Pells Sullivan Meynink
Engineering Consultants
Rock-Soil-Water

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Our Ref: PSM1541-123R

18 November 2015

Goodman Property Services (Aust) Pty Ltd
Level 17, 60 Castlereagh Street
SYDNEY NSW 2000

ATTENTION: KYM DRACOPOULOS

Dear Kym

RE: OAKDALE WEST ESTATE – KEMPS CREEK, NSW
GEOTECHNICAL INVESTIGATION

We are pleased to submit our geotechnical report for the proposed development at Oakdale West Estate, Kemps Creek, NSW.

Please do not hesitate to contact the undersigned if you have any queries.

For and on behalf of
PELLS SULLIVAN MEYNINK

GARRY MOSTYN

Distribution: pdf copy emailed to Kym.Dracopoulos@goodman.com
Original held by PSM

Goodman Property Services

OAKDALE WEST ESTATE
KEMPS CREEK
GEOTECHNICAL INVESTIGATION

PSM1541-123R **NOVEMBER 2015**

CONTENTS

FIGURES

APPENDICES

1 INTRODUCTION

This report presents the results of the geotechnical investigation undertaken by Pells Sullivan Meynink (PSM) for the proposed Oakdale West Estate development at Kemps Creek, NSW.

The work was undertaken in accordance with the PSM proposal dated 9 October 2015 (Ref. PSM1541-116L Rev1).

Prior to the work, PSM was supplied with the following documents:

- SBA Architects, Oakdale Industrial Estate – West, Proposed Stage 1 Works – Site Plan (Ref. 15117_Oak_West_SK11_A.pdf).
- AT&L drawing 15-272 SKC051 "Oakdale West – Optimised Master Plan – Cut to fill plan".

2 PROPOSED DEVELOPMENT

Based on the supplied documents, PSM understand the following about the proposed development at the Oakdale West Estate:

- The site covers an area of approximately 95 Ha.
- The site has significant elevation changes that result in large cuts and fills.
- The proposed development comprise typical warehouse facilities, with estate roads, etc.
- The proposed earthworks will comprise the following:
  - Fill depth up to approximately 12 m
  - Cut depth up to approximately 15 m

Figure 1 presents the proposed cut and fill plan that was used as the basis for the geotechnical investigation undertaken by PSM.

3 GEOTECHNICAL INVESTIGATION

3.1 Fieldwork

The fieldwork was undertaken on 14 to 20 October 2015 under the fulltime supervision of a PSM geotechnical engineer, who undertook the following tasks:

- Setting out test locations
- Preparing engineering logs
- Taking photos of the site and recovered rock cores
- Collection of samples for environmental testing

The test locations were recorded with a hand-held GPS unit with a horizontal accuracy of about ±5 m. Approximate elevations were inferred from the site contour map provided to PSM. Figure 1 presents the test locations.

3.1.1 Augered Boreholes

A total of thirteen (13) augered boreholes (BH01 to BH13) were drilled using a 14 tonne excavator with a pendulum auger attachment.

The boreholes were mostly targeted in the cut area to provide excavatability information.

The boreholes were drilled to depths between 1.5 m and 4.95 m. BH03, reached practical refusal at a depth of 1.5 m.

Engineering borehole logs together with the explanation sheets are presented in Appendix A.

3.1.2 Cored Boreholes

A total of two (2) cored boreholes (BH14 and BH15) were completed using a tracked drill rig. The boreholes were located at the high points of the site, where the proposed cut is deepest. The boreholes were drilled to approximately 15.0 m.

Augering through soil and weathered rock was undertaken using a “TC” bit and the rock was cored using NMLC methods.

Engineering logs were prepared for each cored borehole and are presented in Appendix A, along with explanation sheets. Photographs of the extracted core are presented in Appendix B.

Point load tests on the core were performed at approximately metre intervals. Results are tabulated in Appendix C.

3.1.3 Test pits

A total of twenty seven (27) test pits were excavated predominantly in the proposed fill areas using a 14 tonne excavator with a 600 mm wide bucket.

Test pits were excavated to a maximum depth of 2.0 m. The purpose of excavation of these shallow test pits is to provide general information regarding the subsurface conditions near the surface (eg. depth of topsoil), especially in the proposed fill area.

A summary of the subsurface conditions encountered are tabulated in Appendix A2.

Selected test pit photographs are presented in Appendix D.

The test pits were backfilled with excavated spoil and compacted using the excavator bucket upon completion.

4 SITE CONDITIONS

4.1 Geological Setting

The 1:100,000 Penrith Geological map (1991) indicates the site is underlain by:

- The Wianamatta Group formation (Bringelly Shale) comprising shale, carbonaceous claystone, claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff.
- Alluvium (Qal) comprising fine-grained sand, silt and clay in the eastern portion near the boundary, eg. Ropes Creek.

4.2 Surface Conditions

The Oakdale West Estate comprises 95 Ha of farmland. During the fieldwork, numerous grassy paddocks separated by steel wire fencing were observed. Several dams were also observed.

Appendix D presents some selected photos taken during the fieldwork.

4.3 Subsurface Conditions

The subsurface conditions encountered within the boreholes and test pits are summarised in Table 1. The encountered subsurface conditions were consistent with the published information in the geological map.

TABLE 1
SUMMARY OF INFERRED SUBSURFACE CONDITIONS ENCOUNTERED IN PSM TEST PITS AND BOREHOLES

INFERRED UNIT	ENCOUNTERED DEPTH TO TOP OF INFERRED UNIT (m)	DESCRIPTION
TOPSOIL	0.0	CLAY with rootlets. Clay is low plasticity, dark brown with inferred soft to stiff consistency. Grass surface.
NATURAL SOIL	0.04 to 0.5	CLAY. Clay is medium to high plasticity, light brown to grey with inferred stiff to very stiff consistency.
BEDROCK	0.7 to 4.0	SANDSTONE and SHALE; extremely weathered to moderately weathered, extremely low strength to high strength, light brown to grey.

Table 2 shows the reduced levels of the inferred geotechnical units encountered in PSM boreholes and test pits.

TABLE 2
APPROXIMATE REDUCED LEVELS OF TOP OF INFERRED GEOTECHNICAL UNITS ENCOUNTERED IN PSM TEST PITS AND BOREHOLES

BOREHOLE/ TEST PITS	APPROXIMATE REDUCED LEVEL OF TOP OF INFERRED GEOTECHNICAL UNITS (m AHD)			
	TOP SOIL	NATURAL SOIL	BEDROCK	EOH
BH01	78.0	77.9	76.3	73.2
BH02	83.5	83.3	79.8	78.6
BH03	82.5	82.4	81.5	81.0*
BH04	85.5	85.3	83.5	80.8
BH05	82.5	82.4	N.E.	77.7
BH06	74.5	74.3	N.E.	70.3
BH07	82.5	82.4	79.7	77.8
BH08	77.0	76.9	73.3	72.1
BH09	83.5	83.4	79.5	78.6
BH10	76.5	76.1	74.7	72.2
BH11	76.0	75.8	72.1	71.8
BH12	70.8	70.5	N.E.	66.8
BH13	74.5	74.4	71.5	70.6
BH14	93.0	92.9	91.5	78.1
BH15	87.0	86.9	86.3	72.0
TP01	61.5	61.3	N.E.	59.5
TP02	59.0	58.7	57.8	57.0
TP03	66.0	65.7	64.6	64.0
TP04	67.5	67.3	66.2	65.5
TP05	72.0	71.7	70.8	70.1
TP06	74.0	73.8	N.E.	72.0
TP07	67.5	67.1	N.E.	65.5
TP08	72.5	72.2	N.E.	70.7
TP09	71.0	70.8	N.E.	69.0
TP10	75.5	75.2	N.E.	73.6
TP11	75.0	74.7	73.6	73.0
TP12	70.0	69.6	N.E.	68.0
TP13	71.0	70.7	N.E.	69.1
TP14	66.5	66.2	N.E.	64.5
TP15	69.3	69.1	N.E.	67.4
TP16	69.0	68.8	67.9	67.2
TP17	61.5	61.5	N.E.	59.5
TP18	63.0	62.5	N.E.	61.0

BOREHOLE/ TEST PITS	APPROXIMATE REDUCED LEVEL OF TOP OF INFERRED GEOTECHNICAL UNITS (m AHD)			
	TOP SOIL	NATURAL SOIL	BEDROCK	EOH
TP19	60.0	60.0	N.E.	58.0
TP20	53.5	53.2	51.9	51.8
TP21	59.5	59.4	N.E.	57.5
TP22	69.5	69.2	N.E.	67.5
TP23	66.5	66.1	N.E.	64.5
TP24	63.5	63.2	N.E.	61.5
TP25	68.5	68.2	N.E.	66.5
TP26	65.5	65.1	N.E.	63.8
TP27	69.5	69.2	N.E.	67.5

Note: * = practical refusal using 14 t excavator with pendulum auger attachment
N.E. = Not Encountered
EOH = End of Hole

We note the following:

- The depth of TOPSOIL unit across the site is between 0.1 m and 0.5 m.
- Due to the nature of the ground conditions, the BEDROCK unit may include layers with low strength (hard capping) overlying extremely low strength that may exhibit soil like properties.

4.4 Groundwater

No groundwater was observed at any of the test locations. Water was observed at the surface within the dams on site.

5 DISCUSSION AND RECOMMENDATIONS

5.1 Excavation Conditions

Excavation in the TOPSOIL, NATURAL SOIL, and BEDROCK units is expected to be achievable using conventional earth moving equipment with minor rock breaking.

It is our experience that excavatability is heavily dependent on both the operator and the plant used. Any earthworks contractor should satisfy itself with regard to excavatability especially in the BEDROCK unit.

Please note that the 14 t excavator with an auger attachment encountered practical refusal on the BEDROCK unit within borehole BH03.

Based on the results of the site investigation and the proposed earthworks we expect groundwater will not be encountered during the bulk earthworks. There may be minor groundwater inflows while perched water tables drain initially and after rain.

5.2 Permanent and Temporary Batters

The batter slope angles shown in Table 3 are recommended for the design of batters up to 14m height subject to the following recommendations:

- The batters shall be protected from erosion.
- Permanent batters shall be drained.
- Temporary batters shall not be left unsupported for more than 2 months without further advice, and inspection by a geotechnical engineer should be undertaken following significant rain events.
- No buildings, loads or services should be located within 1 batter height of the crest.

If the conditions above cannot be met, further advice should be sought.

Where Fill is not engineered / controlled fill, batter slope angles should be assessed by a geotechnical engineer.

Exposed rock faces should be inspected by a geotechnical engineer or engineering geologist to assess the need for localised rock bolting to control adverse jointing in the BEDROCK unit and shotcreting for overall face support.

TABLE 3
BATTER SLOPE ANGLES

UNIT		TEMPORARY	PERMANENT
ENGINEERED FILL		1.5H : 1V	2H : 1V
NATURAL SOIL		1.5H : 1V	2H : 1V
BEDROCK*	(for portion of cut less than or equal to 6 m deep)	0.5 H : 1V	1 H : 1V
	(for portion of cut greater than 6 m deep)	1H : 1V	1.5H : 1V

Note: *: See above requirements regarding inspections.

Proper and suitable safe work method statements and OHS documents need to be developed for works to be undertaken in the vicinity of the crest and toe of batters, including temporary batters for the BEDROCK unit.

Steeper batters may be possible subject to further advice, probably including inspection during construction and possibly shotcreting, spot bolting, etc.

5.3 Retaining Walls

Cuts in the ENGINEERED FILL, NATURAL SOIL and BEDROCK units steeper than the recommended permanent batter slopes in Section 5.2 will need to be supported by some form of retaining structure.

The selection of the appropriate retention system is a matter of design. The designer should consider the following factors in making its selection:

- Technical factors:
  - Performance
  - Ground conditions (this is addressed below with the design parameters)
  - Surcharge loading and
  - Proximity of structures, buildings and roads, etc.
- Non- technical factors
  - Cost (to build and to maintain)
  - Other constraints such as real estate, neighbouring site / boundary, aesthetics, legislation, etc.

The design of these structures should be based on the following geotechnical properties:

- Effective soil strength parameters in Table 4, and
- A lateral pressure of 10 kPa for vertical cuts in the BEDROCK units. This is to allow for blocks and rock wedges formed due to adverse defects that may exist within the unit.

Note that design of retention systems may be based on either K_a or K_o earth pressures. Design using active earth pressures provides the minimum lateral earth pressure that must be supported to avoid failure and requires a wall that can rotate or translate to allow the pressures to reduce to these values (vertical and lateral movements up to 2% of height may occur, typical movements will be much less).

Where the design is based on K_o pressures, construction should be carefully controlled to avoid unwanted effects. It should be noted that designing for K_o pressures do not, of themselves, ensure that movement does not occur. Movements are controlled by the construction method, especially sequence.

Both surface and sub-surface drainage needs to be designed and constructed properly to prevent pore water pressures from building up behind the retaining walls or appropriate water pressures must be included in the design.

TABLE 4
ENGINEERING PARAMETERS OF INFERRED GEOTECHNICAL UNITS

INFERRED UNIT	BULK UNIT WEIGHT (kN/m^3)	SOIL EFFECTIVE STRENGTH PARAMETERS		ALLOWABLE BEARING PRESSURE UNDER VERTICAL CENTRIC LOADING (kPa)	ULTIMATE SHAFT ADHESION (KPa)	ELASTIC PARAMETERS	
		c' (kPa)	*ϕ'* (deg)			YOUNG's MODULUS (MPa)	POISSON'S RATIO
ENGINEERED FILL	18	0	30	150	N.A.	10	0.3
NATURAL SOIL	18	0	30	150	N.A.	10	0.3
BEDROCK	22	N.A.	N.A.	500	50	50	0.25

5.4 Bulk Earthworks and Earthworks Specification

A detailed PSM earthworks specification has been prepared for this site. The specification has been prepared to allow for economic construction work and setting out of roles and responsibilities of different parties. The specification is presented in Appendix E.

5.5 Warehouse facilities - Interim Geotechnical Design Advice

Interim Geotechnical Design Advice (IGDA) for the proposed industrial development has been included with this report. It is presented in Appendix F.

The advice for the proposed development has been provided based on the following:

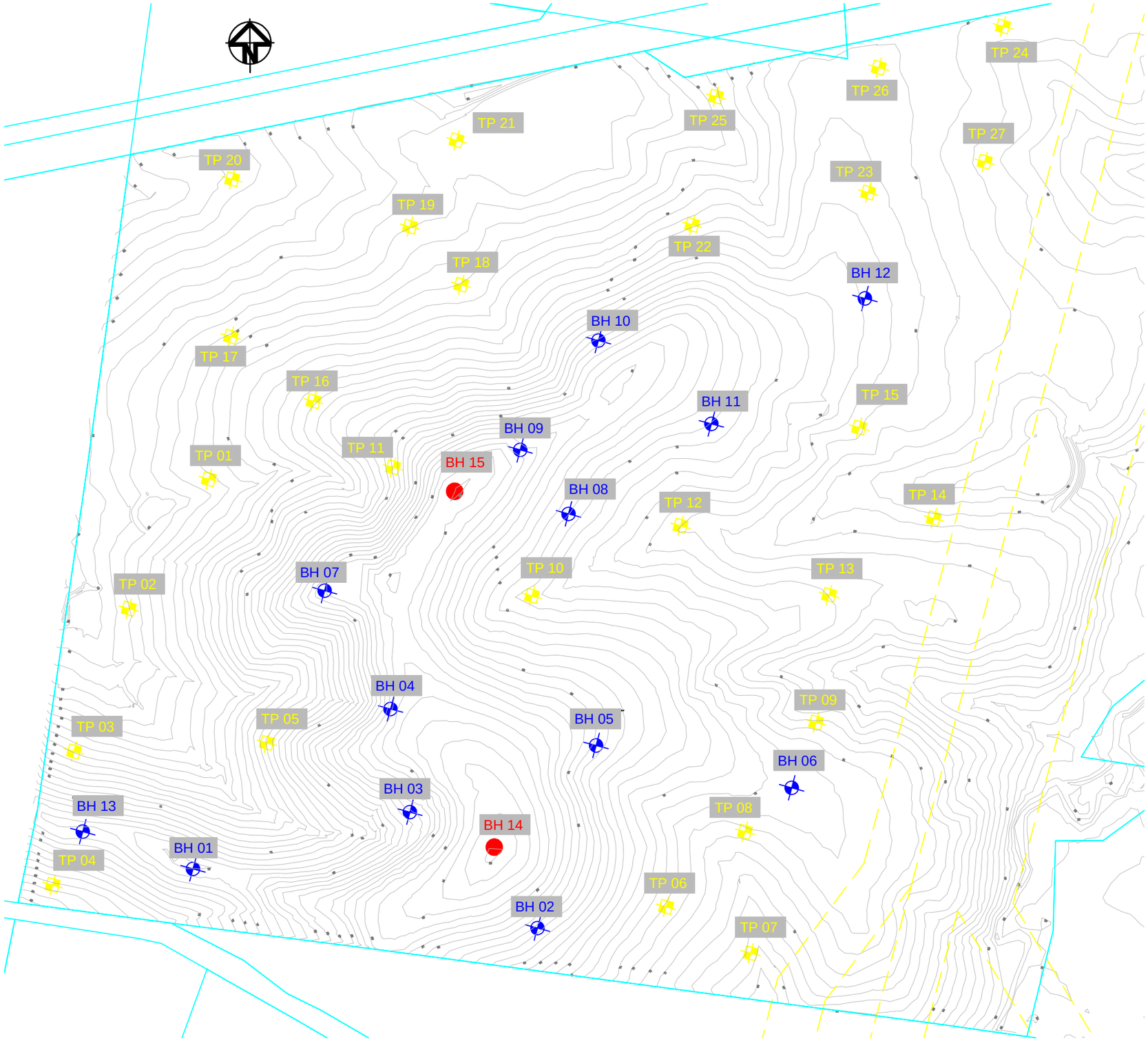
- The results of the investigation presented in this report.
- The bulk earthworks completed in accordance with a PSM Earthworks Specification (Appendix E).
- PSM review the earthworks documents as per the specifications, eg. earthworks audit, to confirm the advice.

6 GENERAL

If at any time, the conditions are found to vary from those described in this report, further advice should be sought.

For and on behalf of
PELLS SULLIVAN MEYNINK

GARRY MOSTYN
Chief Engineer



0 100 200

Scale (m) 1:5000 @ A3

NOTE:

1. PSM geotechnical investigation undertaken between 14 and 20 October 2015.

2. Test locations were surveyed by a hand-held GPS unit with a vertical accuracy of ± 5 m.

3. The base plan was taken from "SKC051 - OPTIMISED MASTER PLAN CUT TO FILL PLAN" dated 14 September 2015

BH 02 - PSM augured borehole locations

TP 02 - PSM augured borehole locations

BH 15 - PSM cored borehole locations

PSM

Pells Sullivan Meynink

Goodman Pty Ltd
Oakdale West Estate
Kemps Creek, NSW

GEOTECHNICAL INVESTIGATION
LOCALITY PLAN

PSM1541-123R	FIGURE 1

APPENDIX A1

ENGINEERING LOGS

PSM

Borehole ID

BH01

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Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	14/10/2015
Project Name:	Oakdale West Estate	Completed:	14/10/2015
Hole Location:		Logged By:	CF
Hole Position:	295986.0 m E 6254198.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	78.00 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T						77.0	1		CL	CLAY: Dark brown, low plasticity	M	St		0.00: Inferred topsoil
									CH	CLAY: Light brown and grey, high plasticity		VSt		
						76.0	2			SHALE: Grey/dark grey, low strength				
										Becoming high strength				
						75.0	3							
						74.0	4			Hole Terminated at 0.00 m				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH02

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Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	14/10/2015
Project Name:	Oakdale West Estate	Completed:	14/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296392.0 m E 6254133.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	83.50 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T				0.10 m PP =400 kPa 0.25 m PP >500 kPa		82.5	1		CL	CLAY: dark brown, low plasticity		St	×	0.00: Inferred topsoil, contains trace of roots
									CH	CLAY: red and light brown, high plasticity		VSt	×	
						81.5	2			Colour changes to grey and brown with medium plasticity	M	H		
						80.5	3							
						79.5	4			SHALE: Dark grey, low strength				

Hole Terminated at 4.35 m

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH03

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Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	14/10/2015
Project Name:	Oakdale West Estate	Completed:	14/10/2015
Hole Location:		Logged By:	DT
Hole Position:	296248.0 m E 6254275.0 m N MGA 56	Checked By:	CF

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	82.50 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T				0.10 m PP =200 kPa 0.20 m PP >500 kPa					CI	CLAY: Brown, low plasticity	M	F	×	0.00: Inferred topsoil
									CI	CLAY: Brown, medium plasticity	M	VSt	×	
						81.5	1			SHALE: Light grey, hard to very hard				
						80.5	2			Hole Terminated at 1.50 m				
						79.5	3							
						78.5	4							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH04

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Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	14/10/2015
Project Name:	Oakdale West Estate	Completed:	14/10/2015
Hole Location:		Logged By:	DT
Hole Position:	296221.0 m E 6254393.0 m N MGA 56	Checked By:	CF

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	85.50 m	
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator: MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T				0.20 m PP =150 kPa 0.40 m PP >500 kPa					CL	CLAY: Light brown, low plasticity	D	S	×	0.00: Inferred topsoil
									CL	CLAY: Dark brown, medium plasticity			×	
						84.5	1				D	VSt		
						83.5	2			SHALE: Light grey, low strength				
										becomes medium strength				
						82.5	3							
				S02 ES 4.50 m		81.5	4							
										Hole Terminated at 4.70 m				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH05

Page 1 of 1

Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	14/10/2015
Project Name:	Oakdale West Estate	Completed:	14/10/2015
Hole Location:		Logged By:	DT
Hole Position:	296463.0 m E 6254350.0 m N MGA 56	Checked By:	CF

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	82.50 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T				0.10 m PP =320 kPa					CL	CLAY: Brown, low plasticity		F	×	0.00: Inferred topsoil
				0.30 m PP >500 kPa					CI	CLAY: Brown, medium plasticity			×	
						81.5	1					VSt		
						80.5	2			becoming brown and grey, high plasticity	M			
						79.5	3					H		
						78.5	4							
										Hole Terminated at 4.80 m				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH06

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Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	14/10/2015
Project Name:	Oakdale West Estate	Completed:	14/10/2015
Hole Location:		Logged By:	DT
Hole Position:	296699.0 m E 6254302.0 m N MGA 56	Checked By:	CF

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	74.50 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T				0.10 m PP =280 kPa					CL	CLAY: dark brown, low plasticity		F - St	×	0.00: Inferred topsoil
				0.30 m PP >500 kPa					CH	CLAY: Brown and red, high plasticity			×	
						73.5	1							
				S1 ES 1.70-1.80 m						Becoming grey, red and brown				
						72.5	2				M	VSt		2.00: Some ironstone clasts
						71.5	3							
						70.5	4							
										Hole Terminated at 4.20 m				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH07

Page 1 of 1

Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	16/10/2015
Project Name:	Oakdale West Estate	Completed:	16/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296131.0 m E 6254532.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	82.50 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description						Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T									CL	CLAY: dark brown, low plasticity	M	F		0.00: Inferred topsoil
									CH	CLAY: red and brown, high plasticity				
						81.5	1				D	St - VSt		
						80.5	2							
				S21 ES 2.70-2.90 m						SHALE: Grey and brown, Extremely weathered				
						79.5	3			Moderately weathered				
						78.5	4			becomes slighly darker in colour				
										Hole Terminated at 4.70 m				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH08

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Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	16/10/2015
Project Name:	Oakdale West Estate	Completed:	16/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296420.0 m E 6254623.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	77.00 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T				0.30 m PP >300 kPa		76.0	1		CL	CLAY: dark brown, low plasticity	M	F		0.00: Inferred topsoil
									CH	CLAY: red and grey, high plasticity		St	×	
				S23 ES 2.40-2.50 m		75.0	2			Becomes medium plasticity				
						74.0	3					VSt		
						73.0	4			SHALE: Brown and grey, very low to low strength				

Hole Terminated at 4.95 m

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH09

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Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	14/10/2015
Project Name:	Oakdale West Estate	Completed:	14/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296363.0 m E 6254699.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	83.50 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T									CL	CLAY: dark brown, low plasticity		F		0.00: Inferred topsoil
									CI	CLAY: orange and brown, medium plasticity				
						82.5	1							
						81.5	2				M	St - VSt		
				S22 ES 2.85-3.00 m		80.5	3							
						79.5	4			SHALE: Dark grey and brown, Very low strength				
										Hole Terminated at 4.85 m				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH10

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Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	14/10/2015
Project Name:	Oakdale West Estate	Completed:	14/10/2015
Hole Location:		Logged By:	DT
Hole Position:	296471.0 m E 6254833.0 m N MGA 56	Checked By:	CF

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	76.50 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T				0.30 m PP >500 kPa					CL	CLAY: Brown, low plasticity	M	St	×	0.00: Inferred topsoil
				0.50 m PP >500 kPa					CH	CLAY: Brown, high plasticity			×	
				S3 ES 1.30-1.50 m		75.5	1				M	VSt		
						74.5	2			SHALE: White grey, medium strength				
						73.5	3			Becomes low strength				
						72.5	4							
										Hole Terminated at 4.30 m				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH11

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Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	14/10/2015
Project Name:	Oakdale West Estate	Completed:	14/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296589.0 m E 6254730.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	76.00 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T				0.30 m PP >500 kPa		75.0	1		CL	CLAY: dark brown, low plasticity	M	St		0.00: Inferred topsoil
									CH	CLAY: grey red brown, high plasticity			×	
				S5 ES 2.70-2.80 m		74.0	2				M	VSt		
						73.0	3							
						72.0	4			SHALE: Brown, very low strength				
										Hole Terminated at 4.25 m				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH12

Page 1 of 1

Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	14/10/2015
Project Name:	Oakdale West Estate	Completed:	14/10/2015
Hole Location:		Logged By:	DT
Hole Position:	296771.0 m E 6254878.0 m N MGA 56	Checked By:	CF

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	70.80 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T				0.20 m PP =300 kPa S4 ES 0.50 m		69.8	1		CL	CLAY: Brown, low plasticity	D	St	×	0.00: Inferred topsoil
									CH	CLAY: Brown red and grey, high plasticity				0.33: Iron staining
						68.8	2				M	VSt		
						67.8	3			some sand, medium grained.				
						66.8	4			Hole Terminated at 4.00 m				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH13

Page 1 of 1

Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	14/10/2015
Project Name:	Oakdale West Estate	Completed:	14/10/2015
Hole Location:		Logged By:	CF
Hole Position:	295844.0 m E 6254247.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	14 tonne excavator	Inclination:	-90°	RL Surface:	74.50 m		
Hole Diameter:	300 mm	Bearing:		Datum:	AHD	Operator:	MP Schultz

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T				0.20 m PP >500 kPa		74.5	0		CL	CLAY: orange brown, low plasticity		F		0.00: inferred topsoil
									CI	CLAY: orange brown, medium plasticity			×	
						73.5	1				M	VSt		
						72.5	2							
						71.5	3			SHALE: Brown, very low to low strength				
						70.5	4			Hole Terminated at 3.90 m				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH14

Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	19/10/2015
Project Name:	Oakdale West Estate	Completed:	19/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296331.0 m E 6254229.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	Commachio Geo305	Inclination:	-90°	RL Surface:	93.00 m	
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator: Soil Check

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T									CL	CLAY: dark brown, low plasticity	M	F		
									CH	CLAY: brown, high plasticity		St		
SPT				SPT 0.50-0.95 m 7,6,9 N=15							D			
						92.0	1					VSt		
AD/T										SANDSTONE: Brown, extremely weathered, high strength				
				24 ES 2.20-2.65 m		91.0	2							
										Continued on cored borehole sheet				
						90.0	3							
						89.0	4							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

See Explanatory Notes for details of abbreviations and basis of descriptions.

Engineering Log - Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	19/10/2015
Project Name:	Oakdale West Estate	Completed:	19/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296331.0 m E 6254229.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	Commachio Geo305	Inclination:	-90°	RL Surface:	93.00 m	
Barrel Type and Length:	NMLC 3 m	Bearing:		Datum:	AHD	Operator: Soil Check

Drilling Information							Rock Substance			Rock Mass Defects	
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering (EW HW MW SW F) / Strength Is(50) ● Axial ○ Diametral (EL <0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	Defect Spacing (mm) (<20, 60, 200, 600, 1000)	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
					92.0	1		Continued from non-cored borehole sheet			
					91.0	2					
NMLC		100	90	3.05m Is(50) a=7.7 d=0 MPa	90.0	3		CLAY (CH): brown, high plasticity SANDSTONE: Pale brown, fine grained, thinly laminated at 0° to 5°			JT 3° CN ST S BP 10° CL CO PR BP 0° FE SN PR S
				3.92m Is(50) d=1.3 a=1.5 MPa	89.0	4					BP 3° CL VN PR
				4.92m Is(50) d=1 a=1 MPa							JT 72° FE SN PR RF JT 86° CN PR RF

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

Engineering Log - Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	19/10/2015
Project Name:	Oakdale West Estate	Completed:	19/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296331.0 m E 6254229.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	Commachio Geo305	Inclination:	-90°	RL Surface:	93.00 m	
Barrel Type and Length:	NMLC 3 m	Bearing:		Datum:	AHD	Operator: Soil Check

Drilling Information							Rock Substance													Rock Mass Defects		
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering EW	HW	MW	SW	F	Strength Is(50) ● - Axial ○ - Diametral EL <0.03	VL 0.1	L 0.3	M 1	H 3	VH 10	EH	Defect Spacing (mm) <20	60	200	600	1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
NMLC		100	90					SANDSTONE: Pale brown, fine grained, thinly laminated at 0° to 5° *(continued)*																	BP 10° CN PR RF
				5.70m Is(50) d=0.1 a=0.8 MPa	87.0	6																			JT 85° CN UN RF BP 3° FE SN PR
		100	100	6.55m Is(50) d=1.5 a=1.7 MPa	86.0	7		Becomes medium grained, and laminated, less distinct structure																	BP 3° CL CO PR
				7.90m Is(50) d=0.4 a=0.9 MPa	85.0	8																			8.25: Shale clast
				8.88m Is(50) d=0.1 a=0.4 MPa	84.0	9		INTERBEDDED SHALE SANSTONE: Dark grey, bedded at 0° to 15°																	IS 0° CL PR 20 mm BP 3° FE SN PR S
		100	100					SANDSTONE: Grey and brown, medium to coarse grained, no distinct structure																	JT 50° FE CO PR RF

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

Engineering Log - Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	19/10/2015
Project Name:	Oakdale West Estate	Completed:	19/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296331.0 m E 6254229.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	Commachio Geo305	Inclination:	-90°	RL Surface:	93.00 m		
Barrel Type and Length:	NMLC 3 m	Bearing:		Datum:	AHD	Operator:	Soil Check

Drilling Information | ***Rock Substance*** | ***Rock Mass Defects***

Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering (EW HW MW SW F)	Strength Is(50) ● Axial ○ Diametral (EL <0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	Defect Spacing (mm) (<20, 60, 200, 600, 1000)	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
NMLC		100	100	10.95m Is(50) d=1.3 a=2.2 MPa	82.0	11		SANDSTONE: Grey and brown, medium to coarse grained, no distinct structure *(continued)* Becomes laminated at 0° to 5°, developed				BP 0° FE SN PR RF
				11.65m Is(50) d=0.9 a=1 MPa								IS 0° CL PR 10 mm
					81.0	12						JT 83° FE SN PR RF 11.84: Shale clasts
		100	100					Becomes poorly developed				
					80.0	13						
					79.0	14						

Hole Terminated at 14.94 m

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

Borehole ID

BH15

Engineering Log - Non Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	20/10/2015
Project Name:	Oakdale West Estate	Completed:	20/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296285.0 m E 6254650.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	Commachio Geo305	Inclination:	-90°	RL Surface:	87.00 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	Soil Check

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T									CL	CLAY: brown, low plasticity		S		
									CH	CLAY: dark brown, high plasticity		VSt		
SPT				1 SPT 0.50-0.85 m 6, 7, 4/50 mm N=11 25 ES 0.85-1.10 m							D			
AD/T						86.0	1			SANDSTONE: Light grey, no distinct structure, high strength				
										Continued on cored borehole sheet				
						85.0	2							
						84.0	3							
						83.0	4							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

See Explanatory Notes for details of abbreviations and basis of descriptions.

Engineering Log - Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	20/10/2015
Project Name:	Oakdale West Estate	Completed:	20/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296285.0 m E 6254650.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting: Commachio Geo305 Inclination: -90° RL Surface: 87.00 m
Barrel Type and Length: NMLC 3 m Bearing: Datum: AHD Operator: Soil Check

Drilling Information							Rock Substance																		Rock Mass Defects		
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering EW	HW	MW	SW	F	Strength Is(50) ● - Axial ○ - Diametral EL <0.03	VL 0.1	L 0.3	M 1	H 3	VH 10	EH	Defect Spacing (mm) <20	60	200	600	1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
					86.0	1		Continued from non-cored borehole sheet																			
NMLC		58	80	2.10m Is(50) d=0.6 a=3 MPa	85.0	2		NO CORE 720 mm																			
								CLAY (CH): brown, high plasticity																			
								SANDSTONE: Grey orange brown, medium grained																			FZ
								Becomes sub horizontally laminated, poorly developed																			IS 0° CL PR
				2.76m Is(50) d=0.9 a=0.9 MPa				SHALE: Grey and brown																			
					84.0	3		SANDSTONE: Grey brown, medium grained, laminated at 20°, developed																			IS 0° CL PR
								SHALE: Grey and brown																			IS 0° CL PR
		100	90	4.21m Is(50) d=0.1 a=0.1 MPa	83.0	4																					CZ 0° IR S

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

Engineering Log - Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	20/10/2015
Project Name:	Oakdale West Estate	Completed:	20/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296285.0 m E 6254650.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	Commachio Geo305	Inclination:	-90°	RL Surface:	87.00 m	
Barrel Type and Length:	NMLC 3 m	Bearing:		Datum:	AHD	Operator: Soil Check

Drilling Information | ***Rock Substance*** | ***Rock Mass Defects***

Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering (EW HW MW SW F)	Strength Is(50) ● - Axial ○ - Diametral (EL <0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	Defect Spacing (mm) (<20, 60, 200, 600, 1000)	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
NMLC		100	90	5.17m Is(50) d=0.7 a=0.6 MPa				SHALE: Grey and brown *(continued)*				
								SANDSTONE: Grey, medium grained, laminated 0° to 20°, poorly developed				
								SHALE: Grey, laminated 0° to 10°, developed				
					81.0	6						
		100	90	6.97m Is(50) d=0.1 a=0.2 MPa	80.0	7						FZ 0° PR
				7.86m Is(50) d=0.1 a=0.2 MPa	79.0	8						BP 10° PR S IS 0° CL PR
					78.0	9		Some ironstone bands				
		100	100					Becomes poorly developed				

Method
- AD/T - Auger drilling TC bit
- AD/V - Auger drilling V bit
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- HQ3- Wireline core (63.5 mm)
- PQ3- Wireline core (85.0 mm)
- SPT- Standard penetration test
- PT - Push tube

Water
- Inflow
- Partial Loss
- Complete Loss

Graphic Log/Core Loss
- Core recovered (hatching indicates material)
- No core recovery

Weathering
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- F - Fresh

Strength
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- VL - Very Low
- L - Low
- M - Medium
- H - High
- VH - Very High
- EH - Extremely High

Defect Type
- FT - Fault
- SS - Shear Surface
- SZ - Shear Zone
- BP - Bedding parting
- SM - Seam
- IS - Infilled Seam
- JT - Joint
- CO - Contact
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- VN - Vein
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Infilling/Coating
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- RF - Rock fragments
- G - Gravel
- S - Sand
- Z - Silt
- CA - Calcite
- CL - Clay
- FE - Iron
- QZ - Quartz
- X - Carbonaceous

Roughness
- SL - Slickensided
- POL - Polished
- S - Smooth
- RF - Rough
- VR - Very Rough

Shape
- PR - Planar
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See Explanatory Notes for details of abbreviations and basis of descriptions.

Engineering Log - Cored Borehole

Project No.: PSM1541.4

Client:	Goodman Pty Ltd	Commenced:	20/10/2015
Project Name:	Oakdale West Estate	Completed:	20/10/2015
Hole Location:		Logged By:	CF
Hole Position:	296285.0 m E 6254650.0 m N MGA 56	Checked By:	AS

Drill Model and Mounting:	Commachio Geo305	Inclination:	-90°	RL Surface:	87.00 m	
Barrel Type and Length:	NMLC 3 m	Bearing:		Datum:	AHD	Operator: Soil Check

Drilling Information | **Rock Substance** | **Rock Mass Defects**

Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering (EW HW MW SW F)	Strength Is(50) ● - Axial ○ - Diametral (EL <0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	Defect Spacing (mm) (<20, 60, 200, 600, 1000)	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
NMLC		100	100		76.0	11		SHALE: Grey, laminated 0° to 10°, developed *(continued)*				
		100	100	11.50m Is(50) d=0.1 a=0.2 MPa				Becomes developed				
		100	100		75.0	12						
		100	100		74.0	13						
		100	100	14.20m Is(50) d=0.2 a=0.4 MPa	73.0	14		Becomes well developed Becomes laminated 0° to 5°				
				Is(50) 14.88m d=0.2 a=1.7 MPa				SANDSTONE: Grey, medium grained, laminated 0° to 5°, some carbonaceous beds				JT 50° CN PR RF
								Hole Terminated at 15.00 m				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
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PQ3- Wireline core (85.0 mm)
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Partial Loss
Complete Loss

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Core recovered (hatching indicates material)
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Defect Type
FT - Fault
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SZ - Shear Zone
BP - Bedding parting
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VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
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SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

EXPLANATION SHEET - SOIL DESCRIPTION

DEFINITIONS

Soil:
In engineering terms, soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

Classification symbol & soil name:
Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

Support:
C - Casing
T - Timbering

See rock description on Sheet 3 for method and samples / field test definitions.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 µm to 2.36 mm
	medium	200 µm to 600 µm
	fine	75 µm to 200 µm

MOISTURE CONDITION

CONDITION	FIELD GUIDE
Dry	Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.
Moist	Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere
Wet	As for moist but with free water forming on hands when handles

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH SU (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort
Soft	12 – 25	A finger can be pushed into the soil to about 25mm depth
Firm	25 – 50	The soil can be indented about 5mm with the thumb, but not penetrated
Stiff	50 – 100	The surface of the soil can be indented with the thumb, but not penetrated
Very Stiff	100 – 200	The surface of the soil can be marked, but not indented with thumb pressure
Hard	>200	The surface of the soil can be marked only with the thumbnail
Friable	-	Crumbles or powders when scraped by thumbnail

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	<15
Loose	15 – 35
Medium Dense	35 – 65
Dense	65 – 85
Very Dense	>85

Where no SPT data, the following descriptions are used:

Loose: Can be removed from exposure by hand in a disaggregated form.

Compact (C) Only removed from exposure with an implement, material readily disaggregated by physical means.

Cemented (Ce) Only removed from exposure with an implement, material cannot be disintegrated / remoulded in air/ water.

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure of sample	**Weakly Cemented**	Easily broken up by hand in air or water
Lenses	Discontinuous layers of lenticular shape	**Moderately Cemented**	Effort is required to break up the soil by hand in air or water
Pockets	Irregular inclusions of different material	**Cemented**	Only removed from exposure by implement, material does not disaggregate
		Compact	Only removed from exposure by implement, material readily disaggregated by physical means

GEOLOGICAL ORIGIN

Weathered in place soils:

Extremely weathered — Structure and fabric of parent rock visible

Residual Soil — Structure and fabric of parent rock not visible

Transported soil:

Aeolian — Deposited by wind

Alluvium — Deposited by streams and rivers

Colluvium — Deposited on slopes (transported downslope by gravity)

Lacustrine — Deposited by lakes

Marine — Deposited in ocean basins, bays, beached and estuaries

Man Made:

Fill — Fill may be significantly more variable between tested locations than naturally occurring soils

EXPLANATION SHEET - SOIL DESCRIPTION

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 60 mm AND BASING FRACTIONS ON ESTIMATED MASS)*							USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	(A 0.475 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.			GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.			GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)			GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)			GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes missing			SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.			SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm			IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.					
		SILTS & CLAYS Liquid limit less than 50	**Dry strength**	**Dilatancy**	**Toughness**			
			None to Low	Quick to slow	None		ML	SILT
			Medium to High	None	Medium		CL	CLAY
			Low to medium	Slow to very slow	Low		OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low to medium		MH	SILT
			High	None	High		CH	CLAY
			Medium to High	None	Low to medium		OH	ORGANIC CLAY
HIGHLY ORGANIC SOIL Readily identified by colour, odour, spongy feel and frequently by fibrous texture							Pt	PEAT
• Low plasticity – Liquid Limit W_L less than 35%. • Medium plasticity – W_L between 35% and 50%.								

*Taken from AS1726 (1993)

COMMON DEFECTS IN SOIL

TERM	DEFINITION
Parting	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (e.g. bedding). May be open or closed.
Joint	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.
Sheared Zone	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.
Sheared Surface	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.
Softened Zone	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.
Tube	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter
Tube Cast	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases, the soil that makes up the tube cast is cemented.
Infilled Seam	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries that cuts through a soil mass. Formed by infilling of open joints.

EXPLANATION SHEET - ROCK DESCRIPTION

DEFINITIONS

Rock Substance:
In engineering terms rock substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material may be isotropic or anisotropic.

Defect:
Discontinuity or break in the continuity of a substance or substances.

Mass:
A body of material that is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

Method:

AD/T	Auger drilling with tcbit
AD/V	Auger drilling with vbit
AS	Auger screwing
AT	Air track
B	Dozer blade
BH	Backhoe bucket
CT	Cable tool
DB	Washbore drag bit
DT	Diatube
E	Excavator
EH	Excavator with hammer
HA	Hang auger
HMLC	HMLC core barrel
HQ3	Coring 63.5mm diameter, triple tube, wireline
MZ	Mazier
N	Natural exposure
NMLC	NMLC core barrel
NQ3	Coring 45.1mm diameter, triple tube, wireline
PQ3	Coring 83.1mm diameter, triple tube, wireline
Pushed SPT	Pushed SPT
PT	Push tube
R	Ripper
RR	Rock roller
SPT	Driven SPT
WB	Washbore
X	Existing excavation

Core Quality:

TCR	Total Core Recovered (%)
RQD	Rock Quality Designation (%)

Samples and Field Tests:

B	Bulk Disturbed Sample
BLK	Block sample
C	Core sample
CBR	CBR mould sample
D	Small disturbed sample
ES	Soil sample for environmental testing
EW	Water sample for environmental testing
G	Gas sample
LB	Large bulk disturbed sample
M	Mazier type sample
P	Piston sample
SPT	Standard Penetration Test
U	Undisturbed push in sample
W	Water sample

Rock Strength:

A	Axial point load test result (Is50)
D	Diametral point load test result (Is50)

Water:

SUBSTANCE DESCRIPTIVE TERMS

Rock name:
Simple rock names are used rather than precise geological classification

Particle size (for sandstone):

Coarse -	Mainly 0.6mm to 2mm
Medium -	Mainly 0.2mm to 0.6mm
Fine -	Mainly 0.05mm (just visible) to 0.2mm

Fabric:

Massive -	No layering or penetrative fabric
Indistinct -	Layering or fabric visible. Little effect on properties
Distinct -	Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric

Bedding:

Thinly Laminated -	<6mm
Laminated -	6 – 20mm
Very Thinly Bedded -	20 – 60mm
Thinly Bedded -	60 – 200mm
Medium Bedded -	200 – 600mm
Thickly Bedded -	600 – 2000mm
Very Thickly Bedded -	>2000mm

ROCK SUBSTANCE STRENGTH

ABBR	TERM	POINT LOAD INDEX, IS50 (MPA)	FIELD GUIDE
EL	Extremely Low	≤0.03	Easily remoulded by hand to a material with soil properties
VL	Very Low	>0.03≤0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.
L	Low	>0.1≤0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	>0.3≤1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
H	High	>1≤3	A piece of core 150mm long by 50mm cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
VH	Very High	>3≤10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break; rock rings under hammer.

EXPLANATION SHEET - ROCK DESCRIPTION

CLASSIFICATION OF WEATHERING

ABBR	TERM	FIELD GUIDE
F	Fresh	Rock substance unaffected by weathering
SW	Slightly Weathered	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance
MW	Moderately Weathered	The whole of the rock substance is discoloured, usually by iron staining or bleaching, to the extent that the colour of the fresh rock is no longer recognisable.
HW	Highly Weathered	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
EW	Extremely Weathered	Material is weathered to such an extent that it has soil properties, i.e.; it either disintegrates or can be remoulded in water. Original rock fabric still visible.

COMMON DEFECTS IN ROCK MASS

ABBR	TERM	FIELD GUIDE
FT	Fault	Fracture long which displacement is recognisable
SS	Shear Seam	A fracture along which movement has taken place but no displacement is recognisable. Evidence for movement may be slickensides, polishing and/or clay gouge
SZ	Sheared Zone	Zone of multiple closely spaced fracture planes with roughly parallel planar boundaries usually forming blocks of lenticular or wedge shaped intact material. Fractures are typically smooth, polished or slickensided; and curved
BP	Bedding Parting	Arrangement in layers of mineral grains or crystals parallel to surface of deposition along which a continuous observable parting occurs
SM	Seam	Seam of soil substance, often with gradational boundaries. Formed by weathering of the rock substance in place
IS	Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface
JT	Joint	A single fracture across which rock has little or no tensile strength and is not obviously related to rock fabric
CO	Contact	Surface between two lithologies
CZ	Crushed Zone	Zone with roughly parallel, planar boundaries (commonly slickensided) containing disoriented usually angular rock fragments of variable size often in a soil matrix.
VN	Vein	Fracture in which a tabular or sheet-like body of minerals have been intruded
FZ	Fractured Zone	A zone of closely spaced defects (mainly joints, bedding, cleavage and/or schistosity) comprised of core lengths in the order of 50mm or less.
BSH	Bedding Shear	A shear formed along a bedding plane
DB	Drilling Break	Drilling induced break

SHAPE TERMS

ABBR	TERM	FIELD GUIDE
PR	Planar	The defect does not vary in orientation
CU	Curved	The defect has a gradual change in orientation
UN	Undulating	The defect has a wavy surface
ST	Stepped	The defect has one or more well defined steps
IR	Irregular	The defect has many sharp changes of orientation

ROUGHNESS TERMS

ABBR	TERM	FIELD GUIDE
SL	Slickensided	Grooved or striated surface, usually polished
POL	Polished	Shiny smooth surface
S	Smooth	Smooth to touch. Few or no surface irregularities
RF	Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
VR	Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.

COATING TERMS

ABBR	TERM	FIELD GUIDE
CN	Clean	No visible coating
SN	Stained	No visible coating but surfaces are discoloured
VR	Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
CT	Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (e.g., infilled seam). Thicker rock strength material is usually described as a vein

INFILLING MATERIAL

ABBR	TERM
CA	Calcite
Clay	Clay
Fe	Iron Oxide
Fe Clay	Iron Oxide Clay
KT	Chlorite
MS	Secondary Mineral
MU	Unidentified Mineral
Qz	Quartz
X	Carbonaceous
RF	Rock fragments
G	Gravel
S	Sand
Z	Silt

APPENDIX A2

TEST PIT LOGS

TABLE A2-1
COORDINATES AND ELEVATIONS OF TEST PIT LOCATIONS

TEST ID	MGA COORDINATES		ELEVATIONS* (RL m AHD)
	EASTING (m E)	NORTHING (m N)	
TP01	295994	6254664	61.5
TP02	295899	6254511	59.0
TP03	295834	6254342	66.0
TP04	295809	6254184	67.5
TP05	296062	6254352	72.0
TP06	296535	6254158	74.0
TP07	296635	6254103	67.5
TP08	296629	6254247	72.5
TP09	296713	6254376	71.0
TP10	296376	6254526	75.5
TP11	296212	6254678	75.0
TP12	296552	6254609	70.0
TP13	296728	6254527	71.0
TP14	296852	6254618	66.5
TP15	296764	6254725	69.5
TP16	296118	6254756	69.0
TP17	296020	6254833	61.5
TP18	296293	6254894	63.0
TP19	296232	6254963	60.0
TP20	296021	6255019	53.5
TP21	296287	6255065	59.5
TP22	296566	6254965	68.0
TP23	296775	6255003	69.5
TP24	296934	6255200	66.5
TP25	296594	6255117	63.5
TP26	296787	6255151	68.5
TP27	296913	6255040	65.5

Note: * Elevations were based on a survey contour plan provided to PSM.

TABLE A2-2
SUMMARY OF SUBSURFACE CONDITIONS ENCOUNTERED IN TEST PITS

TP	DEPTH (m)	MATERIAL	CONSISTENCY (POCKET PENETROMETER)
TP01	0.0 - 0.16 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.16 - 2.0 m	CLAY; high plasticity, red, brown and grey.	300 kPa
	2.0 m	Hole terminated.	
TP02	0.0 - 0.35 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.35 - 1.2 m	CLAY; high plasticity, orange, brown and grey.	400 kPa
	1.2 – 2.0 m	SHALE; extremely weathered, light grey and brown. Becoming highly weathered at 1.9 m depth.	
	2.0 m	Hole terminated.	
TP03	0.0 – 0.32 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.32 – 1.4 m	CLAY; high plasticity, light brown and grey.	400 kPa
	1.4 m -2.0 m	SHALE; extremely weathered, light grey and brown.	
	2.0 m	Hole terminated.	
TP04	0.0 – 0.24 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	At 0.15 m depth =400 kPa
	0.24 – 1.3 m	CLAY; medium plasticity, brown and light brown.	400 kPa
	1.3 – 2.0 m	SHALE; extremely weathered, grey and dark grey.	
	2.0 m	Hole terminated.	
TP05	0.0 – 0.3 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.3 – 1.2 m	CLAY; high plasticity, light brown.	300 kPa
	1.2 – 1.9 m	SHALE; extremely weathered, grey and brown.	
	1.9 m	Hole terminated.	
TP06	0.0 - 0.18 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	100 kPa
	0.18 – 2.0 m	CLAY; medium to high plasticity, light brown grey and red.	200 kPa
	2.0 m	Hole terminated.	
TP07	0.0 – 0.44 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.44 – 2.0 m	CLAY; high plasticity, orange, brown and grey.	200 kPa
	2.0 m	Hole terminated.	
TP08	0.0 – 0.35 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.35 – 1.8 m	CLAY; high plasticity, red and grey.	200 kPa
	1.8 m	Hole terminated.	

TP	DEPTH (m)	MATERIAL	CONSISTENCY (POCKET PENETROMETER)
TP09	0.0 – 0.2 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.2 – 2.0 m	CLAY; high plasticity, red, grey and brown.	
	2.0 m	Hole terminated.	
TP10	0.0 – 0.27 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.27 – 1.9 m	CLAY; medium to high plasticity, grey, brown and red.	300 kPa
	1.9 m	Hole terminated.	
TP11	0.0 - 0.35 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.35 - 1.4 m	CLAY; medium plasticity, red, brown and grey.	
	1.4 m -2.0 m	SHALE; extremely weathered, light grey and brown.	
	2.0 m	Hole terminated.	
TP12	0.0 - 0.45 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	At 0.25 m depth =300 kPa
	0.45 – 2.0 m	CLAY; high plasticity, orange, brown and grey.	400 kPa
	2.0 m	Hole terminated.	
TP13	0.0 – 0.3 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.3 – 1.9 m	CLAY; high plasticity, red and grey	200 kPa
	1.9 m	Hole terminated.	
TP14	0.0 – 0.3 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.3 – 2.0 m	CLAY; high plasticity, red, brown and grey.	200 kPa
	2.0 m	Hole terminated.	
TP15	0.0 – 0.25 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.25 – 1.9 m	CLAY; high plasticity, red and grey.	
	1.9 m	Hole terminated.	
TP16	0.0 – 0.2 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.2 – 1.1 m	CLAY; high plasticity, red and brown.	
	1.1 – 1.8 m	SHALE; highly weathered, grey and black	
	1.8 m	Hole terminated.	
TP17	0 – 0.04 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.04 – 2.0 m	CLAY; medium to high plasticity, grey, red and brown	300 kPa
	2.0 m	Hole terminated.	
TP18	0 – 0.5 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.5 -2.0 m	CLAY; medium plasticity, red and brown.	
	2.0 m	Hole terminated.	

TP	DEPTH (m)	MATERIAL	CONSISTENCY (POCKET PENETROMETER)
TP19	0 – 0.05 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.05 -2.0 m	CLAY; medium plasticity, red and grey.	
	2.0 m	Hole terminated.	
TP20	0 – 0.3 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.3 – 1.6 m	CLAY; high plasticity, light brown and grey.	400 kPa
	1.6 – 1.75 m	SHALE; moderately weathered, grey and brown.	
	1.75 m	Hole terminated.	
TP21	0 – 0.15 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.15 -2.0 m	CLAY; high plasticity, red, brown and grey.	500 kPa
	2.0 m	Hole terminated.	
TP22	0 – 0.15 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.15 -1.6 m	CLAY; medium plasticity, brown, red and grey.	
	1.6 – 2.0 m	SHALE; highly weathered, brown and grey.	
	2.0 m	Hole terminated.	
TP23	0.0 – 0.3 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.3 – 2.0 m	CLAY; medium plasticity, red, brown and grey.	200 kPa
	2.0 m	Hole terminated.	
TP24	0.0 – 0.4 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.4 – 2.0 m	CLAY; high plasticity, red, brown and grey.	200 kPa
	2.0 m	Hole terminated.	
TP25	0.0 – 0.35 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.35 – 2.0 m	CLAY; high plasticity, red, brown and grey	200 kPa
	2.0 m	Hole terminated.	
TP26	0.0 – 0.3 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.3 – 2.0 m	CLAY; high plasticity, red, grey and brown.	150 kPa
	2.0 m	Hole terminated.	
TP27	0.0 – 0.4 m	TOPSOIL; CLAY, low plasticity, dark brown, trace root fibres.	
	0.4 – 1.7 m	CLAY; high plasticity, red, brown and grey	400 kPa
	1.7 m	Hole terminated.	

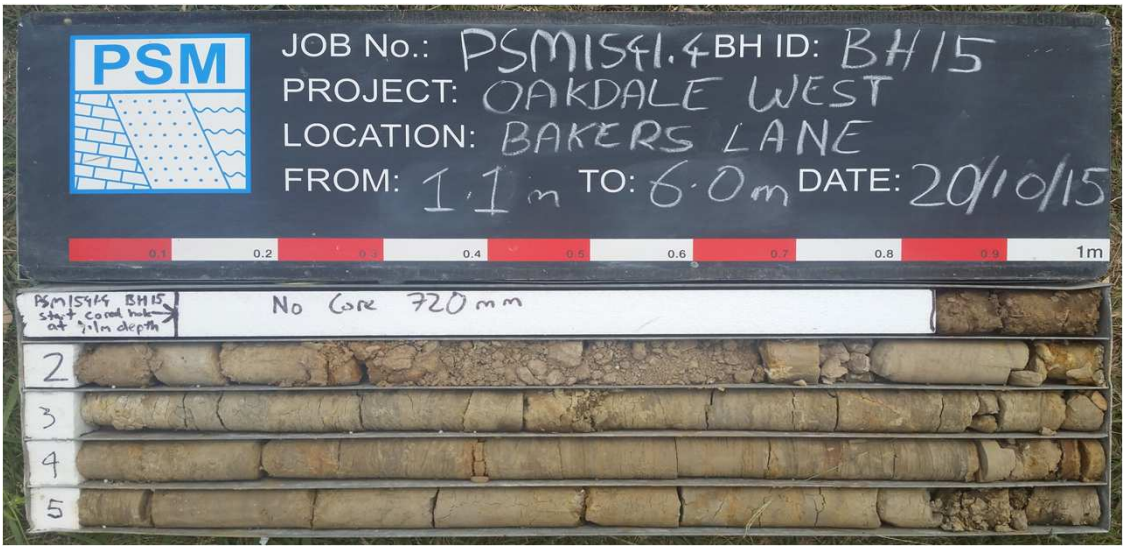
APPENDIX B

CORE PHOTOGRAPHY

Pells Sullivan Meynink

Goodman Pty Ltd
Oakdale West Estate
Eastern Creek, NSW
CORE PHOTOGRAPHY
BH14

PSM1541-123R	Appendix B-1



Goodman Pty Ltd
Oakdale West Estate
Kemps Creek, NSW
CORE PHOTOGRAPHY
BH15

Pells Sullivan Meynink

PSM1541-123R	Appendix B-1

APPENDIX C

POINT LOAD INDEX TEST RESULTS

Pells Sullivan Meynink

POINT LOAD STRENGTH INDEX TEST RESULTS

Job No. ***PSM1541.4*** **Sheet 1 of 1**

Project ***Oakdale West***

Test Method	*AS 4133.4.1 - 1993 Methods of Testing Rocks for Engineering Purposes, Determination of Point Load Strength Index*	Sampling Technique		Sampling Date	*19&20/10/2015*
		Storage History	*North Ryde office indoor core storage area*	Testing Date	*21/10/2015*
Test Machine	*GSA 6500*	Moisture Condition		Tested By	*DT*
Calibration Date	*3/12/2012*	Loading Rate	*< 30 seconds*		

Rock Type	Location	Depth	Diametral Tests					Axial, Block, and Irregular Lump Tests							AS 1726 Strength Class
			D	L	P	$I_{s(50)}$	Failure Mode	W	D	L	P	I_s	$I_{s(50)}$	Failure Mode	
		(m)	(mm)	(mm)	(kN)	(MPa)		(mm)	(mm)	(mm)	(kN)	(MPa)	(MPa)		
Shale	***BH14***	***3.05***	*51*	*38*	*0.1*	***0***	*Parallel to bedding*	*51*	*0.21*		*0.3*	*24.9*	***7.7***	*Through substance*	***VH***
Sandstone	***BH14***	***3.92***	*51*	*145*	*3.2*	***1.3***	*Through substance*	*51*	*33*		*3.3*	*1.5*	***1.5***	*Through substance*	***H***
Sandstone	***BH14***	***4.92***	*50*	*50*	*2.5*	***1***	*Through substance*	*50*	*30*		*2*	*1.1*	***1***	*Through substance*	***H***
Sandstone	***BH14***	***5.70***	*50*	*70*	*0.2*	***0.1***	*Parallel to bedding*	*50*	*39*		*2*	*0.8*	***0.8***	*Through substance*	***VL / M***
Sandstone	***BH14***	***6.55***	*50*	*115*	*3.8*	***1.5***	*Parallel to bedding*	*50*	*33*		*3.7*	*1.7*	***1.7***	*Through substance*	***H***
Sandstone	***BH14***	***7.90***	*52*	*160*	*1*	***0.4***	*Parallel to bedding*	*52*	*28*		*1.8*	*1*	***0.9***	*Through substance*	***M***
Shale	***BH14***	***8.88***	*51*	*95*	*0.3*	***0.1***	*Parallel to bedding*	*51*	*32*		*0.8*	*0.4*	***0.4***	*Through substance*	***L / M***
Sandstone	***BH14***	***10.95***	*51*	*70*	*3.3*	***1.3***	*Parallel to bedding*	*51*	*31*		*4.7*	*2.3*	***2.2***	*Through substance*	***H***
Sandstone	***BH14***	***11.65***	*50*	*85*	*2.2*	***0.9***	*Parallel to bedding*	*50*	*23*		*1.7*	*1.2*	***1***	*Through substance*	***M / H***
Sandstone	***BH15***	***2.10***	*51*	*60*	*1.5*	***0.6***	*Parallel to bedding*	*51*	*29*		*6.1*	*3.2*	***3***	*Through substance*	***M / VH***
Sandstone	***BH15***	***2.76***	*50*	*130*	*2.3*	***0.9***	*Parallel to bedding*	*50*	*32*		*2*	*1*	***0.9***	*Through substance*	***M***
Shale	***BH15***	***4.21***	*49*	*60*	*0.1*	***0.1***	*Parallel to bedding*	*49*	*40*		*0.2*	*0.1*	***0.1***	*Bad break*	***VL***
Sandstone	***BH15***	***5.17***	*51*	*150*	*1.8*	***0.7***	*Parallel to bedding*	*51*	*44*		*1.6*	*0.6*	***0.6***	*Through substance*	***M***
Shale	***BH15***	***6.97***	*53*	*65*	*0.3*	***0.1***	*Parallel to bedding*	*53*	*36*		*0.4*	*0.2*	***0.2***	*Through substance*	***VL / L***
Shale	***BH15***	***7.86***	*51*	*72*	*0.4*	***0.1***	*Parallel to bedding*	*51*	*33*		*0.4*	*0.2*	***0.2***	*Through substance*	***L***
Shale	***BH15***	***11.50***	*50*	*75*	*0.2*	***0.1***	*Parallel to bedding*	*50*	*30*		*0.5*	*0.2*	***0.2***	*Through substance*	***VL / L***
Shale	***BH15***	***14.20***	*51*	*145*	*0.5*	***0.2***	*Parallel to bedding*	*51*	*35*		*1*	*0.5*	***0.4***	*Through substance*	***L / M***
Sandstone	***BH15***	***14.88***	*51*	*215*	*0.6*	***0.2***	*Parallel to bedding*	*51*	*40*		*4.4*	*1.7*	***1.7***	*Through substance*	***L / H***

By: ***DT*** **Checked:** ***CF*** **Date:** ***22/10/2015***

APPENDIX D

SELECTED SITE PHOTOS

Photo 1: 14 tonne excavtor with pendulum auger at BH09 south

Photo 2: BH11 topsoil

Goodman Pty Ltd
Oakdale West Estate
Kemps Creek, NSW

SELECTED PHOTOS (1 OF 7)

PSM1541-123R	**Appendix D-1**

Pells Sullivan Meynink

Photo 3: 14 tonne excavtor at TP13 looking south

Photo 4: 14 tonne excavtor at TP14 looking north east

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Oakdale West Estate
Kemps Creek, NSW

SELECTED PHOTOS (2 OF 7)

Pells Sullivan Meynink

PSM1541-123R	Appendix D-2

Photo 5: TP08 Topsoil

Photo 6: TP08 Profile

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SELECTED PHOTOS (3 OF 7)

Pells Sullivan Meynink

PSM1541-123R	Appendix D-3

Photo 7: TP18 Profile

Photo 8: TP24 Profile

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Kemps Creek, NSW

SELECTED PHOTOS (4 OF 7)

PSM1541-123R	**Appendix D-4**

Pells Sullivan Meynink

Photo 9: Looking north from BH01

Photo 10: Looking north from BH01

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Oakdale West Estate
Kemps Creek, NSW

SELECTED PHOTOS (5 OF 7)

Pells Sullivan Meynink

PSM1541-123R	Appendix D-5

Photo 11: Looking north from BH01

Photo 12: Looking East from BH14

Photo 13: BH14 Drill rig set up looking east

Photo 14: BH15 Drill rig set up looking south

APPENDIX E

EARTHWORKS SPECIFICATION
OAKDALE WEST ESTATE

Oakdale West Estate

BULK EARTHWORK SPECIFICATION
FILLING, CUTTING AND TESTING
(With Blended Topsoil Fill and Compacted Insitu "Topsoil")

PSM1541-126S REV 0 **November 2015**

CONTENTS

1. SCOPE

This specification details the requirements for the bulk earthworks to be undertaken at the proposed development for Goodman at the Oakdale West Estate. This includes areas where material is filled or cut to bulk excavation level (BEL) within the site.

Fill placed in accordance with this specification is denoted as Select Fill.

This specification does not address any environmental, contamination or erosion issues with respect to the fill material.

There is a **HOLD POINT** on placing fill in Section 2.4 of this Specification

2. FILLING WORKS

2.1. Subgrade Preparation

The condition of the subgrade should be assessed immediately prior to filling commencing.

All Select Fill is to be placed on one of the following five (5) materials:

1. Bedrock.
2. Natural insitu material of at least stiff consistency.
3. Compacted Insitu Topsoil as defined in Section 2.1.1 as approved by PSM.
4. Engineered compacted fill placed in accordance with this or other approved specifications for which the Geotechnical Inspection and Testing Authority (GITA) has a Level 1 certificate certifying compliance with that approved specification.
5. Other materials as approved by PSM.

Proof rolling shall only be undertaken under the direction of PSM. PSM may also direct a bridging layer of Select Fill be placed and compacted to a Dry or Hilf Density Ratio (Standard Compaction) of between 95% and 102%. Any such layer shall be a Lot under Clause 5.3.

The GITA should satisfy itself that the subgrade has not been desiccated, affected by rain or disturbed. If the GITA cannot so satisfy itself, then the subgrade should be moisture conditioned and compacted to be in accordance with Clauses 2.5 and 2.6 of this specification.

Select Fill shall be placed only on subgrade approved by the GITA as being in accordance with this specification.

2.1.1. Compacted Insitu Topsoil subgrade

Compacted Insitu Topsoil is defined as follows:

1. Where there is greater than 2 m of Select Fill to be placed over the existing subgrade, the following shall be adopted:
   (a) grub shrubs and trees, then
   (b) moisture condition and compact the grass and topsoil insitu.
2. Where there is between 1 m and 2 m of Select Fill to be placed over the existing subgrade, the following shall be adopted:
   (a) grub shrubs and trees,
   (b) strip grass and dispose, then
   (c) moisture condition and compact the topsoil insitu.

Where there is less than 1 m of Select Fill is to be placed over the existing subgrade, the following shall be adopted:

(a) grub shrubs and trees,
(b) strip all grass and topsoil, and
(c) assess the subgrade condition in accordance with the subgrade preparation requirements of Clause 2.1 of this specification prior to placement of fill material.

2.2. Base Geometry

The slope of any buried batter shall be less than 2H:1V unless otherwise directed by PSM.

The contractor shall remove or flatten any geometrical obstructions (e.g. protrusions or holes) such that subsequent Select Fill can be placed to achieve the requirements of this specification.

Select Fill shall be placed only on areas where the base geometry has been approved by the GITA and conforming to this specification.

2.3. Material

We understand that the bulk earthworks would comprise the following:

1. Cut to fill with site won natural insitu clay / shale.
2. Filling with imported fill.

Select Fill is to conform to one of the following definitions.

2.3.1. Site Won Natural Material

Site won natural material is to conform to one of the following definitions:

1. "Virgin excavated natural material" (**VENM**) as defined by the Protection of the Environment Operations Act 1997 No 156, Schedule 1, on Page 209:

   "Virgin excavated natural material (eg clay, gravel, sand, soil and rock) that is not mixed with any other waste and that:

   a) has been excavated from areas that are not contaminated, as a result of industrial, commercial, mining or agricultural activities, with manufactured chemicals and that does not contain sulphide ores or soils, or

   b) consists of excavated natural materials that meet such criteria as may be approved by the EPA".

2. "Excavated natural material" (**ENM**) as defined by the Protection of the Environment Operations (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A, the excavated natural material exemption 2012:

   "Excavated natural material is naturally occurring rock and soil (including but not limited to materials such as sandstone, shale, clay and soil) that has:

   a) been excavated from the ground, and

   b) contains at least 98% (by weight) natural material, and

   c) does not meet the definition of Virgin Excavated Natural Material in the Act.

   Excavated Natural Material does not include material that has been located in a hotspot; that has been processed; or that contains asbestos, Acid Sulphate Soils (ASS), Potential Acid Sulphate soils (PASS) or sulfidic ores."

   and which meets the requirements of this exemption.

2.3.2. Imported Fill

Imported Select Fill is to conform to the definition of VENM or ENM as defined in Clause 2.3.1 of this specification.

2.3.3. Blended Topsoil

Blended Topsoil is to comprise existing stockpiled topsoil or topsoil stripped from the works blended with materials defined by Clause 2.3.1 or Clause 2.3.2 above. Blended Topsoil shall:

- not include grass and / or organic material
- be blended at a maximum ratio of 1 part topsoil to 8 parts VENM or ENM
- be thoroughly mixed and homogenous

The GITA shall assess the above criteria and approve the material as suitable for use as Engineered Fill.

Blended Topsoil shall not be placed within 1.0 m of the final Bulk Earthworks Level (BEL).

2.3.4. All Fill

The Select Fill shall be approved by the GITA as suitable for use in a structural fill.

Select Fill shall not comprise unsuitable material as defined by Clause 4.2 of AS3798-2007 “Guidelines on earthworks for commercial and residential developments" as:

a) *“organic soils, such as many topsoils, severely root-affected subsoils and peat;*

b) *materials contaminated through past site usage which may contain toxic substances or soluble compounds harmful to water supply or agriculture;*

c) *materials containing substances which can be dissolved or leached out in the presence of moisture (eg: gypsum), or which undergo volume change or loss of strength when disturbed and exposed to moisture (eg: some shales and sandstones), unless these matters are specifically addressed in the design;*

d) *silts, or materials that have the deleterious engineering properties of silt;*

e) *other materials with properties that are unsuitable for the forming of structural fill; and*

f) *fill that contains wood, metal, plastic, boulders or other deleterious material, in sufficient proportions to affect the required performance of the fill."*

All Select Fill particles shall be able to be incorporated within a single layer. Further, less than 30% of particles shall be retained on the 37.5 mm sieve. The proportion of particles retained on the 37.5 mm sieve shall be assessed using the rock correction method in AS1289.5.4.1 and AS1289.5.7.1.

Select Fill shall be able to be tested in accordance with the Standard Compaction method (AS1289.5.4.1) or Hilf test method (AS1289.5.7.1). These methods require less than 20% retained on the 37.5 mm sieve. Where between 20% and 30% of particles are retained on the 37.5 mm sieve the above test methods shall still be adopted and test reports annotated appropriately.

These requirements should be met by the material after placement and compaction.

The GITA shall assess that the proportion of deleterious material in each Lot is not greater than 0.25% by weight and that all particles of deleterious material have a maximum dimension smaller than 300 mm.

Deleterious material is defined by Table 3015.3 of the RTA QA Specification 3051 (Edition 5 June 1998) as:

> *"Type III: Rubber, Plastic, Bitumen, Paper, Cloth, Paint, Wood and Other Vegetable Matter"*

If the GITA is not able to visually assess the above criterion, the GITA shall arrange appropriate testing. The owner may elect to undertake its own audit testing of the fill for deleterious material content. Should this testing indicate that the quantity of deleterious is higher than 0.25% the Contractor shall be required to remove and replace the fill at its own cost.

The Contractor shall ensure that the quantity of deleterious material placed in the fill is kept to a minimum by:

1. Identifying and rejecting loads with identifiable deleterious material.
2. Removing deleterious material where it is observed at the tipping location prior to spreading.
3. Removing observable deleterious material once the material has been spread and rolled into layers.

The GITA shall confirm that the steps 2 and 3 of the above are undertaken on site.

Only material approved by the GITA shall be placed as Select Fill.

2.4. Fill Zonation and Placement

HOLD POINT

PROCESS HELD	PLACING OF FILL
Submission detail	The Contractor / GITA submit to PSM a Weekly Certificate as defined in Clause 6.2.1 of this Specification for the earthworks completed to the previous Saturday no later than 5 pm of the subsequent Wednesday.
Release of Hold Point	PSM to confirm receipt of Weekly Certificate and release Hold Point if initial assessment of the Weekly Certificate indicates it complies with requirements of this Specification.

Select Fill shall be placed in accordance with the following requirements:

1. In near horizontal, laterally extensive layers of uniform material and thickness, deposited systematically across the work area as determined by the GITA.
2. The compacted thickness of each layer shall be equal to or less than 300 mm.

3. Where Select Fill is placed on a subgrade comprising of Compacted Insitu Topsoil, the compacted thickness of the first layer shall be equal to or less than 150 mm.

Select Fill shall only be placed on subgrade in accordance with this specification and approved by the GITA.

2.5. Compaction

Select Fill shall be placed and compacted to a Dry or Hilf Density Ratio (Standard Compaction) of between 98% and 102%.

The insitu density shall be measured over the full depth of each layer placed.

2.6. Moisture Control

The placement moisture variation or Hilf moisture variation shall be controlled to be between 2% dry of optimum and 2% wet of optimum.

Placement moisture content of the Select Fill shall be measured.

3. CUTTING

3.1. Subgrade Condition

The subgrade is to comprise one of the following materials:

1. Bedrock.
2. Natural insitu material of at least stiff consistency.
3. Other materials as approved by PSM.

Proof rolling shall only be undertaken under the direction of PSM.

The GITA should satisfy itself that the subgrade has not been desiccated, affected by rain or disturbed. If the GITA cannot so satisfy itself, then the subgrade should be excavated and filled to the BEL in accordance with this specification.

4. SURVEY

4.1. Filling areas

The survey requirements are as follows:

1. Any approved subgrade shall be surveyed prior to first filling such that subgrade levels are established to within ± 0.1 m. The area subject to approval shall be assessed and shown on a plan drawing to an accuracy of at least +/- 5 m in plan. Areas subject to Clause 2.1.1 shall be clearly identified on this survey.

2. The Lot boundaries shall be surveyed and shown on a plan drawing to an accuracy of at least +/- 5 m in plan.

3. The location of the field density tests shall be surveyed and shown on the Lot boundary plan drawing to an accuracy of at least +/-5 m in plan.

4. The elevation of the field density tests shall be surveyed to an accuracy of +/-0.05 m.

The plan drawing shall show at the boundaries of the site and other identifiable site features, so as to allow the location of the lots and the test to be recoverable.

4.2. Cutting areas

Any approved subgrade for cut areas shall be surveyed such that subgrade levels are established to within ± 0.1 m.

5. INSPECTION AND TESTING

5.1. Role of the GITA

The Geotechnical Inspection and Testing Authority (GITA) shall be contracted to document and certify that the works undertaken by the contractor has been completed in accordance with the relevant design and specifications.

5.2. Level 1 Control

The GITA shall adopt Level 1 responsibility as described in Section 8.2 of AS 3798-2007 "Guidelines on earthworks for commercial and residential developments":

> *"The primary objective of Level 1 Inspection and Testing is for the geotechnical inspection and testing authority (GITA) to be able to express an opinion on the compliance of the work. The GITA is responsible for ensuring that the inspection and testing are sufficient for this purpose.*
>
> *The geotechnical inspection and testing authority needs to have competent personnel on site at all times while earthwork operations are undertaken. Such operations include:*
>
> - *Completion of removal of top soil*
> - *Placing of imported or cut material*
> - *Compaction and adding/removal of moisture*
> - *Trenching and backfilling*
> - *Test rolling*
> - *Testing*
>
> *The superintendent should agree a suitable inspection and testing plan prior to commencement of the works.*
>
> *On completion of the earthworks, the GITA will usually be required to provide a report setting out the inspections, sampling and testing it has carried out, and the*

locations and results thereof. Unless very unusual conditions apply, the GITA should also be able to express an opinion that the works (as far as it has been able to determine) comply with the requirements of the specification and drawings."

For this particular contract, Level 1 responsibility includes:

1. Lot testing as per Clause 5.3 of this specification.
2. A frequency of testing not less than that specified in Clause 5.4 of this specification.
3. The GITA documenting and reporting its activity in the terms required by Clause 6 of this specification.
4. The GITA undertaking adequate inspections and testing to comply with the above requirements and to be able to certify the fill in the terms required by Clause 6 of this specification.

5.3. Lot Testing

This specification requires lot testing to be undertaken.

A Lot is defined as a single layer of Select Fill consisting of uniform material which has undergone similar treatment.

Lot testing comprises the following:

1. A Lot shall be identified by the Contractor or the GITA with a Lot Number and presented for testing.
2. A Lot shall be deemed to be in accordance with the specification if all the tests undertaken within the Lot are in accordance with the specification, i.e. "a none to fail basis".
3. If any one test undertaken within a Lot fails, the whole of the Lot shall be reworked and retested.

Any portion of the placed Select Fill must be part of a single lot and all Lots will require approval by the GITA.

5.4. Testing Frequency

The frequency of compaction testing for each lot shall not be less than the greater of:

- 1 test per 300 m^3 of material placed as Blended Topsoil as defined in Clause 2.3.3 of this specification.
- 1 test per 500 m^3 of material placed.
- 3 tests per lot.

A laboratory moisture content test shall be undertaken for each field density test.

5.5. Proof Rolling and Plate Load Testing

Proof rolling, together with minor boxing out and refilling, of the upper surface of the bulk earthworks will be undertaken as directed by PSM. The plant to be adopted depends upon the design loads adopted by the structural engineers for each portion of the site.

Plate load testing shall be undertaken at the direction of PSM at the following stages:

1. Prior to placement of Select Fill where the subgrade comprise Compacted Insitu Topsoil.
2. Following placement and compaction of the first two (2) layers of Blended Topsoil and subsequently as directed by PSM. Expected test frequency is 1 test per 5000 m^3 of Blended Topsoil.
3. At final bulk earthworks level (BEL). Expected test frequency is approximately a day of testing for each building pad.

The contractor is to make a suitable reaction (eg 20 tonne excavator) available for the tests.

5.6. Inspection, Testing and Survey

The GITA shall at least undertake the following tasks:

Cut areas

1. For cut areas, identify the subgrade as one of the three (3) subgrade types listed in Clause 3.1 of this specification and assess that the subgrade condition of cut areas is in accordance with the subgrade condition requirements of Clause 3.1 of this specification. If the cut subgrade has been approved by PSM, the GITA will be required to reference the approval in its weekly report.
2. Should Select Fill be required to fill overcut areas, assess that filling has been placed in accordance with this specification.

Fill areas

3. For fill areas, identify the subgrade as one of the five (5) subgrade types listed in Clause 2.1 of this specification and assess that the subgrade condition of any area prior to placement of fill material is in accordance with the subgrade preparation requirements of Clause 2.1 of this specification. For the following subgrade types, GITA needs to include / refer to PSM approval in its weekly report.
   (a) Compacted Insitu Topsoil as defined in Section 2.1.1 as approved by PSM.
   (b) Other materials as approved by PSM.
4. Assess that the base geometry of any area prior to placement of fill material is in accordance with the base geometry requirements of Clause 2.2 of this specification.

5. For each Lot, identify the material as either Site Won, Imported or Blended Topsoil as defined in Clause 2.3 of this specification and assess that the material placed is in accordance with the fill material requirements of Clause 2.3 of this specification.

6. Assess that Blended Topsoil placed is in accordance with the requirements of Clause 2.3.3 of this specification.

7. Assess the proportion of deleterious material for each Lot is in accordance with Clause 2.3.4 of this specification.

8. Assess that the Select Fill has been placed in accordance with the requirements for fill zonation and placement of Clause 2.4 of this specification.

9. Assess that each Lot as presented for approval by the contractor is in accordance with the requirements for Lot definition of Clause 5.3 of this specification.

10. Ensure that the survey requirements in Clause 4 of this specification have been completed.

11. Estimate the approximate volume of Select Fill placed in each Lot presented for approval.

12. Conduct Lot testing in accordance with the construction control testing requirements of Clauses 5.3 and 5.4 of this specification.

13. Assess that the compaction of each Lot is in accordance with the requirements of Clause 2.5 of this specification. The GITA shall select a depth of insitu density tests that allows the density of the full layer to be assessed.

14. Assess that the moisture variation of each Lot is in accordance with the requirements for moisture control in Clause 2.6 of this specification.

15. Conduct material property testing in accordance with the material testing requirements in this specification (eg Deleterious material testing if required).

6. REPORTING AND CERTIFICATION

6.1. Reporting

The GITA shall produce at least the following reports:

1. *VENM / ENM Validation Reports.* Such a report shall transmit the VENM or ENM validation certificates for the fill imported to site.

2. *Subgrade Approval Reports* (a sample is attached). Such a report shall:

   - Document assessments undertaken for tasks 1 and 3 of Clause 5.6 including reporting the subgrade type.
   - Document the subgrade survey that has been undertaken.
   - Approve or reject the subgrade condition for cut areas based on task 1 of Clause 5.6.

- Approve or reject the subgrade condition and base geometry for filling, based on tasks 3 and 4 of Clause 5.6.

3. *Lot Approval Reports (a sample is attached).* Such a report shall:

   - Document assessments, testing and survey undertaken for tasks 5 to 15 of Clause 5.6.
   - Report material identification undertaken for task 5 of Clause 5.6.
   - Report the assessed proportion of deleterious material for task 7 of Clause 5.6.
   - Report the results of testing undertaken for task 12 of Clause 5.6.
   - Approve or reject lots based on tasks 13 and 14 of Clause 5.6.

4. *Material Testing Reports.* Such a report shall:

   - Report the results of material property testing undertaken for task 15 of Clause 5.6.

5. *Daily Reports (a sample is attached).* Such a report shall be completed daily and shall:

   - Document time spent on site by the GITA personnel.
   - List subgrade assessments and approvals undertaken each day with reference to relevant Subgrade Approval Report(s).
   - List Lots presented, accepted and approved or rejected each day, with reference to relevant Lot Approval Report(s).
   - List survey undertaken each day as for task 10 of Clause 5.6 and not already documented in the Subgrade or Lot Approval Reports.
   - Document other relevant activities undertaken on site that day (site instructions, breakdowns, compaction equipment used, etc.)

6. *Chain of Custody Certificates.* These certificates shall include the following information:

   (a) Receipt for delivery of the landfill material.

   (b) Copy of the truck driver's log book showing evidence of the delivery.

   (c) Statutory Declaration by the person responsible for transfer of the landfill material stating:

      i. Dates when landfill material was picked up and delivered.

      ii. Who picked up and delivered the landfill material (full names and addresses of individual companies must be provided).

      iii. Quantity of landfill material transferred (tones/cubic metres)

      iv. Location where material was picked up and delivered to.

6.2. Certification

6.2.1. Weekly Certificates

The GITA shall produce a Weekly Certificate for any week in which earthworks are undertaken in accordance with this specification. The Weekly Certificate will cover all works from the previous Weekly Certificate until the end of work on a Saturday.

The Weekly Certificate shall transmit the following:

- Copy or reference to the complete specification document(s).
- Subgrade Approval Reports.
- Lot Approval Reports.
- Material property testing reports.
- Daily Reports.
- Survey of subgrade geometry prior to filling or in cut areas.
- Plan survey drawing showing lot boundaries and location of density tests.
- Survey documenting filling undertaken to date and showing location of testing.
- VENM/ENM validation reports.
- Chain of custody certificates.

And certify that:

"All the earthworks undertaken and the subgrade condition in the cut areas [in the stated period] are documented in the above reports and have been undertaken in accordance with the Specification (Ref. PSM1541-126S Rev XX dated XXXX)."

6.2.2. Interim or Final Filling Certificate

At the completion of the bulk earthworks, or as requested by the Client, the GITA shall provide an Interim or Final Filling Certificate which shall:

1. Transmit a reference list of the Weekly Certificates.
2. Provide an Excel spreadsheet presenting the results of all the acceptance testing completed by the GITA.
3. Certify that *"All the earthworks undertaken and the subgrade condition in the cut areas [in the stated period] are documented in the above reports and have been undertaken in accordance with the Specification (Ref. PSM1541-126S RevXX dated XXXX)."*

NOTES

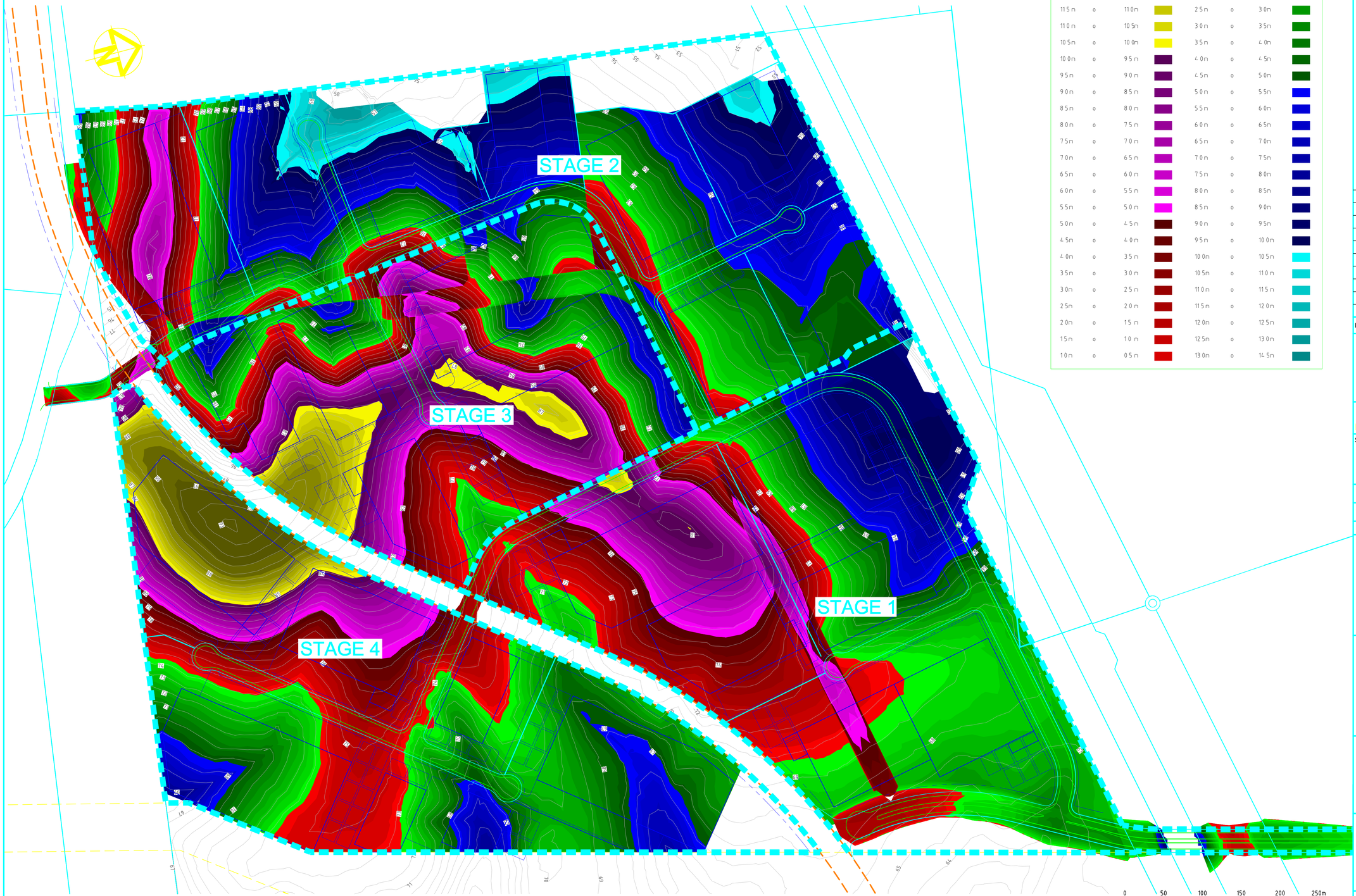
1. TOTAL PAD AREA EXCLUDES BATTERS.
2. PROPOSED BATTER SLOPE IS 1 (V) IN 3(H).
3. EARTHWORKS VOLUMES DENOTED ARE APPROXIMATE ONLY AND HAVE BEEN CALCULATED BETWEEN THE EARTHWORKS SURFACE LEVEL AND THE EXISTING SURFACE LEVEL. THE VOLUMES DO NOT TAKE INTO ACCOUNT THE FOLLOWING :–
   - STRIPPING AND STOCKPILING OF EXISTING TOP SOIL
   - BULKING FACTORS OF REMOVED CUT
   - REMOVAL OF EXISTING BUILDING SLABS AND PAVEMENTS
   - REMOVAL AND\OR REMEDIATION OF ANY EXISTING UNCONTROLLED FILL
   - PROPOSED LANDSCAPING
   - STORMWATER AND UTILITIES TRENCHING
   - EXISTING DAMS OR WATER BODIES WHERE BY THE BASE HAS NOT BEEN SURVEYED DUE TO THE PRESENCE OF WATER AT TIME OF SURVEY

LEGEND

STAGE BOUNDARY

EARTHWORKS
CUT/FILL LEGEND

LOWER VALUE		UPPER VALUE	COLOUR	LOWER VALUE		UPPER VALUE	COLOUR
15.5m	o	14.0m		0.5m	o	0m	
14.0m	o	14.5m		0m	o	0.5m	
14.5m	o	13.0m		0.5m	o	1.0m	
13.0m	o	12.5m		1.0m	o	1.5m	
12.5m	o	12.0m		1.5m	o	2.0m	
12.0m	o	11.5m		2.0m	o	2.5m	
11.5m	o	11.0m		2.5m	o	3.0m	
11.0m	o	10.5m		3.0m	o	3.5m	
10.5m	o	10.0m		3.5m	o	4.0m	
10.0m	o	9.5m		4.0m	o	4.5m	
9.5m	o	9.0m		4.5m	o	5.0m	
9.0m	o	8.5m		5.0m	o	5.5m	
8.5m	o	8.0m		5.5m	o	6.0m	
8.0m	o	7.5m		6.0m	o	6.5m	
7.5m	o	7.0m		6.5m	o	7.0m	
7.0m	o	6.5m		7.0m	o	7.5m	
6.5m	o	6.0m		7.5m	o	8.0m	
6.0m	o	5.5m		8.0m	o	8.5m	
5.5m	o	5.0m		8.5m	o	9.0m	
5.0m	o	4.5m		9.0m	o	9.5m	
4.5m	o	4.0m		9.5m	o	10.0m	
4.0m	o	3.5m		10.0m	o	10.5m	
3.5m	o	3.0m		10.5m	o	11.0m	
3.0m	o	2.5m		11.0m	o	11.5m	
2.5m	o	2.0m		11.5m	o	12.0m	
2.0m	o	1.5m		12.0m	o	12.5m	
1.5m	o	1.0m		12.5m	o	13.0m	
1.0m	o	0.5m		13.0m	o	14.5m	



Issue	Description	Date
P1	ISSUED FOR INFORMATION	2-06-15

Status: PRELIMINARY ONLY
NOT TO BE USED FOR CONSTRUCTION

A1

Scales	1:2500	Drawn	JB
		Designed	JB
Height Datum	AHD	Checked	
Grid	MGA	Approved	

File: SKC051 - OPTIMISED MASTER PLAN CUT TO FILL PLAN.dwg

Client: Goodman

Civil Engineers and Project Managers
at&l
Suite 702, 154 Pacific Hwy
St Leonards NSW 2065
ABN 96 130 882 405
Tel: 02 9439 1777
Fax: 02 9460 8413
www.atl.net.au
info@atl.net.au

Project: OAKDALE WEST

Title: OPTIMISED MASTER PLAN CUT TO FILL PLAN

Drawing No.	Project No.	Issue
SKC051	15-272	P1

ATTACHMENT 1

SUBGRADE APPROVAL REPORT (SAMPLE ONLY)

GEOTECHNICAL INSPECTION AND TESTING AUTHORITY

NATA accreditation number

SUBGRADE APPROVAL REPORT

Client:	Contractor:
Job number:	Report number:
Project:	Technician:

Subgrade areas assessed:

Area ID	Date	Approximate extent	Subgrade description	Geometry summary	Specification reference	Compliance (Pass/Fail)	Survey reference	Approved (Yes/No)

COMMENTS:

Signed: Date:

ATTACHMENT 2

LOT APPROVAL REPORT (SAMPLE ONLY)

GEOTECHNICAL INSPECTION AND TESTING AUTHORITY

NATA accreditation number

LOT APPROVAL REPORT

Client:	Report number:
Job number:	Report date:
Project:	Technician:
Contractor:	Test methods:

LOT ID: Sheet of

Retest (Yes/No) Original test report number:

Specification reference

Location:

Lot boundary survey reference:cation:

Materials description: *(MATERIAL TYPE, colour, minor components, maximum particle size)*

Layer thickness:

Accepted as Lot: (Yes/No) Date:

Approximate volume (m3) Number of tests required:

Test ID No.				
Test soil description				
Date tested:				
Grid reference				
Surveyed test locations (RL,E,N)				
Test depth (mm)				
Max size (mm)				
% Oversize material (wet)				
Field wet density (t/m^3)				
Field moisture content (%)				
PWCD (t/m^3)				
Compactive effort				
Moisture variation (%)				
HILF density ratio (%)				
TEST (Pass/Fail)				

LOT APPROVAL (Pass/Fail) Signed: Date:

ATTACHMENT 3

DAILY REPORT (SAMPLE ONLY)

GEOTECHNICAL INSPECTION AND TESTING AUTHORITY

NATA accreditation number

DAILY REPORT

Client:	Report number:
Job number:	Report date:
Project:	
Location:	Level of testing: Level 1
Contractor	Technician:

Time on site:
Time off site:

1. Subgrade Approval

Areas ID	Subgrade Approval Report No:	Comments

2. Lot Approval

Lot ID	Lot Approval Report No:	Comments

3. Survey

Type of survey	Survey undertaken by:	Reference

4. Instructions received on site

5. Instructions given on site

COMMENTS:

Signed: Date:

ATTACHMENT 4

CERTIFICATION LETTER (SAMPLE ONLY)

SAMPLE INTERIM (OR FINAL) FILLING CERTIFICATE

Letter Ref:
Date:

Addressed to GOODMAN
ATTENTION: GOODMAN REPRESENTATIVE

Dear Sir

RE: INTERIM (OR FINAL) FILLING CERTIFICATE
OAKDALE WEST PRECINCT
CERTIFICATION OF EARTHWORKS
BETWEEN [DATE OF COMMENCEMENT] AND [DATE OF COMPLETION]

In the period between [date start] and [date finish] the contractor has undertaken earthworks in areas XXX and XXX.

During the above period:

- The GITA has prepared the following Subgrade Approval Reports:
  1. Subgrade Approval Report No 1
  2. ……
- The GTA has prepared the following Lot Approval Reports:
  1. Lot Approval Report No 1
  2. …..
- The GTA has prepared the following Daily Reports:
  1. Daily Report No 1…….
  2. ……
- The following subgrade survey was undertaken:
  1. Subgrade Survey reference……
  2. ……
- The following weekly survey was undertaken:
  1. Weekly survey of week ending …….reference……..
  2. ……

Copies of all the above documents are attached.

The GITA certifies that all the earthworks undertaken in the above stated period are documented in the above reports and have been undertaken in accordance with the Specification (ref. PSM1541-126S RevXX dated xxx) a copy of which is attached, with the exception of:

1. List outstanding issues (not approved subgrade, lots, unsuitable material etc.)
2. ……..

Signed

GITA

APPENDIX F

INTERIM GEOTECHNICAL DESIGN ADVICE
OAKDALE WEST ESTATE

Pells Sullivan Meynink
Engineering Consultants
Rock-Soil-Water

G3 56 Delhi Road
North Ryde NSW 2113
P: 61-2 9812 5000
F: 61-2 9812 5001
mailbox@psm.com.au
www.psm.com.au

Our Ref: PSM1541-127L

18 November 2015

Goodman Property Services (Aust) Pty Ltd
Level 17, 60 Castlereagh St
SYDNEY NSW 2000

ATTENTION: KYM DRACOPOULOS
By email: kym.dracopoulos@goodman.com

Dear Kym

RE: OAKDALE WEST ESTATE
INTERIM GEOTECHNICAL DESIGN ADVICE

1 INTODRUCTION

This letter provides interim geotechnical design advice (IGDA) for the proposed warehouse developments at the Oakdale West Estate. This interim advice will be issued as final on completion of the bulk earthworks.

2 BULK EARTHWORKS

The design intent is for the bulk earthworks on site to be completed in accordance with a PSM Specification, currently PSM1541-126S Rev0, dated 18 November 2015 **(the Specification)**. The resulting fill will be well compacted under tight site supervision and subgrade will be stiff or better. The Specification will only be varied with the consent of PSM to ensure that this interim design advice is able to be confirmed at the completion of the earthworks.

The Specification complies with the intent of AS 3798-2007 *"Guidelines on earthworks for commercial and residential developments"* and is intended to specify the minimum requirements to achieve a fill with the properties provided in Section 3 of this letter. The Specification is generally in accord with AS3798-2007 but for this site, it allows retention of grass and roots following grubbing of shrubs and trees.

The Specification allows for a broad range of fill to be incorporated into the earthworks. The Specification requires close inspection, frequent testing and external auditing of the earthworks to provide a high level of confidence that the completed work complies with the Specification.

We have based our assessment of moduli on numerous plate load tests (PLTs) completed on VENM / ENM fills by PSM and PLTs at this site on the prepare subgrade.

If the structural or civil engineer requires engineering properties different to those provided in Section 3 then the specification can be modified such that these properties will be obtained in the final earthworks. This allows the additional cost of the earthworks to be balanced against any economies achieved in other parts of the works.

3 DESIGN ADVICE

3.1 All areas

This section provides interim design advice for all areas where the bulk earthworks has been undertaken in accordance with the Specification. Note, allows for compacted insitu topsoil and blended topsoil

3.1.1 Site classification

While the proposed development is out of scope of AS2870-2011 *"Residential slabs and footings"*, we assess that, for fill placed in accordance with the Specification, the characteristic surface movement, y_s, would be in the range 40 mm to 70 mm and thus would classify the site as Class H1. The civil and structural engineers should consider likely heave / settlement due to the effect of climatic factors in their designs.

We recommend that all structures and services be detailed such that they preclude any local wetting up or drying out of the subgrade after initial equilibrium is reached following construction of the slab and that the subgrade be within specification at the time of construction of the slab. We note that normal mounding or sagging away from the perimeter of covered areas will still occur and perimeters, or open joints, will still respond to environmental changes.

For effectively sealed areas away from the perimeter, the design should allow for the following:

- Differential mound movement, y_m = 20 mm. We note that this is not the total heave or settlement but the estimated local heave or settlement due to fill variability.
- Tilts of up to approximately 1 in 300.

Mounds at perimeters or penetrations of slabs open to the environment can be taken to be as per AS2870-2011 for y_s = 55 mm.

3.1.2 Pad footings

Pad footings can be proportioned on the basis of an allowable bearing pressure (ABP) for centric vertical loads of 150 kPa. Higher ABPs may be available but these depend on the size, depth, loads, etc and would be subject to specific advice.

Footing settlement can be assessed based on the subgrade Young's moduli provided in the sections below for the specific areas for pad footings founded in one of the following materials:

- Natural clay
- Bedrock
- Engineered Fill with the base of footing located more than 2 m above the "*Compacted Topsoil*" (See Section 2.1.1 of the Specification for the definition of *"Compacted Topsoil"*).

If the base of a pad footing is founded between 0 and 2 m above the "*Compacted topsoil*", then an additional 20 mm should be added to the settlement calculation.

3.1.3 Piles

In areas with compacted insitu topsoil, piles shall not be founded such that they rely on end bearing within 4 pile diameters above (+4D) and 2 pile diameters below (-2D) the original natural surface level (ie surface level prior to the bulk earthworks).

3.1.4 Slabs

Refer to advice provided in the sections below for the specific areas.

3.1.5 Pavements

A CBR of 2% can be adopted for subgrade and fill formed in bulk earthworks constructed in accordance with the Specification. Higher values, particularly in areas of significant cut, may be provided on completion of testing on the finished bulk earthworks or if, on request, the Specification is varied to obtain such higher value on fill.

3.2 Fill areas

This section provides interim design advice for areas where:

1. VENM or ENM has been used as Select Fill and placed in accordance with the Specification
2. Topsoil has been incorporated either by blending or compacted insitu and treated as a subgrade prior to filling in accordance with the Specification or
3. Cut areas with less than 2 m of cut from natural surface levels.

The design under the warehouse can be based on a subgrade with the following Young's moduli:

- Long term Young's modulus (E_{LT}) of 10 MPa.
- Short term Young's modulus (E_{ST}) of 15 MPa.

3.3 Cut areas and natural subgrade underlying fill

Natural subgrade within 2 m of natural surface level should be taken to have the properties provided in Section 3.2 above.

Where there is more than 2 m of cut from natural surface levels, the long term Young's modulus of the natural subgrade can be taken to be 30 MPa and the short term Young's modulus to be 50 MPa.

3.4 Variation of fill depth

The designer should consider variation of fill depth across any area; we assess that the fill depth will vary up to 14 m across the site. It is our opinion that creep settlements can be ignored for fill of up to 10 m depth placed in accordance with the Specification.

Where the fill is over 10 m deep, there may be an additional 25 mm creep settlement due to self-weight of the fill during the first 10 year life of a building. The designer should take this into account for any settlement intolerant structures.

3.5 General

We note that the final bulk earthworks subgrade will require proof rolling and plate load testing to confirm the properties provided and may require some boxing out and refilling, etc.

Plate load testing during the filling will be required where blended topsoil has been used in the Select Fill or where topsoil has been left in place.

We understand that the structural engineer should be able to design an efficient slab and shallow footings for these geotechnical conditions. If assessed deformation and settlement is an issue then our advice can be further refined if required.

The structural designer or builder may wish to employ a surface layer of road base / crushed sandstone / concrete for trafficability or structural purposes.

Should there be any queries, do not hesitate to contact the undersigned.

For and on behalf of
PELLS SULLIVAN MEYNINK

CHRISTOPHER FERNANDEZ
Geotechnical Engineer

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