Geotechnical Site Investigation Report

RE: Proposed apartment building at:

1 Vine Street, Heidelberg

Client:	Roniak Developments Pty Ltd C/- Arden Siena Pty Ltd 8/2-8 St Andrews Street BRIGHTON VIC 3186
Distribution:	- Roniak Developments Pty Ltd - Arden Siena Pty Ltd - J & P Building Solutions
File Number:	170552
Date:	30 May 2017

HardRock Geotechnical Pty Ltd ABN: 24 066 600 002
223 Coppin Street Richmond Victoria 3121 Ph: (03) 9421 0482 Email: admin@hardrockgeo.com.au

Introduction

A geotechnical site investigation was conducted by a geotechnical engineer at this site on the 2/3/17, 5/5/17, and 9/5/17. The purpose of the investigation was to provide foundation recommendations and geotechnical parameters for the proposed new four level apartment building incorporating a double level basement.

Site Description

The site is currently occupied by a single storey weatherboard residence with a rear garage and shed. The ground cover is primarily grass with areas of paving and garden beds. There are small to large sized trees on this and adjacent sites. The site has a moderate to steep fall towards the front and has moderate natural surface drainage.

Scope of the Investigation

The site investigation comprised:

- The drilling of three mechanically augured boreholes to depths of between 14.50m and 20.00m using a combination of solid flight augers and wash bore drilling.
    - Boreholes were conducted utilising a FRASTE Multidrill drill rig
- Coring of the underlying siltstone ROCK in boreholes 2 and 3.
    - Logging of the core, including RQD
    - Selected core samples were sent to Douglas Partners laboratory for testing
- Standard penetration testing (SPT) in boreholes 2 and 3.
- The subsurface profile was logged and bulk sampled using visual-tactile methods in accordance with AS2870-2011.

Borehole logs and locations are shown on pages 14 to 17 of this report.

Subsurface Conditions

Regional geology

The site is identified on the 'Geological Survey of Victoria' Ringwood Sheet (1:63,360) as being close to the contact between the Quaternary "High level alluvium" and the Quaternary "Low level alluvium" and the Silurian "Dargile formation".

Subsurface profile

See borehole logs on pages 14 to 16.

The boreholes encountered a variable alluvial profile containing silts, sands and gravels, underlain by siltstone ROCK.

Siltstone ROCK was encountered at:

- 14.50m in boreholes 1 & 3
- 10.0m in borehole 2

The existing fill material can be considered the equivalent of rolled non-sand fill in accordance with AS2870 -2011.

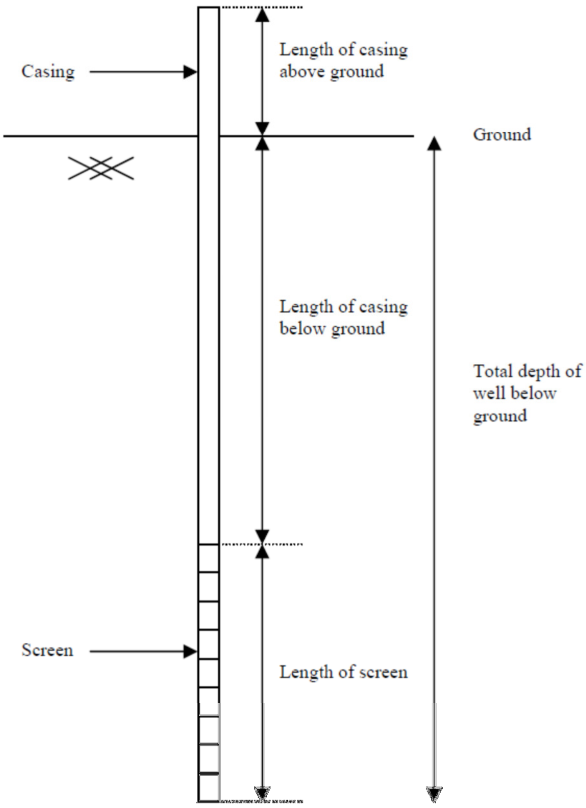
Soil moisture & groundwater

The boreholes encountered wet soils at depth, above the siltstone ROCK. Filling and upper natural soils were otherwise in a moist condition.

A temporary groundwater monitoring well were installed in borehole 2 (refer to details below).

The well was checked on 12/5/17, groundwater was found to be at 8.30m.
The details of the temporary groundwater monitoring well are provided below.

	Borehole 2
Material	**Depth (m)**
Length of screen	3.0
Length of casing below ground surface	17.0
Length of casing above ground surface	-
Total depth of well below ground surface	20.0
Depth to groundwater at end of investigation	**-**
Depth to groundwater below surface at borehole location on 12/5/17	**8.3**



Bored piers may need to be cased and/or CFA methods adopted for construction where installed below the groundwater table.

Sub-Soil Classification

The sub-soil is classified as **Class C_e** – Shallow Soil Site in accordance with AS1170.4-2007.

Site Classification

The site is classified as **CLASS P** in accordance with AS2870-2011.

Geotechnical Design Parameters

Geotechnical design parameters are provided in Appendix A of this report.

Standard Penetration Test (SPT) Results

In-situ SPTs were conducted within boreholes 2 and 3. SPT Results are summarised below.

Borehole 2

Location	Depth (m)	Blows per Interval			Uncorrected N-Value
		150mm	300mm	450mm	
BH2	1.00	2	5	9	14
BH2	2.50	11	12	14	26
BH2	4.00	11	14	17	31
BH2	5.50	5	8	10	18
BH2	7.00	6	11	13	24
BH2	8.50	6	8	10	18

SPT samples recovered in borehole 2


1.00m


2.50m


4.00m


5.50m


7.00m


8.50m

Borehole 3

Location	Depth (m)	Blows per Interval			Uncorrected N-Value
		150mm	300mm	450mm	
BH3	1.00	7	9	10	19
BH3	2.50	4	7	8	15
BH3	4.00	8	10	14	24
BH3	5.50	10	15	16	31
BH3	7.00	4	7	9	16
BH3	8.50	7	8	8	16
BH3	10.0	2	4	4	8
BH3	11.5	HW/250mm, 1		2	3
BH3	13.0	HW/50mm, 2	4	4	8

SPT samples recovered in borehole 3

Recovered SPT samples from top to bottom: 1.00m, 2.50m, 4.00m

Recovered SPT samples from top to bottom: 5.50m, 7.00m, 8.50m

Recovered SPT samples from top to bottom: 10.00m, 11.50m, 13.00m. Note the thumb prints to show the firmness / softness of the clay.

Rock core photographs & RQD

Borehole 2

Sample recovered from 10.0m to 13.0m.

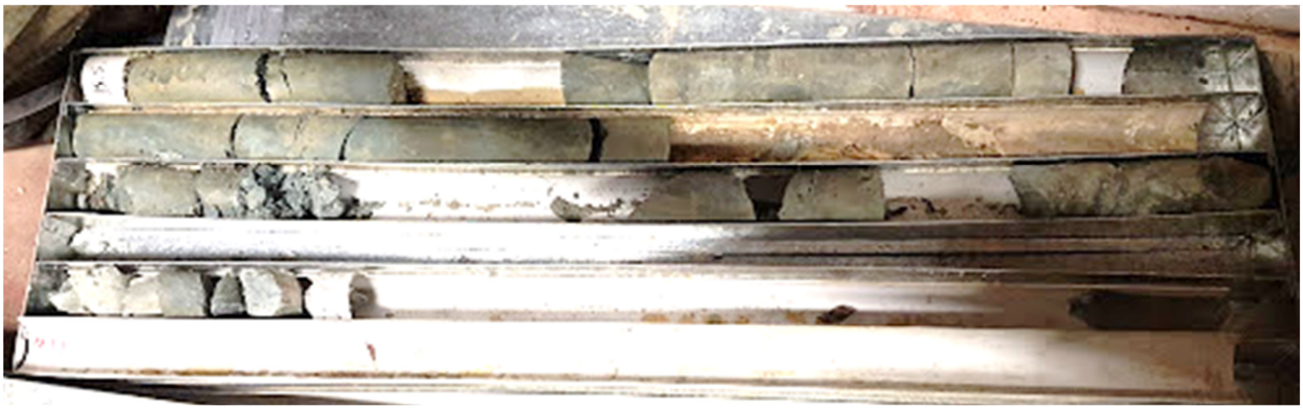
Sample recovered from 13.0m to 16.0m.

Sample recovered from 16.0m to 20.0m.

Rock Quality Designation

Core run (m)	Recovered (m)	RQD (%)
10.0-11.5	1.4	85
11.5-13.0	1.45	79
13.0-14.5	1.3	92
14.5-16.0	1.5	80
16.0-17.5	1.5	86
17.5-19.0	1.5	73
19.0-20.0	1.0	90

Borehole 3



Note that this photograph was taken after samples for lab testing were removed.

Rock Quality Designation

Core run (m)	Recovered (m)	RQD (%)
15.5-17.0	1.4	74
17.0-18.5	1.4	65
18.5-20.0	1.5	73

Laboratory testing results

Please find these attached at the end of this report. A summary table is below.

Borehole Number	2	2	2	2	2	3	3	3
Sample Diameter (mm)	51.4	51.4	51.2	51.2	51.2	51.4	51.4	51.4
Depth (m)	10	13	16.5	18.5	20	16	18	19.5
Saturated moisture content (%)	4.2	4	3.5	3.5	3	6.3	8.1	9.2
Point Load strength index test failure load (N) (AS 4133.4.1)	N/A	3330	2490	3960	N/A	N/A	870	760
Is50 (MPa)	N/A	1.62	1.1	1.87	N/A	N/A	0.38	0.35
UCS (from Is50) (MPa) (Broch)	N/A	38.88	26.4	44.88	N/A	N/A	9.12	8.4
UCS (Chiu,81) (MPa)	6.39	6.58	7.07	7.07	7.60	4.71	3.63	3.09
Load P (from Is50) (MPa) (Fitzhardinge)	N/A	4.26	2.88	4.89	N/A	N/A	1.00	0.92
UCS from Laboratory Testing (MPa) (AS 4133.4.2)	14.2	N/A	N/A	N/A	24	5.6	N/A	N/A

Foundation Recommendations

From the supplied plans, it appears that the basement encompasses the entire building footprint.

The risk of differential movement between shallow and deep foundations is high. Potential reactivity induced differential movements of between 20mm and 40mm may occur, or greater if good foundation maintenance is not practiced.

The proposed basements will necessitate significant excavation. The soil profile encountered onsite became moisture affected and softened at depth. We recommend that the proposed building not be supported from the moisture affected and softened soils at depth.

With consideration to the scope of the proposed works, the proposed basement and the soil profile encountered onsite it is recommended that all footings, including those outside the basement, are pile supported from the underlying distinctly weathered siltstone ROCK throughout.

Continuous flight auger (CFA) piles are recommended as collapse and water ingress will occur at depth at this site.

Where excavating below the groundwater depth, rapid water ingress must be anticipated.

Suspended foundations

Pile capacity (Distinctly weathered siltstone ROCK)

An ultimate bearing capacity of 4000kPa is available in the distinctly weathered siltstone rock.

An allowable bearing pressure of 1333kPa (FOS = 3) may be adopted beneath bored piers founding 500mm in distinctly weathered siltstone rock. This pressure may be reviewed once design loads have been determined.

Rock socketed bored piers founded a minimum of three pile diameters in the distinctly weathered siltstone rock can adopt an allowable bearing capacity of 4.0MPa (FOS =3).

The presence of a shallow perched water table and/or loose filling and natural sand soils above the natural clay profile may require piers to be cased. It is essential that the base of the bored piers is clean of any loose and fallen debris prior to pouring concrete.

Excavation & Retaining Walls

Safe batter angles

Recommended safe batter slope angle for the soils on site are provided below.

Soil Type	**Safe batter slope angles degrees**	
	short term	long term
FILLING	30	30
silty SAND	30	30
stiff silty & sandy CLAY	55	45
clayey SAND	55	45

Without engineered support the crest of any excavation should not be within 2m of any existing footings without written approval from this office.

Basement construction method

A double level basement is proposed. Basement excavations will not be possible and engineer designed soldier pile walls are recommended.

Engineered Walls

Contiguous piles or soldier piles with 'top down' structural shotcrete infill are recommended for this site. Solider piles can be designed to be propped or tied back.

Pile spacing

Where the capping beam does not exceed the depth of upper silty sand and fill material, pile spacing may need to be reduced and/or contiguous/secant (touching) should the upper topsoils become saturated or, conversely, dry. Saturated or excessively dry topsoils may also necessitate the use of CFA methods.

It is important to note that ground conditions can change, and that during drier periods the groundwater may not be so much of an issue for construction.

Where the silty sand is not saturated (wet) it may stand unsupported for short periods and it may be possible to undertake the construction using conventional methods without CFA techniques and space piles at greater centres.

It is highly recommended test pits are excavated to verify the stability of the natural silty sand topsoils.

An experienced piling contractor should be contacted for further advice regarding pile installation in the conditions encountered on site.

General guidelines for pile spacing

The highest risk of instability for piled retaining systems is within the upper filling and loose silty SAND top soils. The natural silty and sandy CLAY and clayey SAND soils will arch between piles.

Good construction practices include:

(1) Leaving soils in place at the front of the piles until reinforcing and construction materials are on site and construction is immediately ready to proceed;
(2) Undertaking shotcrete infill wall construction as quickly as safely practicable with no delays once the infill soil is removed and reinforcing placed;
(3) Limit top down stages to say 2.0m depths,
(4) Ensuring contingency plans are in place to immediately respond to any localised instability in consultation with the Structural Engineer (this could include shotcrete, or placement of bulk soil or crushed rock on the boundary);
(5) Continually monitor the bulk excavation and following any significant rainfall; and
(6) Undertake excavation with caution.

Please note where localized collapse occurs, adjacent ground may settle. The stability of adjacent land and buildings must be ensured.

Tied back/propped pile walls

A tied back pile wall may be installed utilising bored concrete piers and temporary tieback anchors. Tieback retaining walls should be designed incorporating full hydrostatic pressure, unless the wall can incorporate permanent drainage. Drainage could be strip drains nailed to the excavation face prior to shot creating.

The embedment depth will be dependent on the passive pressure required to prevent kicking out of the base of the pile which should be checked by the structural engineers. Piles that are laterally loaded will need to be founded on rock.

It is essential that the base of the bored piers is clean of any loose and fallen debris prior to pouring concrete.

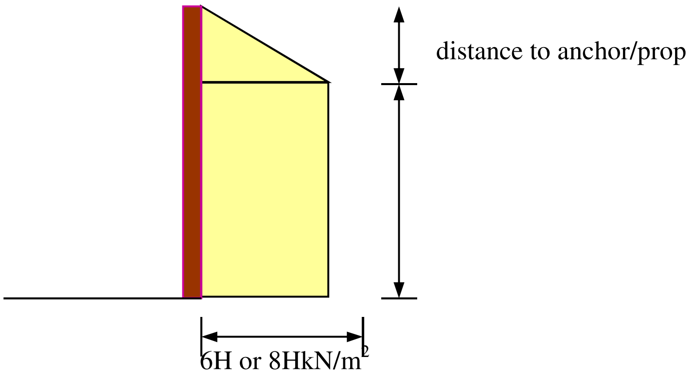
The (non-yielding) walls/piles should be designed for a triangular distribution down to the top anchor/prop and then adopt a uniform rectangular lateral earth pressure distribution using:

- $P_0 = 8H$ kN/m^2 where abutting or within a very close proximity to adjacent buildings,
- $P_0 = 6H$ kN/m^2 elsewhere

where H equals the height of the wall in metres.

An adequate factor of safety should be applied. Passive resistance at the toe can be calculated by static geomechanics principles adopting the soil parameters provided below.

Lateral earth pressure distribution for tie back walls:



Any additional surcharges should be added to the lateral earth pressure, i.e. hydrostatic, the line load from the existing building and surcharge loads. Note that AS4678-2002 recommends a minimum 5kPa surcharge loading to all walls.

Anchors

Temporary anchor/piles should be installed to a depth such that the bonded length is beyond the active wedge of soil (an angle of 60° above horizontal from the base of the cut can be adopted for the active wedge). The bonded length should be founded within the natural soil profile.

Pile pull out tests must be conducted to ensure that the piles have adequate capacity as per the current piling code AS2159-1995; the piles/anchors may need to be tensioned to limit deflections. This will be dependent on the construction and excavation sequence, and should be reviewed by the Structural Engineer.

The allowable capacity for anchors must be determined by load tests. Advice from the structural engineer should be obtained for the maximum deflection acceptable.

The anchors are expected to be temporary until the retaining wall achieves a ‘fixed head’ by the ground and level floor.

Contiguous piles

If contiguous piles are adopted the wall will act as a conventional retaining wall not as individual piles. The wall will need to retain the lateral earth pressure above as for the tie back walls. Drainage must be provided behind the wall or hydrostatic pressure added to the lateral earth pressure, i.e. strip drains nailed to the excavated face and allowed to drain to weep holes. The allowable bearing pressure beneath this wall can adopt the same pressure as for the basement strip footings.

Passive resistance at the toe can be calculated by static geomechanics principles adopting the soil parameters in the appendix.

Pavements

Sub-grade preparation

Periods of wet weather will make subgrade preparation and fill placement difficult if not impossible when trying to achieve optimum moisture contents and compaction. It is highly recommended that construction is undertaken in the drier months.

Outside the area of the basement

Preparation of pavements, down ramps and floor slab subgrades should consist of stripping of grass; root zone material and the surface fill material to expose the natural CLAY subgrade.

Areas within the proposed basement

Any loose, saturated or disturbed soils should be stripped to expose the natural silty CLAY sub-grade.

In both areas

The exposed surface should be proof rolled with the aim of achieving a dry density ratio of 98% as measured by standard compaction (AS1289 5.1.1). Any soft, wet or loose material which does not respond to compaction should be additionally excavated to expose a firm working base.

The moisture content of the sub-grade is critical in the pavement design. Depending on the moisture content of the subgrade at the time of construction, it may be necessary to add water or allow the subgrade to dry back to achieve satisfactory compaction.

We recommend that the pavement construction be commenced without delay once the subgrade has been exposed and proof rolled. A minimum compacted lift of 200mm imported filling should be placed immediately once subgrade preparation is completed to protect the subgrade from moisture changes and provide a working platform for vehicles.

Subgrade drainage

The subgrade should be provided with subsurface drainage to maintain any groundwater table to at least 300mm beneath the underside of the pavements, or a lower CBR value should be used in the design.

Pavements

Based on experience within the immediate area and the site investigation to date, it is recommended that pavements be designed on the:

- Natural silty CLAY soils using an estimated C.B.R value of 4.5% and a long term Young's modulus E_{sl} of 18MPa and a correlation factor of 0.7 can be adopted as per the Cement and Concrete Association of Australia 'Industrial Floors and pavements' section 3 Design for strength.

Earthworks

The on-site excavated soils should be removed to spoil.

Any imported filling used should comprise of clean, **essentially of a granular nature**, non-organic and have a plasticity index of less than 12%. Suitable material may include crushed scoria, non-descript crushed rock, mudstone or siltstone or equivalent. Fill material should have a nominal particle size of 75mm or less and as a guide, appropriate material would meet the following criteria:

P.I x %pass 0.425 (As sieve) < 600

Any filling should be placed in lifts not exceeding 250mm loose thickness. Each layer should be compacted to a dry density ratio of 98% measured by standard compaction (AS1289 5.1.1) using an appropriate medium weight vibratory roller. The recommended moisture content is within 2% of optimum moisture content under standard compaction.

Construction & Maintenance

Easements & service trenches adjacent to excavation

The location of existing easements and service trenches close to the bulk excavation is a common cause of instability. These trenches can impart lateral loads to the batters via hydrostatic pressures is the trench is carrying water of is the pipes leak. All easements or service trenches close to the bulk excavation must be identified and the invert depths determined. Should there be pipes adjacent to the bulk excavations this office contacted for further advice.

Service trenches/easements

The presence of service trenches and easements is a common cause of unsatisfactory performance of foundations through either direct undermining or through the introduction of undesirable levels of soil moisture. For this reason, we recommend:

- Where piles are located in close proximity or adjacent to a backfilled service trench or easements, the footing must be deepened and founded at a depth at or below the level of plane of inclination of 45° above horizontal extending outwards from the base of the trench or filling (as illustrated by figure C6.4.1 AS 2870 2011). This includes service trenches which may be present on adjacent sites or on site prior to the current development (such as abandoned stormwater and sewer trenches).

Construction

All contractors should be well briefed as to the requirements and specifications in this report. The subgrade preparation, compaction testing, and inspection of foundation excavations should be conducted to ensure that they are in accordance with this report. It is recommended that fill material type is verified and that the compaction be tested during placement. Testing should be conducted in accordance with AS3798-1990, ‘Guidelines of earthworks for commercial and residential developments’.

This report is based on the assumptions that conditions revealed through selective sampling are indicative of the actual conditions throughout the site, i.e. correlation between boreholes. Variations between boreholes may exist due to previous land use or natural geologic processes. Additional deepening of the foundations, deeper than the minimum specified founding depths in this report, may be required. The actual subsurface conditions can be discerned only during earthworks when the subsurface profile can be directly observed.

For further information regarding geotechnical site investigation reports, refer to reference (5) below.

Inspection of all foundation excavations, site works and compaction must be conducted by a suitably qualified, experienced engineer, engineering geologist, building surveyor or similar to ensure that the founding material and site works are in accordance with this report. Should there be any doubt, this office should be immediately contacted.

Please do not hesitate to contact this office, should there be any further queries.

Yours faithfully,
HardRock Geotechnical Pty Ltd

T Darby

Tim Darby B.Sci. (Civil) M.Eng. (Civil)
(Geotechnical Engineer)

References

(1) AS2870-2011. “Residential slabs and footings- Construction.”
(2) “Guidelines for the Provision of Geotechnical Information in Construction Contracts”, published by the Institution of Engineers, Australia, 1987.
(3) AS1726-1993 "Geotechnical Site Investigations".
(4) AS 3798-2007 “Guidelines on Earthworks for commercial and residential developments”.
(5) AS2159 – 1978 “SAA Piling Code”
(6) BS 8002-1994 “Earth Retaining Structures”.
(7) AS 4678-2002 “Earth Retaining Structures”.
(8) AS2159-2009. “Piling – Design and Installation”.
(9) AS2159 Supp1 - 1996. “Piling – Design and Installation Guidelines”.
(10) Cover image: https://www.domain.com.au/203-1-vine-street-heidelberg-vic-3084-2013435071

HardRock Geotechnical P/L

Consulting geotechnical engineers.

Borehole Logs

File: 170552
Date: 02/03/2017
Supervisor: HM/ MB

Client: Roniak Developments Pty Ltd

Project: 1 Vine Street, Heidelberg

Borehole No. 1 **Drilling method**: A (FRASTE MULTIDRILL) **Location:** see figure 1.

Depth (m)	Structure	Description	Cohesion/ density	Soil moisture/ groundwater	Testing:
	Pavement	brick pavers			4 1/2" solid augers
0.08	Fill	silty SAND/ gravel	L	M	
0.20	SP	silty SAND (SM), fine grained, light grey, some gravel	L	M	
0.40		silty CLAY (CL), medium plasticity, orange/ brown/ grey	ST	M	
1.00		sandy CLAY (CS), medium plasticity, orange/ brown	ST	M	
1.50		clayey SAND (SC), medium grained, orange/ brown	MD	M	
2.50		silty CLAY (CL), medium plasticity, orange/ brown/ light brown trace sand decreasing sand content with depth grading to brown/ orange increasing silt content with depth Firm below 7.50m Wet below ~7-8m.	ST ST F F SOFT/F	M M W W W	
14.50		Borehole terminated at 14.50m on siltstone ROCK			

Legend:

Density	Cohesion	Moisture	
VL - Very Loose	S - Soft	W - Wet	**HA -** Hand Auger **A -** Flight Auger Drill Rig
L - Loose	F- Firm	M - Moist	Unified Soil Classification Symbols: CL, SM, SW
MD - Medium Density	ST - Stiff	D - Dry	SP - Soil Profile
D - Dense	VST- Very Stiff		Some< 15%
			Trace< 5%

HardRock Geotechnical P/L

Consulting geotechnical engineers.

Borehole Logs

File: 170552
Date: 05/05/2017
Supervisor: TD

Client: Roniak Developments Pty Ltd

Project: 1 Vine Street, Heidelberg

Borehole No. 2 **Drilling method**: A (FRASTE MULTIDRILL) **Location:** see figure 1.

Depth (m)	Structure	Description	Cohesion/ density	Soil moisture/ groundwater	Testing:
	Fill	silt, sand, clay, gravel	L	M	4 1/2" solid augers to 10.0m
0.80	SP	silty CLAY (CL), medium plasticity, brown/ grey Iron seam at ≈ 7.00m Firm/ Stiff below 8.00m trace gravel grading to extremely weathered siltstone ROCK	ST ST F/ST ST	M M M M	SPT @ 1.00m= 2,5,9 SPT @ 2.50m= 11,12,14 SPT @ 4.00m= 11,14,17 SPT @ 5.50m= 5,8,10 SPT @ 7.00m= 6,11,13 SPT @ 8.50m= 6,8,10
10.00	Weathered ROCK	Distinctly weathered siltstone ROCK	D D D	M M M	NMLC Diamond Core Barrel.
20.00		Borehole terminated at 20.00m			

Legend:

Density	Cohesion	Moisture	
VL - Very Loose	S - Soft	W - Wet	**HA -** Hand Auger **A -** Flight Auger Drill Rig
L - Loose	F- Firm	M - Moist	Unified Soil Classification Symbols: CL, SM, SW
MD - Medium Density	ST - Stiff	D - Dry	SP - Soil Profile
D - Dense	VST- Very Stiff		Some< 15%
			Trace< 5%

HardRock Geotechnical P/L

Consulting geotechnical engineers.

Borehole Logs

File: 170552
Date: 05/05/2017
Supervisor: TD

Client: Roniak Developments Pty Ltd

Project: 1 Vine Street, Heidelberg

Borehole No. 3 **Drilling method**: A (FRASTE MULTIDRILL) **Location:** see figure 1.

Depth (m)	Structure	Description	Cohesion/ density	Soil moisture/ groundwater	Testing:
	Pavement	brick pavers			4 1/2" solid augers to 14.5m
0.08	Fill	silty SAND/ gravel	L	M	
0.20	SP	silty SAND (SM), fine grained, light grey, some gravel	L	M	
0.40		silty CLAY (CL), medium plasticity, orange/ brown/ grey	ST	M	SPT @ 1.00m= 7,9,10 SPT @ 2.50m= 4,7,8 SPT @ 4.00m= 8,10,14 SPT @ 5.50m= 10,15,16 SPT @ 7.00m= 4,7,9 SPT @ 8.50m= 7,8,8 SPT @ 10.00m= 2,4,4 SPT @ 11.50m= HW/250mm , 1,2 SPT @ 13.00m= HW/50mm, 2,4,4
1.00		sandy CLAY (CS), medium plasticity, orange/ brown	ST	M	
1.50		clayey SAND (SC), medium grained, orange/ brown	MD	M	
2.50		silty CLAY (CL), medium plasticity, orange/ brown/ light brown	ST	M	
		trace sand	ST	M	
		decreasing sand content with depth			
		grading to brown/ orange	F	W	
		increasing silt content with depth	F	W	
		firm – stiff below 8.50m			
		firm- soft below 10.50m, dark grey, high plasticity	SOFT/F	W	
14.50	Weathered ROCK	Distinctly weathered siltstone ROCK	D	M	NMLC Diamond Core Barrel.
			D	M	
			D	M	
20.00		Borehole terminated at 20.00m in siltstone ROCK			

Legend:

Density	Cohesion	Moisture	
VL - Very Loose	S - Soft	W - Wet	**HA -** Hand Auger **A -** Flight Auger Drill Rig
L - Loose	F- Firm	M - Moist	Unified Soil Classification Symbols: CL, SM, SW
MD - Medium Density	ST - Stiff	D - Dry	SP - Soil Profile
D - Dense	VST- Very Stiff		Some< 15%
			Trace< 5%

HARDROCK GEOTECHNICAL P/L
Consulting geotechnical engineers

File: 170552
Date: 05/05/2017

LOCATION PLAN

Figure No. 1

Project:
1 Vine Street, Heidelberg
Scale.
Not to Scale (sketch for borehole locations).

Legend:
⊕ Borehole
Footing inspection

Appendix A: 1 Vine Street, Heidelberg

Material	Design Parameters						Poisson's Ratio	Young's Modulus (MPa)	K_0	K_p
	Drained		Undrained		Moist Bulk Weight γ (kN/m^3)	Saturated Bulk Weight γ (kN/m^3)			$(1 - \sin\phi')$	$\frac{(1 + \sin\phi')}{(1 - \sin\phi')}$
	c' (kPa)	ϕ' (°)	C_u (kPa)	ϕ (°)						
FILL (loose)	0	28	0	28	17	20	0.1-0.2	1-5	0.53	2.76
silty CLAY (stiff)	3	25	100	0	18	18	0.2-0.3	20-40	0.58	2.46
silty CLAY (firm/soft)	0	25	30	0	18	18	0.2	10	0.58	2.46
Distinctly weathered siltstone ROCK (high to moderately weathered)	3 (joint strength)	25 (joint strength)	200	0	24	24	0.2-0.3	150-500	0.58	2.46

Please note these parameters are difficult to measure and exhibit large natural variations. Sound engineering judgement is recommended in their use.

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
231 Normanby Road
PO Box 5051
South Melbourne VIC 3205
Phone (03) 9673 3500
Fax (03) 9673 3599

Results of Moisture Content Test

Client:	HardRock Geotechnical Pty Ltd	**Project No:**	69089.00
		Report No:	M17157001
Project:	HEIDELBERG, Vine St	**Report Date:**	19-May-2017
		Date Sampled:	-
Location:	1 Vine St, Heidelberg, VIC 3084	**Date of Test:**	18-May-2017
		Page:	1 of 1

TEST LOCATION	DEPTH (m)	DESCRIPTION	MOISTURE CONTENT (%)
BH2	13	SILTSTONE	4.0
BH2	16.5	SILTSTONE	3.5
BH2	18.5	SILTSTONE	3.5
BH3	18	SILTSTONE	8.1
BH3	19.5	SILTSTONE	9.2

Test Method(s): AS1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks: Saturated Moisture content

NATA

ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number: 828

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025

Tested: CP
Checked: AG

Arveendra Gounder
Laboratory Manager

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
231 Normanby Road
PO Box 5051
South Melbourne VIC 3205
Phone (03) 9673 3500
Fax (03) 9673 3599

Results of Point Load Strength Index Test

Client:	HardRock Geotechnical Pty Ltd	**Project No:**	69089.00
		Report No:	M17157002
Project:	HEIDELBERG, Vine St	**Report Date:**	19-May-2017
		Date Sampled:	-
Location:	1 Vine St, Heidelberg, VIC 3084	**Date of Test:**	18-May-2017
		Page:	1 of 1

Bore / Pit	Depth (m)	Description Of Rock	Test Type	Failure Load (N)	Failure Mode	I_s (MPa)	$I_{s(50)}$ (MPa)	Saturated Moisture Content (%)
BH2	13	SILTSTONE	D	3330	C	1.72	1.62	4.0
BH2	16.5	SILTSTONE	D	2490	P	1.13	1.10	3.5
BH2	18.5	SILTSTONE	D	3960	C	1.96	1.87	3.5
BH3	18	SILTSTONE	D	870	P	0.39	0.38	8.1
BH3	19.5	SILTSTONE	D	760	P	0.36	0.35	9.2

Test Method(s): AS 4133.4.1, AS 1289.2.1.1

Sampling Technique: Sampled By Engineering Department

Remarks:

Failure Mode:
P = Plane of weakness
B = Bedding
M = Matrix
C = Combination

Type of Test
A – Axial
D – Diametral
L - Lump

Sample Stored in Sealed Plastic Bag

NATA Accredited Laboratory Number: 828

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025

ACCREDITED FOR TECHNICAL COMPETENCE

Tested: CP
Checked: AG

Arveendra Gounder
Laboratory Manager

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
15 Callistemon Close
Warabrook NSW 2304
PO Box 324
Hunter Regional MC NSW 2310
Phone (02) 4960 9600
Fax (02) 4960 9601

RESULTS OF UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORES

Client: **HardRock Geotechnical Pty Ltd**

Project: Heidelberg, Vine Street

Location: 1 Vine Street, Heidelberg

Project No: 69089.00
Report No: 69089.00-1
Report Date: 26.05.2017

Date Sampled: -
Page: 1 of 1

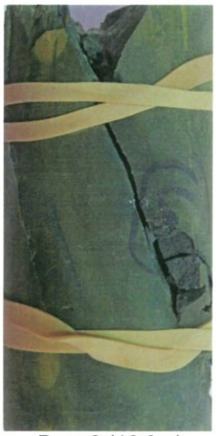
Uniaxial Compressive Strength - Test Method AS 4133.4.2

Bore Location		Bore 2	Bore 2	Bore 3	
Bore Depth	m	10.0	20.0	16.0	
Rock Description		SILTSTONE	SILTSTONE	SILTSTONE	
Storage History and Environment		Tested as received			
Date of Testing		22.05.2017	22.05.2017	22.05.2017	
Specimen Diameter	mm	51.4	51.2	51.4	
Specimen Height	mm	130	121	99	
Moisture Content (AS 4133.1.1.1)	%	4.2	3.0	6.3	
Dry Mass Per Unit Volume	t/m³	2.41	2.48	2.28	
UNIAXIAL COMPRESSIVE STRENGTH ***MPa***		**14.2**	**24.0**	**5.6**	
Remarks			Specimen did not meet the minimum height to diameter ratio of 2.5 to 3.0:1	Specimen did not meet the minimum height to diameter ratio of 2.5 to 3.0:1	

Compression Machine: Autocon (1500kN) – Model CL10320


Bore 2 (10.0m)


Bore 2 (20.0m)


Bore 3 (16.0m)

Tested:	JH
Checked:	DM

Dave Millard
Laboratory Manager