GEOTECHNIQUE® PTY LTD

ABN 64 002 841 063

LEGACY PROPERTY (Legacy) PTY LTD

PROPOSED RESIDENTIAL DEVELOPMENT of LAND LOCATED at CADDENS ROAD, KINGSWOOD ROAD and CASTLE ROAD, ORCHARD HILLS NORTH

For The Site Known as (the rezoning area)

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

REPORT NO 14447/1-AC 1 DECEMBER 2021

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Job No: 14447/1
Our Ref: 14447/1-AC
1 December 2021

Legacy Property Pty Ltd
MLC Centre, Level 45
25 Martin Place
SYDNEY NSW 2000
Email: pperkovic@legacyproperty.com.au

Attention: Mr P Perkovic

Dear Sir

re: Proposed Residential Development
Castle Road, Orchard Hills North
Preliminary Geotechnical Investigation Report

Please find herewith a Geotechnical Investigation Report for the proposed residential subdivision development at the above site.

The objectives of this investigation were:

- To determine the sub-surface conditions across the site.
- To develop preliminary geotechnical parameters for the design of the proposed development.
- To provide preliminary pavement thickness design for the proposed roads.
- To assess slope stability and recommendations on cut/ fill batter slopes.
- To ascertain if soils across the site are affected by salinity or are aggressive to building materials.
- To prepare a "Saline Soil Management" Plan.

The scope of work included site inspections and testing, review of available geological information, provision of geotechnical and soil salinity, aggressivity and erodibility assessments.

If you have any questions, please do not hesitate to contact the undersigned.

Yours faithfully
GEOTECHNIQUE PTY LTD

pp DR MD ARIFUL ISLAM
Senior Geotechnical Engineer

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EXECUTIVE SUMMARY

This report has been prepared in response to a requirement under a Gateway Determination issued by The Department of Planning & Environment – NSW Government, **Planning proposal (Department Ref: PP_2018_PENRI_006_00)**: to rezone the area known as Orchard Hills North for urban development. Issued by the Delegate of the Minister for Planning on 22 May 2019.

This executive summary presents a synopsis of a geotechnical investigation for the proposed residential subdivision development at Orchard Hills.

The objectives of this assessment were:

- To determine the sub-surface conditions across the site.
- To develop preliminary geotechnical parameters for the design of the proposed development.
- To provide preliminary pavement thickness design for the proposed roads.
- To assess slope stability and recommendations on cut/ fill batter slopes.
- To ascertain if soils across the site are affected by salinity or are aggressive to building materials.
- To prepare a “Saline Soil Management” Plan.

The work was carried out in accordance with the Geotechnique fee proposal Al.er/Q8785 dated 25 March 2019. In order to achieve the objectives of the investigation, the scope of work included a desktop study of available information including geological, landscape and salinity maps; excavation of 33 test pits and 11 boreholes to determine sub-surface conditions and laboratory tests on recovered representative soil and rock samples.

Based on the material encountered in test pits and boreholes, the sub-surface profile within the site is anticipated to comprise a sequence of topsoil (200mm to 300mm thick) and natural soils (both clayey and sandy) underlain by bedrock (sandstone/ shale/ mudstone). The bedrock encountered at site is generally low strength weathered shale/mudstone and medium strength sandstone. Although, natural soils were found in all the test pits and boreholes, localised fill can also be found at some places. Considering existing subsurface conditions, footings for proposed structures can be supported on controlled fill or stiff clays or weathered bedrock.

The topography of the site is generally undulating with difference in elevation of about 45m (RL40 to RL85 AHD) and slopes towards the creeks in east and west directions. The slope across the site is generally mild to moderate and no slope instability issues were noted during the investigation. However, signs of erosion were noted at some places particularly near the dams and water courses.

With regards to excavation conditions, it is expected that overburden clayey/sandy soils and low strength shale/mudstone bedrock could be excavated using conventional earthmoving equipment such as excavators and dozers. Occasional rock hammering might be required if hard ironstone / siltstone band is encountered. For areas where medium strength sandstone bedrock is expected, it will be more difficult to excavate and will require larger equipment such as ripper attached to Caterpillar D8 or D9 dozer.
Rock sawing might be required for trenching in medium to high strength siltstone / sandstone if smooth finished surface is required. Further investigation by drilling deep boreholes and recovering rock cores will be required to assess bedrock strength at a particular location of interest.

Based on anticipated thickness of soils (including controlled fill and natural clays) and estimated shrink-swell movements, site classifications for future residential lots across the site are expected to be Class "M" (Moderately reactive) or "H1" (Highly reactive), in accordance with AS2870-2011 "Residential slabs and footings". In areas where weathered shale, mudstone and sandstone bedrock will be exposed, the residential lots would generally be classified as Class "A" (Non-reactive) or "S" (Slightly reactive). In areas where natural clays are exposed or clayey fills are placed it is expected that the residential lots will be classified as Class "M" and Class "H1".

CBR tests on the recovered bulk samples from the proposed road showed CBR values ranging between 1.5% and 4.0% for clayey soil with one exception where a CBR value of 10% was reported for sandy soil. High swelling values (up to 4.0%) of the natural clayey soil was also reported. Considering low subgrade CBR value and expansive nature of natural clays, treatment options were recommended to improve the CBR value of subgrade soil (either natural or fill) to at least 4.0%. However, a higher design CBR of 7.0% is considered for the design of the road section where weathered bedrock is expected in deep cut areas.

Laboratory testing for soil erodibility, salinity and aggressivity indicated the following:

- Soils across the site are dispersive and susceptible to excessive erosion. Although, majority of the site is assessed to be non-saline to slightly saline, moderately to very saline soils are expected near the low lying creek areas. Therefore, we recommend that the soil management plan is followed to minimise impacts of soil salinity and erosion.
- Soils across the site are assessed to be non-aggressive towards steel but mildly aggressive to concrete. Therefore, we recommend use of construction materials, such as concrete and steel that are appropriate to assessed aggressivity.

Reference should be made to Sections 7.0 to 12.0 of the report for detailed recommendations and limitations of the assessment.

Condition 4. of the Gateway Determination issued on 22 May 2019, Local Planning Direction, Section 117(2) of the Environmental Planning and Assessment Act 1979. To satisfy **Direction 4.2 Mine Subsidence and Unstable Land**, we have reviewed this requirement and it has been determined that the direction does not apply to the subject site. Subsidence Advisory NSW - NSW Government, has also confirmed that the site does not fall within a Mine Subsidence District. In addition, the site is not deemed to be unstable as outlined in the investigations undertaken as part of this report.

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1.0 INTRODUCTION

Geotechnique was commissioned by Mr P Perkovic of Legacy Property Pty Ltd to undertake a preliminary geotechnical investigation for the development of a proposed residential subdivision located on Caddens Road, Kingswood Road and Castle Road in Orchard Hills North (the rezoning area). This report documents the results of the investigation, which was carried out in accordance with Geotechnique fee proposal AI.er/Q8785 dated 25 March 2019.

2.0 PROPOSED DEVELOPMENT

We understand that the proposed development at Orchard Hills North includes construction of internal roads and creation of approximately 1,729 residential lots with playing areas, open space, water bodies and other associated structures. The entire project site lies within the Penrith Local Government Area. A geotechnical investigation was required to determine existing subsurface conditions across the site and develop geotechnical recommendations for the planning and design of the proposed development including pavement thickness design.

3.0 FIELD WORK

Field work for this geotechnical investigation was carried out between 29 April and 10 May 2019 in accordance with Australian Standard AS1726-1993 (Reference 1). Prior to to the commencement of fieldwork, the field engineers were made aware of the exclusion zones within the site. Proposed test pit and borehole locations were transferred to both GPS and near map images to help in establishing the locations at the site. The actual field work consisted of the following:

- Obtain and review available geological and geotechnical information relevant to the site.
- Obtain and review services plans from “Dial Before you Dig” to identify locations of underground services within and in the vicinity of the site.
- Carrying out a walk over survey to assess existing geological and geotechnical conditions within and in the vicinity of the site.
- Locate a total of 33 test pits and 11 boreholes across the site using our GPS and establish them in the field before starting excavation / drilling.
- Scanning the proposed test pit and borehole locations for underground services to ensure excavation would not damage existing services. Underground services drawings for the site were obtained from DBYD prior to going to the site. Also, a specialist service locator was hired for this purpose at some critical areas.
- Excavate test pits (TP1 to TP33) to depths up to 3.0m or prior refusal on bedrock using a backhoe fitted with a 450mm bucket. Also, drill boreholes (BH1 to BH11) to depths up to 8m (including rock coring), using a track mounted drilling rig fully equipped for geotechnical investigation.
- Test pits and boreholes were uniformly distributed over the site and their locations are shown on the attached Drawing No 14447/1-AA1. The engineering logs along with explanatory notes are also attached at the end of the report.
- Carry out Standard Penetration Tests (SPT) in the boreholes at regular depth intervals to assess the strength characteristics of sub-surface soils.
- Recovery of the representative soil samples from the selected test pits and boreholes for visual assessment and laboratory testing (CBR, EC, pH, ESP etc.).
- Measure the depth to groundwater level or seepage in the test pits and boreholes, if encountered.

Field work was carried out by geotechnical engineers from this company who were responsible for locating test pits and boreholes, recovering soil and rock samples, preparation of logs and overall supervision.

4.0 REGIONAL GEOLOGY

The Geological Map of Penrith (Geological Series Sheet 9030, Scale 1:100,000, Edition 1, 1991) indicates the residual soils within the site to be underlain by Triassic Age Shale of the Wianamatta Group, comprising shale, carbonaceous claystone, claystone, laminite, fine to medium grained lithic sandstone, rare coal and tuff. However, Quarternary Age soils consisting of fine grained sand, silt and clay is expected along the Claremont Creek near eastern boundary.

The Soil Landscape Map of Penrith (Soil Landscape Series Sheet 9030, Scale 1:100,000, 1989), indicates that the site is located within the Luddenham Landscape area and typically consists of poorly drained/relatively impermeable residual natural soils. Eastern side of the site belongs to South Creek landscape area and typically consists of residual soils, which range from sandy clay to clay.

The Salinity Potential in Western Sydney (2002) map indicates that the site has moderate to high Salinity Potential.

5.0 SITE LOCALITY, DESCRIPTION & SUB-SURFACE CONDITIONS

5.1 Site Locality & Description

The site is of irregular shaped and bounded by Caddens Road to the north, M4 Motorway to the south, Claremont Creek to the east and Kingswood Road and rural properties to the west. Castle Road runs through middle of the site in east-west direction. Also, Warrington Creek and a parallel ridge are running through the site. The site is currently occupied by a number of rural residential properties and currently being used for market gardening, cattle farming and other farming activities. Remaining portion of the site is vacant and covered with long grown grasses and scattered trees. There are a number of dams of different sizes and water retaining capacities. Topography of the site is generally undulating and with slopes away from the central ridge line towards the creeks. The site locality map is shown in the Figure 1 below.

FIGURE 1

Map Data ©2019 Google

The topography of the site is generally undulating and slopes towards the creeks in east and west directions with difference in elevation of about 45m (RL40 to RL85 AHD). The slope across the site was found gentle to moderate and no slope instability issues were noted during the investigation. However, signs of erosion were noted at some places particularly near the dams and water courses.

5.2 Sub-surface Conditions

Sub-surface conditions encountered in the boreholes and test pits are summarised in Table 1A and 1B respectively and detailed in the attached engineering logs.

Table 1A: Sub-surface Conditions in Boreholes

Borehole No	Easting (m)	Northing (m)	Top RL (mAHD)	Termination Depth (m)	Topsoil/ Fill (m)	Natural (m)	Very Low to Low Strength Bedrock (m)	Medium Strength Bedrock (m)
BH1	289284	6259800	74.02	8.9	0.0 - 0.2	0.2 – 0.7	0.7 - 2.2	2.2 – >8.9
BH2	289139	6259571	78.48	8.0	0.0 - 0.1	0.1 – 1.2	1.2 – 5.0	5.0 – >8.0
BH3	288977	6259709	82.75	7.0	0.0 - 0.3	0.3 – 0.8	0.8 – 3.5	3.5 – >7.0
BH4	289467	6259629	75.50	6.4	0.0 - 0.2	0.2 – 1.0	1.0 – 1.3	1.3 – >6.4
BH5	289732	6259621	64.34	8.4	0.0 - 0.2	0.2 – 3.5	3.5 – 7.1	7.1 – >8.4
BH6	288755	6259774	86.60	6.65	0.0 - 0.1	0.1 – 0.4	0.4 – 3.0	3.0 – >6.65
BH7	289835	6259964	71.18	8.2	0.0 - 0.2	0.2 – 1.0	1.0 – 5.5	5.5 – >8.2
BH8	289434	6260329	77.60	7.2	0.0 - 0.2	0.2 – 1.0	1.0 – 3.0	3.0 – >7.2
BH9	290008	6260150	64.03	8.3	0.0 - 0.2	0.2 – 2.2	2.2 – >8.3	NE
BH10	290505	6260032	60.41	7.85	0.0 - 0.2	0.2 – 1.0	1.0 – >7.85	NE
BH11	290294	6260053	70.60	7.65	0.0 - 0.2	0.2 – 1.0	1.0 – >7.65	NE

*NE = Not Encountered to the depth of excavation

Table 1B: Sub-surface Conditions in Test Pits

Test Pit No	Easting (m)	Northing (m)	Top RL (mAHD)	Termination Depth (m)	Topsoil/ Fill (m)	Natural (m)	Bedrock (m)
TP1	289132	6259944	68.13	2.3	0.0 - 0.2	0.2 – 2.3	NE
TP2	289546	6259881	63.62	2.9	0.0 - 0.2	0.2 – 2.9	NE
TP3	289720	6259853	70.27	2.5	0.0 - 0.2	0.2 – 2.5	NE
TP4	290129	6259786	45.87	2.3	0.0 - 0.2	0.2 – 2.3	NE
TP5	290388	6259745	40.04	2.3	0.0 - 0.2	0.2 – 2.3	NE
TP6	290146	6260040	55.25	2.5	0.0 - 0.2	0.2 – 2.5	NE
TP7	290169	6260200	69.31	1.5	0.0 - 0.2	0.2 – 1.5	>1.5
TP8	290590	6260172	48.31	2.2	0.0 - 0.2	0.2 – 2.2	NE
TP9	290547	6259895	41.26	2.5	0.0 - 0.3	0.3 – 2.5	NE
TP10	290377	6259915	48.57	2.5	0.0 - 0.3	0.3 – 2.5	NE
TP11	290442	6260021	62.52	2.5	0.0 - 0.2	0.2 – 2.5	NE
TP12	290354	6260171	60.22	3.0	0.0 - 0.3	0.3 – 3.0	NE

Test Pit No	Easting (m)	Northing (m)	Top RL (mAHD)	Termination Depth (m)	Topsoil/ Fill (m)	Natural (m)	Bedrock (m)
TP13	289091	6259693	72.87	2.8	0.0 - 0.2	0.2 – 2.8	NE
TP14	289394	6259712	68.68	2.5	0.0 - 0.3	0.3 – 2.5	NE
TP15	289317	6259575	76.67	1.3	0.0 - 0.2	0.2 – 1.3	>1.3
TP16	289062	6259477	66.30	2.5	0.0 - 0.3	0.3 – 2.5	NE
TP17	288723	6259968	83.57	1.7	0.0 - 0.2	0.2 – 1.7	>1.7
TP18	288840	6259616	68.94	1.5	0.0 - 0.3	0.3 – 1.5	>1.5
TP19	288853	6259769	85.15	1.8	0.0 - 0.3	0.3 – 1.8	>1.8
TP20	289929	6260012	69.85	1.8	0.0 - 0.2	0.2 – 1.8	>1.8
TP21	289854	6260129	58.06	2.5	0.0 - 0.2	0.2 – 2.5	NE
TP22	290014	6260266	58.07	2.8	0.0 - 0.2	0.2 – 2.8	NE
TP23	289916	6259867	62.86	1.0	0.0 - 0.2	0.2 – 1.0	>1.0
TP24	289202	6260346	80.96	0.8	0.0 - 0.3	0.3 – 0.8	>0.8
TP25	289281	6260183	76.72	0.8	0.0 - 0.2	0.2 – 0.8	>0.8
TP26	289559	6260208	70.41	1.2	0.0 - 0.3	0.3 – 1.2	>1.2
TP27	289733	6260342	59.68	2.9	0.0 - 0.2	0.2 – 2.9	>2.9
TP28	289725	6260002	60.62	2.6	0.0 - 0.2	0.2 – 2.6	NE
TP29	290025	6259589	45.59	2.8	0.0 - 0.3	0.3 – 2.8	NE
TP30	289918	6259720	58.49	3.0	0.0 - 0.2	0.2 – 3.0	NE
TP31	290192	6259604	41.82	2.5	0.0 - 0.2	0.2 – 2.5	NE
TP32	289624	6259726	73.05	0.8	0.0 - 0.2	0.2 – 0.8	>0.8
TP33	289556	6259509	57.60	2.3	0.0 - 0.2	0.2 – 2.3	NE

*NE = Not Encountered to the depth of excavation

Topsoil	Silty Clay, low plasticity, brown, with grass roots Silty Sandy Clay, low plasticity, brown, with grass roots Silty Sand, fine grained, brown, with grass roots
Fill	Mixture of Road-base, Gravel and Sandy Clay
Natural	Silty CLAY, low to medium plasticity, brown Silty CLAY, medium to high plasticity, red/ brown/grey Silty CLAY, medium to high plasticity, red/brown/grey, with ironstone gravels Silty CLAY, medium plasticity, grey-brown, with shale and ironstone layers interbedded Silty Sandy CLAY, low to medium plasticity, brown, with ironstone gravels Silty Clayey SAND, fine to medium grained, brown, with ironstone/sandstone layers interbedded
Bedrock	SANDSTONE, fine to medium grained, grey-brown, extremely to distinctly weathered, very low to low strength, with ironstone/siltstone and clay bands SANDSTONE, fine to medium grained, distinctly to slightly weathered, medium strength SHALE, grey, extremely to distinctly weathered, very low to low strength, with ironstone and clay bands SHALE/ MUDSTONE, grey-brown, extremely to distinctly weathered, very low to low strength, with interbedded siltstone, sandstone and clay bands Interbedded SHALE, MUDSTONE, SILTSTONE, fine grained SANDSTONE, grey and brown, with ironstone and clay bands

6.0 LABORATORY TESTING

6.1 Geotechnical Tests Results

Selected soil samples recovered from the test pits were analysed in a NATA accredited laboratory called Geotech Testing Pty Ltd for California Bearing Ratio (CBR) values. The CBR tests were conducted on representative subgrade samples compacted at 100% standard dry density with optimum moisture content and soaked for four days. The laboratory test results certificates are attached in Appendix A and summarised below.

Table 2 : California Bearing Ratio

Test Pit No	Depth (m)	Sample Description	MDD (t/m^3)	OMC (%)	FMC (%)	Swell (%)	CBR (%)
TP2	2.5 - 2.8	(CH) Silty CLAY, high plasticity, red-brown & grey	1.73	19.6	17.0	4.0	2.5
TP12	2.5 - 2.8	(CH) Silty CLAY, high plasticity, grey	1.72	17.4	13.2	4.0	1.5
TP20	1.3 - 1.6	(SC) Silty Clayey SAND, fines of medium grained, brown	1.80	15.0	10.2	1.0	10.0
TP22	2.4 - 2.7	(CI) Silty CLAY, medium plasticity, grey & brown	1.82	17.5	16.3	2.0	2.5
TP27	2.5 - 2.8	(CI-CH) Silty CLAY, medium to high plasticity, grey	1.64	20.4	18.3	1.5	2.0
TP29	2.2 - 2.5	(CI-CH) Silty CLAY, medium to high plasticity, red-brown & grey	1.68	19.4	17.2	0.5	4.0

MDD : Maximum Dry Density; OMC : Optimum Moisture Content; FMC : Field Moisture Content

The above test results show that the CBR values generally ranges between 1.5% and 4.0% for clayey soil with one exception where a CBR value of 10 was reported for sandy soil.

6.2 Salinity, Aggressivity and Erodibility Tests Results

During field work, a total of 63 soil samples were collected for chemical testing in a NATA accredited laboratory called SGS for salinity, aggressivity and erodibility properties. The laboratory test results certificates from SGS are included in Appendix B and summarised below in Table 3.

Table 3 : Salinity and Aggressivity

Test Pit	Depth (m)	pH	EC (µS/cm)	ECe (dS/m)	Chloride (ppm)	Sulphate (ppm)	ESP (%)
BH1	0.5-0.95	6.5	460	3.22	59	67	2.8
BH2	0.5-0.95	6.8	56	0.39	55	7.4	4.2
BH3	0.5-0.95	4.9	640	4.48	620	500	24.6
BH4	0.5-0.95	8.1	220	1.54	30	4.5	1.3
BH5	1.0-1.45	9.2	400	2.80	27	290	11.7
BH6	1.0-1.45	5.5	63	0.44	87	7.1	4.6
BH7	0.5-0.95	5.7	36	0.25	57	7.6	2.5
BH8	0.5-0.95	6.5	38	0.27	26	6.4	2.7
BH9	1.0-1.45	7	68	0.48	62	6.5	6.6
BH10	0.5-0.95	8.8	580	4.06	320	400	15.2
BH11	0.5-0.95	7.3	130	0.91	96	13	1.2

Test Pit	Depth (m)	pH	EC (µS/cm)	ECe (dS/m)	Chloride (ppm)	Sulphate (ppm)	ESP (%)
TP1	0.7-0.8	5	440	3.08	170	500	21.9
TP1	2.0-2.1	4.5	920	6.44	160	1300	-
TP2	0.6-0.7	6.3	1200	8.40	94	1800	31.2
TP2	1.2-1.3	5	1100	7.70	50	1700	-
TP3	1.3-1.4	6.4	21	0.15	19	2.8	-
TP3	2.2-2.3	6.4	24	0.17	28	0.91	2.7
TP4	0.7-0.8	8.2	120	0.84	17	11	3.6
TP4	1.9-1.9	7.9	260	1.82	<5	270	-
TP5	1.0-1.1	8.8	850	5.95	96	930	23.9
TP5	2.0-2.1	8.7	700	4.90	61	810	-
TP6	1.0-1.1	8.5	300	2.10	160	72	-
TP6	2.0-2.1	9.1	440	3.08	140	50	12.1
TP7	1.1-1.2	7.5	110	0.77	120	4.4	2.1
TP8	1.2-1.3	7.9	1300	9.10	270	1900	-
TP8	1.8-1.9	4.7	1100	7.70	180	1800	35.5
TP9	2.0-2.1	5.9	41	0.29	69	2.3	3.1
TP10	1.1-1.2	6.9	37	0.26	32	4.2	6.7
TP10	2.1-2.2	9	370	2.59	14	290	-
TP11	2.2-2.3	9	150	1.05	21	9.4	8.6
TP12	1.0-1.1	9.4	500	3.50	54	330	11.8
TP12	2.5-2.6	9.4	520	3.64	48	380	-
TP13	0.8-0.9	9.4	310	2.17	86	40	38.9
TP13	2.5-2.6	9.2	310	2.17	82	34	-
TP14	1.4-1.5	8.3	240	1.68	130	96	7
TP15	0.7-0.8	7	49	0.34	70	3.5	5.1
TP16	1.2-1.3	8.5	320	2.24	81	130	-
TP16	2.3-2.4	9.5	740	5.18	150	570	16.7
TP17	0.5-0.6	6.2	47	0.33	52	22	10.7
TP18	1.2-1.3	9	290	2.03	43	54	15.9
TP19	1.3-1.4	8.8	330	2.31	220	98	17.6
TP20	1.0-1.1	6.3	51	0.36	44	28	1.9
TP21	1.0-1.1	9.1	590	4.13	99	510	-
TP21	1.9-2.0	9.1	510	3.57	64	430	16.6
TP22	1.5-1.6	8.7	930	6.51	190	1000	18.1
TP22	2.5-2.6	8.9	580	4.06	27	550	-
TP23	0.4-0.5	8.3	470	3.29	110	330	-
TP23	0.8-0.9	8.4	320	2.24	65	210	14.7
TP24	0.5-0.6	5.7	65	0.46	98	6	2
TP25	0.6-0.7	7.2	41	0.29	33	1.3	1.5
TP26	0.8-0.9	5.7	120	0.84	15	160	8.5

Test Pit	Depth (m)	pH	EC (µS/cm)	ECe (dS/m)	Chloride (ppm)	Sulphate (ppm)	ESP (%)
TP27	1.5-1.6	9.6	690	4.83	160	350	-
TP27	2.4-2.5	9.1	890	6.23	200	710	29.4
TP28	1.2-1.3	9.6	380	2.66	29	120	-
TP28	2.3-2.4	9.6	390	2.73	14	100	16.6
TP29	1.5-1.6	6.1	670	4.69	190	890	-
TP29	2.0-2.1	6.4	750	5.25	190	1100	31.5
TP30	1.6-1.7	9	470	3.29	92	460	15.1
TP30	2.6-2.7	9.2	270	1.89	29	180	-
TP31	0.9-1.0	8.3	230	1.61	120	70	22.2
TP31	2.2-2.3	8.2	800	5.60	170	1000	-
TP32	0.5-0.6	6.6	41	0.29	56	4.8	-
TP33	1.7-1.8	9	270	1.89	92	70	14.8

7.0 DISCUSSION AND RECOMMENDATIONS

7.1 Geotechnical Model

Based on information presented in Table 1, the sub-surface profile within the site is anticipated to comprise a sequence of topsoil and natural soils (both clayey and sandy) underlain by bedrock (sandstone/ shale/ mudstone). The expected bedrocks within the proposed excavation depths across the site are generally very low to low strength shale/ mudstone and medium strength sandstone.

The thickness of the topsoil across the site is generally varies between 200 and 300mm. Although significant fill material was not encountered at any of the borehole and test pit locations, the presence of deep fill within the site is expected. The depth to bedrock across the site varies from less than a meter at hill top areas to more than three meters (maximum reach of backhoe) at creeks and valleys.

Groundwater/seepage was not encountered in any of the test pit/borehole locations during the time they remained open. It should be noted that levels of groundwater / seepage might change due to changes in temperature, rainfall and other factors not evident during the field work.

7.2 Slope Stability

Site factors such as slope angles, depth of insitu soils, strength of sub-surface material and concentrations of water, generally govern the slope stability of a site. The Australian Geomechanics Society (AGS) recommends that the landslide risk of a site is assessed on the basis of the likelihood of a landslide event and the consequences of that event. The guidelines on qualitative measures for the likelihood and consequence of landslides and assumed level of risk are provided by AGS.

Qualitative Measures of Likelihood: It is our assessment that the event of a landslide within the sites might occur under very adverse circumstances over the design life (Annual Probability $\approx 10^{-4}$), i.e: it is "Unlikely".

Qualitative Measures of Consequences to Property: It is our assessment that the consequences of landslides within the site to properties would be "Minor", causing limited damage to part of structures or part of the site requiring some reinstatement / stabilisation work.

Qualitative Risk Analysis: Based on the above Qualitative Measures, the sites for the proposed development are assessed to have a "Low" Risk of slope instability. The abstract of definitions of risk levels provided by AGS (Reference 2) is as follows:

Risk Level		Implication
VH	Very High Risk	Extensive detailed investigation and research, planning and implementation of treatment options, essential to reduce risk to acceptable levels; may be too expensive and not practical.
H	High Risk	Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable levels.
M	Moderate Risk	Tolerable, provided a treatment plan is implemented to maintain or reduce risks. May be accepted. May require investigation and planning of treatment options.
L	Low Risk	Usually accepted. Treatment requirements and responsibility to be defined to maintain or reduce risk.
VL	Very Low Risk	Acceptable. Manage by normal slope maintenance procedures.

Applying the AGS guidelines, the site for the proposed development may be assessed as follows.

As mentioned earlier, topography of the site is generally undulating with difference in elevation of about 45m (RL40 to RL85 AHD). The slope across the site is generally mild to moderate and inspection of some of these accessible slopes did not indicate any signs of failure with exception of few signs of erosion. It is our assessment that the site is suitable for the proposed development, from a slope stability point of view. It is important that excavation, formation of batters and retaining structures should be carried out in accordance with good engineering and construction practices.

7.3 Excavation Conditions

From the cut-fill plan, it is understood that the proposed development requires up to about 8m deep cut with approximate volume of cut 1,232,000 m^3. We consider that overburden clayey/sandy soils and low strength shale/mudstone bedrock could be excavated using conventional earthmoving equipment such as excavators and dozers. Occasional rock hammering might be required if hard ironstone / siltstone band is encountered. For areas where medium strength sandstone bedrock is expected, it will be more difficult to excavate and will require larger equipment such as ripper attached to Caterpillar D8 or D9 dozer. Rock sawing might be required for trenching in medium to high strength siltstone / sandstone if smooth finished surface is required. Further investigation by drilling deep boreholes and recovering rock cores will be required to assess bedrock strength at a particular location of interest.

Selection of excavation equipment should be based on site access, strength of sub-surface materials and the likely impact of vibration to structures in the vicinity of the excavation. Acceptable vibration is based on the nature and state of neighbouring structures, which will have to be established by a dilapidation survey. As a general guide, the acceptable maximum peak particle velocity (PPV) in a residential area would range from about 5mm/s to 10mm/s. Contractors should make their own judgement when tendering for excavation works, using the engineering logs attached to this report and experience in such circumstances.

Groundwater / seepage was not encountered in any of the test pit / borehole locations during the time they remained open. We do not anticipate significant groundwater inflow during excavation except at some low lying areas near the creek. Groundwater inflow during excavation, if any, could be adequately managed using a conventional pump and sump system. However, trafficability problems might arise locally during wet weather or if water is allowed to pond at the site. A layer of recycled gravel can be used to provide good working platform.

7.4 Site Filling

It is understood that the proposed development requires fill placement to achieve designed grades. The following procedures are recommended for placement of controlled fill, where required.

- Strip existing topsoil and stockpile separately for possible future use (see Section 7.5 for further recommendations).
- Undertake proof rolling (using an 8 to 10 tonnes roller) of the exposed natural soils to detect potentially weak spots (ground heave). Excavate areas of localised heaving to a depth of about 300mm and replace with granular fill, compacted as described below.
- Undertake proof rolling of soft spots backfilled with granular fill, as described above. If the backfilled area shows movement during proof rolling, this office should be contacted for further recommendations.
- Place suitable fill materials on proof rolled natural soils. The fill should be placed in horizontal layers of 200mm to 250mm maximum loose thickness (depending on the size of equipment) and compacted to a Minimum Dry Density Ratio (MDDR) of 98% Standard, at moisture content within 2% of Optimum Moisture Content (OMC). The top 300mm of fill forming pavement subgrade should be compacted to at least 100% Standard.
- Controlled fill should preferably comprise non-reactive fill (e.g. crushed bedrock) with a maximum particle size not exceeding 75mm, or low plasticity clay. Natural soils and weathered bedrock obtained from excavations within the site may be used in controlled fill after removal of unsuitable materials, if any, crushing to sizes finer than 75mm, properly mixing and moisture conditioning.
- Fill placement should be supervised to ensure that material quality, layer thickness, testing frequency and compaction criteria conform to the specifications. We recommend "Level 1" supervision in accordance with AS3798-2007 – "Guidelines on Earthworks for Commercial and Residential Developments" (Reference 3).

7.5 Reuse of Existing Materials

It is our assessment that natural clayey soils and shale, mudstone and sandstone bedrock obtained from excavation in cut areas can be reused in fill areas as controlled and/or general fill. However, moisture conditioning and removal of deleterious material, if any, might be required prior to fill.

Logs of 11 boreholes and 33 test pits showed that the thickness of topsoil across the site varied from 200mm to 300mm. Topsoil can be blended with natural clays and can be reused as recommended below:

- Separate the top 50mm of the topsoil consisting of highly organic matter and stockpile it for possible future use in landscaping.

- The bottom layer of the topsoil (i.e. below the top 50mm) which generally has less organic matter can be mixed with natural clays in the ratio of 1:4 and can be used in controlled fill area at depths below 1.5m.

7.6 Safe Batters & Retaining Structures

Cut and fill during and after site excavation should be battered for stability or retained by engineered retaining structures. Where battered slopes in overburden soils and bedrock are possible we recommend the following safe batters.

Table 4 : Recommended Batter Slopes

Material	Temporary (Vertical : Horizontal)		Permanent (Vertical : Horizontal)	
	Protected	Exposed	Protected	Exposed
Controlled Fill and Residual Soil	1.0 : 1.0	1.0 : 1.5	1.0 : 2.0	1.0 : 2.5
Very low to low strength bedrock	1.0 : 0.75	1.0 : 1.0	1.0 : 1.0	1.0 : 1.5
Medium to high strength bedrock	Sub-vertical	Sub-vertical	Sub-vertical	Sub-vertical

The above batter slopes are recommended, providing:

- Cut and fill slopes are at sufficient distance from structures in the vicinity of the site.
- Adequate surface and sub-surface drainage is provided.
- Excavation faces are monitored regularly to observe any signs of movements so that appropriate remedial actions can be taken immediately.
- Collapse of excavation faces if it occurs is unlikely to pose a threat to the safety of people and structures in the vicinity.

Earth pressure for design for retaining wall could be calculated as recommended below.

Earth pressure distribution for non-anchored (cantilever) retaining walls is assumed triangular and estimated as follows:

$$p_h = \gamma k H$$

Where,

p_h = Horizontal active pressure (kN/m^2)
γ = Total density of materials to be retained (kN/m^3)
k = Coefficient of earth pressure (k_a or k_o)
H = Retained height (m)

For anchored retaining walls earth pressure can be assumed trapezoidal and estimated as 5H kPa, where H is the retained height in metres. The pressure distribution should be nil at the surface, increasing to 5H at a depth of 0.25H and remaining constant to 0.75H, then decreasing to nil at the base of the excavation.

For design of flexible retaining structures where some lateral movement is acceptable, an active earth pressure coefficient is recommended. If it is critical to limit the horizontal deformation of a retaining structure, use of an earth pressure coefficient at rest should be considered. Recommended parameters for the design of retaining structures are provided in the following Table 5.

Table 5 : Recommended Earth Pressure Parameters

Retained Material	Unit Weight (kN/m^3)	Active Earth Pressure Coefficient	At Rest Earth Pressure Coefficient	Ultimate Passive Earth Pressure (kPa)*
Existing fill	18	0.40	0.60	Ignore
Natural soil	19	0.30	0.50	3.0
Extremely low to low strength bedrock	21	0.25	0.40	350*
Medium to high strength bedrock	23	Not Applicable	Not Applicable	1000*

** Apply appropriate factor of safety*

These coefficients are based on the assumption that ground level behind the retaining structure is horizontal and the retained material is effectively drained. If retained materials are subjected to groundwater pressure and other surcharge loads (structures and traffic in the vicinity of the site), additional earth pressures resulting from groundwater and surcharge loads should also be allowed for in design of retaining structures. The design of any retaining structure should also be checked for bearing capacity, overturning, sliding and overall stability of the slope.

7.7 Site Classification

It is our assessment that the site is suitable for construction of residential buildings after completion of site preparation works. At completion of site preparation (cut and fill) for proposed development works, when building platforms and footing subgrade are ready for construction of residences, sub-surface profiles within the residential lots are anticipated to comprise either of the following:

- Controlled fill overlying, natural clays overlying bedrock; or
- Natural clays overlying bedrock; or
- Shale/ mudstone/ sandstone bedrock

The magnitude of ground surface movement due to moisture variation, which is required for site classification, depends on shrink-swell index values and thickness of soils underlying a building slab. Based on the results of the investigation, natural clayey soils are generally medium to high plasticity with pockets of low plasticity sandy clays. Hence, the natural soils and controlled fill are likely to be moderately to highly reactive. Weathered shale, mudstone and sandstone bedrock would generally be non-reactive to slightly reactive.

Based on anticipated thickness of soils (including controlled fill and natural clays) and estimated shrink-swell movements, site classifications for future residential lots across the site are expected to be Class “M” (Moderately reactive) or “H1” (Highly reactive), in accordance with AS2870-2011 “Residential slabs and footings”. In areas where weathered shale, mudstone and sandstone bedrock will be exposed, the residential lots would generally be classified as Class “A” (Non-reactive) or “S” (Slightly reactive). In areas where natural clays are exposed or clayey fills are placed it is expected that the residential lots will be classified as Class “M” and Class “H1”.

Definitions of site classes provided in AS2870-2011 (Reference 4) are reproduced below:

Site Classification	Foundation Condition	Ground Surface Movement (mm)
Class A	Most sand and rock sites with little or no ground movement from moisture changes	Not Applicable
Class S	Slightly reactive clay sites, which may experience with only slight ground movement from moisture changes	Less than 20
Class M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes	20 to 40
Class H1	Highly reactive clay sites, which may experience high ground movement from moisture changes	40 to 60
Class H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes	60 to 75

7.8 Floor Slabs & Footings

Floor slabs for future residential buildings may be designed as ground bearing or suspended slabs supported by footings. If ground bearing floor slabs are preferred, slabs appropriate for site classes may be designed in accordance with AS2870-2011.

Site classification in accordance with AS2870-2011 is only applicable for the design of footing systems for a single dwelling, house, townhouse or similar structure that would be detached or separated by a party wall or common wall including buildings classified as Class 1 and Class 10a in the Building Code of Australia (BCA). AS2870 is not suitable for dwellings that are situated vertically above or below another dwelling. Therefore, a geotechnical investigation will be required for other dwellings that would be classified in accordance with the BCA.

Foundation materials across the site might vary from controlled fill to natural clayey soils to shale / mudstone / sandstone bedrock, depending on the location of a building with regard to cut and fill profile. Therefore, assessment of foundation materials and allowable bearing pressure for a specific building should be reassessed after completion of site preparation works and during footing construction. For preliminary design, the following is recommended.

Table 6 : Recommended Bearing Capacity

Founding Material	Allowable End Bearing Capacity (kPa)	Shaft Adhesion (kPa)
Controlled fill and stiff natural clays	100	-
Very stiff to hard natural clays	150	-
Low strength shale/ mudstone bedrock	600	50*
Medium strength sandstone bedrock	1800	150*

** Bored Piers only*

8.0 PAVEMENTS

8.1 Subgrade CBR Design

During field work, a total of 6 subgrade samples were collected for soaked California Bearing Ratio (CBR) tests from the selected test pits along the proposed roads. The CBR tests were conducted on samples compacted at 100% standard dry density with optimum moisture content and soaked for four days in a NATA accredited laboratory called Geotech Testing Pty Ltd. The CBR values ranges between 1.5% and 4.0% for clayey soil with one exception where a CBR value of 10% was reported for sandy soil. High swelling values (up to 4.0%) of the natural clayey soil was also reported.

Considering low subgrade CBR value and expansive nature of natural clays encountered at site, we recommend the clayey subgrade (either natural or fill) is stabilised or replaced prior to construction of the pavement. Based on the test results and applying Japan Road Association guideline to calculate average CBR, a design CBR of 4.0% was adopted for the pavement design considering either of the following two treatment options are adopted.

Subgrade Treatment
Option 1: Lime Stabilisation
Stabilise top 300mm of the subgrade soil by addition of 4% hydrated lime.

Option 2: Select Subgrade
Replace 200mm of the subgrade soil with granular material (e.g., crushed sandstone).

A treatment option being the most efficient method of managing subgrade moisture condition should be chosen. With the benefit of increased subgrade stiffness provided by soil treatment, a reduction of the pavement thickness was calculated to offset the cost of stabilisation. Details of subgrade treatment procedure are described in the Subgrade Preparation section of this report.

It should be noted that detail investigation with additional CBR testing would be required to identify areas of high swell potential and roads or section of a road that require subgrade treatment. No treatment will be required in cut areas if bedrock is encountered at subgrade levels. Following design CBR values can be considered for preliminary pavement thickness design.

Table 7 : Design CBR Values

Subgrade Material	CBR
Clayey Fill/ Natural Clay (with recommended treatment)	4.0%
Low Strength Shale/ Mudstone Bedrock	7.0%

8.2 Traffic Design Loading

Following design traffic loadings were considered for the design of proposed roads within the proposed development area based on Penrith City Council's design guidelines.

Table 8 : Design Traffic Loading (ESA)

Council Road Type	Design Traffic Loading (ESA)
Distributor	$1x10^6$
Collector and Access Street with bus route	$5x10^5$
Access Street/ Pace	$5x10^4$

ESA : Equivalent Standard Axles

8.3 Pavement Composition

The pavement design is based on the Austroads publication "Guide to Pavement Technology, Part 2: "Pavement Structural Design", (2010) (Reference 5). Based on above traffic loadings and a design CBR values, we recommend the following pavement composition. It should be noted that these are preliminary pavement thickness design only and detail investigation is required to confirm the design once long sections of the proposed roads are available.

Table 9 : Pavement Thickness Design

Road Type	Design Traffic Loading (ESA)	Subgrade Soil Type	Design CBR (%)	AC10 (mm)+	Base Course (DGB20) (mm)	Sub-base Course (mm)	Total (mm)
Distributor	$1x10^6$	Clayey Soil	4.0	50	150	300	500
		Shale / mudstone	7.0	50	150	175	375
Collector and Access Street with bus route	$5x10^5$	Clay	4.0	50	150	270	470
		Shale / mudstone	7.0	50	150	175	375
Access Street / Pace	$5x10^4$	Clay	4.0	50	150	175	375
		Shale / mudstone	7.0	50	150	175	375

+ Over single coat hot bitumen flush seal and compacted in two layers of 25mm each

The pavement depths are only valid if the subgrade and pavement materials are compacted to the following Minimum Dry Density Ratios (AS1289 5.4.1) as per Penrith City Council Specifications.

Basecourse	98% Modified
Sub-basecourse	95% Modified
Subgrade	100% Standard

The pavement design assumes provision of adequate surface and sub-surface drainage of the pavement and adjacent areas. It is recommended that a sub-surface drainage system is installed, as directed by Council Engineers.

The pavement design for the roundabout shall be in accordance with 'Section 5.1.4 Roundabouts' of Penrith City Council's Engineering Construction Specification for Civil Works. The pavement design for the roundabout shall consist of a minimum one layer of 75mm AC14 polymer-modified asphalt wearing course, on 200mm deep-lift AC28 material, placed on a compacted sub-base of select fill material.

8.4 Subgrade Preparation

Longitudinal sections of the proposed roads were not available at the time this report was prepared. However, the cut-fill plan shows that the proposed development requires up to about 8m deep cut and fill to achieve designed grades. We recommend the following procedures for placement of controlled fill as subgrade for road pavement:

- Strip existing topsoil / fill and stockpile for possible future use in landscaping. This will mostly be required in areas which will require grade raise fill.
- Undertake proof rolling (using an 8 to 10 tonnes roller) of the exposed residual soils to detect potentially weak spots (ground heave). Excavate areas of localised heaving to depth of about 300mm and replace with granular materials or low plasticity clay, compacted as described below. Proof rolling will not be required if bedrock is exposed during stripping of topsoil/ fill.

- Repeat proof rolling of soft spots backfilled with granular materials or low plasticity clay. If the backfilled area shows movement during proof rolling, this office should be contacted for further recommendations.
- Place suitable fill materials on proof rolled soils to a height up to 200mm or 300mm below the subgrade level depending on the preferred treatment option. The fill should be placed in horizontal layers of 200mm to 250mm maximum loose thickness (depending on the size of equipment) and compacted to achieve a Minimum Dry Density Ratio (MDDR) of 100% Standard, at moisture content within 2% of Optimum Moisture Content (OMC).Suitable fill materials may comprise crushed bedrock or low plasticity clay. Residual soils and shale / sandstone obtained from excavations within the site may also be used, after removal of unsuitable materials, if any, crushing to sizes finer than 75mm and moisture conditioning.
- Place 300mm of lime stabilised soil (treatment option 1) or 200mm of crushed sandstone (treatment option 2) over the compacted fill and compact as described above. As mentioned earlier, subgrade treatment is only required for clayey subgrade with high swell potential.
- Fill placement should be supervised to ensure that material quality, layer thickness, testing frequency and compaction criteria conform to the specifications. We recommend "Level 1" supervision, in accordance with AS3798-2007.

9.0 ERODIBILITY ASSESSMENT

Erosion is the detachment and movement of soil materials. Depending on the local landscape and weather conditions, erosion could be very slow or very rapid. Susceptibility of soils to erosion depends on dispersivity (and sodicity) of soils. Soil dispersivity is generally assessed by conducting chemical tests such as Exchangeable Sodium Percentage (ESP), Sodium Absorption Ratio (SAR) and physical tests such as Emerson Class, Dispersion Percentage. It should, however be noted that assessment of soil dispersibility based on these methods might differ from each other.

For the proposed work, only ESP for representative soil samples were determined. Soils with ESP values of 5% or more are considered sodic and those with ESP more than 15% are considered highly sodic (Reference 6). Sodic soils are susceptible to excessive erosion.
ESP values for 43 representative soil samples are presented in Table 3 and indicate ESP values range between 1.2 and 38.9%. Twelve samples have ESP values ranging between 5 and 15% and in fact seventeen samples have ESP values of more than 15%. Therefore, it is our assessment that the soils across the site are generally dispersive and susceptible to excessive erosion.

10.0 SALINITY ASSESSMENT

Salinity refers to the presence of excess salt in the environment, either in soil or water. Salinity is a serious problem for any development due to the many environmental, economic and social impacts. Soil salinity is generally assessed by measuring Electrical Conductivity (EC) of a soil sample made up of 1:5 soil water suspension. Thus, determined Electrical Conductivity (EC) is multiplied by a factor varying from 6 to 23, based on the texture of the soil sample, to obtain Corrected Electrical Conductivity designated as ECe (Reference 7). Alternatively, ECe may be directly measured in soil saturation extracts. Soils are classified as saline if ECe of the saturated extracts exceed 4.0dS/m. The criteria for assessment of soil salinity classes are shown below (Reference 7):

Classification	EC_e (dS/m)	Comments
Non-saline	<2	Salinity effects mostly negligible
Slightly saline	2 – 4	Yields of very sensitive crops may be affected
Moderately saline	4 – 8	Yields of many crops affected
Very saline	8 – 16	Only tolerant crops yield satisfactorily
Highly saline	>16	Only a few tolerant crops yield satisfactorily

Electrical Conductivity (EC) values for 63 representative soil samples recovered from across the site are summarised in Table 3. For the nature of soils encountered across the site, a multiplying factor of 7 is considered to be appropriate. Therefore, Corrected Electrical Conductivity (ECe) for the soils across the site is anticipated to vary from 0.15 to 9.1dS/m. Majority of the 63 samples tested were found to have ECe values less than 4.0dS/m. However, samples collected from low lying creeks areas indicate higher ECe values. Out of 63 samples tested, 45 have ECe values less than 4.0dS/m, 16 have ECe values between 4.0 and 8.0dS/m and 2 have ECe values over 8.0dS/m.

Therefore, it is our assessment that the soils likely to be disturbed or excavated during the proposed development works are non-saline to slightly saline. However, near the low lying creek areas, soils are likely to be moderately to very saline. Therefore, earthworks for the proposed development require saline soil management plan.

This salinity assessment was carried out in accordance with the Environment Protection Authority (EPA) guidelines on investigation and management of salinity. These guidelines are detailed in “Site Investigations for Urban Salinity” and were prepared by the then Department of Land & Water Conservation in 2002. The publication refers to the following:

- AS3600: Concrete Structures.
- AS2159: Piling – Design and Installation.
- AS2870: Residential slabs and footings.

11.0 AGGRESSIVITY ASSESSMENT

Aqueous solution of chlorides causes corrosion of iron and steel, including steel reinforcement in concrete. High acidity and soils with high sulphates and magnesium affect the integrity of concrete structures buried in the soil. Concrete structures constructed in aggressive soils will require increased concrete strength proportional to the increased in soil aggressivity (Reference 4). In addition, the concrete cover and curing period should be increased depending on the degree of aggressivity of the soil.

The aggressivity classifications of soil and groundwater applicable to iron and steel, in accordance with Australian Standard AS2159 (Reference 8), are given below:

Chloride		pH	Resistivity (ohm cm)	Soil Condition A*	Soil Condition B#
In Soil (%)	In Water (ppm)				
<0.5	<1000	>5.0	>5000	Non-aggressive	Non-aggressive
0.5-2.0	1000-10000	4.0-5.0	2000-5000	Mild	Non-aggressive
2.0-5.0	10000-20000	3.0-4.0	1000-2000	Moderate	Mild
>5.0	>20000	<3.0	<1000	Severe	Moderate

*Soil Condition A = high permeability soils (e.g. sands and gravels) which are below groundwater
#Soil Condition B = low permeability soils (e.g. silts and clays) and all soils above groundwater

The aggressivity classifications of soil and groundwater applicable to concrete, in accordance with Reference 8 are given below:

Sulphate expressed as SO_3		pH	Chloride in Water (ppm)	Soil Condition A	Soil Condition B
In Soil (%)	In Groundwater (ppm)				
<0.2	<300	>6.5	<2000	Non-aggressive	Non-aggressive
0.2-0.5	300-1000	5.0-6.0	2000-6000	Mild	Non-aggressive
0.5-1.0	1000-2500	4.5-5.0	6000-12000	Moderate	Mild
1.0-2.0	2500-500	4.0-4.5	12000-30000	Severe	Moderate
>2.0	>5000	<4.0	>30000	Very Severe	Severe

Approximately 100ppm of SO_4 = 80ppm of SO_3

Results of aggressivity tests on representative soil samples from the site are summarised in Table 3. The soils across the site are clayey in nature with low permeability. Therefore, appropriate site condition for predominant soils at the site is assessed to be “Condition B”.

Aggressivity tests indicated the following:

- The pH values of soil samples vary from 4.5 to 9.6, indicating that the site conditions are non-aggressive to steel/iron but mildly aggressive to concrete in some areas.
- Chloride contents in soil samples vary from 5 to 620ppm, indicating that the site conditions are non-aggressive to both steel/iron and concrete.
- Sulphate contents in soil samples vary from 0.91 to 1900ppm, indicating that the site conditions are non-aggressive to mildly aggressive to concrete.

Based on the laboratory test results and the assumption that soils are predominantly clayey, the soils across the site are assessed to be non-aggressive towards steel/iron but mildly aggressive to concrete. Therefore, we recommend use of construction materials, such as concrete and steel that are appropriate to assessed aggressivity.

12.0 SOIL MANAGEMENT PLAN

As assessed earlier, the soils likely to be disturbed or excavated during the proposed development works are non-saline to moderately saline with the possibility of finding high saline soil near low lying creek areas. The soils encountered across the site are generally susceptible to erosion and it could be a major concern for the proposed development. Therefore, we recommend that disturbance and excavation of the soils are carried out in accordance with a soil management plan in order to minimise the adverse effects of saline soils and impacts of soil erosion.

The following should be considered in developing a Soil Management Plan:

- Minimise erosion and sediment loss before, during and after construction.
- Minimise water pollution due to erosion, siltation and sedimentation.
- Reduce and manage salinity within the site so that impacts on future structures (including buildings, roads etc.) are minimised and acceptable.

We recommended the following as part of the Soil Management Plan during earthworks to manage impacts from erosive and saline soils:

- We anticipate earthworks for the proposed development to involve cut and fill operations for construction of building platform, preparation of road subgrades and installation of services. However, best use of the existing topography should be developed in order to minimise cut and fill operations.
- Construct a V-drain behind the crest of all slopes to divert water away from the slope face.
- Ensure that earthworks and construction activities do not affect the natural flow of groundwater. Where groundwater is intercepted during development works / excavation, the flow should be diverted to stormwater drains or creeks by providing appropriate surface and sub-surface drainage. We do not consider that proposed earthworks will affect the natural flow of groundwater. However, NSW Office of Water should be contacted if groundwater is intercepted before any water is drained into the stormwater. The EPA might need to be contacted regarding any diversion to stormwater drains.
- Finished ground surface in each lot should be provided with adequate fall to the street to allow water run-off and prevent water ponding, waterlogging and infiltration of rainwater.
- Erosion and Sediment Control Plans must be developed and implemented by the earthworks contractors, in accordance with recommendations provided by the NSW Department of Housing. All sediment and erosion controls proposed by the Erosion and Sediment Control Plan are to be installed prior to commencement of any construction works.
- On cut and fill batters provide a secured turf overlay or shotcreting to guard against erosion.
- Retaining walls for cut and fill slopes, where required, should be provided with adequate and appropriate drainage.
- Utilise native and deep-rooted plants to minimise soil erosion. Where vegetation cover is not adequate to control erosion, improve soil resistance to erosion by stabilising dispersive soils with hydrated lime and gypsum. Exact proportions of lime and gypsum to be used can be determined on the basis of laboratory testing, but for preliminary planning purposes we suggest about 3% to 5% of lime and gypsum.
- Select construction materials and techniques suitable for a mildly aggressive site.
- Reduce groundwater recharge through appropriate land use and land management practices. This can be achieved by minimising deep infiltration by providing well compacted impermeable liners along surfaces of waterways (drains, channels, creeks etc) and maximising vegetation cover, planting of deep rooted trees and use of salt tolerant plants.
- For low lying portions of the site, stormwater drains along roads can be used to control groundwater level. However, to reduce the distance between drains, subsoil drains could also be installed along the property boundaries.
- Soil importation is not allowed unless the imported soil is thoroughly tested for salinity and is assessed as VENM (Virgin Excavated Natural Material) by an Environmental Consultant in accordance with EPA Guidelines. Any imported soil should have a maximum salinity (EC_e) of 4dS/m (non to slightly saline soils) and used in the top 1.5m to minimise the effect of saline soils on buried utilities and footings.
- If required, a post site works salinity assessment to confirm salinity and aggressivity of the completed residential lots can be carried out on completion of all site works.

13.0 LIMITATIONS

The conclusions and recommendations of this report are based on results obtained from a total of 33 test pits and 11 boreholes excavated / drilled across the site and laboratory tests on recovered representative soil samples. Although, we believe that the sub-surface profile presented in this report is indicative of the general profile across the site, it is possible that the sub-surface profile across the site could differ from that encountered in the test pits. A detail geotechnical investigation will be required prior to commencement of construction to verify some of the recommendations provided in this report.

The services performed by Geotechnique in preparing this report were conducted in a manner consistent with the level of quality and skill generally exercised by members of the profession and consulting practice. To the best of our knowledge, all information obtained and contained in this report is true and accurate. No further investigation has been carried out to authenticate the information.

This report has been prepared for Legacy Property Pty Ltd for the purposes stated within. Department of Planning & Environment may rely on this report in making a determination for rezoning. Also the Penrith City Council may rely on the report in making development application determinations. Any reliance on this report by other parties shall be at such parties' sole risk as the report might not contain sufficient information for other purposes.

This report shall only be presented in full and may not be used to support any other objective than those set out in the report, except where written approval is provided by Geotechnique.

The information in this report is considered accurate at the time of conducting the field work, in accordance with the current conditions of the site. Any variations to the site form or use beyond this date could nullify the conclusions stated.

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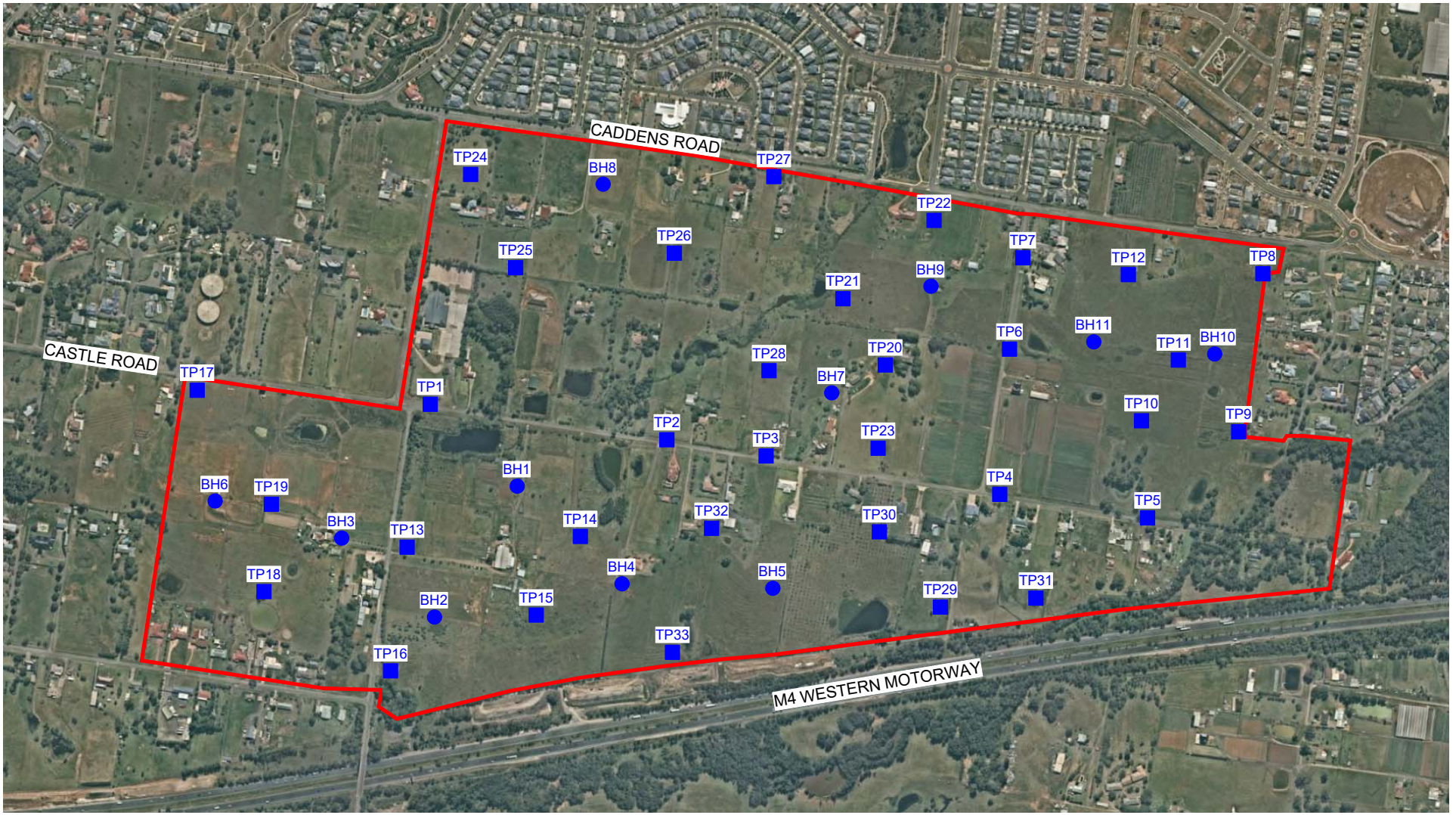
References

1. *Australian Standard, AS1726-2017: Geotechnical Site Investigation*
2. *Australian Geomechanics - "Practice Note Guidelines for Landslide Risk Management (2007)"*
3. *Australian Standard AS3798-2007: Guidelines on Earthworks for Commercial and Residential Developments*
4. *Australian Standard AS2870-2011: Residential Slabs and Footings*
5. *Austroads Guide to Pavement Technology, Part 2: Pavement Structural Design (2008)*
6. *Fell, R., MacGregor, P and Stapledon, D., Geotechnical Engineering of Embankment Dams, 1992.*
7. *Lillicrap, A and McGhie, S., Site Investigation for Urban Salinity, Department of Land and Water Conservation, 2002.*
8. *Australian Standard AS2159-1995: Piling – Design and Installation*

DRAWINGS

Drawing No	*14447/1-AA1*	*Locations of Test Pits and Boreholes*



Imagery ©2019 NearMap.com

LEGEND

Borehole Test Pit

0 100 200 300 400 500m

Scale 1:10,000

GEOTECHNIQUE® PTY LTD
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NOTES

1. Site features are indicative and are not to scale.
2. This drawing has been produced using a base plan provided by others to which additional information e.g test pits, borehole locations or notes have been added. Some or all of the plan may not be relevant at the time of producing this drawing

Legacy Property
Proposed Residential Development
Castle Road
Orchard Hills North

Borehole and Test Pit Locations

Drawing No: 14447/1-AA1
Job No: 14447/1
Drawn By: MH
Date: 16 May 2019
Checked By: AI

File No: 14447-1
Layers: 0, AA1

APPENDIX A

ENGINEERING LOGS

GEOTECHNIQUE
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engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH1
Date : 30/04/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 74.025

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
								SC	Silty Clayey SAND, fine to medium grained, brown	M	MD		Residual
					N=30 3,5,22	0.5							
	DRY				N=R 19/100	1			SANDSTONE, fine to medium grained, grey-brown, extremely to distinctly weathered, very low to low strength				Bedrock
									Strated coring at 1.1m				
						1.5							
						2							
						2.5							
						3							
						3.5							
						4							
						4.5							

GEOTECHNIQUE
PTY LTD

engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH1
Date : 30/04/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 74.025

core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
		1		Started coring at 1.1m					
		1.5		SANDSTONE, fine to medium grained, brown, with clay bands	DW	L			J=0°, Pl, Sn, Cg J=0°, Pl, Sn, Cg Bp=0°, Pl, Ro, Sn J=70°, Ir, Ro, Sn J=90°, Un, Ro, Sn Bp=0°, Pl, Sn, Cg J=0°, Pl, Sn, Cg Bp=0°, Pl, Ro, Cg
		2							J=0°, Pl, Ro, Sn
		2.5		SANDSTONE, fine to medium grained, grey	DW-SW	M			Bp=0°, Un, Ro, Cg J=90°, Pl, Ro, Sn
		3		SANDSTONE, fine to medium grained, brown, with clay bands	EW-DW	L			J=o°, Un, Ro, Sn Bp=0°, Pl, Sn, Cg
		3.5							Bp=0°, Ir, Ro, Sn
		4							Bp=0°, Un, Ro, Sn Bp=0°, Un, Ro, Sn
		4.5							J=90°, Un, Ro, Cg J=0°, Pl, Sn, Cg
		5							Bp=0°, Pl, Ro, Sn
		5.5							J=90°, Ir, Sn, Cg J=90°, Ir, Sn, Cg

GEOTECHNIQUE
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engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH1
Date : 30/04/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 74.025

core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 600 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
		6		Interbedded MUDSTONE AND SILTSTONE, brown and grey, with clay bands	EW	L			Bp=0°, Pl, Ro, Cg Bp=0°, Ir, Ro, Sn J=90°, Pl, Sn, Cg J=0°, Un, Ro, Sn Bp=0°, Un, Ro, Cg
		6.5							Bp=0°, Un, Ro, Sn
		7							
		7.5		SHALE, grey ironstained, with clay bands	EW-DW	VL-L			Bp=0°, Pl, Sn, Cg J=0°, Un, Ro, Sn Bp=0°, Pl, Sn, Cg J=0°, Un, Ro, Sn
		8							
		8.5							Bp=0°, Pl, Sn, Cg
		9		BH1 terminated at 8.9m					Bp=0°, Pl, Ro, Sn, Sn
		9.5							
		10							

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Job No 14447/1 BH1 Started Coring at 1.1m

BH1 terminated at 8.9m

GEOTECHNIQUE
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engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH2
Date : 30/04/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 78.477

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			TOPSOIL: Silty Sand, fine grained, brown, with grass roots				
								SC	Silty SAND, fine grained, brown	M	MD		Residual
					N=13 3,5,5	0.5							
								CL-CI	Silty Sandy CLAY, low to medium plasticity, brown	M<PL	St-VSt		
					N=R 9,17,12/ 50	1							
									SANDSTONE, fine grained, grey-brown, extremely to distinctly weathered, very low to low strength, with clay bands				Bedrock
						1.5							
						2							
					N=R 11/100	2.5							
						3			SANDSTONE, fine grained, grey, distinctly weathered, low strength				
						3.5							
						4			SANDSTONE, fine to medium grained, grey, distinctly to slightly weathered, medium strength				
						4.5							

GEOTECHNIQUE
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engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH2
Date : 30/04/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 78.477

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
	DRY					5			Strated coring at 5.0m				
						5.5							
						6							
						6.5							
						7							
						7.5							
						8							
						8.5							
						9							
						9.5							

GEOTECHNIQUE
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engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH2
Date : 30/04/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 78.477
core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
				Started coring at 5.0m					
		5		SANDSTONE, fine to medium grained, grey, ironstained	DW-SW	M			J=0°, Ir, Ro, Sn
		5.5							Bp=0°, Pl, Sn, Cg J=0°, Pl, Ro, Sn Bp=20°, Un, Ro, Sn
		6							Bp=10°, Pl, Ro, Cg
		6.5		SANDSTONE, fine grained, grey	SW	M			Bp=10°, Pl, Ro, Sn Bp=10°, Pl, Ro, Sn
		7							
		7.5							Bp=0°, Pl, Ro, Sn
		8		BH2 terminated at 8.0m					
		8.5							
		9							
		9.5							

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Job No 14447/1 BH2 Started Coring at 5.0m

5.0m
6.0m
7.0m

BH2 terminated at 8.0m

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engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH3
Date : 30/04/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 82.753

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			FILL: Mixture of roadbase gravel and Sandy Clay	M<OMC			Well compacted
								SC	Clayey SAND, fine to medium grained, orange and grey	M	D		
					N=33 4,10,23	0.5							
						1			SANDSTONE, fine to medium grained, brown and grey, extremely to distinctly weathered, very low to low strength, with clay bands				Bedrock
						1.5							
						2			SANDSTONE, fine to medium grained, grey and brown, distinctly weathered, very low to low strength, with ironstone/siltstone bands				
	DRY					2.5							
						3							
						3.5			Started coring at 3.5m				
						4							
						4.5							

GEOTECHNIQUE
PTY LTD

engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH3
Date : 30/04/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 82.753

core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
				Started coring at 3.5m					
		3.5		SANDSTONE, fine to medium grained, grey ironstained	DW-SW	M-H			J=10°, Un, Ro, Sn J=0°, Un, Ro, Sn J=0°, Pl, Ro, Sn
		4							J=20°, Pl, Ro, Sn
		4.5							
		5							Cs=110mm J=0°, Un, Ro, Sn
		5.5							
		6							J=60°, Pl, Ro, Cg
		6.5							
		7		BH3 terminated at 7.0m					
		7.5							
		8							

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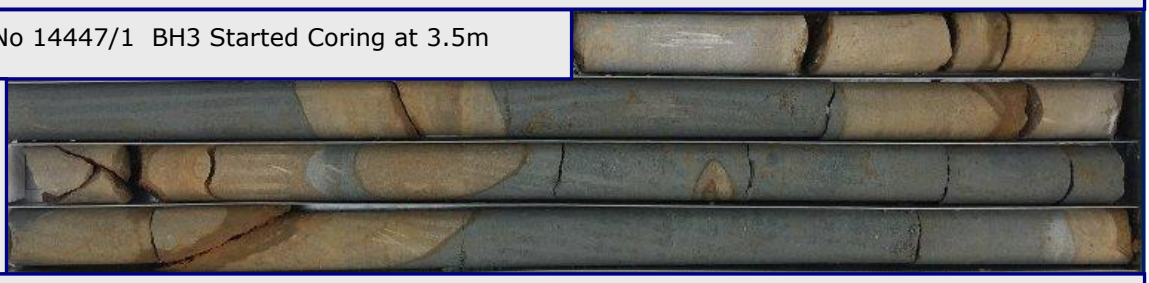
Job No 14447/1 BH3 Started Coring at 3.5m



BH3 terminated at 7.0m

GEOTECHNIQUE
PTY LTD

engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH4
Date : 01/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 75.497

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
					N=49 1,11,37	0.5		SC	Silty Clayey SAND, fine to medium grained, brown	M	MD		Residual
	DRY					1			SANDSTONE, fine grained, grey, extremely to distinctly weathered, low to medium strength, with clay bands				Bedrock
						1.5			Started coring at 1.3m				
						2							
						2.5							
						3							
						3.5							
						4							
						4.5							

GEOTECHNIQUE
PTY LTD

engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH4
Date : 14/05/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 75.497
core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
				Started coring at 1.3m					
		1.5		SANDSTONE, fine to medium grained, brown	DW-SW	M-H			Cs=140mm J=40°, Un, Ro, Is
		2							J=0°, Pl, Ro, Sn J=0°, Pl, Ro, Sn
		2.5							J=0°, Un, Ro, Sn
		3							
		3.5							J=0°, Un, Ro, Sn J=0°, un, Ro, Sn
		4							J=30°, Un, Ro, Sn J=60°, Un, Ro, Sn
		4.5							J=0°, Un, Ro, Sn J=0°, Un, Ro, Sn
		5							J=0°, Pl, Ro, Sn
		5.5							Cs=110mm J=30°, Pl, Ro, Sn J=0°, Pl, Ro, Sn
				SANDSTONE, fine to medium grained, grey	SW-	M-H			

GEOTECHNIQUE
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engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH4
Date : 14/05/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 75.497
core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 600 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
		6			FR				
		6.5		BH4 terminated at 6.4m					
		7							
		7.5							
		8							
		8.5							
		9							
		9.5							
		10							
		10.5							

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Job No 14447/1 BH4 Started Coring at 1.3m

GEOTECHNIQUE
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engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH5
Date : 01/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 64.336

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
								CI	Silty Sandy CLAY, medium plasticity, brown	M<PL	St-VSt		Residual
					N=18 3,5,10	0.5							
						1		CL-CI	Silty CLAY, low to medium plasticity, grey and brown, with gravels	M<PL	H		Possible fill
					N=30 6,13,11	1.5							
						2							
						2.5		CI	Silty CLAY, medium plasticity, grey and brown, with ironstone/shale gravels	M<PL	H		
					N=28 9,9,10	3							
						3.5			SHALE/MUDSTONE, grey-brown, extremely to distinctly weathered, very low to low strength, with interbedded siltstone, sandstone and clay bands				Bedrock
					N=73 10,32,31	4							
						4.5							

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engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH5
Date : 01/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 64.336

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
	DRY				N=R 39/150	5 5.5 6 6.5 7							
					N=R 22/140	7 7.5 8 8.5 9 9.5			Started coring at 7.1m				

GEOTECHNIQUE
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engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH5
Date : 01/05/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 64.336

core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
		7		Started coring at 7.1m					
		7.5 8		Interbedded SHALE, MUDSTONE, SILTSTONE, fine grained SANDSTONE, grey and brown, with ironstone and clay bands	EW-DW	VL-L	×		Cs=40mm J=0°, Pl, Sm, Sn J=0°, Ir, Sm, Cg Cs=50mm Cs=300mm
		8.5 9 9.5 10 10.5 11 11.5		BH5 terminated at 8.4m					

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Job No 14447/1 BH5 Started Coring at 7.1m

7.0m	7.1m	
8.0m		BH5 terminated at 8.4m

GEOTECHNIQUE PTY LTD

engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH6
Date : 01/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 86.597

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			TOPSOIL: Silty Sandy Clay, low plasticity, brown				
								CI	Silty CLAY, medium plasticity, brown, with ironstone gravel	M<PL	H		Residual
					N=64 21,22,21	0.5			SANDSTONE, fine to medium grained, brown, red and grey, extremely to distinctly weathered, very low to low strength, with ironstone and clay bands				Bedrock
					N=37 6,17,14	1							
						1.5							
						2							
					N=R 27/150	2.5							
						3			SANDSTONE, fine to medium grained, brown-red, disSCtinctly weathered, low to medium strength, with ironstone bands				
	DRY					3.5							
						4			Started coring at 4.0m				
						4.5							

GEOTECHNIQUE
PTY LTD

engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH6
Date : 01/05/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 86.597
core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
				Started coring at 4.0m					
		4		SANDSTONE, fine to medium grained, red-brown	DW	M			J=0°, Ir, Ro, Cg J=10°, Pl, Ro, Sn
		4.5							
		5							
		5.5							J=0°, Pl, Ro, Sn J=20°, Un, Ro, Sn
		6		SANDSTONE, fine to medium grained, grey	SW	L-M			Sh=40mm
		6.5							
		7		BH6 terminated at 6.85m					
		7.5							
		8							
		8.5							

GEOTECHNIQUE
PTY LTD

Job No 14447/1 BH6 Started Coring at 4.0m

4.0m
5.0m
6.0m

6.85m

BH6 terminated at 6.85m

GEOTECHNIQUE
PTY LTD

engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH7
Date : 02/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 71.177

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
								CL-CI	Silty CLAY, low to medium plasticity, brown, with shale gravels	M<PL	St-VSt		Residual
					N=19 3,7,9	0.5							
					N=63 21,20,22	1			SANDSTONE, fine to medium grained, brown-grey, extremely to distinctly weathered, low strength, with ironstone and clay bands				Bedrock
					N=R 16/150	1.5							
						2							
						2.5							
						3							
						3.5							
						4							
						4.5							

GEOTECHNIQUE
PTY LTD

engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH7
Date : 02/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 71.177

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
	DRY					5							
						5.5			Started coring at 5.5m				
						6							
						6.5							
						7							
						7.5							
						8							
						8.5							
						9							
						9.5							

GEOTECHNIQUE
PTY LTD

engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH7
Date : 02/05/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 71.177

core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
				Started coring at 5.5m					
		5.5		SANDSTONE, fine to medium grained, brown then grey	DW-SW	M-H			J=0°, Pl, Ro, Sn
									J=0°, Pl, Ro, Sn
		6							
									J=0°, Un, Ro, Sn
		6.5							
		7							
		7.5							J=0°, Pl, Ro, Sn
				SHALE, grey	DW	L			
		8							
				BH7 terminated at 8.2m					
		8.5							
		9							
		9.5							
		10							

GEOTECHNIQUE
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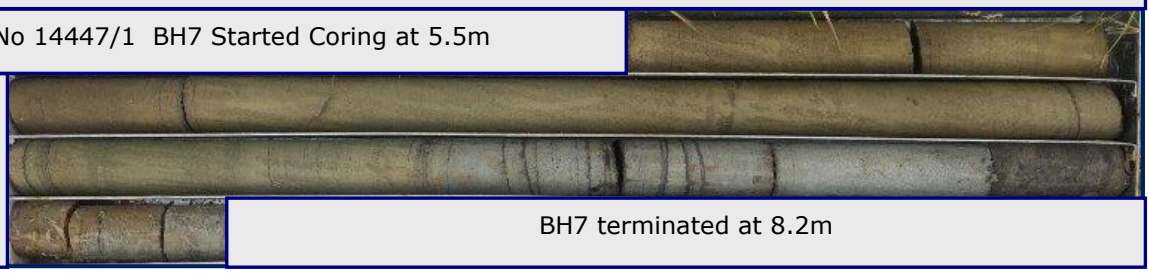
Job No 14447/1 BH7 Started Coring at 5.5m



6.0m

7.0m

8.0m

BH7 terminated at 8.2m

GEOTECHNIQUE
PTY LTD

engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH8
Date : 02/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 77.605

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
								CL-CI	Silty CLAY, low to medium plasticity, brown	M<PL	St		Residual
					N=9 4,4,5	0.5							
					N=R 10/90	1			SANDSTONE, fine to medium grained, brown and grey, extremely to distinctly weathered,very low to low strength				Bedrock
	DRY					1.5							
						2							
						2.5							
						3			Started coring at 3.0m				
						3.5							
						4							
						4.5							

GEOTECHNIQUE
PTY LTD

engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH8
Date : 02/05/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 77.605

core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
				Started coring at 3.0m					
		3		SANDSTONE, fine to medium grained, grey and brown, with interbedded ironstone and shale layers	DW	L-M	×		J=0°, Un, Ro, sn
		3.5							J=0°, Pl, Ro, Sn J=0°, Pl, Ro, Cg
		4					×		J=0°, Un, Ro, Sn J=0°, Pl, Ro, Cg
									J=60°, Un, Ro, sn j=0°, Pl, Ro, Sn
		4.5							J=0°, Pl, Ro, Sn
		5					×		
		5.5							J=20°, Un, Ro, sn J=30°, Un, Ro, Sn
		6							J=0°, Un, Ro, Sn
							×		J=0°, Pl, Ro, Sn
		6.5							J=10°, Un, Ro, Sn J=0°, Un, Ro, Sn
									J=0°, Pl, Ro, Sn
		7					×		J=0°, Un, Ro, Sn J=0°, un, Ro, Sn
		7.5		BH8 terminated at 7.2m					

GEOTECHNIQUE
PTY LTD

Job No 14447/1 BH8 Started Coring at 3.0m

3.0m
4.0m
5.0m
6.0m
7.0m

BH8 terminated at 7.2m

GEOTECHNIQUE
PTY LTD

engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH9
Date : 02/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 64.031

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
					N=14 3,5,6	0.5		CL-CI	Silty Sandy CLAY, low to medium plasticity, brown	M<PL	St-VSt		Residual
					N=29 6,11,12	1		CI	Silty CLAY, medium plasticity, brown, with shale gravels	M<PL	VSt		
					N=25 5,9,11	1.5							
						2			SHALE, grey, extremely to distinctly weathered, very low to low strength, with ironstone and clay bands				Bedrock
						2.5							
						3							
						3.5							
					N=R 16/110	4							
						4.5							

GEOTECHNIQUE
PTY LTD

engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH9
Date : 02/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 64.031

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
	DRY					5							
						5.5			Started coring at 5.5m				
						6							
						6.5							
						7							
						7.5							
						8							
						8.5							
						9							
						9.5							

GEOTECHNIQUE
PTY LTD

engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH9
Date : 02/05/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 64.031
core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS: defect spacing (mm) 2000 1000 500 300 100 50	DEFECT DETAILS: DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific	General
				Started coring at 5.5m						
		5.5		SHALE, grey, with clay bands	EW-DW	VL-L			J=0°, Pl, Ro, Sn	
									J=0°, Un, Ro, Sn	
		6							J=0°, Un, Ro, Sn	
									J=0°, Un, Ro, Sn	
									J=45°, Un, Ro, Sn	
									J=0°, Un, Ro, Sn	
		6.5							Cs=120mm	
									J=0°, Pl, Ro, Sn	
									Cs=60mm	
									J=0°, Pl, Ro, Sn	
		7							Cs=40mm	
									J=0°, Pl, Ro, Sn	
									J=0°, Un, Ro, Cg	
		7.5							Cs=40mm	
									J=0°, Un, Ro, Sn	
		8							J=0°, Pl, Ro, Sn	
				BH9 terminated at 8.3m						
		8.5								
		9								
		9.5								
		10								

GEOTECHNIQUE
PTY LTD

Job No 14447/1 BH9 Started Coring at 5.5m

6.0m

7.0m

8.0m

BH9 terminated at 8.3m

GEOTECHNIQUE
PTY LTD

engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH10
Date : 03/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 60.408

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
								CL-CI	Silty CLAY, low to medium plasticity, brown, with gravels	M<PL	St-VSt		Residual
					N=31 7,12,12	0.5							
					N=41 10,15,16	1			SHALE, grey-brown, extremely to distinctly weathered, very low to low strength, with interbedded sandstone and clay bands				Bedrock
						1.5							
						2							
					N=37 2,10,25	2.5							
						3							
						3.5							
					N=R 16/100	4							
						4.5							

GEOTECHNIQUE
PTY LTD

engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH10
Date : 03/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 60.408

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
	DRY					5							
						5.5			Started coring at 5.5m				
						6							
						6.5							
						7							
						7.5							
						8							
						8.5							
						9							
						9.5							

GEOTECHNIQUE
PTY LTD

engineering log
cored borehole

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH10
Date : 03/05/2019
Logged/Checked by : NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 60.408

core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
				Started coring at 5.5m					
		5.5		SHALE/MUDSTONE, grey, with ironstone and clay bands	EW-DW	VL-L			j=0°, Un, Ro, Sn
									J=0°, Pl, Ro, Sn
									J=0°, Pl, Ro, Sn
		6							
									J=45°, Pl, Ro, Sn
		6.5							Cs=50mm
									J=20°, Un, Ro, Sn
		7							J=0°, Pl, Ro, Cg
									J=45°, Un, Ro, Sn
									J=0°, Pl, Ro, Sn
		7.5							Cs=40mm
									J=0°, Pl, Ro, Sn
				BH10 terminated at 7.85m					
		8							
		8.5							
		9							
		9.5							
		10							

GEOTECHNIQUE
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Job No 14447/1 BH10 Started Coring at 5.5m

6.0m

7.0m

7.85m

BH10 terminated at 7.85m

GEOTECHNIQUE
PTY LTD

engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH11
Date : 03/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 70.596

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
					N=16 3,7,6	0.5		CL-CI	Silty Sandy CLAY, low to medium plasticity, brown and grey	M<PL	St-VSt		Residual
					N=R 23/150	1			SANDSTONE/MUDSTONE, grey-brown, extremely to distinctly weathered, very low to low strength				Bedrock
						1.5							
						2							
						2.5							
						3							
						3.5							
						4							
						4.5							

GEOTECHNIQUE
PTY LTD

engineering log - borehole

Client : LEGACY PROPOERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No. : 14447/1
Borehole No. : BH11
Date : 03/05/2019
Logged/Checked by: NK/AI

drill model and mounting : TRACK MOUNTED **slope :** **deg.** **R.L. surface :** 70.596

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
	DRY					5 5.5 6 6.5 7 7.5							
						7.5			BH11 terminated at 7.5m				
						8 8.5 9 9.5							

GEOTECHNIQUE PTY LTD

engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP1
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 68.13
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
							CI-CH	Silty CLAY, medium to high plasticity, red-brown	M<PL	VSt-H		Residual
			DS		0.5							
					1		CH	Silty CLAY, high plasticity, grey	M<PL	H		
DRY			DS		1.5							
					2							
								TP1 terminated at 2.3m				
					2.5							
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE PTY LTD

engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP2
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 63.62
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
							CI-CH	Silty CLAY, medium to high plasticity, red-brown and grey	M<PL	VSt-H		Residual
			DS		0.5							
					1							
							H	Silty CLAY, high plasticity, red-grey, with ironstone gravels	M<PL	H		
			DS		1.5							
					2							
					2.5							
DRY			DB									
					3			TP2 terminated at 2.9m				
					3.5							
					4							
					4.5							

GEOTECHNIQUE PTY LTD

engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP3
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 70.27
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
							CI	Silty CLAY, medium plasticity, brown	M<PL	VSt-H		Residual
					0.5							
					1							
			DS									
					1.5							
							CH	Silty CLAY, high plasticity, brown	M<PL	H		
			DS		2							
DRY					2.5			TP3 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE PTY LTD

engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP4
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 45.87
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
DRY			DS		0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
					0.5		CI	Silty Sandy CLAY, medium plasticity, brown	M<PL	VSt-H		Residual
			DS		1		CH	Silty CLAY, high plasticity, brown	M<PL	H		
					1.5							
			DS		2							
					2.5			TP4 terminated at 2.3m				
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE
PTY LTD

engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP5
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 40.04
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
							CH	Silty CLAY, high plasticity, brown-grey	M<PL	H		Residual
			DS		0.5							
					1							
					1.5							
			DS		2		CI-CH	Silty CLAY, medium to high plasticity, brown, with ironstone gravels	M<PL	VSt-H		
DRY					2.5			TP5 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP6
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 55.25
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
DRY					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
							CI-CH	Silty CLAY, medium to high plasticity, brown, with ironstone gravels	M<PL	VSt-H		Residual
			DS		0.5							
					1							
							CI	Silty CLAY, medium plasticity, brown	M<PL	VSt		
			DS		1.5							
					2							
					2.5			TP6 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE PTY LTD

engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP7
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 69.31
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
DRY			DS		0.5		SC	Silty Clayey SAND, fine to medium grained, brown, with ironstone gravels	M	MD		Residual
					1.5			TP7 terminated at 1.5m due to refusal on IRONSTONE/ SANDSTONE bedrock				Bedrock

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP8
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 48.31
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
							CI	Silty CLAY, medium plasticity, brown, with ironstone gravels	M<PL	VSt-H		Residual
			DS		0.5							
					1							
					1.5		CH	Silty CLAY, high plasticity, grey mottled red, with ironstone gravels	M<PL	H		
DRY			DS		2							
								TP8 terminated at 2.2m				
					2.5							
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP9
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 41.26
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
					0.5		CI	Silty CLAY, medium plasticity, brown	M<PL	VSt-H		Residual
					1		CH	Silty CLAY, high plasticity, brown	M<PL	H		
DRY			DS		1.5							
					2							
					2.5			TP 9 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP10
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 48.57
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
					0.5		CI-CH	Silty CLAY, medium to high plasticity, brown	M<PL	VSt-H		Residual
			DS		1							
					1.5		CI	Silty CLAY, medium plasticity, grey-brown, with shale and ironstone gravels/ layers interbedded	M<PL	VSt		
DRY			DS		2							
					2.5			TP 10 termninated at 2.5m				
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP11
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 62.52
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
							CL-CI	Silty Sandy CLAY, low to medium plasticity, brown	M<PL	St-VSt		Residual
					0.5							
					1		CI	Silty CLAY, medium plasticity, brown, with shale and ironstone gravels/ layers interbedded	M<PL	VSt-H		
DRY			DS		1.5							
					2							
					2.5			TP11 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP12
Date : 08/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 60.22
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
					0.5		CL-CI	Silty Sandy CLAY, low to medium plasticity, brown	M<PL	St-VSt		Residual
			DS		1							
					1.5							
					2		CH	Silty Clay, high plasticity, grey, with shale gravels	M<PL	VSt-H		
			DS		2.5							
			DB									
DRY					3			TP12 terminated at 3.0m				
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP13
Date : 09/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 72.87
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
							CI	Silty Sandy CLAY, medium plasticity, brown, with ironstone gravels	M<PL	VSt		Residual
			DS		0.5							
					1							
					1.5		CH	Silty CLAY, high plasticity, brown, with ironstone gravels	M<PL	H		
DRY			DS		2							
					2.5							
								TP13 terminated at 2.8m				
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP14
Date : 09/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 68.68
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
DRY			DS		0.5 1 1.5 2		CI-CH	Silty Sandy CLAY, medium to high plasticity, brown	M<PL	VSt-H		Residual
					2.5			TP 14 terminated at 2.5m				
					3 3.5 4 4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP15
Date : 09/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 76.67
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
DRY			DS		0.5		SC	Silty Clayey SAND, fine to medium grained, brown	M	MD		Residual
					1							
					1.5			TP15 terminated at 1.3m due to refusal on IRONSTONE/ SANDSTONE bedrock				Bedrock
					2							
					2.5							
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP16
Date : 09/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 66.30
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
							SC	Silty Clayey SAND, fine to medium grained, brown	M	MD		Residual
			DS		0.5							
					1							
					1.5		CH	Silty CLAY, medium to high plasticity, grey, with shale gravels	M<PL	VSt-H		
DRY			DS		2							
					2.5			TP16 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP17
Date : 09/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 83.57
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
DRY			DS		0.5		SC	Silty Clayey SAND, fine to medium ghrained, brown, with ironstone and sandstone gravels/ layers interbedded	M	MD		Residual
					1							
					1.5							
								TP17 terminated at 1.7m due to refusal on IRONSTONE/ SANDSTONE bedrock				Bedrock
					2							
					2.5							
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP18
Date : 09/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 68.94
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
DRY					0.5		SC	Silty Clayey SAND, fine to medium grained, brown, with ironstone and sandstone gravels/ layers interbedded	M	MD		Residual
					1.5			TP18 terminated at 1.5m due to refusal on IRONSTONE/ SANDSTONE bedrock				Bedrock
					2							
					2.5							
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP19
Date : 09/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 85.15
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
DRY			DS		0.5 1 1.5		SC	Silty Clayey SAND, fine to medium grained, brown	M	MD		Residual
					2 2.5 3 3.5 4 4.5			TP19 terminated at 1.8m due to refusal on IRONSTONE/ SANDSTONE bedrock				Bedrock

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP20
Date : 09/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 69.85
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
DRY			DS DB		0.5 1 1.5		SC	Silty Clayey SAND, fine to medium grained, brown	M	MD		Residual
					2 2.5 3 3.5 4 4.5			TP20 terminated at 1.8m due to refusal on IRONSTONE/ SANDSTONE bedrock				Bedrock

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP21
Date : 09/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 58.06
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
DRY					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
							CI	Silty CLAY, medium plasticity, brown and orange	M<PL	VSt		Residual
			DS		0.5							
					1							
					1.5							
			DS				CH	Silty CLAY, high plasticity, brown-grey and orange, with shale gravels	M<PL	VSt-H		
					2							
					2.5			TP21 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP22
Date : 09/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 58.07
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
							CH	Silty CLAY, high plasticity, red-brown	M<PL	H		Residual
					0.5							
					1							
			DS		1.5							
					2		CI-CH	Silty CLAY, medium to high plasticity, grey and brown, with shale gravels	M<PL	VSt-H		
DRY			DB DS		2.5							
								TP22 terminated at 2.8m				
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP23
Date : 09/05/2018
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 62.86
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
			DS		0.5		CH	Silty CLAY, high plasticity, brown-yellow	M<PL	H		Residual
DRY			DS		1		CI-CH	Silty CLAY, medium to high plasticity, brown, with sandstone and ironstone gravels/ layers interbedded	M<PL	VSt-H		
								TP23 terminated due to refusal on IRONSTONE/ SANDSTONE bedrock				Bedrock
					1.5							
					2							
					2.5							
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP24
Date : 10/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 80.96
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
DRY			DS		0.5		CL-CI	Silty CLAY, low to medium plasticity, brown, with sandstone and ironstone gravels/ layers interbedded	M<PL	St-VSt		
					1			TP24 terminated at 0.8m due to refusal on IRONSTONE/ SANDSTONE bedrock				Bedrock
					1.5							
					2							
					2.5							
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE PTY LTD

engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP25
Date : 10/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 76.72
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
DRY			DS		0.5		SC	Silty Clayey SAND, fine to medium grained, brown, with sandstone and ironstone gravels/ layers interbedded	M	MD		Residual
					1			TP25 terminated at 0.8m due to refusal on IRONSTONE/ SANDSTONE bedrock				Bedrock
					1.5							
					2							
					2.5							
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP26
Date : 10/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 70.41
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
DRY			DS		0.5		SC	Silty Clayey SAND, fine to medium grained, brown and orange, with ironstone and sandstone gravels/ layers interbedded	M	MD		Residual
					1							
					1.2			TP26 terminated at 1.2m due to refusal on IRONSTONE/ SANDSTONE bedrock				Bedrock
					1.5							
					2							
					2.5							
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP27
Date : 10/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 59.68
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
							CL-CI	Silty CLAY, low to medium plasticity, brown and yellow	M<PL	St-VSt		Residual
					0.5							
					1							
			DS		1.5							
							CI-CH	Silty CLAY, medium to high plasticity, grey, with shale gravels	M<PL			
			DS		2							
			DB		2.5							
DRY												
					3			TP27 terminated at 2.9m due to refusal on IRONSTONE/ SHALE bedrock				Bedrock
					3.5							
					4							
					4.5							

GEOTECHNIQUE PTY LTD

engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP28
Date : 10/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 60.62
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
							CL-CI	Silty Sandy CLAY, low to medium plasticity, brown-yellow	M<PL	St-VSt		Residual
			DS		0.5							
					1							
					1.5		CI-CH	Silty CLAY, medium to high plasticity, grey and yellow-brown, with shale gravels	M<PL	VSt-H		
DRY			DS		2							
					2.5							
								TP28 terminated at 2.6m				
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP29
Date : 10/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 45.59
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
							CI-CH	Silty CLAY, medium to high plasticity, brown	M<PL	VSt-H		Residual
					0.5							
					1							
			DS		1.5							
							CH	Silty CLAY, high plasticity, red-brown and grey	M<PL	H		
			DS		2							
			DB		2.5							
DRY												
								TP29 terminated at 2.8m				
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP30
Date : 10/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 58.49
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
							SC	Silty Clayey SAND, fine to medium grained, brown	M	MD		Residual
			DS		1.5							
DRY			DS		2		SC	Silty Clayey SAND, fine to medium grained, brown-grey and oragravelsnge, with shale and ironstone gravels/ layers interbedded	M	MD		
					3			TP30 terminated at 3.0m				

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP31
Date : 10/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 41.82
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low plasticity, brown, with grass roots				
					0.5		CI-CH	Silty CLAY, medium to high plasticity, brown	M<PL	VSt-H		Residual
			DS		1							
					1.5		CH	Silty CLAY, high plasticity, brown-yellow and grey, with ironstone gravels	M<PL	H		
			DS		2							
					2.5			TP31 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

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engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP32
Date : 10/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 73.05
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
DRY			DS		0.5		SC	Silty Clayey SAND, fine to medium grained, brow, with ironstone layers interbedded	M	MD		Residual
					1			TP32 terminated at 0.8m due to refusal on IRONSTONE/ SANDSTONE bedrock				Bedrock
					1.5							
					2							
					2.5							
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE PTY LTD

engineering log - excavation

Client : LEGACY PROPERTY
Project : PROPOSED RESIDENTIAL DEVELOPMENT
Location : CASTLE ROAD, ORCHARD HILLS NORTH

Job No : 14447/1
Pit No : TP33
Date : 10/05/2019
Logged/Checked by: NK/AI

Equipment type and model: BACKHOE
R.L. surface : 57.60
Excavation dimensions : 2.0 **m long** 0.45 **m wide**
datum : AHD

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Sandy Clay, low plasticity, brown, with grass roots				
DRY			DS		0.5		SC	Silty Clayey SAND, fine to medium grained, brown, with sandstone and ironstone gravels/ layers interbedded	M	MD		Residual
					1							
					1.5							
					2							
					2.5			TP33 terminated at 2.3m				
					3							
					3.5							
					4							
					4.5							

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Log Symbols & Abbreviations (Non-cored Borehole Log)

Log Column	Symbol/Value	Description
Drilling Method	V-bit TC-bit RR DB BB	Hardened steel 'V' shaped bit attached to auger Tungsten Carbide bit attached to auger Tricone (Rock Roller) bit Drag bit Blade bit
Groundwater	Dry  	Groundwater not encountered to the drilled or auger refusal depth Groundwater level at depths shown on log Groundwater seepage at depths shown on log
Environment Sample	GP G P	Glass bottle and plastic bag sample over depths shown on log Glass bottle sample over depths shown on log Plastic bag sample over depths shown on log
PID Reading	100	PID reading in ppm
Geotechnical Sample	DS DB U_{50}	Disturbed Small bag sample over depths shown on log Disturbed Bulk sample over depths shown on log Undisturbed 50mm tube sample over depths shown on log
Field Test	N=10 3,5,5 N=R 10,15/100	Standard Penetration Test (SPT) 'N' value. Individual numbers indicate blows per 150mm penetration. 'R' represents refusal to penetration in hard/very dense soils or in cobbles or boulders. The first number represents10 blows for 150mm penetration whereas the second number represents 15 blows for 100mm penetration where SPT met refusal
	DCP/PSP: 5 6 R/10	Dynamic Cone Penetration (DCP) or Perth Sand Penetrometer (PSP). Each number represents blows per 100mm penetration. 'R/10' represents refusal after 10mm penetration in hard/very dense soils or in gravels or boulders.
Classification	GP GW GM GC SP SW SM SC ML MI MH CL CI CH	Poorly Graded GRAVEL Well graded GRAVEL Silty GRAVEL Clayey GRAVEL Poorly graded SAND Well graded SAND Silty SAND Clayey SAND SILT / Sandy SILT / clayey SILT, low plasticity SILT / Sandy SILT / clayey SILT, medium plasticity SILT / Sandy SILT / clayey SILT, high plasticity CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, low plasticity CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, medium plasticity CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, high plasticity
Moisture Condition Cohesive soils Cohesionless soils	 M<PL M=PL M>PL D M W	 Moisture content less than Plastic Limit Moisture content equal to Plastic Limit Moisture content to be greater than Plastic Limit Dry - Runs freely through hand Moist - Tends to cohere Wet - Tends to cohere
Consistency Cohesive soils	 VS S F St VSt H	**Term** / **Undrained shear strength, C_u (kPa)** / **Hand Penetrometer (Qu)** Very Soft / ≤12 / <25 Soft / >12 & ≤25 / 25 – 50 Firm / >25 & ≤50 / 50 – 100 Stiff / >50 & ≤100 / 100 – 200 Very Stiff / >100 & ≤200 / 200 – 400 Hard / >200 / >400
Density Index Cohesionless soils	 VL L M D VD	**Term** / **Density Index, I_D (%)** / **SPT 'N' (blows/300mm)** Very Loose / ≤15 / ≤5 Loose / >15 & ≤35 / >5 & ≤10 Medium Dense / >35 & ≤65 / >10 & ≤30 Dense / >65 & ≤85 / >30 & ≤50 Very Dense / >85 / >50
Hand Penetrometer	100 200	Unconfined compressive strength (q_u) in kPa determined using pocket penetrometer, at depths shown on log
Remarks	 Residual Alluvium Colluvial Aeolian Marine	Geological origin of soils Residual soils above bedrock River deposited Alluvial soils Gravity deposited Colluvial soils Wind deposited Aeolian soils Marine Soils

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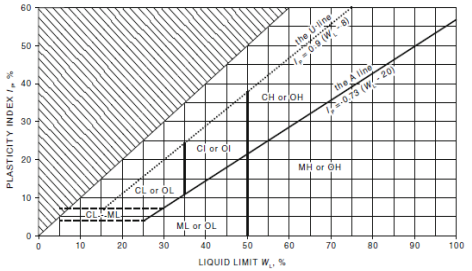
AS1726 : 2017– Unified Soil Classification System

Major Divisions		Particle size (mm)	Group Symbol	Typical Names	Field Identifications Sand and Gravels			Laboratory classification				
OVERSIZE	BOULDERS	>200						% Fines (2)	Plasticity of Fine Fraction	$C_u = D_{60}/D_{10}$	$C_c = (D_{30})^2/(D_{10}D_{60})$	Notes
	COBBLES	63										
COARSE GRAINED SOIL (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm)	Coarse 19	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength			≤5	-	>4	between 1 and 3	1. Identify lines by the method given for fine grained soils 2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.075mm size) is greater than 5% and less than 12%. Borderline classifications require the use of dual symbols e.g. SP-SM, GW-GC
		Medium 6.7	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength			≤5	-	Fails to comply with above		
			GM	Silty gravels, gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength			≥12	Below 'A' line or I_p<4	-	-	
		Fine 2.36	GC	Clayey gravels, gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength			≥12	Above 'A' line or I_p>7	-	-	
	SAND (more than half of coarse fraction is smaller than 2.36mm)	Coarse 0.6	SW	Well-graded sands, gravelly sands, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength			≤5	-	>6	between 1 and 3	
		Medium 0.21	SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength			≤5	-	Fails to comply with above		
			SM	Silty sands, sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength			≥12	Below 'A' line or I_p<4	-	-	
		Fine 0.075	SC	Clayey sand, sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength			≥12	Above 'A' line of I_p>7	-	-	
FINE GRAINED SOIL (more than 35% of soil excluding oversize fraction is less than 0.075mm)					**Dry Strength**	**Dilatancy**	**Toughness**					
	SILT (0.075mm to 0.002mm) & CLAY (<0.002mm) Liquid Limit<50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	None to low	Slow to rapid	Low	More than 35% passing 0.075mm	Below 'A' line			
			CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium to high	None to very slow	Medium		Above 'A' line			
			OL	Organic silts and organic silty clays of low plasticity	Low to medium	Slow	Low		Below 'A' line			
	SILT (0.075mm to 0.002mm) & CLAY (<0.002mm) Liquid Limit>50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Low to medium	None to slow	Low to medium		Below 'A' line			
			CH	Inorganic clays of medium to high plasticity, fat clays	High to very high	None	High		Above 'A' line			
			OH (1)	Organic clays of medium to high plasticity, organic silts	Medium to high	None to very slow	Low to medium		Below 'A' line			
	HIGHLY ORGANIC SOILS		Pt (1)	Peat and highly organic soils	Identified by colour, odour, spongy feel and generally by fibrous texture			Effervesces with H_2O_2				

Use the gradation of material passing 63mm for classification of fractions according to the criteria given in 'Major Divisions'



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Log Symbols & Abbreviations (Cored Borehole Log)

Log Column	Symbol / Abbreviation	Description	
Core Size		Nominal Core Size (mm)	
	NQ	47	
	NMLC	52	
	HQ	63	
Water Loss	◀	Complete water loss	
	◁	Partial water loss	
Weathering (AS1726:2017)	RS	Residual Soil	Material is 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
	XW	Extremely Weathered	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
	HW	Highly Weathered	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 recognizable. 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.
	MW	Moderately Weathered	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 recognizable, but shows little or no change of strength from fresh rock
	SW	Slightly Weathered	Rock is partially discoloured with staining or bleaching along joints but shows little or no change in strength from fresh rock
	FR	Fresh	Rock shows no sign of decomposition of individual minerals or colour changes
		Note : Where it is not possible to distinguish between HW and MW rock the term Distinctly Weathered (DW) may be used. DW is defined as 'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased by deposition of weathering products in pores'	
Strength (AS1726:2017)		**Term**	**Point Load Strength Index (I_{s50}, MPa)**
	VL	Very Low	≥0.03 ≤0.1
	L	Low	>0.1 ≤0.3
	M	Medium	>0.3 ≤1
	H	High	>1 ≤3
	VH	Very High	>3 ≤10
	EH	Extremely High	>10
Defect Spacing		**Description**	**Spacing (mm)**
		Extremely closely spaced	<20
		Very closely spaced	20 to 60
		Closely spaced	60 to 200
		Medium spaced	200 to 600
		Widely spaced	600 to 2000
		Very widely spaced	2000 to 6000
		Extremely widely spaced	>6000
Defect Description (AS1726:2017) Type			
	Pt	Parting	
	Jo	Joint	
	Sh	Sheared Surface	
	Sz	Sheared Zone	
	Ss	Sheared Seam	
	Cs	Crushed Seam	
	Is	Infilled Seam	
	Ews	Extremely Weathered Seam	
Macro-surface geometry	St	Stepped	
	Cu	Curved	
	Un	Undulating	
	Ir	Irregular	
	Pl	Planar	
Micro-surface geometry	Vro	Very Rough	
	Ro	Rough	
	Sm	Smooth	
	Po	Polished	
	Sl	Slickensided	
Coating or infilling	cn	clean	
	sn	stained	
	vn	veneer	
	cg	coating	

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AS1726 – Identification of Sedimentary Rocks for Engineering Purposes

Grain Size mm		Bedded rocks (mostly sedimentary)								
More than 20	20	Grain Size Description				At least 50% of grains are of carbonate			At least 50% of grains are of fine-grained volcanic rock	
	6	RUDACEOUS		CONGLOMERATE Rounded boulders, cobbles and gravel cemented in a finer matrix		LIMESTONE and DOLOMITE (undifferentiated)	Calcirudite		Fragments of volcanic ejecta in a finer matrix	SALINE ROCKS
	2			Breccia Irregular rock fragments in a finer matrix					Rounded grains AGGLOMERATE Angular grains VOLCANIC BRECCIA	Halite Anhydrite
	0.6	ARENACEOUS	Coarse	SANDSTONE Angular or rounded grains, commonly cemented by clay, calcite or iron minerals			Calcarenite		Cemented volcanic ash	Gypsum
	0.2		Medium	Quartzite Quartz grains and siliceous cement					TUFF	
	0.06		Fine	Arkose Many feldspar grains Greywacke Many rock chips						
	0.002	ARGILLACEOUS		MUDSTONE	SILTSTONE Mostly silt	Calcareous Mudstone	Calcisiltite	CHALK	Fine-grained TUFF	
	Less than 0.002			SHALE Fissile	CLAYSTONE Mostly clay		Calcilutite		Very fine-grained TUFF	
Amorphous or crypto-crystalline				Flint: occurs as hands of nodules in the chalk Chert: occurs as nodules and beds in limestone and calcareous sandstone						COAL LIGNITE
				Granular cemented – except amorphous rocks						
				SILICEOUS		CALCAREOUS			SILICEOUS	CARBONACEOUS
				SEDIMENTARY ROCKS Granular cemented rocks vary greatly in strength, some sandstones are stronger than many Igneous rocks. Bedding may not show in hand specimens and is best seen in outcrop. Only sedimentary rocks, and some metamorphic rocks derived from them, contain fossils Calcareous rocks contain calcite (calcium carbonate) which effervesces with dilute hydrochloric acid						

AS1726 – Identification of Metamorphic and Igneous Rocks for Engineering Purposes

Obviously foliated rocks (mostly metamorphic)		Rocks with massive structure and crystalline texture (mostly igneous)						Grain size (mm)
Grain size description			Grain size description	Pegmatite			Pyrosenite	More than 20
		MARBLE						20
	GNEISS Well developed but often widely spaced foliation sometimes with schistose bands	QUARTZITE		GRANITE	Diorite	GABBRO	Peridorite	6
COARSE		Granulite	COARSE	These rocks are sometimes phorphyritic and are then described, for example, as porphyritic granite				
	Migmatite Irregularly foliated: mixed schists and gneisses	HORNFELS						2
	SCHIST Well developed undulose foliation; generally much mica	Amphibolite		Micorgranite	Microdiorite			0.6
MEDIUM		Serpentine	MEDIUM	These rocks are sometimes phorphyritic and are then described as porphyries		Dolerite		0.2
								0.06
	PHYLLITE Slightly undulose foliation; sometimes 'spotted'			RHYOLITE	ANDESITE			0.002
FINE	SLATE Well developed plane cleavage (foliation)		FINE	These rocks are sometimes phorphyritic and are then described as porphyries		BASALT		Less than 0.002
	Mylonite Found in fault zones, mainly in igneous and metamorphic areas			Obsidian	Volcanic glass			Amorphous or cryptocrystalline
CRYSTALLINE				Pale<----------->Dark				
SILICEOUS		Mainly SILICEOUS		ACID Much quartz	INTERMEDIATE Some quartz	BASIC Little or no quartz	ULTRA BASIC	
METAMORPHIC ROCKS Most metamorphic rocks are distinguished by foliation which may impart fissility. Foliation in gneisses is best observed in outcrop. Non-foliated metamorphics are difficult to recognize except by association. Any rock baked by contact metamorphism is described as 'hornfels' and is generally somewhat stronger than the parent rock Most fresh metamorphic rocks are strong although perhaps fissile			IGNEOUS ROCKS Composed of closely interlocking mineral grains. Strong when fresh; not porous Mode of occurrence : 1 Batholith; 2 Laccoliths; 3 Sills; 4 Dykes; 5 Lava Flows; 6 Veins					

APPENDIX B

LABORATORY TEST RESULTS

GEOTECH TESTING PTY LTD ®
ABN 71 076 676 321

LEGACY PROPERTY
MLC CENTRE, LEVEL 27, 19-29 MARTIN PLACE
SYDNEY NSW 2000

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT, CASTLE ROAD, ORCHARD HILLS NORTH

CALIFORNIA BEARING RATIO TEST REPORT

CBR Test Procedure	Laboratory Compaction Method	Sampling Method	Date of Test
AS1289 6.1.1	AS1289 5.1.1	AS1289 1.2.1 Clause 6.5.4	20/05/2019
Job No: 14447/1	Tested By: SS	Checked By: AK	Lab Penrith

Laboratory Number	14447/1-1	14447/1-2	14447/1-3	14447/1-4
Drawing No	Test Pit 2 14447/1-AA1	Test Pit 12 14447/1-AA1	Test Pit 20 14447/1-AA1	Test Pit 22 14447/1-AA1
Sample No	1	2	3	4
Depth (m)	2.5 - 2.8	2.5 - 2.8	1.3 - 1.6	2.4 - 2.7
Date Sampled	10/05/2019	10/05/2019	10/05/2019	10/05/2019
Sample Description	(CH) Silty CLAY, high plasticity, red-brown & grey	(CH) Silty CLAY, high plasticity, grey	(SC) Silty Clayey SAND, fines of medium grained, brown	(CI) Silty CLAY, medium plasticity, grey & brown
Maximum Dry Density t/m3	1.73	1.72	1.80	1.82
Optimum Moisture Content %	19.6	17.4	15.0	17.5
Field Moisture Content %	17.0	13.2	10.2	16.3
% Retained 19mm	0	0	0	0
Excluded (Yes / No / Not Applicable)	Not Applicable	Not Applicable	Not Applicable	Not Applicable

CBR TEST RESULTS

Dry Density t/m^3	Before soaking	1.72	1.74	1.79	1.81
	After soaking	1.66	1.68	1.77	1.77
Density Ratio %	Before soaking	99.5	101	99.5	99.5
Moisture Content %	Before soaking	18.7	17.9	15.0	17.6
	After soaking	31.1	22.8	17.3	22.2
Moisture Ratio %	Before soaking	95.5	103	100	100.5
Number of Days Soaked		4	4	4	4
Surcharge	kg	6.75	6.75	6.75	6.75
Moisture Content after test %	Top 30mm	27.2	24.0	21.4	21.7
	Whole Sample	30.7	22.3	17.1	21.6
Swell after soaking %		4.0	4.0	1.0	2.0
Penetration mm		2.5	2.5	5.0	2.5
CBR VALUE %		**2.5**	**1.5**	**10**	**2.5**

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Corporate Site Number 2727

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Approved Signatory

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GEOTECH TESTING PTY LTD®
ABN 71 076 676 321

LEGACY PROPERTY
MLC CENTRE, LEVEL 27, 19-29 MARTIN PLACE
SYDNEY NSW 2000

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT, CASTLE ROAD, ORCHARD HILLS NORTH

CALIFORNIA BEARING RATIO TEST REPORT

CBR Test Procedure	Laboratory Compaction Method	Sampling Method	Date of Test
AS1289 6.1.1	AS1289 5.1.1	AS1289 1.2.1 Clause 6.5.4	20/05/2019
Job No: 14447/1	Tested By: SS	Checked By: AK	Lab Penrith

Laboratory Number		14447/1-5	14447/1-6		
Drawing No		Test Pit 27 14447/1-AA1	Test Pit 29 14447/1-AA1		
Sample No		5	6		
Depth (m)		2.5 - 2.8	2.2 - 2.5		
Date Sampled		10/05/2019	10/05/2019		
Sample Description		(CI-CH) Silty CLAY, medium to high plasticity, grey	(CI-CH) Silty CLAY, medium to high plasticity, red-brown & grey		
Maximum Dry Density	t/m3	1.64	1.68		
Optimum Moisture Content	%	20.4	19.4		
Field Moisture Content	%	18.3	17.2		
% Retained 19mm		0	0		
Excluded (Yes / No / Not Applicable)		Not Applicable	Not Applicable		
CBR TEST RESULTS					
Dry Density t/m^3	Before soaking	1.67	1.74		
	After soaking	1.64	1.73		
Density Ratio %	Before soaking	102	103.5		
Moisture Content %	Before soaking	20.6	18.6		
	After soaking	26.3	21.6		
Moisture Ratio %	Before soaking	101	96		
Number of Days Soaked		4	4		
Surcharge	kg	6.75	6.75		
Moisture Content after test %	Top 30mm	28.1	23.2		
	Whole Sample	25.9	21.0		
Swell after soaking	%	1.5	0.5		
Penetration	mm	2.5	2.5		
CBR VALUE	**%**	**2**	**4**		

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APPENDIX C

INDICATIVE MASTER PLAN – ORCHARD HILLS NORTH

Cadda Ridge Drive

O'Connell Lane

Caddens Road

Kingswood Road

Ulm Road

Castle Road

Castle Road

M4 WESTERN MOTORWAY

Kingswood Road

Indicative Master Plan

ORCHARD HILLS NORTH

NORTH

20 0 40 80 120 160 200 240 280 metres

Ref:	LEGOH-2-004-1	Date:	11/11/2021	Revision:	V	Scale:	1:2,000@A0

Note: All areas and dimensions subject to detailed survey

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