CONDITION Washed sieve with dispersing agent

GROUP SYMBOL: CI

SOIL NAME: CLAY trace sand & gravel orange brown

REMARKS:

INDEX PROPERTIES (%)
Liquid Limit = 38 Plastic Limit = 14
Plasticity Index = 24 Linear Shrinkage % =

Atterberg Limits (History/Preparation) Oven Dried

Liquid Limit (type of test) 4 Point

Linear Shrinkage (mould size)

Tested by: AM
Date tested: 28.03.24
Checked by: DB
Date checked: 28/03/2024

Approved Signatory:

D. Brooke 28/03/2024

GHD Pty Ltd
Unit 5, 43 Herbert St, Artarmon NSW, 2064
Tel: (02) 9462 4700 Fax: (02) 9462 4710

Accredited for compliance with ISO/IEC 17025 - Testing

Laboratory Accreditation Number - 679

JOB No.	**12627900**
REPORT No.	**SYD2400462**

Ref: Document F9.1.16 issue 1.2

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2400462
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0088-03
Date Sampled	28/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Pl, Gl Orange NSW
BH / TP No.	TP03
Depth (m)	2.01 - 2.10
Soil Classification	CLAY (CI) trace sand & gravel orange brown as per AS1726 tables 9 & 10

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	16.6	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	Not Tested	
Liquid Limit (%)	AS 1289.3.1.1	38	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	14	
Plasticity Index (%)	AS 1289.3.3.1	24	
Date Tested		21/03/2024	

Comments

N/A

Sydney Laboratory
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Fax:(02) 9462 4710

Material Test Report

Report No: SYD2400463
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0088-04
Date Sampled	28/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Pl, Gl Orange NSW
BH / TP No.	TP06
Depth (m)	0.50 - 0.60
Soil Classification	CLAY (Cl) with gravel, trace sand pale brown as per AS1726 tables 9 & 10

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	10.4	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	9.0	
Mould Length (mm)		125.04	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	35	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	14	
Plasticity Index (%)	AS 1289.3.3.1	21	
Date Tested		21/03/2024	
Emerson Class Number	AS 1289.3.8.1	6	
Soil Description		CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		22	
Date Tested		22/03/2024	

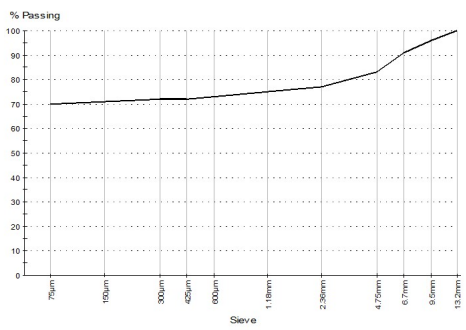
Particle Size Distribution

Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/03/2024

Note: Sample Washed

Sieve Size	% Passing	Limits
13.2mm	100	
9.5mm	96	
6.7mm	91	
4.75mm	83	
2.36mm	77	
1.18mm	75	
600µm	73	
425µm	72	
300µm	72	
150µm	71	
75µm	70	

Chart



Comments

N/A

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web: www.ghd.com.au/ghdgeotechnics
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Fax:(02) 9462 4710

Material Test Report

Report No: SYD2400464
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0088-05
Date Sampled	28/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Pl, Gl Orange NSW
	CLAY with sand grey brown
BH / TP No.	TP07
Depth (m)	1.00 - 1.10

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	15.9	
Date Tested		14/03/2024	

Comments

N/A

Sydney Laboratory
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web: www.ghd.com.au/ghdgeotechnics
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Material Test Report

Report No: SYD2400465
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0088-06
Date Sampled	28/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Pl, Gl Orange NSW
	Clayey SAND / sandy CLAY trace gravel pale brown
BH / TP No.	TP08
Depth (m)	1.00 - 1.10

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	10.1	
Date Tested		14/03/2024	

Comments

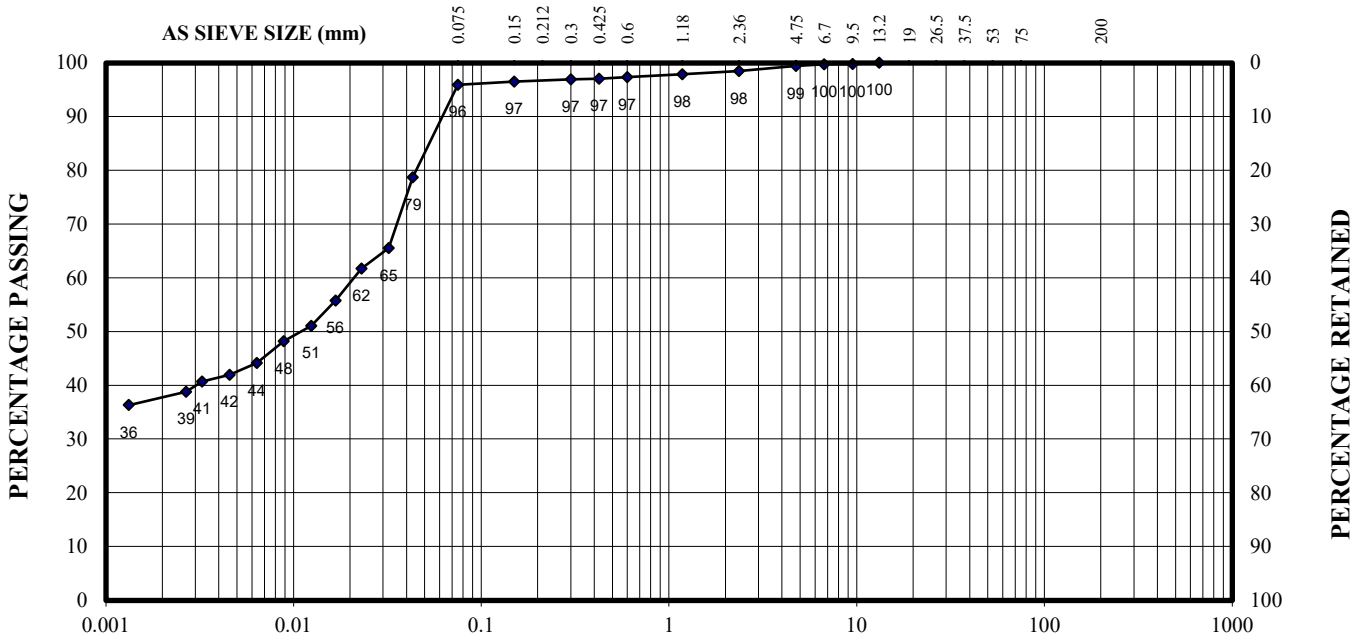
N/A

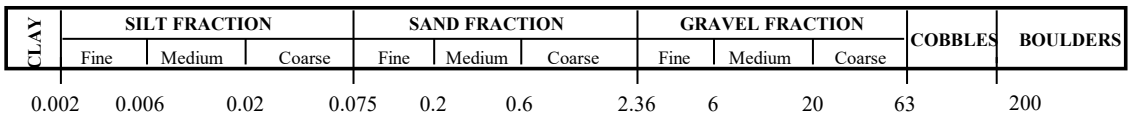
SOIL CLASSIFICATION REPORT

Trial Hole:	TP08
Depth (m):	2.50-2.60
Sample No:	SYD24-0088-07

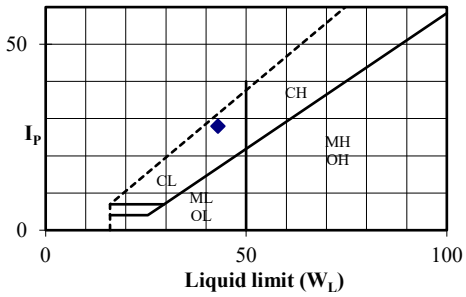
Client: Landcom
Project: Redmond Place GI
Location: Orange, NSW

Sample Id.:
Sample History: Sampled by GHD Geotech





PARTICLE SIZE (mm)



TEST METHODS
Particle size AS1289.3.6.3

OTHER TESTS AS1289.3.1.1
AS1289.3.2.1 AS1289.3.3.1 AS1289.3.5.1

GRADING
$C_u = D_{60} / D_{10}$ = not determinable
$C_c = D_{30}^2 / (D_{10} \times D_{60})$ = not determinable

PARTICLE DENSITY 2.579 (measured)

PRE-TREATMENT HYDROMETER N/A

TEST CONDITION Washed sieve with dispersing agent

GROUP SYMBOL: CI

INDEX PROPERTIES (%)
Liquid Limit = 43 Plastic Limit = 15
Plasticity Index = 28 Linear Shrinkage % =

Atterberg Limits (History/Preparation) Oven Dried

Liquid Limit (type of test) 4 Point

Linear Shrinkage (mould size)

SOIL NAME: CLAY trace sand & gravel mottled grey, red & brown

REMARKS:

Tested by: AM
Date tested: 28.03.24
Checked by: DB
Date checked: 28/03/2024

Approved Signatory:

D. Brooke 28/03/2024

GHD Pty Ltd
Unit 5, 43 Herbert St, Artarmon NSW, 2064
Tel: (02) 9462 4700 Fax: (02) 9462 4710

Accredited for compliance with ISO/IEC 17025 - Testing

Laboratory Accreditation Number - 679

JOB No.	**12627900**
REPORT No.	**SYD2400466**

Ref: Document F9.1.16 issue 1.2

Sydney Laboratory
Unit 5/43 Herbert St
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email: artarmon@ghd.com.au
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Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2400466
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0088-07
Date Sampled	28/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Pl, Gl Orange NSW
BH / TP No.	TP08
Depth (m)	2.50 - 2.60
Soil Classification	CLAY (CI) trace sand & gravel as per AS1726 tables 9 & 10

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	20.8	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	Not Tested	
Liquid Limit (%)	AS 1289.3.1.1	43	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	15	
Plasticity Index (%)	AS 1289.3.3.1	28	
Date Tested		21/03/2024	

Comments

N/A

Sydney Laboratory
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Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
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Material Test Report

Report No: SYD2400467
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0088-08
Date Sampled	28/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Pl, Gl Orange NSW
	Sandy CLAY pale brown
BH / TP No.	TP10
Depth (m)	0.50 - 0.60

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	17.1	
Date Tested		14/03/2024	

Comments

N/A

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2400480
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-11
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
	CLAY with sand orange brown
BH / TP No.	TP10
Depth (m)	1.00-1.70

Test Results

Description	Method	Result	Limits
Standard MDD (t/m³)	AS 1289.5.1.1 - 2017	**1.72**	
Standard OMC (%)		**17.0**	
Retained Sieve (mm)		19	
Oversize Material (%)		0	
Curing Time (h)		116	
LL Method		Visual / Tactile Assessment	
Date Tested		19/03/2024	
CBR at 2.5mm (%)	AS 1289.6.1.1 - 2017	**8**	
Dry Density before Soaking (t/m³)		1.72	
Density Ratio before Soaking (%)		100.0	
Moisture Content before Soaking (%)		16.9	
Moisture Ratio before Soaking (%)		100.0	
Dry Density after Soaking (t/m³)		1.72	
Density Ratio after Soaking (%)		99.5	
Swell (%)		0.0	
Moisture Content of Top 30mm (%)		19.9	
Moisture Content of Remaining Depth (%)		18.7	
Compaction Hammer Used		Standard	
Surcharge Mass (kg)		4.50	
Period of Soaking (Days)		4	
Retained on 19 mm Sieve (%)		0	
CBR Moisture Content Method		AS 1289.2.1.1	
Sample Curing Time (h)		50	
Plasticity Method		Visual/Tactile Assessment	
Date Tested		25/03/2024	

Comments

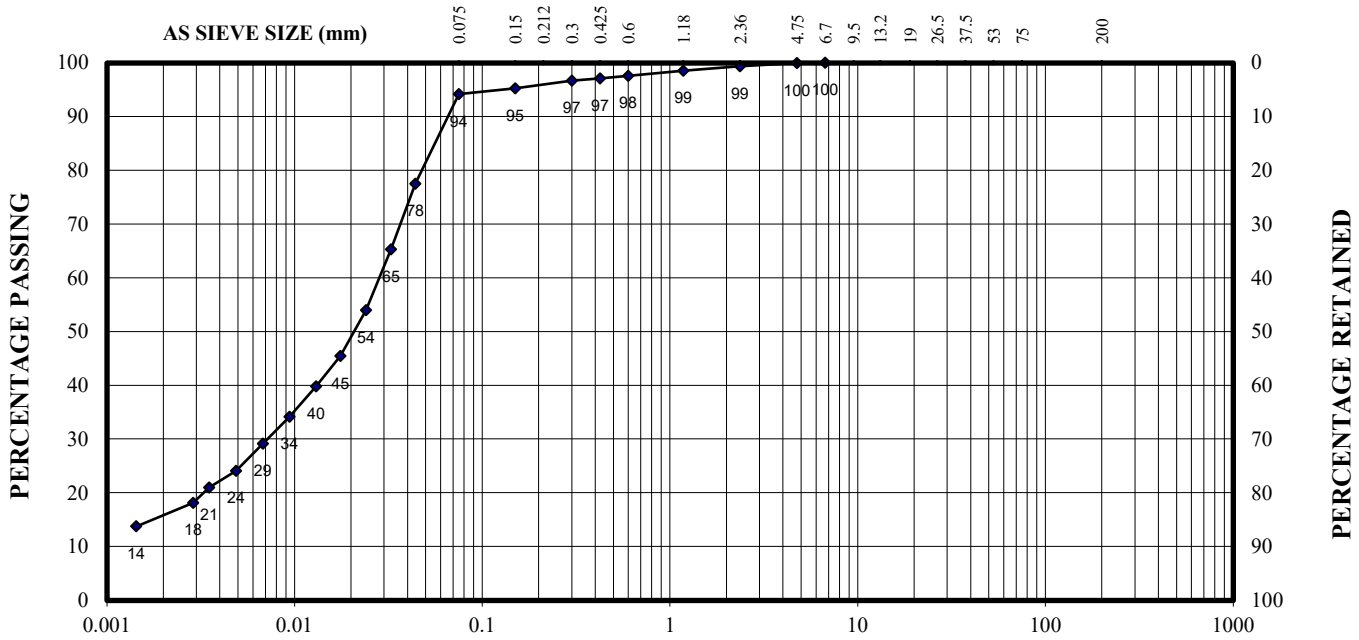
N/A

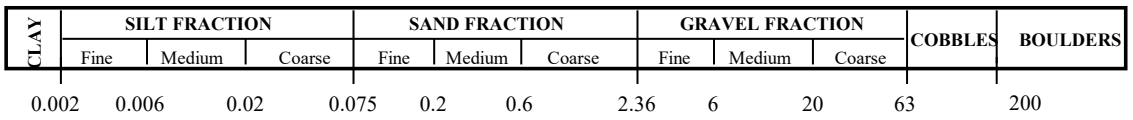
SOIL CLASSIFICATION REPORT

Trial Hole:	TP11
Depth (m):	0.50-1.00
Sample No:	SYD24-0088-09

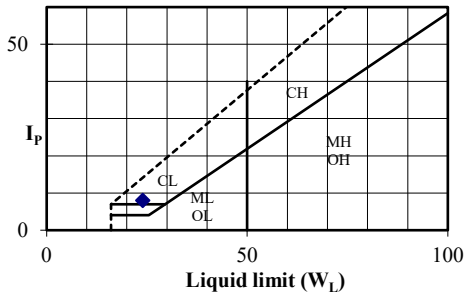
Client: Landcom
Project: Redmond Place GI
Location: Orange, NSW

Sample Id.:
Sample History: Sampled by GHD Geotech





PARTICLE SIZE (mm)



TEST METHODS
Particle size AS1289.3.6.3

OTHER TESTS AS1289.3.1.1
AS1289.3.2.1 AS1289.3.3.1 AS1289.3.5.1

GRADING
$C_u = D_{60} / D_{10}$ = not determinable
$C_c = D_{30}^2 / (D_{10} \times D_{60})$ = not determinable

PARTICLE DENSITY 2.542 (measured)

PRE-TREATMENT HYDROMETER N/A

TEST CONDITION Washed sieve with dispersing agent

GROUP SYMBOL: CL

SOIL NAME: CLAY trace sand & gravel pale grey brown

INDEX PROPERTIES (%)
Liquid Limit = 24 Plastic Limit = 16
Plasticity Index = 8 Linear Shrinkage % =

Atterberg Limits (History/Preparation) Oven Dried

Liquid Limit (type of test) 4 Point

Linear Shrinkage (mould size)

REMARKS:

Tested by: AM
Date tested: 28.03.24
Checked by: DB
Date checked: 28/03/2024

Approved Signatory:

D. Brooke 28/03/2024

GHD Pty Ltd
Unit 5, 43 Herbert St, Artarmon NSW, 2064
Tel: (02) 9462 4700 Fax: (02) 9462 4710

Accredited for compliance with ISO/IEC 17025 - Testing

Laboratory Accreditation Number - 679

JOB No.	**12627900**
REPORT No.	**SYD240469.1**

Ref: Document F9.1.16 issue 1.2

Sydney Laboratory
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Material Test Report

Report No: SYD2400468
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0088-09
Date Sampled	28/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Pl, Gl Orange NSW
BH / TP No.	TP11
Depth (m)	0.50 - 1.00
Soil Classification	CLAY (CI) trace sand & gravel pale grey brown as per AS1726 tables 9 & 10

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	18.6	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	Not Tested	
Liquid Limit (%)	AS 1289.3.1.1	24	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	8	
Date Tested		21/03/2024	
Emerson Class Number	AS 1289.3.8.1	3	
Soil Description		CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		23	
Date Tested		21/03/2024	

Comments

N/A

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Material Test Report

Report No: SYD2400485
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-16
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
	CLAY with sand mottled yellow & brown
BH / TP No.	TP13
Depth (m)	0.50 - 1.00

Test Results

Description	Method	Result	Limits
Initial Swell Moisture Content (%)	AS 1289.7.1.1	16.9	
Final Swell Moisture Content (%)		19.1	
Shrinkage Moisture Content (%)		16.9	
Estimated Inert Inclusions (%)		< 5	
Extent of Soil Crumbling		nil	
Extent of Soil Cracking		nil	
Shrink-Swell Index (%)		1.4	
Date Tested		19/03/2024	

Comments

N/A

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Material Test Report

Report No: SYD2400469
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0088-10
Date Sampled	28/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Pl, Gl Orange NSW
BH / TP No.	TP14
Depth (m)	1.00 - 1.50
Soil Classification	CLAY (CI) with gravel trace sand pale grey as per AS1726 tables 9 & 10

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	18.8	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
	AS 1289.3.4.1		
Linear Shrinkage (%)		Not Tested	
Liquid Limit (%)	AS 1289.3.1.1	48	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	32	
Date Tested		22/03/2024	

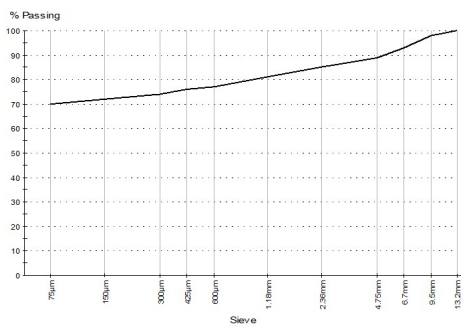
Particle Size Distribution

Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/03/2024

Note: Sample Washed

Sieve Size	% Passing	Limits
13.2mm	100	
9.5mm	98	
6.7mm	93	
4.75mm	89	
2.36mm	85	
1.18mm	81	
600µm	77	
425µm	76	
300µm	74	
150µm	72	
75µm	70	

Chart



Comments

N/A

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Material Test Report

Report No: SYD2400470
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-01
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
BH / TP No.	TP15
Depth (m)	0.50-1.00
Soil Classification	CLAY (CH) trace sand & gravel pale brown as per AS1726 tables 9 & 10

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	17.4	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	8.0	
Mould Length (mm)		125.2	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	51	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	35	
Date Tested		21/03/2024	

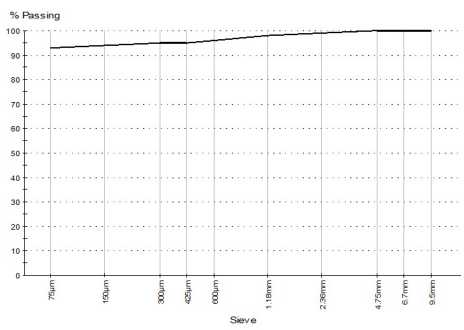
Particle Size Distribution

Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/03/2024

Note: Sample Washed

Sieve Size	% Passing	Limits
9.5mm	100	
6.7mm	100	
4.75mm	100	
2.36mm	99	
1.18mm	98	
600µm	96	
425µm	95	
300µm	95	
150µm	94	
75µm	93	

Chart



Comments

N/A

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Material Test Report

Report No: SYD2400481
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-12
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
	CLAY with sand red brown
BH / TP No.	TP16
Depth (m)	0.50 - 1.00

Test Results

Description	Method	Result	Limits
Standard MDD (t/m³)	AS 1289.5.1.1 - 2017	**1.40**	
Standard OMC (%)		**31.0**	
Retained Sieve (mm)		19	
Oversize Material (%)		0	
Curing Time (h)		117	
LL Method		Visual / Tactile Assessment	
Date Tested		19/03/2024	
CBR at 5.0mm (%)	AS 1289.6.1.1 - 2017	**7**	
Dry Density before Soaking (t/m³)		1.40	
Density Ratio before Soaking (%)		99.5	
Moisture Content before Soaking (%)		31.0	
Moisture Ratio before Soaking (%)		100.0	
Dry Density after Soaking (t/m³)		1.38	
Density Ratio after Soaking (%)		98.0	
Swell (%)		1.5	
Moisture Content of Top 30mm (%)		36.1	
Moisture Content of Remaining Depth (%)		34.6	
Compaction Hammer Used		Standard	
Surcharge Mass (kg)		4.50	
Period of Soaking (Days)		4	
Retained on 19 mm Sieve (%)		0	
CBR Moisture Content Method		AS 1289.2.1.1	
Sample Curing Time (h)		50	
Plasticity Method		Visual/Tactile Assessment	
Date Tested		25/03/2024	

Comments

N/A

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Material Test Report

Report No: SYD2400471
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-02
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
	CLAY with sand pale brown
BH / TP No.	TP17
Depth (m)	0.50-1.00

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	18.0	
Date Tested		14/03/2024	

Comments

N/A

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Material Test Report

Report No: SYD2400472
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-03
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
BH / TP No.	TP17
Depth (m)	2.00-2.50
Soil Classification	CLAY with sand trace gravel mottled red, orange & brown as per AS1726 tables 9 & 10

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	23.3	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
	AS 1289.3.4.1		
Linear Shrinkage (%)		Not Tested	
Liquid Limit (%)	AS 1289.3.1.1	61	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	20	
Plasticity Index (%)	AS 1289.3.3.1	41	
Date Tested		22/03/2024	

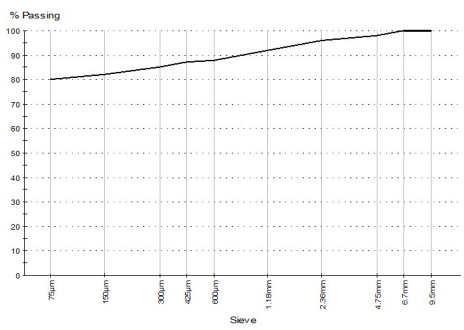
Particle Size Distribution

Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/03/2024

Note: Sample Washed

Sieve Size	% Passing	Limits
9.5mm	100	
6.7mm	100	
4.75mm	98	
2.36mm	96	
1.18mm	92	
600µm	88	
425µm	87	
300µm	85	
150µm	82	
75µm	80	

Chart



Comments

N/A

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Material Test Report

Report No: SYD2400473
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-04
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
BH / TP No.	TP19
Depth (m)	0.50 - 0.75
Soil Classification	CLAY (CI) with sand trace gravel red brown as per AS1726 tables 9 & 10

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	14.2	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	10.5	
Mould Length (mm)		125	
Crumbling		Yes	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	39	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	17	
Plasticity Index (%)	AS 1289.3.3.1	22	
Date Tested		22/03/2024	

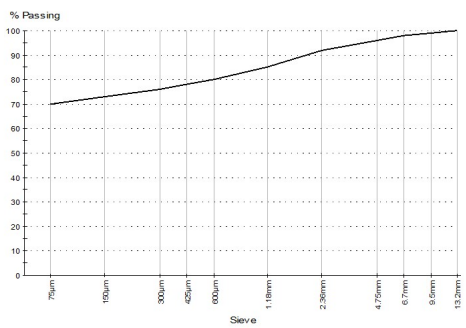
Particle Size Distribution

Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/03/2024

Note: Sample Washed

Sieve Size	% Passing	Limits
13.2mm	100	
9.5mm	99	
6.7mm	98	
4.75mm	96	
2.36mm	92	
1.18mm	85	
600µm	80	
425µm	78	
300µm	76	
150µm	73	
75µm	70	

Chart



Comments

N/A

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Material Test Report

Report No: SYD2400474
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-05
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
	CLAY trace sand pale brown
BH / TP No.	TP21
Depth (m)	0.50-1.00

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	23.6	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.5	
Mould Length (mm)		125	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	47	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	31	

Comments

N/A

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Material Test Report

Report No: SYD2400475
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-06
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
	CLAY with sand : red/brown
BH / TP No.	TP22
Depth (m)	0.50-1.00

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	19.4	
Date Tested		14/03/2024	
Emerson Class Number	AS 1289.3.8.1	6	
Soil Description		CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		22	
Date Tested		22/03/2024	

Comments

N/A

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Material Test Report

Report No: SYD2400476
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-07
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
	CLAY with sand trace gravel red brown
BH / TP No.	TP23
Depth (m)	0.60-1.00

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	20.0	
Date Tested		14/03/2024	

Comments

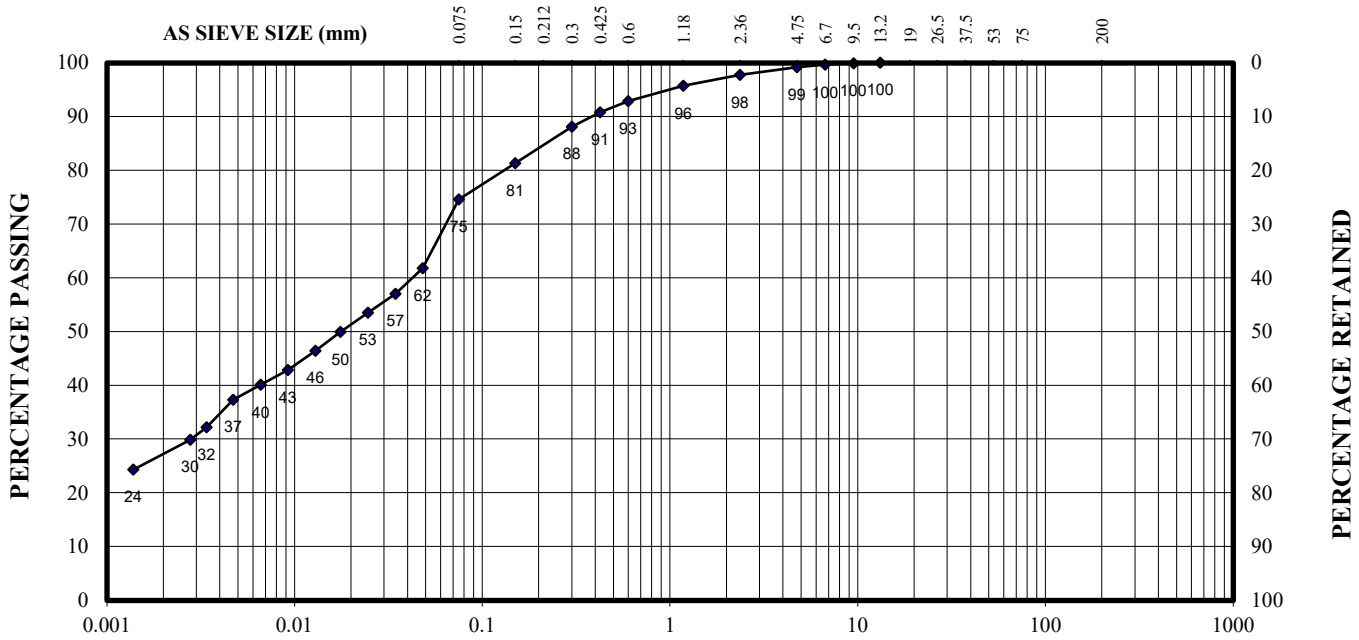
N/A

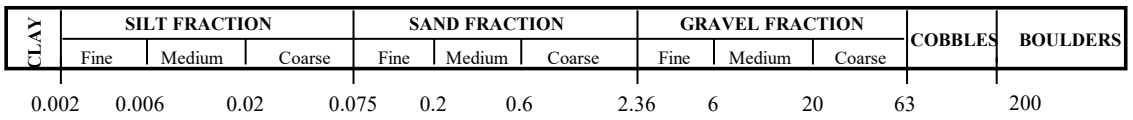
SOIL CLASSIFICATION REPORT

Trial Hole:	TP23
Depth (m):	2.00-2.50
Sample No:	SYD24-0089-08

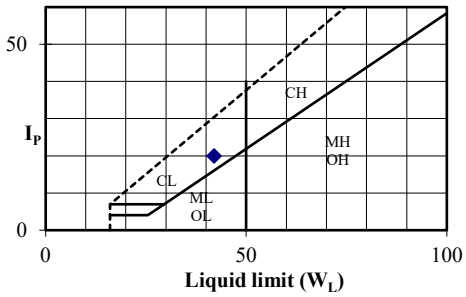
Client: Landcom
Project: Redmond Place GI
Location: Orange, NSW

Sample Id.:
Sample History: Sampled by GHD Geotech





PARTICLE SIZE (mm)



TEST METHODS
Particle size AS1289.3.6.3

OTHER TESTS AS1289.3.1.1
AS1289.3.2.1 AS1289.3.3.1 AS1289.3.5.1

GRADING
$C_u = D_{60} / D_{10}$ = not determinable
$C_c = D_{30}^2 / (D_{10} \times D_{60})$ = not determinable

PARTICLE DENSITY 2.599 (measured)

PRE-TREATMENT HYDROMETER N/A

TEST CONDITION Washed sieve with dispersing agent

GROUP SYMBOL: CI

SOIL NAME: CLAY with sand trace gravel red brown

REMARKS:

INDEX PROPERTIES (%)
Liquid Limit = 42 Plastic Limit = 22
Plasticity Index = 20 Linear Shrinkage % =

Atterberg Limits (History/Preparation) Ovend Dried

Liquid Limit (type of test) 4 Point

Linear Shrinkage (mould size)

Tested by: AM
Date tested: 28.03.24
Checked by: DB
Date checked: 28/03/2024

Approved Signatory:

D. Brooke 28/03/2024

GHD Pty Ltd
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Tel: (02) 9462 4700 Fax: (02) 9462 4710

Accredited for compliance with ISO/IEC 17025 - Testing

Laboratory Accreditation Number - 679

JOB No.	**12627900**
REPORT No.	**SYD2400477.1**

Ref: Document F9.1.16 issue 1.2

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Material Test Report

Report No: SYD2400477
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-08
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
BH / TP No.	TP23
Depth (m)	2.00 - 2.50
Soil Classification	CLAY (CI) with sand trace gravel red brown as per AS1726 tables 9 & 10

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	27.7	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	Not Tested	
Liquid Limit (%)	AS 1289.3.1.1	42	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	22	
Plasticity Index (%)	AS 1289.3.3.1	20	

Comments

N/A

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Material Test Report

Report No: SYD2400482
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-13
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI SILT with sand: grey/brown
BH / TP No.	TP24
Depth (m)	0.20-0.50

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	21.1	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	1.0	
Mould Length (mm)		126	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	18	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	2	
Emerson Class Number	AS 1289.3.8.1	3	
Soil Description		SILT with Sand: grey/brown	
Type of Water		Distilled	
Temperature of Water (°C)		23	
Date Tested		21/03/2024	

Comments

N/A

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Material Test Report

Report No: SYD2400483
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-14
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
	CLAY with sand trace gravel grey brown
BH / TP No.	TP25
Depth (m)	0.50 - 1.00

Test Results

Description	Method	Result	Limits
Standard MDD (t/m³)	AS 1289.5.1.1 - 2017	**1.82**	
Standard OMC (%)		**15.5**	
Retained Sieve (mm)		19	
Oversize Material (%)		3	
Curing Time (h)		95	
LL Method		Visual / Tactile Assessment	
Date Tested		19/03/2024	
CBR at 2.5mm (%)	AS 1289.6.1.1 - 2017	**9**	
Dry Density before Soaking (t/m³)		1.82	
Density Ratio before Soaking (%)		100.0	
Moisture Content before Soaking (%)		15.5	
Moisture Ratio before Soaking (%)		99.0	
Dry Density after Soaking (t/m³)		1.82	
Density Ratio after Soaking (%)		99.5	
Swell (%)		0.5	
Moisture Content of Top 30mm (%)		16.7	
Moisture Content of Remaining Depth (%)		16.0	
Compaction Hammer Used		Standard	
Surcharge Mass (kg)		4.50	
Period of Soaking (Days)		4	
Retained on 19 mm Sieve (%)		3	
CBR Moisture Content Method		AS 1289.2.1.1	
Sample Curing Time (h)		50	
Plasticity Method		Visual/Tactile Assessment	
Date Tested		25/03/2024	

Comments

N/A

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Material Test Report

Report No: SYD2400478
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

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NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-09
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
BH / TP No.	TP26
Depth (m)	0.50 - 1.00
Soil Classification	Clayey GRAVEL (GC) with sand brown as per AS1726 tables 9 & 10

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	14.2	
Date Tested		14/03/2024	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
	AS 1289.3.4.1		
Linear Shrinkage (%)		Not Tested	
Liquid Limit (%)	AS 1289.3.1.1	31	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	15	
Date Tested		26/03/2024	

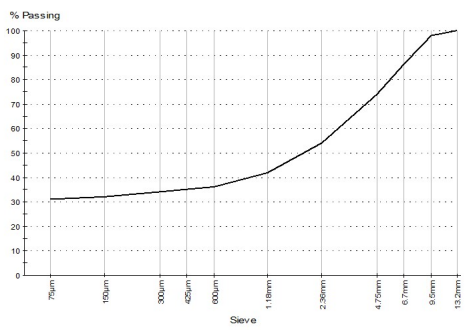
Particle Size Distribution

Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 19/03/2024

Note: Sample Washed

Sieve Size	% Passing	Limits
13.2mm	100	
9.5mm	98	
6.7mm	86	
4.75mm	74	
2.36mm	54	
1.18mm	42	
600µm	36	
425µm	35	
300µm	34	
150µm	32	
75µm	31	

Chart



Comments

Small sample - Insufficient sample mass to comply with minimum mass requirements AS1289 1.1

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Material Test Report

Report No: SYD2400484
Issue No: 1

Client: Landcom
L14 60 Station St
Parramatta NSW 2150

Project: 12627900 Redmond Place,Orange

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NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-15
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
BH / TP No.	TP27
Depth (m)	0.50 - 1.00
Soil Classification	CLAY (CI) with sand & gravel red brown as per AS1726 tables 9 & 10

Other Test Results

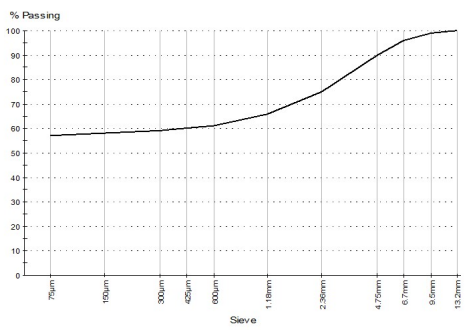
Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	20.1	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	8.5	
Mould Length (mm)		93	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.2	36	
Plastic Limit (%)	AS 1289.3.2.1	17	
Plasticity Index (%)	AS 1289.3.3.1	19	
Emerson Class Number	AS 1289.3.8.1	6	
Soil Description		CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		22	
Date Tested		22/03/2024	

Particle Size Distribution

Method:	AS 1289.3.6.1
Drying By:	Oven
Date Tested:	21/03/2024
Note:	Sample Washed

Sieve Size	% Passing	Limits
13.2mm	100	
9.5mm	99	
6.7mm	96	
4.75mm	90	
2.36mm	75	
1.18mm	66	
600µm	61	
425µm	60	
300µm	59	
150µm	58	
75µm	57	

Chart



Comments

N/A

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Material Test Report

Report No: SYD2400479
Issue No: 1

Client: Landcom
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Project: 12627900 Redmond Place,Orange

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NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 28/03/2024

Sample Details

GHD Sample No	SYD24-0089-10
Date Sampled	29/02/2024
Sampled By	Sampled by GHD Geotechnical
Client Location	Redmond Place GI
	CLAY trace sand pale grey
BH / TP No.	TP28
Depth (m)	1.00 - 1.50

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	22.1	
Date Tested		14/03/2024	

Comments

N/A

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