GEOTECHNICAL INVESTIGATION REPORT

87 – 91 NUWARRA ROAD, MOOREBANK NSW

PREPARED FOR
ST. GEORGE COMMUNITY HOUSING
REPORT ID: E17013MOR-R02F

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geotechnical • environmental • landfills

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1 PROJECT INFORMATION

1.1 INTRODUCTION AND OBJECTIVE

Geo-Environmental Engineering Pty Ltd (GEE) was commissioned by St George Community Housing (SGCH) to undertake a complete a geotechnical investigation at 87 – 91 Nuwarra Road, Moorebank New South Wales (herein referred to as the 'site'). The site covers an area of 2,010m^2 and comprises three allotments which are legally referred to as Lot 110 in Deposited Plan (DP) 235787 and Lots 5 and 6 in DP 236405. A site location map is provided as **Figure 1**, while a survey plan is provided in **Appendix A**.

The investigation relates to the proposed construction of a multi-storey residential apartment development on the site and was required to support a Development Application (DA) with Liverpool Council and to assist with the design and construction of the development.

The report presents the factual results of the field investigations and provides interpretation and recommendations regarding the ground conditions at the site in accordance with client requirements and the agreed scope of work.

1.2 PROPOSED DEVELOPMENT

As previously mentioned, the proposed development will comprise the construction a six storey residential development which is to be constructed on existing grade. In this regard GEE anticipated only minor earthworks including the removal of existing pavements and topsoil.

A copy of the site survey and Development Application plans are provided for reference in **Appendix A**.

1.3 SCOPE OF WORK

The scope of work undertaken by GEE, to satisfy the above objectives, was as follows:

- ◊ Dial Before You Dig (DBYD) desktop search for underground services,
- ◊ Visual appraisal of the site conditions and locality,
- ◊ Review of published geological and acid sulphate maps for the area,
- ◊ The excavation of test pits, drilling of boreholes and the performance Dynamic Cone Penetrometer (DCP) tests to assess the subsurface conditions,

- ◊ The collection of representative soil samples for the preliminary assessment of soil aggressivity, and
- ◊ Engineering assessment and reporting.

2 SITE INFORMATION

2.1 SITE DESCRIPTION

The site is bounded by Nuwarra Road to the east, a residential townhouse to the north, and by low-density residential dwellings elsewhere. The site covers a combined area of 2,013m^2 (by survey) and comprises three allotments which are legally referred to as:

- Lot 5 and Lot 6 in Deposited Plan (DP) 236405
- Lot 110 in DP 235787

At the time of the investigation, the centre of each allotment was occupied by a residential dwelling. At the rear of No. 89 was also a metal shed while there were two sheds at the rear of No. 91. A driveway extends along the southern boundary of each allotment, while the remaining site surface was predominantly covered by grass, with the exception of some concrete footpaths, shrubs and garden beds.

Photographs taken during the field investigation are provided in **Plate 1** to **Plate 4** for reference.

Plate 1 – View from Nuwarra Road, facing north-west, depicting No. 91

Plate 2 – View from Nuwarra Road, facing west, depicting No. 89

Plate 3 – View from Nuwarra Road, facing west, depicting No. 87

Plate 4 – View from Nuwarra Street, facing north, depicting front of site

Of particular significance to the proposed development is the presence of a Sydney Water Sewer Line which crosses the north-eastern portion of the site (**Appendix B**). However, this is the end of a sewer pipeline and therefore it is expected that the new development would simply connect the existing sewer at the site boundary. Discussions with Sydney Water are recommended.

2.2 TOPOGRAPHY

Spot heights available on the survey plan (**Appendix A**) indicate the site surface elevation is between approximately 25.8m and 27.5m AHD. The highest ground is in the south-eastern corner of the site, dipping towards the north, north-west with an average gradient of approximately 2%.

2.3 REGIONAL GEOLOGY AND SOILS

A review of the regional geological map (reference 1) indicates that the site is underlain by the Middle Triassic aged Bringelly Shale formation of the Wianamatta Group which typically consists of "*shale, carbonaceous claystone, claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff*". The site is also near the similarly aged Ashfield Shale formation, with Minchinbury Sandstone often found at the contact between Bringelly Shale and Ashfield Shale. Ashfield shale typically comprises dark grey to black claystone-siltstone and fine sandstone-siltstone laminite, while the Minchinbury sandstone formation typically comprises fine to medium grained lithic-quartz sandstone.

A review of the regional soils map indicates that the site is located within the Blacktown Soil Landscape Group (reference 2), recognised by gently undulating rises on the underlying shale formation. Local reliefs are up to 30m and slopes are usually less than

5% in gradient. Soils of the Blacktown Group typically comprise heavy clays that have been derived from the weathering process of shale bedrock, have low fertility and are often strongly acidic.

2.4 REGIONAL HYDROGEOLOGY

The regional and permanent groundwater in the vicinity of the site is expected to be confined or partly confined, discrete, water-bearing zones within the bedrock formation. However, intermittent 'perched' water seepage is likely to occur at the soil / bedrock interface following heavy and prolonged rainfall events.

Permanent groundwater associated with the Wianamatta group of Shale bedrock is characterised by high salinity (reference 3 and 4) and high ammonia concentrations (>10 mg/L, reference 5). In this regard, groundwater within the shale formation is not extracted for potable use and rarely extracted for any commercial / industrial purposes.

The rate of groundwater movement is likely to be low as a result of low relief, low altitude (approximately 27m AHD) and the low permeability of the Shale formation (between 10^{-13} and 10^{-9} m/sec – reference 6). Groundwater flow is dominated by water movement through fractures (or joints), where stress has caused partial loss of cohesion in the rock and evidence of potential water bearing fractures is usually the presence of clay or iron-staining along the face of the joints.

2.5 ACID SULFATE SOIL RISK

Acid Sulfate Soil is naturally occurring sediments and soils containing iron sulfides (principally iron sulfide, iron disulfide or their precursors). Oxidation of these soils through exposure to the atmosphere or through lowering of groundwater levels results in the generation of sulfuric acid.

Land that may contain potential acid sulfate soils was mapped by the NSW Department of Land and Water Conservation (DLWC) and based on these maps local Councils produced their own acid sulfate soil maps to be used for planning purposes.

The DLWC '*Liverpool'* Acid Sulfate Soil Risk Map (reference 7), indicates that the site lies within an area with no known occurrences of acid sulphate soil and land activities within this area are "...*not likely to be affected by acid sulphate soil materials*".

The Acid Sulfate Soils Map produced by the NSW Department of Planning and Environment, via interactive online mapping, indicates that the site lies outside of areas

defined as '*Class 1*' to '*Class 5*'. In this regard, there is no need for an acid sulphate soil assessment or management plan.

3 METHOD OF INVESTIGATION AND RESULTS

3.1 FIELDWORK METHODOLOGY

Fieldwork was undertaken on the 21st of June 2017 by Andy Chiem, a geotechnical engineer, and comprised:

- ◊ The drilling / excavation and logging of two boreholes (BH1 & BH2) and six testpits (TP1 to TP6) in accessible areas of the site to assess the soil conditions and depth to bedrock,
- ◊ The performance of DCPs adjacent to selected boreholes / test pits to assess the consistency and/or relative density of the soil profile and to assist with determining the depth to bedrock, and
- ◊ The collection of representative soil samples for the preliminary assessment of soil aggressivity.

The boreholes were drilled using an 85mm stainless steel hand auger and advanced through shallow to moderately deep fill (i.e. either imported material or disturbed soils) and natural (i.e. previously undisturbed) silty clay soil. The test pits were excavated using a 2T mini-excavator, owned and operated by the AB-11 Group, equipped with a 450mm wide bucket. The boreholes and test pits advanced to depths between 0.9m and 1.25m bgs before refusing on weathered siltstone / sandstone bedrock.

The DCP tests were performed adjacent to selected boreholes / test pits in accordance with Australian Standard 1289.6.3.2 (reference 8). The DCP tests refused at similar depth to their corresponding boreholes / test pits, inferring that the refusal of the DCP was caused when encountering the bedrock formation.

The location of the boreholes and testpits was estimated using measurements from existing features and is shown on **Figure 2**. A copy of the borehole/testpit logs is provided in **Appendix C**.

3.2 SUBSURFACE CONDITIONS

The site stratigraphy, as observed in the boreholes, typically comprised shallow to moderately deep fill, underlain by natural silty clay soil which graded into weathered siltstone or sandstone bedrock. Detailed descriptions of the subsurface conditions on site are provided in the borehole logs provided in **Appendix C**, while the soil profile is also summarised in **Table 1**.

Table 1: Summary of Subsurface Conditions

Layer / Unit	Description	Depth to Base of Layer (m)[1]	Consistency / Relative Density[1]
FILL	Silty SAND / Gravelly Clayey SAND: dark grey, fine to coarse grained, trace fine to coarse gravels, tile, brick, fibro	0.2 – 0.7	Loose
	Gravelly CLAY: grey / brown, medium to high plasticity, fine to medium gravels, sheet metal	1.0	Firm
NATURAL SOIL	Silty Gravelly SAND: grey-brown, low to medium plasticity, fine to coarse grained, fine to medium gravels, charcoal	0.45	Loose to medium dense
	Silty CLAY: light grey mottled orange, medium plasticity, some sand	1.0 – 1.25	Firm to stiff
BEDROCK	SILTSTONE / SANDSTONE:	>1.25	--

Note 1: Determined from the borehole and DCP observations

3.2.1 *Groundwater*

Permanent groundwater was not encountered during the drilling of the boreholes or the excavation of the testpits, and was also not encountered during the short time that they remained open. The only water encountered was minor seepage within testpits TP2 and TP4. Seepage within TP2 was observed at the base of the pit following completion and was assessed to be perched water flowing at the interface of soil and bedrock interface. Seepage observed at TP4 occurred within the fill unit littered with broken clay pipes. This water was also considered to be perched above the low permeable clay profile and recharged by rainfall events. Therefore its presence is intermittent.

3.3 LABORATORY TESTING

Representative samples of soil were collected from each borehole and submitted to Envirolab Services Pty Ltd (Envirolab) and for selective testing which included Sulphate, Chloride, resistivity and pH to determine the exposure classification of the soil with respect to buried structural concrete and unprotected steel.

The laboratory test results are presented in **Appendix D**[1]**,** while a summary of the results is provided in the following sub-sections.

To determine the aggressiveness of the soil and water environment on concrete or steel, the chemical test results are compared to Tables 6.1 and 6.3 from Section 6 of the Australian Standard AS 2159 (reference 9). This section provides assessment criteria to assess the 'exposure classification' for a concrete or steel pile. The Standard has two classes of soil conditions:

(A) high permeability soils below groundwater; and
(B) low permeability soils and all soils above groundwater.

For this site, all the soil samples are considered to be condition 'B'. Based on the chemical testing results, the standard provides a range of 'exposure classifications' from non-aggressive to very severe. For the range of chemical conditions in the soil surrounding the structure, the condition leading to the most severe aggressive conditions is adopted.

A summary of the soil results is provided in **Table 2**.

Table 2: Exposure classification (aggressivity) test results

Sample ID	Soil Condition	pH	Sulphate (SO_4) mg/kg	Chloride (Cl) mg/kg	Resistivity Ohm.cm
TP3 / 0.8 – 0.9	B	5.2	92	<10	17,000
TP6 / 0.5 – 0.6	B	5.2	130	20	11,000
BH1 / 0.6 – 0.7	B	5.5	65	<10	20,000
BH2 / 0.6 – 0.7	B	5.5	85	<10	16,000

The aggressivity potential of an environment on concrete is dependent on the sulphate and pH levels of the soil. Based on the limited number of test results above and taking into account the 'worst-case' sample, the subsurface profile is mildly-aggressive towards concrete. According to Australian Standard AS 3600-2009 (reference 10), specifically Table 4.8.1, this equates to an exposure classification of 'A2'.

[1] The laboratory report included results from a concurrent site contamination investigation and only the relevant geotechnical test results are included in Appendix D.

The corrosive potential of an environment on unprotected steel is normally dependent on pH, chloride, and resistivity levels of the soil. Based on the limited number of test results above and taking into account the 'worst-case' sample, the subsurface profile is considered to be non-aggressive / non-corrosive towards any unprotected steel.

4 DISCUSSION

4.1 SITE PREPARATION

Following demolition of the existing structures and prior to bulk excavation works, all topsoil with organic matter and any pavement materials, should be removed from the proposed building and pavement areas. Stripped topsoil should be stockpiled for re-use as landscape material, or disposed off-site.

Material removed from site will need to be managed in accordance with the provisions of current legislation and may include segregation by material type classification in accordance with NSW EPA (2014) Waste Classification Guidelines (reference 11) and disposal at facilities appropriately licensed to receive the particular materials. GEE notes that a fragment of bonded ACM was encountered within the fill at one location (TP4) and fill material impacted with ACM will be classified as 'Special Waste – Asbestos'. To minimise the amount of special waste it is considered prudent to delineate of the presence of ACM in the fill material.

GEE notes that the natural silty clay soil profile is expected to be susceptible to loss of strength when wet. In this regard, it may be necessary to construct a working platform above the prepared sub-grade in areas of high construction vehicle traffic, comprising a minimum of 150 mm of gravel or recycled concrete.

4.2 EARTHWORKS

GEE anticipates that only minor earthworks (if any) will be required during construction works to create the desired surface gradient and to avoid the ponding of stormwater at the surface. Any excavation works may be carried out using standard excavation equipment such as excavators without the need for rock-breaking equipment which may cause vibrations that can in turn impact on adjoining developments.

4.3 FOUNDATIONS

GEE recommends that footings be founded on a consistent medium, to minimise the potential for differential settlement. Given the relative consistency of the subsurface profile, the anticipated building loads and the relatively shallow depth to bedrock, GEE recommends that footings be founded within the underlying siltstone / sandstone bedrock, which at this preliminary stage is assessed as being capable of providing an allowable bearing capacity of 700kPa (Pells et al – reference 13). Should higher bearing capacity be required, further geotechnical investigation will be required to assess the strength and quality of the bedrock formation.

Finally, footing systems should be designed by a suitably qualified and experienced structural engineer and GEE recommends that inspection by a geotechnical engineer is undertaken during the footing excavation stage, to confirm that the design founding conditions have been achieved.

4.3.1 *Aggressivity / Exposure Classification*

Based on the limited exposure classification test results (Section 4.3.1), and in accordance with AS 2159-2009 (reference 9), the subsurface concrete structures (*e.g.* footings) should be designed based on mildly-aggressive soil conditions for concrete. According to Australian Standard AS 3600-2009 (reference 10), the equivalent exposure classification is 'A2'.

With respect to unprotected steel, the natural soil profile is considered to be non-aggressive / non-corrosive.

5 CONCLUSION

GEE considers that sufficient information has been gained to be confident of the subsurface conditions across the site, to assist with design of the proposed development and to provide Council with assurances regarding the geotechnical feasibility of the proposed development. Based on the results of the investigation, the proposed development is considered feasible.

The geotechnical issues associated with the proposed development have been addressed by the investigation and are discussed in this report. If, during construction, any conditions are encountered that vary significantly from those described or inferred in the above report, it is a condition of the report that we be advised so that those conditions, and the conclusions discussed in the report, can be reviewed and alternative recommendations assessed, if appropriate.

GEE will be pleased to assist with any further advice or geotechnical services required in regard to the proposed development.

6 GENERAL LIMITATIONS

Soil and rock formations are variable. The logs or other information presented as part of this report indicate the approximate subsurface conditions only at the specific test locations. Boundaries between zones on the logs or stratigraphic sections are often not distinct, but rather are transitional and have been interpreted.

The precision with which subsurface conditions are indicated depends largely on the frequency and method of sampling, and on the uniformity of subsurface conditions. The spacing of test sites also usually reflects budget and schedule constraints. Groundwater conditions described in this report refer only to those observed at the place and under circumstances noted in the report. The conditions may vary seasonally or as a consequence of construction activities on the site or adjacent sites.

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that GEE be notified of any variations and be provided with an opportunity to review the recommendations of this report. Recognition of changed soil and rock conditions requires experience and it is recommended that a suitably experienced geotechnical engineer be engaged to visit the site with sufficient frequency to detect if conditions have changed significantly.

The comments given in this report are intended only for the guidance of the design engineer, or for other purposes specifically noted in the report. The number of boreholes or test excavations necessary to determine all relevant underground conditions which may affect construction costs, techniques and equipment choice, scheduling, and sequence of operations would normally be greater than has been carried out for design purposes. Contractors should therefore rely on their own additional investigations, as well as their own interpretations of the borehole data in this report, as to how subsurface conditions may affect their work.

7 REFERENCES

1. Department of Mineral Resources, 1991: Penrith 1:100,000 *Geological Series Map Sheet 9030 (Edition 1).*
2. Soil Conservation Service of NSW, 1990: *Penrith 1:100,000 Soil Landscape Series Sheet 9030 (first edition)*.
3. Wooley, D.R., 1983: Groundwater. In Herbert, C., (Ed), Geology of the Sydney 1:100,000 Sheet 9130, Geological Survey of New South Wales, Department of Mineral Resources, pp. 145-148.
4. Krumins, H., Bradd, J., and McKibbon, D., 1998: Hawkesbury-Nepean Catchment Groundwater Availability Map: Map Notes. Department of Land and Water Conversation, December, 1998, Parramatta, 12 pp.
5. Old, A. N., 1942: The Wianamatta Shale Waters of the Sydney District. Agricultural Gazette of New South Wales, Miscellaneous Publication 3225.
6. Cook P.G., 2003: *A Guide to Regional Groundwater Flow in Fractured Rock Aquifers*. Seaview Press, Henley Beach (South Australia), 108pp.
7. DLWC, 1997: Department of Land and Water Conservation of NSW, 1997: *Liverpool Acid Sulfate Soil Risk Map – Edition Two.*
8. Australian Standards, 1997. *AS1289.6.3.2 Methods of testing soils for engineering purposes - Soil strength and consolidation tests – Determination of the penetration resistance of a soil – 9kg dynamic cone penetrometer test*
9. Australian Standard (AS) 2159 -2009: *Piling Design and Installation*.
10. Australian Standard (AS) 3600 –2009: *Concrete Structures*.
11. New South Wales Environment Protection authority (NSW EPA), 2014: *Waste classification guidelines – Part 1 classifying waste.* November 2014.
12. Australian Standard: AS3798-2007: *Guidelines on earthworks for commercial and residential developments.*
13. Pells et al, 1998: *Foundations on Sandstone and Shale in the Sydney Region*, Australian Geomechanics Society, 1998.

FIGURES

1 – Site Location Map
2 – Site Plan

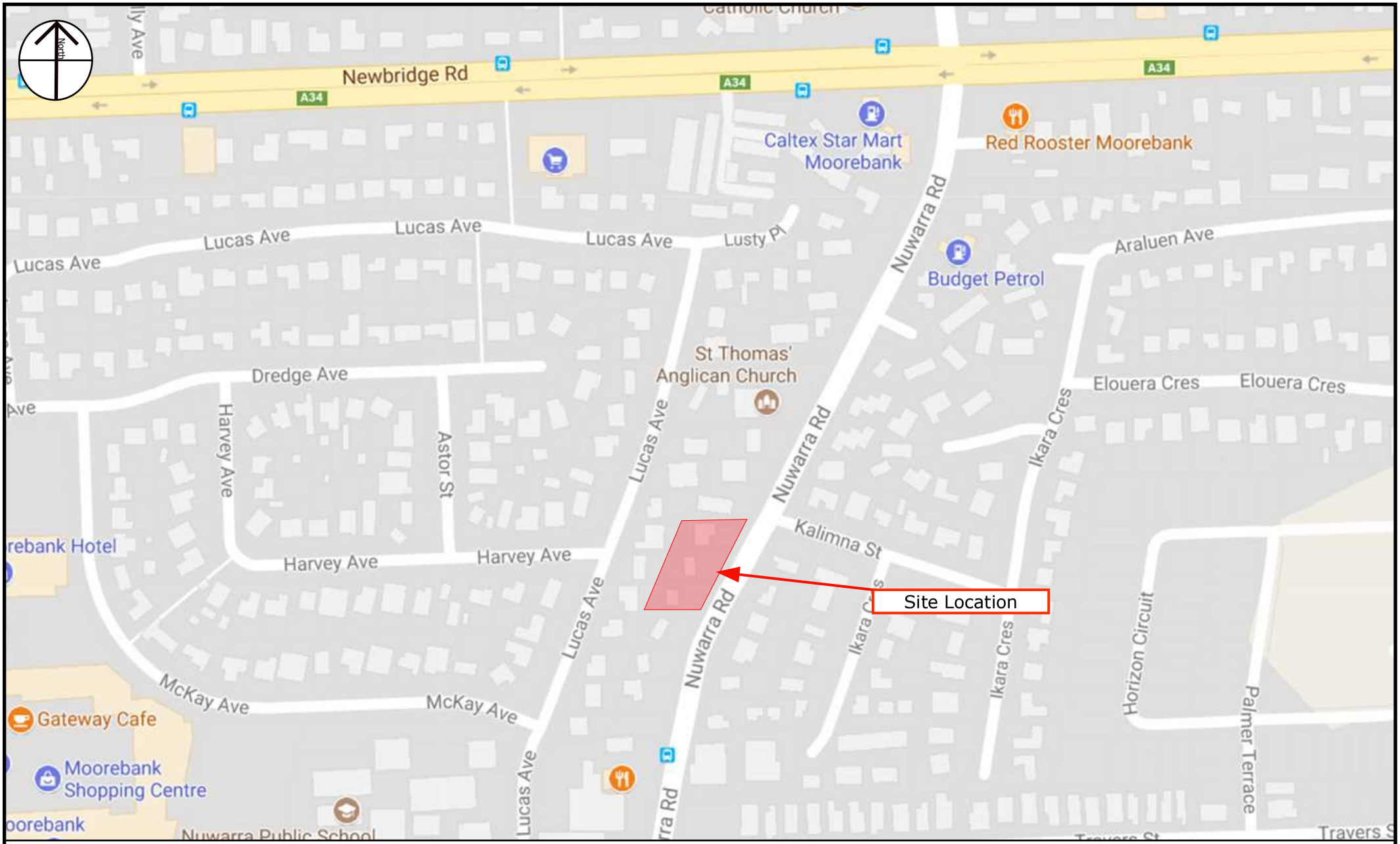

Image Source: provided by Google (www.google.com/maps) - retrieved 23/06/2017

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TITLE: SITE LOCATION 87-91 Nuwarra Road, Moorebank NSW	SCALE: **N.T.S**	DATE: **23 Jun 2017**	FIGURE No. **1**
	DRAWN: **A. Chiem**	JOB No.: **E17013MOR**	REVISION: **A**

Aerial image: provided by SIXmaps (NSW LPI) - retrieved 23/06/2017

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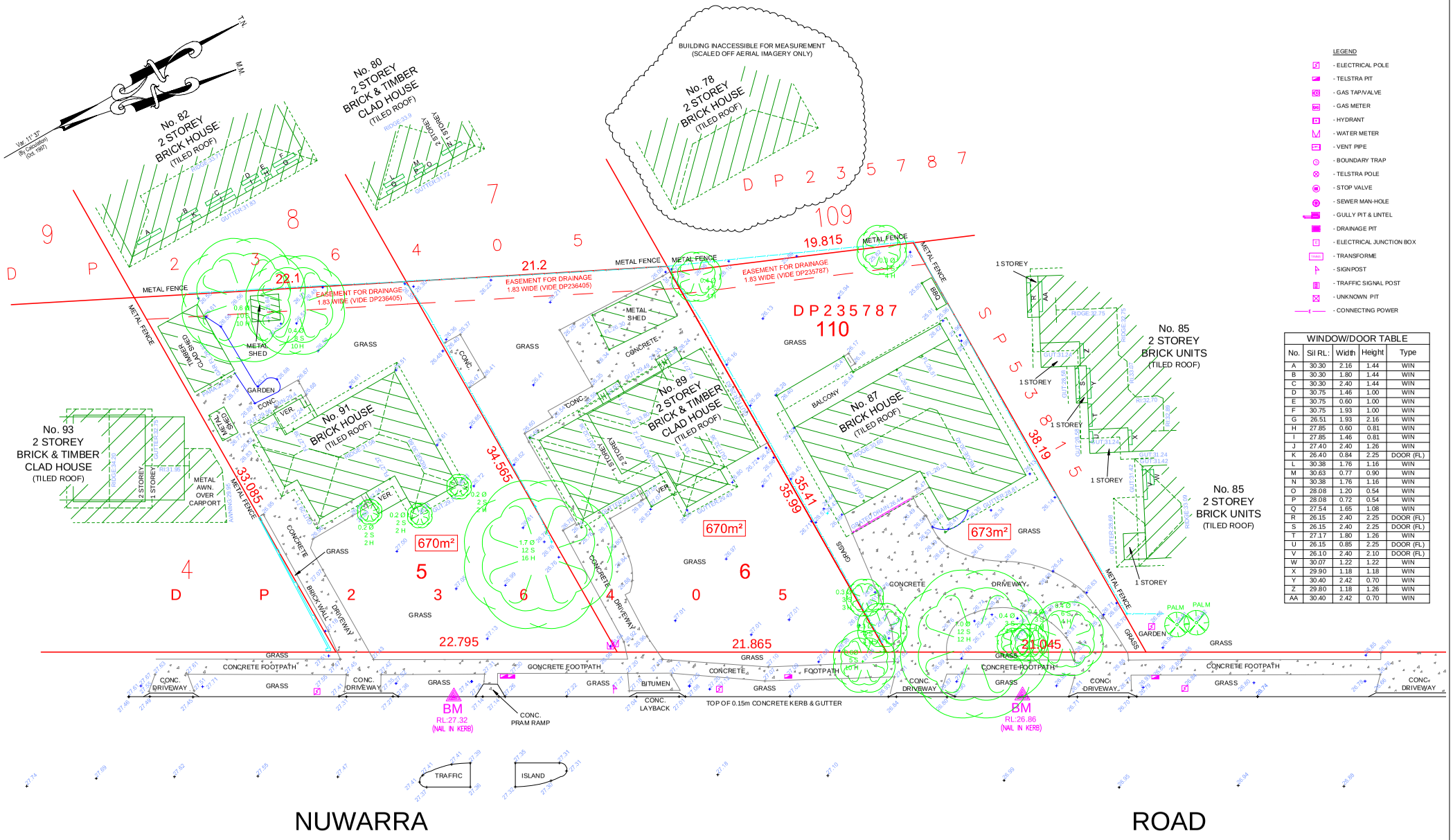
TITLE:	SCALE:	DATE:	FIGURE No.
SITE PLAN 87-91 Nuwarra Road, Moorebank NSW	N.T.S	3 Jul 2017	2
	DRAWN: A. Chiem	JOB No.: E17013MOR	REVISION: A

APPENDIX A

SITE SURVEY AND PRELIMINARY DEVELOPMENT PLANS (3 SHEETS)



LEGEND

- ELECTRICAL POLE
- TELSTRA PIT
- GAS TAP/VALVE
- GAS METER
- HYDRANT
- WATER METER
- VENT PIPE
- BOUNDARY TRAP
- TELSTRA POLE
- STOP VALVE
- SEWER MAN-HOLE
- GULLY PIT & LINTEL
- DRAINAGE PIT
- ELECTRICAL JUNCTION BOX
- TRANSFORME
- SIGNPOST
- TRAFFIC SIGNAL POST
- UNKNOWN PIT
- CONNECTING POWER

WINDOW/DOOR TABLE

No.	Sil RL:	Width	Height	Type
A	30.30	2.16	1.44	WIN
B	30.30	1.80	1.44	WIN
C	30.30	2.40	1.44	WIN
D	30.75	1.46	1.00	WIN
E	30.75	0.60	1.00	WIN
F	30.75	1.93	1.00	WIN
G	26.51	1.93	2.16	WIN
H	27.85	0.60	0.81	WIN
I	27.85	1.46	0.81	WIN
J	27.40	2.40	1.26	WIN
K	26.40	0.84	2.25	DOOR (FL)
L	30.38	1.76	1.16	WIN
M	30.63	0.77	0.90	WIN
N	30.38	1.76	1.16	WIN
O	28.08	1.20	0.54	WIN
P	28.08	0.72	0.54	WIN
Q	27.54	1.65	1.08	WIN
R	26.15	2.40	2.25	DOOR (FL)
S	26.15	2.40	2.25	DOOR (FL)
T	27.17	1.80	1.26	WIN
U	26.15	0.85	2.25	DOOR (FL)
V	26.10	2.40	2.10	DOOR (FL)
W	30.07	1.22	1.22	WIN
X	29.90	1.18	1.18	WIN
Y	30.40	2.42	0.70	WIN
Z	29.80	1.18	1.26	WIN
AA	30.40	2.42	0.70	WIN

NOTES

- TREE SPREADS SHOWN 'APPROXIMATELY' ONLY
- VISIBLE SERVICES (AT TIME OF SURVEY) SHOWN ONLY
- NO SERVICE PITS ACCESSED/OPENED SHOWN AS LABELED
- BOUNDARIES BY TITLE DIAGRAM ONLY, NOT SURVEYED
- ALL PITS SHOULD BE ACCESSED, CONFIRMED AND HAVE SUBSURFACE EXTENTS MEASURED BY THE RELEVANT AUTHORITIES, PRIOR TO ADOPTION.
- ALL PIPES, CABLES & DUCTS IN THE EXCAVATION AREA SHOULD BE ACCURATELY LOCATED BY A "PIPE LOCATOR" OR BY THE RELEVANT AUTHORITY, PRIOR TO ANY EXCAVATION IS UNDERTAKEN.
- THE SUBJECT TITLE'S ARE BURDENED BY EASEMENTS FOR DRAINAGE (VIDE DP236405 & DP235787) AND CAVEAT'S (VIDE AK673585, AK673586 & AK673587)

THE SITE FOREMAN
Architects + Project Managers

Peak Surveying
ABN 14 357 738 834

Peak Surveying Services
Engineering Surveyors
peaksurveying.com.au
P.O. Box 679
Milsons Point NSW 1565

PO BOX 679
MILSONS POINT, NSW, 1565
Ph: (04) 04 140 758
Web: peaksurveying.com.au
Email: martin@peaksurveying.com.au

DETAIL SURVEY @
87-91 Nuwarra Road,
Moorebank, NSW, 2170

CLIENT: The Site Foreman

JOB No: 16-842

SURVEYED ON: 13/09/2016
BY: M ELLIOTT & V WANG

DRAWN ON: 20/09/2016
BY: T PELL

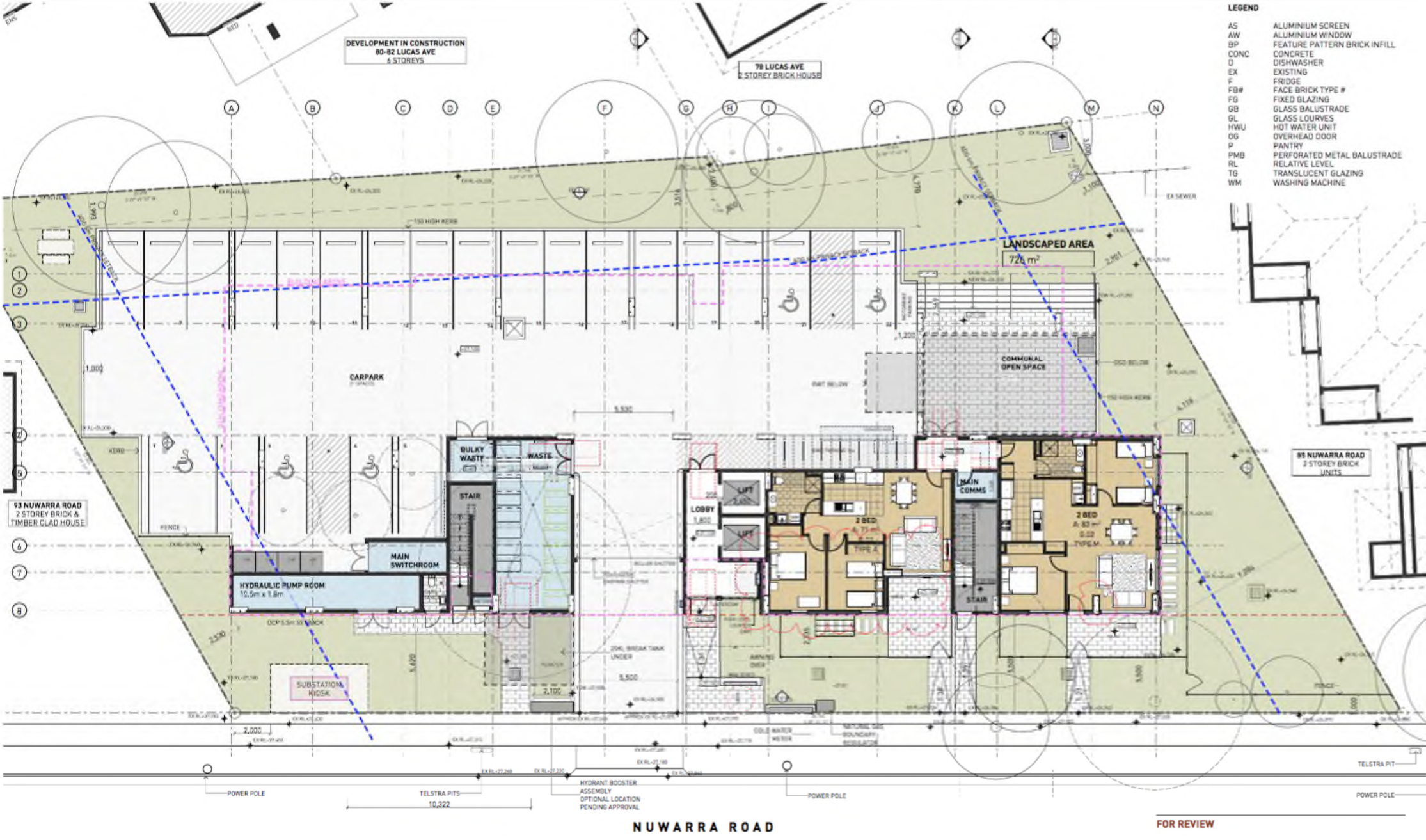
SCALE: 1:150 (@A1)/ 1:300 (@A3)

NORTH: Magnetic (by DP236405)

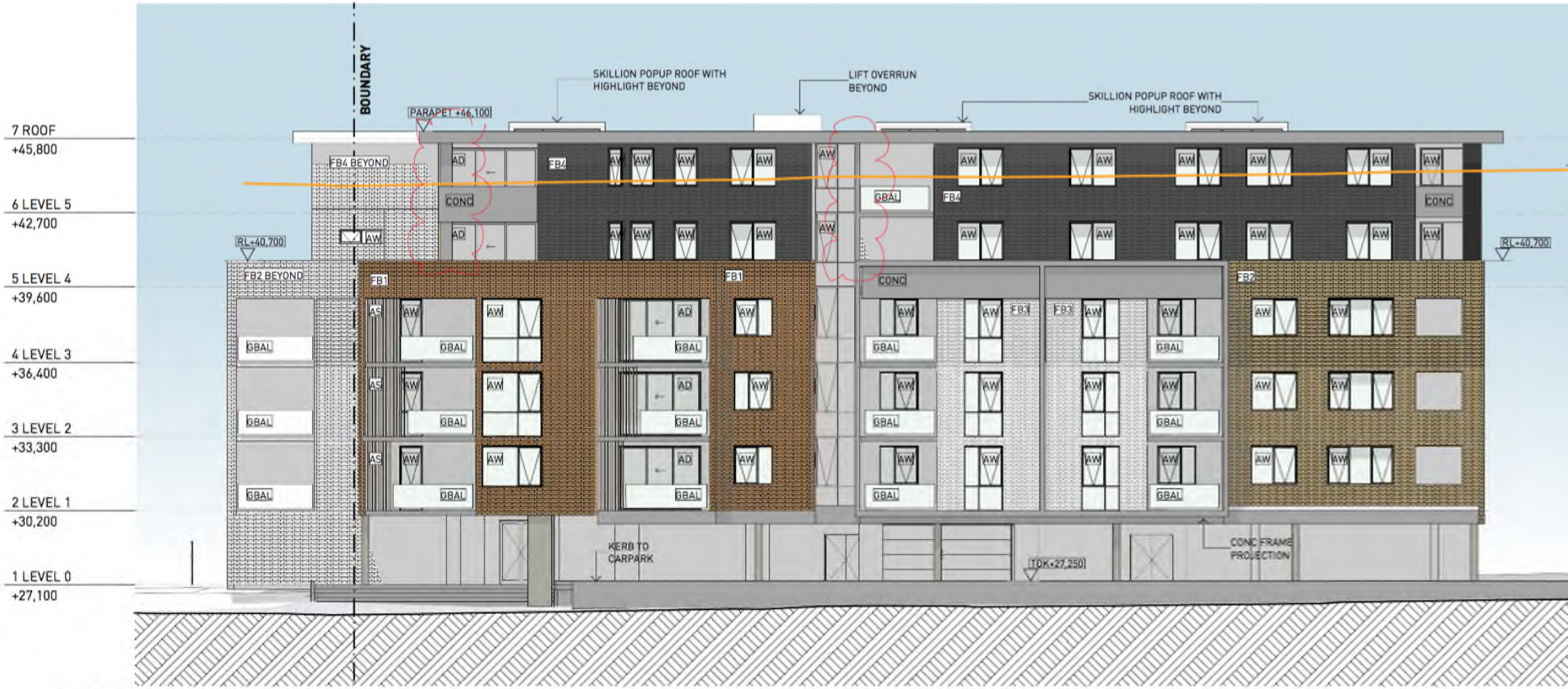
DATUM: SSM67438 RL:29.432(AHD)

CONTOUR INT: N/A

SHEET 1/1


DEVELOPMENT IN CONSTRUCTION
80-82 LUCAS AVE
6 STOREYS
78 LUCAS AVE
2 STOREY BRICK HOUSE
LEGEND
AS ALUMINIUM SCREEN
AW ALUMINIUM WINDOW
BP FEATURE PATTERN BRICK INFILL
CONC CONCRETE
D DISHWASHER
EX EXISTING
F FRIDGE
FB# FACE BRICK TYPE #
FG FIXED GLAZING
GB GLASS BALUSTRADE
GL GLASS LOURVES
HWU HOT WATER UNIT
OG OVERHEAD DOOR
P PANTRY
PMB PERFORATED METAL BALUSTRADE
RL RELATIVE LEVEL
TG TRANSLUCENT GLAZING
WM WASHING MACHINE
LANDSCAPED AREA
726 m²
COMMUNAL OPEN SPACE
CARPARK
BULKY WASTE
WASTE
STAIR
LIFT
LOBBY
MAIN SWITCHROOM
HYDRAULIC PUMP ROOM
10.5m x 1.8m
SUBSTATION KIOSK
2 BED
TYPE A
MAIN COMMS
2 BED
TYPE M
93 NUWARRA ROAD
2 STOREY BRICK & TIMBER CLAD HOUSE
85 NUWARRA ROAD
2 STOREY BRICK UNITS
FENCE
20KL BREAK TANK UNDER
POWER POLE
TELSTRA PITS
10,322
HYDRANT BOOSTER ASSEMBLY OPTIONAL LOCATION PENDING APPROVAL
POWER POLE
TELSTRA PIT
POWER POLE
NUWARRA ROAD

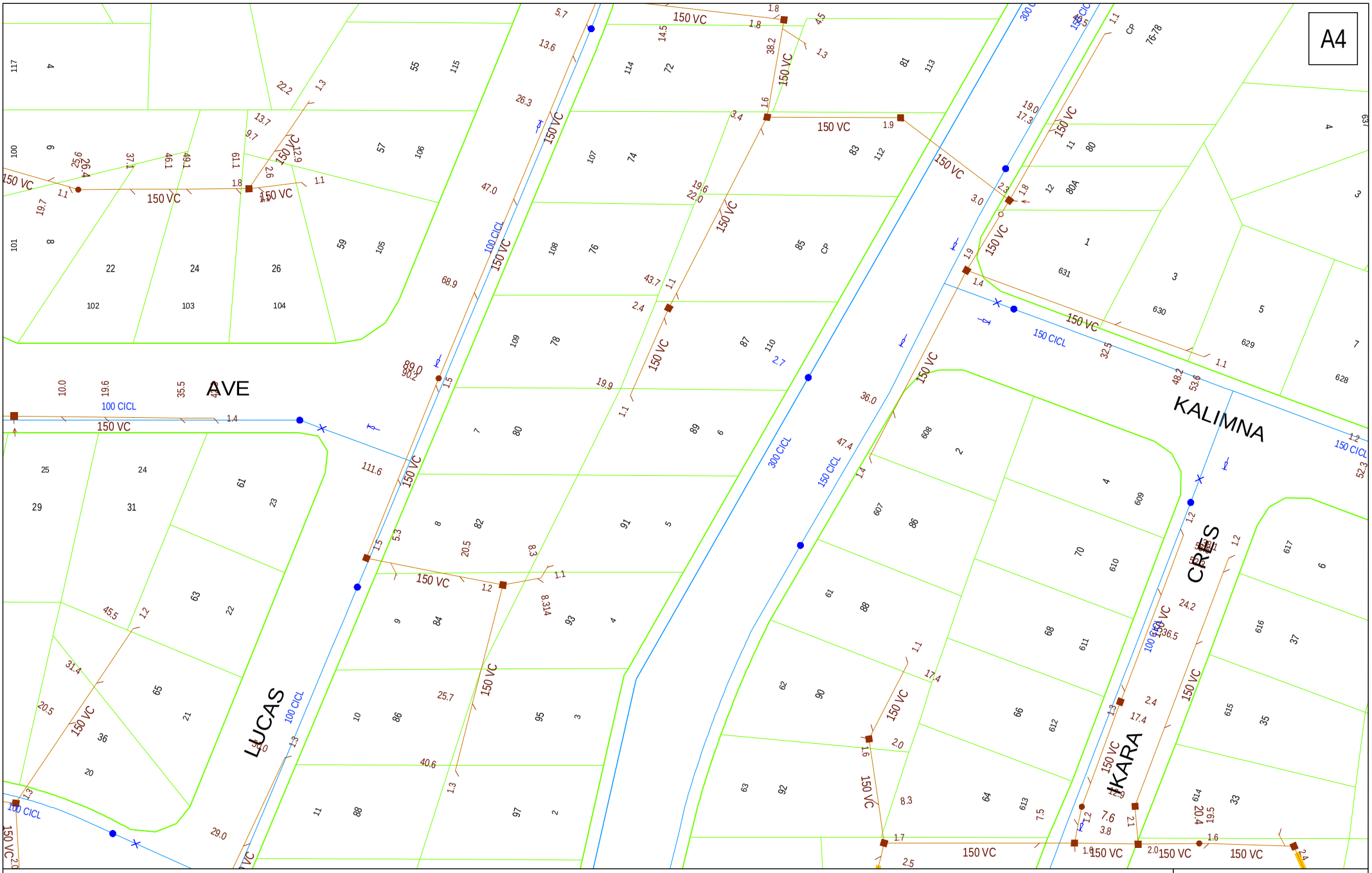
FOR REVIEW



1 WEST ELEVATION
1:200

APPENDIX B

SYDNEY WATER SEWER PLAN (1 SHEET)



DBYD Address:
89 Nuwarra Road
Moorebank NSW
2170

DBYD Job No: 12495176

DBYD Sequence No: 62058167

No warranty is given that the information shown is complete or accurate.

SYDNEY WATER CORPORATION

Scale: 1:1000

Date of Production: 19/06/2017

Plan 1 of 1

N

0m 5m 10m 15m 20m

APPENDIX C

BOREHOLE/TESTPIT LOGS (9 SHEETS)

Borehole Log Report

Geo Environmental Engineering Pty Ltd
82 Bridge Street
Lane Cove NSW 2066
T 02 9420 3361

Hole ID. **BH1**
Hole Depth: **1.20 m**
Sheet: **1 of 1**

Project Name: **Environmental Site Assessment** Project Number: **E17013MOR**
Location / Site: **87-91 Nuwarra Road, Moorebank NSW** Client: **St George Community Housing**

Drilling Company: **Geo Environmental Engineering** Date Started: **21/06/2017** Ground Level: ----------
Drill Method: **Hand Auger** Date Completed: **21/06/2017** Easting: ----------
Equipment: **Manual** Northing: ----------

Method	Depth (m)	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests ID No.	Observations / Comments
				Surface: grass				
Hand Auger		SM	Fill	**FILL**- Silty Sand, dark grey, fine to coarse grained, trace fine gravels, roots.	loose	moist	AC210617-21 0.1-0.2m	
		GM		**Silty Gravelly SAND**- grey-brown, low plasticity, fine to coarse grained, fine to medium gravels, charcoal.	loose to medium dense	moist	AC210617-22 0.2-0.3m	
	1.0	CH	Natural	**Silty CLAY**- orange-brown / red-brown, medium plasticity.	stiff	moist	AC210617-23 0.5-0.6m BH1 / 0.6-0.7m	
				becoming light grey mottled orange, with some sand from 1.0m.			BH1 / 1.1-1.2m	
	2.0			**Practical refusal at 1.20m** Hand auger refusal on weathered siltstone bedrock				borehole was dry upon completion DCP refusal at 1.34m (bouncing)

DCP blows/100mm: 5 10 15

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Andy Chiem** Date: **21/06/2017** Checked By: **Stephen McCormack** Date: **30/06/2017**

GEE DAVIES BH LOG E17013MOR.GPJ GEE.GDT 4/7/17 12:59:53 PM

Borehole Log Report

Geo Environmental Engineering Pty Ltd
82 Bridge Street
Lane Cove NSW 2066
T 02 9420 3361

Hole ID. **BH2**
Hole Depth: **1.25 m**
Sheet: **1 of 1**

Project Name: **Environmental Site Assessment** Project Number: **E17013MOR**
Location / Site: **87-91 Nuwarra Road, Moorebank NSW** Client: **St George Community Housing**

Drilling Company: **Geo Environmental Engineering** Date Started: **21/06/2017** Ground Level: ----------
Drill Method: **Hand Auger** Date Completed: **21/06/2017** Easting: ----------
Equipment: **Manual** Northing: ----------

Method	Depth (m)	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests ID No.	Observations / Comments
				Surface: grass				
Hand Auger		SM	Fill	**FILL**- Silty Sand, dark grey, fine to coarse grained, trace fine to coarse gravels, tile, brick.	loose	moist	AC210617-24 0.1-0.2m	
							AC210617-25 0.4-0.5m	
		CH	Natural	**Silty CLAY**- brown, medium plasticity. becoming orange from 0.8m.	firm	moist	AC210617-26 BH2 / 0.6-0.7m	
	1.0				stiff			
	2.0			**Practical refusal at 1.25m** Hand auger refusal on weathered siltstone bedrock				borehole was dry upon completion. DCP refusal at 1.35m (bouncing)

DCP blows/100mm: 5 10 15

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Andy Chiem** Date: **21/06/2017** Checked By: **Stephen McCormack** Date: **30/06/2017**

GEE DAVIES BH LOG E17013MOR.GPJ GEE.GDT 4/7/17 12:59:54 PM

Test Pit Log Report

Geo Environmental Engineering Pty Ltd
82 Bridge Street
Lane Cove NSW 2066
T 02 9420 3361

Hole ID. **TP1**
Hole Depth: **1.00 m**
Sheet: **1 of 1**

Project Name: **Environmental Site Assessment** Project Number: **E17013MOR**
Location / Site: **87-91 Nuwarra Road, Moorebank NSW** Client: **St George Community Housing**

Drilling Company: **AB-11 Group** Date Started: **21/06/2017** Ground Level: ----------
Drill Method: **Excavation** Date Completed: **21/06/2017** Easting: ----------
Equipment: **2T Mini-excavator** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests ID No.	Observations / Comments
							Surface: grass				
Excavation					GC	Fill	**FILL**- Silty Clay With Gravel, dark grey / brown, low to medium plasticity, fine to medium gravels.	stiff	moist	AC210617-01 / TP1 0.1-0.2m	Sample AC210617-TP1 (0.0 - 0.3m) sieved from bucket weighing 7.2kg
					CH	Natural	**Silty CLAY**- orange-brown / light grey, medium plasticity. becoming orange / red-brown from 0.8m.	stiff	moist	AC210617-02 0.4-0.5m AC210617-03 0.9-1.0m	
		1.0					**Hole Terminated at 1.00m** Target depth reached				testpit was dry upon completion
		2.0									

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Andy Chiem** Date: **21/06/2017** Checked By: **Stephen McCormack** Date: **30/06/2017**

GEE DAVIES BH LOG E17013MOR.GPJ GEE.GDT 4/7/17 12:59:55 PM

Test Pit Log Report

Geo Environmental Engineering Pty Ltd
82 Bridge Street
Lane Cove NSW 2066
T 02 9420 3361

Hole ID. **TP2**
Hole Depth: **1.10 m**
Sheet: **1 of 1**

Project Name: **Environmental Site Assessment** Project Number: **E17013MOR**
Location / Site: **87-91 Nuwarra Road, Moorebank NSW** Client: **St George Community Housing**

Drilling Company: **AB-11 Group** Date Started: **21/06/2017** Ground Level: ----------
Drill Method: **Excavation** Date Completed: **21/06/2017** Easting: ----------
Equipment: **2T Mini-excavator** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests: ID No.	Samples / Tests: DCP blows/100mm	Observations / Comments
							Surface: grass				5 10 15	
Excavation					SM	Fill	**FILL**- Silty Sand, dark grey, fine to coarse grained, clay inclusions, brick, sandstone fragments.	loose to medium dense	moist	AC210617-04 / 05 / TP2 0.1-0.2m		Sample AC210617-TP2 (0.0 - 0.3m) sieved from bucket weighing 9.4kg
					CH	Natural	**Silty CLAY**- orange-brown, medium plasticity.	firm to stiff	moist	AC210617-06 0.3-0.4m TP2 / 0.4-0.5m		
		1.0					becoming light grey mottled orange from 0.9m.			AC210617-07 0.9-1.0m TP2 / 1.0-1.1m		
							Practical refusal at 1.10m Excavator bucket scraping on weathered siltstone bedrock					minor seepage at base of pit upon completion DCP refusal at 1.26m (bouncing)
		2.0										

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Andy Chiem** Date: **21/06/2017** Checked By: **Stephen McCormack** Date: **30/06/2017**

GEE DAVIES BH LOG E17013MOR.GPJ GEE.GDT 4/7/17 12:59:56 PM

Test Pit Log Report

Geo Environmental Engineering Pty Ltd
82 Bridge Street
Lane Cove NSW 2066
T 02 9420 3361

Hole ID. **TP3**
Hole Depth: **1.25 m**
Sheet: **1 of 1**

Project Name: **Environmental Site Assessment** Project Number: **E17013MOR**
Location / Site: **87-91 Nuwarra Road, Moorebank NSW** Client: **St George Community Housing**

Drilling Company: **AB-11 Group** Date Started: **21/06/2017** Ground Level: ----------
Drill Method: **Excavation** Date Completed: **21/06/2017** Easting: ----------
Equipment: **2T Mini-excavator** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests ID No.	Observations / Comments
							Surface: grass				
Excavation					SM	Fill	**FILL**- Silty Sand, dark brown / orange, fine to coarse grained, clay pipes.	loose	moist	AC210617-08 / TP3 0.1-0.2m	Sample AC210617-TP3 (0.0 - 0.3m) sieved from bucket weighing 15.6kg
		1.0			CH	Natural	**Silty CLAY**- orange-brown / red-brown, medium plasticity. becoming light grey mottled orange, with sand from 1.1m.	stiff	moist	AC210617-09 0.5-0.6m TP3 / 0.8-0.9m AC210617-10 0.9-1.0m	
		2.0					**Practical refusal at 1.25m** Excavator bucket scraping on weathered sandstone bedrock				test pit was dry upon completion

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Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Andy Chiem** Date: **21/06/2017** Checked By: **Stephen McCormack** Date: **30/06/2017**

Test Pit Log Report

Geo Environmental Engineering Pty Ltd
82 Bridge Street
Lane Cove NSW 2066
T 02 9420 3361

Hole ID. **TP4**
Hole Depth: **0.90 m**
Sheet: **1 of 1**

Project Name: **Environmental Site Assessment** Project Number: **E17013MOR**
Location / Site: **87-91 Nuwarra Road, Moorebank NSW** Client: **St George Community Housing**

Drilling Company: **AB-11 Group** Date Started: **21/06/2017** Ground Level: ----------
Drill Method: **Excavation** Date Completed: **21/06/2017** Easting: ----------
Equipment: **2T Mini-excavator** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests ID No.	Observations / Comments
							Surface: grass				
Excavation	0.6m perched 21/06/2017				GM	Fill	**FILL**- Silty Gravelly Sand, dark grey, fine to coarse grained, fibro.	loose	very moist	AC210617-11 / TP4 0.1-0.2m	Sample AC210617-TP4 (0.0 - 0.3m) sieved from bucket weighing 14.9kg. One fragment of fibro encountered in fill (AC210617-100)
							clay pipes from 0.4m.				pit of broken clay pipes
											seepage occurring from 0.6m, likely perched water
					CH	Natural	**Silty CLAY**- orange-brown / red-brown, medium plasticity.	stiff	wet	AC210617-12 0.7-0.8m	
		1.0					**Hole Terminated at 0.90m** Target depth reached				
		2.0									

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Andy Chiem** Date: **21/06/2017** Checked By: **Stephen McCormack** Date: **30/06/2017**

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Test Pit Log Report

Geo Environmental Engineering Pty Ltd
82 Bridge Street
Lane Cove NSW 2066
T 02 9420 3361

Hole ID. **TP5**
Hole Depth: **1.20 m**
Sheet: **1 of 1**

Project Name: **Environmental Site Assessment** Project Number: **E17013MOR**
Location / Site: **87-91 Nuwarra Road, Moorebank NSW** Client: **St George Community Housing**

Drilling Company: **AB-11 Group** Date Started: **21/06/2017** Ground Level: ----------
Drill Method: **Excavation** Date Completed: **21/06/2017** Easting: ----------
Equipment: **2T Mini-excavator** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests ID No.	Observations / Comments
							Surface: grass				
Excavation					GC	Fill	**FILL**- Gravelly Clayey Sand, dark brown, fine to coarse grained, fine to coarse gravels.	loose	moist	AC210617-13 / TP5 0.1-0.2m	Sample AC210617-TP5 (0.0 - 0.3m) sieved from bucket weighing 14.8kg
					GC	Fill	**FILL**- Gravelly Clay, grey / brown, medium to high plasticty, fine to medium gravel, sheet metal.	stiff	moist	AC210617-14 0.4-0.5m	
		1.0			CH	Natural	**Silty CLAY**- light grey mottled red-brown, medium to high plasticty.	stiff	moist	AC210617-15 0.9-1.0m AC210617-16 1.1-1.2m	
		2.0					**Hole Terminated at 1.20m** Target depth reached				test pit dry upon completion

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Andy Chiem** Date: **21/06/2017** Checked By: **Stephen McCormack** Date: **30/06/2017**

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Test Pit Log Report

Geo Environmental Engineering Pty Ltd
82 Bridge Street
Lane Cove NSW 2066
T 02 9420 3361

Hole ID. **TP6**
Hole Depth: **1.00 m**
Sheet: **1 of 1**

Project Name: **Environmental Site Assessment**
Project Number: **E17013MOR**
Location / Site: **87-91 Nuwarra Road, Moorebank NSW**
Client: **St George Community Housing**

Drilling Company: **AB-11 Group**
Date Started: **21/06/2017**
Ground Level: ----------
Drill Method: **Excavation**
Date Completed: **21/06/2017**
Easting: ----------
Equipment: **2T Mini-excavator**
Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests: ID No.	Samples / Tests: DCP blows/100mm	Observations / Comments
							Surface: grass				5 10 15	
Excavation					GM	Fill	**FILL**- Silty Gravelly Sand, dark grey, fine to coarse grained, fine to coarse gravels, clay inclusions.	loose	moist	AC210617-17 / 18 / TP6 0.1-0.2m		Sample AC210617-TP6 (0.0 - 0.3m) sieved from bucket weighing 17.4kg
					CH	Natural	**Silty CLAY**- red-brown / orange-brown, medium plasticity.	firm	moist	AC210617-19 0.3-0.4m		
										TP6 / 0.5-0.6m		
		1.0					becoming red-brown / light grey from 0.6m.			AC210617-20 0.9-1.0m		
							Practical refusal at 1.00m Excavator bucket scraping on weathered siltstone bedrock					test pit dry on completion DCP refusal at 1.1m (bouncing)
		2.0										

Moisture

D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Andy Chiem** Date: **21/06/2017**
Checked By: **Stephen McCormack** Date: **30/06/2017**

GEE DAVIES BH LOG E17013MOR.GPJ GEE.GDT 4/7/17 1:00:00 PM

Geo Environmental Engineering
82 Bridge Street
Lane Cove NSW 2066
E info@geoenvironmental.com.au

Log Report Legend

MATERIAL SYMBOL

FILL	CONCRETE	ASPHALT	TOPSOIL
ORGANICS	ESTUARINE MUD		

CLAY	SAND	SILT	GRAVEL
Sandy CLAY	Clayey SAND	Clayey SILT	Clayey GRAVEL
Silty CLAY	Silty SAND	Sandy SILT	Sandy GRAVEL
Gravelly CLAY	Gravelly SAND	Gravelly SILT	Silty GRAVEL
CLAY & SAND	SAND & CLAY	SILT & CLAY	GRAVEL & CLAY
CLAY & SILT	SAND & SILT	SILT & SAND	GRAVEL & SAND
CLAY & GRAVEL	SAND & GRAVEL	SILT & GRAVEL	GRAVEL & SILT
Sandy Silty CLAY	Clayey Silty SAND	Sandy Clayey SILT	Sandy Clayey GRAVEL
Silty Sandy CLAY	Silty Clayey SAND	Clayey Sandy SILT	Clayey Sandy GRAVEL
Sandy Gravelly CLAY	Clayey Gravelly SAND	Sandy Gravelly SILT	Silty Clayey GRAVEL
Silty Gravelly CLAY	Silty Gravelly SAND	Clayey Gravelly SILT	Clayey Silty GRAVEL
Gravelly Silty CLAY	Gravelly Silty SAND	Gravelly Clayey SILT	Sandy Silty GRAVEL
Gravelly Sandy CLAY	Gravelly Clayey SAND	Gravelly Sandy SILT	Silty Sandy GRAVEL

SANDSTONE	SHALE	GRANITE	BASALT	SHALE / SANDSTONE
PORCELLANITE	GNEISS	SHALE / CLAYSTONE	MUDSTONE	
CLAYSTONE	MUDSTONE / CLAYSTONE	SHALE / SILTSTONE	IRONSTONE	

WATER LEVELS

Encountered Water

Standing Water

ABBREVIATIONS

PT	Pushtube
SFA	Solid Flight Auger
PWS	Percussion Window Sampler
HA	Hand Auger
HFA	Hollow Flight Auger

WELL GRAPHICS

Cuttings	Bentonite	Screen
Gravel Pack	Grout	Cave-in

GEE LEGEND * * 29/10/09 5:04:07 PM

APPENDIX D

LABORATORY REPORT – EXTRACT OF RELEVANT RESULTS ONLY (3 SHEETS)

12 Ashley Street, Chatswood, NSW 2067
tel: +61 2 9910 6200

email: sydney@envirolab.com.au
envirolab.com.au

Envirolab Services Pty Ltd - Sydney | ABN 37 112 535 645

CERTIFICATE OF ANALYSIS 169824

Client:

Geo-Environmental Engineering
82 Bridge St
Lane Cove
NSW 2066

Attention: Steve McCormack

Sample log in details:

Your Reference:	**E17013MOR**
No. of samples:	41 Soils, 1 Material
Date samples received / completed instructions received	22/06/2017 / 22/06/2017

This report supersedes previous report R00. Addition for weight of asbestos material as per client request.

Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	29/06/17 / 30/06/17
Date of Preliminary Report:	Not Issued

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

Results Approved By:

David Springer
General Manager

Misc Inorg - Soil						
Our Reference:	UNITS	169824-1	169824-2	169824-4	169824-6	169824-8
Your Reference	---------- -	AC210617-01	AC210617-02	AC210617-04	AC210617-06	AC210617-08
Depth	----------	-	-	-	-	-
Date Sampled		21/06/2017	21/06/2017	21/06/2017	21/06/2017	21/06/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	27/06/2017	27/06/2017	27/06/2017	27/06/2017	27/06/2017
Date analysed	-	27/06/2017	27/06/2017	27/06/2017	27/06/2017	27/06/2017
pH 1:5 soil:water	pH Units	5.8	5.3	6.6	5.5	5.7

Misc Inorg - Soil						
Our Reference:	UNITS	169824-9	169824-11	169824-12	169824-13	169824-14
Your Reference	---------- -	AC210617-09	AC210617-11	AC210617-12	AC210617-13	AC210617-14
Depth	----------	-	-	-	-	-
Date Sampled		21/06/2017	21/06/2017	21/06/2017	21/06/2017	21/06/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	27/06/2017	27/06/2017	27/06/2017	27/06/2017	27/06/2017
Date analysed	-	27/06/2017	27/06/2017	27/06/2017	27/06/2017	27/06/2017
pH 1:5 soil:water	pH Units	5.1	8.3	5.2	7.7	7.5

Misc Inorg - Soil						
Our Reference:	UNITS	169824-16	169824-17	169824-19	169824-21	169824-22
Your Reference	---------- -	AC210617-16	AC210617-17	AC210617-19	AC210617-21	AC210617-22
Depth	----------	-	-	-	-	-
Date Sampled		21/06/2017	21/06/2017	21/06/2017	21/06/2017	21/06/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	27/06/2017	27/06/2017	27/06/2017	27/06/2017	27/06/2017
Date analysed	-	27/06/2017	27/06/2017	27/06/2017	27/06/2017	27/06/2017
pH 1:5 soil:water	pH Units	5.2	7.0	5.2	6.5	6.3

Misc Inorg - Soil						
Our Reference:	UNITS	169824-23	169824-24	169824-26	169824-33	169824-34
Your Reference	---------- -	AC210617-23	AC210617-24	AC210617-26	TP2	TP2
Depth	----------	-	-	-	0.4-0.5	1.0-1.1
Date Sampled		21/06/2017	21/06/2017	21/06/2017	21/06/2017	21/06/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	27/06/2017	27/06/2017	27/06/2017	27/06/2017	27/06/2017
Date analysed	-	27/06/2017	27/06/2017	27/06/2017	27/06/2017	27/06/2017
pH 1:5 soil:water	pH Units	5.8	5.8	7.0	6.2	5.3
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	[NA]	[NA]	<10	24
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	[NA]	[NA]	<10	86
Resistivity in soil*	ohm m	[NA]	[NA]	[NA]	360	120

Misc Inorg - Soil					
Our Reference:	UNITS	169824-35	169824-36	169824-37	169824-38
Your Reference	---------- -	TP3	TP6	BH1	BH2
Depth	----------	0.8-0.9	0.5-0.6	0.6-0.7	0.6-0.7
Date Sampled		21/06/2017	21/06/2017	21/06/2017	21/06/2017
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	27/06/2017	27/06/2017	27/06/2017	27/06/2017
Date analysed	-	27/06/2017	27/06/2017	27/06/2017	27/06/2017
pH 1:5 soil:water	pH Units	5.2	5.2	5.5	5.5
Chloride, Cl 1:5 soil:water	mg/kg	<10	20	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	92	130	65	85
Resistivity in soil*	ohm m	170	110	200	160