Douglas Partners
Geotechnics / Environment / Groundwater

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Memorandum

To	Henroth Investments Pty Ltd	Dan Maurici	dan@henroth.com.au
From	Scott Easton	**Date**	5 December 2016
Subject	Groundwater Measurements 3-12 Boondah Road, Warriewood	**Project No.**	85749.00

This provides the factual results of groundwater monitoring undertaken for the proposed Bulky Goods Centre at 3-12 Boondah Road, Warriewood. The monitoring was carried out at the request of Henroth Investments Pty Ltd (Henroth).

Four boreholes (BH1 to BH4) were drilled at the locations nominated by Henroth (see attached Drawing 1). The boreholes were drilled to depths of between 4.5 m and 6.0 m using a bobcat sized and truck mounted drilling rig. Groundwater monitoring wells comprising Class 18 machine slotted PVC were installed in each of the boreholes. Steel protective covers were installed at the surface.

The borehole logs are attached and show the soil profile encountered and the monitoring well construction details. The boreholes were logged on site by a geotechnical engineer. The surface levels at each of the boreholes were measured using optical survey equipment relative to State Survey Mark (PM6869, RL2.603 m relative to Australia Height Datum [AHD]).

A summary of the measured groundwater levels within the monitoring wells is provided in Table 1.

Table 1: Summary of Groundwater Measurements in Monitoring Wells

Borehole (Well)	Surface RL (m, AHD)	Well Depth (m)	Measured Depth (m) and RL (m, AHD) to Groundwater in Monitoring Wells 23 November 2016
1	2.4	4.9	1.6 (RL0.8)
2	2.3	4.0	1.2 (RL1.1)
3	4.1	5.8	2.7 (RL1.4)
4	2.1	4.0	1.4 (RL0.7)

Measured water levels vary from RL0.8 m to RL1.0 m over most of the site (BH1 to BH3) and rise slightly to RL1.4 m on the elevated northern end part of the site (BH4). Groundwater levels will fluctuate and may temporarily rise by at least 1 m (or higher and up to flood levels) following prolonged rainfall. Further monitoring would be required to assess fluctuations in groundwater levels.

We trust the above satisfies your present requirements. Please contact the undersigned should you have any queries.

Yours faithfully,
Douglas Partners Pty Ltd

Scott Easton
Principal

Reviewed by

Ray Blinman
Principal

Attached: About this Report
Borehole Logs
Drawing 1 – Location of Boreholes

About this Report

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Introduction

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

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

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Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

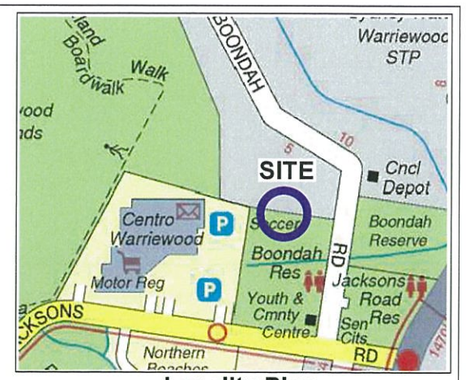
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later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

Information for Contractual Purposes

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

Site Inspection

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



Locality Plan

NOTE:
1: Base image from Nearmap.com (Dated 17 November 2016)
2: Test locations are approximate only and are shown with reference to existing features.

0 10 20 30 40 60 80 100 150 200 250m
1:2500 @ A3

LEGEND
Borehole location

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Henroth Investments Pty Ltd	TITLE: **Location of Boreholes** **Proposed Bulky Goods Centre** **3-12 Boondah Road, WARRIEWOOD**	PROJECT No: 85749.00
	OFFICE: Sydney DRAWN BY: PSCH		DRAWING No: 1
	SCALE: 1:2500 @ A3 DATE: 25.11.2016		REVISION: 0

BOREHOLE LOG

CLIENT: Henroth Investments Pty Ltd
PROJECT: Proposed Bulky Goods Centre
LOCATION: 3-12 Boondah Road, Warriewood

SURFACE LEVEL: 2.39 AHD^
EASTING: 342229.8
NORTHING: 6270135
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 85749.00
DATE: 21/11/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.0	FILLING - red-brown, silty sand filling, humid							Gatic cover Backfill 0.0-0.2m Bentonite 0.2-0.6m
		0.5m: with a trace of shell fragments							
		1.2m: damp to moist							
		1.6m: saturated						23-11-16	Gravel 0.6-4.9m
	1.9	SAND - grey fine to coarse sand with a trace of clay, saturated							Machine slotted PVC screen 0.9-4.9m
	5.1	SANDY CLAY - dark grey sandy clay, saturated							End cap
	5.5	Bore discontinued at 5.5m - target depth reached							

RIG: Scout 1 **DRILLER:** W Gartside **LOGGED:** A McIntyre **CASING:** Uncased

TYPE OF BORING: Solid flight auger (TC-bit) to 5.5m

WATER OBSERVATIONS: Free groundwater observed in well at 1.62m on 23/11/16

REMARKS: ^Co-ordinates obtained by Nearmaps, RL by Survey

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Henroth Investments Pty Ltd
PROJECT: Proposed Bulky Goods Centre
LOCATION: 3-12 Boondah Road, Warriewood

SURFACE LEVEL: 2.25 AHD^
EASTING: 342226.4
NORTHING: 6270495.7
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 85749.00
DATE: 21/11/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.0	FILLING - orange-brown, silty fine to medium sand filling with a trace of shells and terracotta fragments, humid		A	0.1 0.2				Gatic cover Backfill 0.0-0.4m
				A	0.4 0.5				Bentonite 0.4-0.7m
	0.7	SAND - grey, fine to coarse sand with some clay, moist		A	0.9 1.0				
		1.2m: saturated						23-11-16	
	1.4	CLAYEY SAND - dark grey clayey sand, saturated		A	1.4 1.5				Gravel 0.7-4.0m
	1.9	SANDY CLAY - dark grey, sandy clay, saturated, slight organic odour		A/E	1.9 2.0				
				A	2.4 2.5				Machine slotted PVC screen 1.0-4.0m
	3.8	CLAY - light brown clay with some fine sand, MC>PL							End cap
				A	4.4				
	4.5	Bore discontinued at 4.5m - target depth reached			4.5				

RIG: Scout 1 **DRILLER:** W Gartside **LOGGED:** A McIntyre **CASING:** Uncased

TYPE OF BORING: Solid flight auger (TC-bit) to 4.5m

WATER OBSERVATIONS: Free groundwater observed in well at 1.2m on 23/11/16

REMARKS: ^Co-ordinates obtained by Nearmaps, RL by Survey

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Henroth Investments Pty Ltd
PROJECT: Proposed Bulky Goods Centre
LOCATION: 3-12 Boondah Road, Warriewood

SURFACE LEVEL: 4.1 AHD^
EASTING: 342177
NORTHING: 6270617
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 85749.00
DATE: 21/11/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.0	FILLING - grey-brown sand filling with some fine gravel and a trace of charcoal, damp		A	0.1-0.2				Gatic cover; Backfill 0.0-0.1m; Bentonite 0.1-0.3m
				A	0.4-0.5				
				A/E	0.9-1.0				
	1.2	SAND - orange-brown, slightly clayey sand, damp to moist		A	1.4-1.5				Gravel 0.8-5.8m
	1.7	CLAY - orange clay with a trace of sand, MC~PL		A	1.9-2.0				
		2.2m: becoming orange-grey with a trace of ironstone gravel		A	2.4-2.5				
	2.8	CLAY - grey mottled red-brown clay with a trace of sand and fine ironstone gravel, MC~PL		A	2.9-3.0			23-11-16	
				A	3.9-4.0				Machine slotted PVC screen 0.8-5.8m
	4.7	SILTY CLAY - light brown, silty clay with a trace of sand, MC>PL		A	4.9-5.0				
				A	5.9-6.0				End cap
	6.0	Bore discontinued at 6.0m - target depth reached							

RIG: Scout 1 **DRILLER:** W Gartside **LOGGED:** A McIntyre **CASING:** Uncased

TYPE OF BORING: Solid flight auger (TC-bit) to 6.0m

WATER OBSERVATIONS: Free groundwater observed in well at 2.67m on 23/11/16

REMARKS: ^Co-ordinates obtained by Nearmaps, RL by Survey

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Henroth Investments Pty Ltd
PROJECT: Proposed Bulky Goods Centre
LOCATION: 3-12 Boondah Road, Warriewood

SURFACE LEVEL: 2.1 AHD^
EASTING: 342425.7
NORTHING: 6270502.7
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 85749.00
DATE: 23/11/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.3	FILLING - brown silty sand filling with some terracotta fragments (50mm), humid		A	0.1 0.2				
		FILLING - dark grey fine to coarse sand filling with some clay and fine basalt gravel, humid to damp		A/E	0.4 0.5				
	0.8	SAND - grey fine to coarse sand with a trace of silt, damp to moist		A	0.9 1.0				
		1.3m: wet		A	1.4 1.5			▼ 23-11-16	
		1.6m: saturated							
	1.7	CLAYEY SAND - dark grey, slightly clayey fine to coarse sand, saturated, organic odour		A	1.9 2.0				
				A	2.4 2.5				
				A	2.9 3.0				
		4.0m: becoming more clayey		A	3.9 4.0				
				A	4.9 5.0				
	5.8	CLAY - light grey clay with a trace of sand, MC<PL		A	5.9				
	6.0	Bore discontinued at 6.0m - target depth reached			6.0				

RIG: Bobcat **DRILLER:** G Marino **LOGGED:** A McIntyre **CASING:** Uncased

TYPE OF BORING: Solid flight auger (TC-bit) to 6.0m

WATER OBSERVATIONS: Free groundwater observed in well at 1.43m on 23/11/16

REMARKS: ^Co-ordinates obtained by Nearmaps, RL by Survey

SAMPLING & IN SITU TESTING LEGEND

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

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