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Report on
Geotechnical Assessment, Preliminary Site Investigation (Contamination) and Salinity Investigation

North Shearwater Residential Subdivision,
Stages 2 and 3
Durness Station, Viney Creek Road, Tea Gardens

Prepared for
Wolin Investments Pty Ltd

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		19 June 2018
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Report on Geotechnical Assessment, Preliminary Site Investigation (Contamination) and Salinity Investigation

North Shearwater Residential Subdivision, Stages 2 and 3

Durness Station, Viney Creek Road, Tea Gardens

1. Introduction

This report presents the results of a geotechnical assessment, preliminary site investigation (contamination) and salinity investigation undertaken for Stages 2 and 3 of the North Shearwater residential subdivision. The Investigation was commissioned via signed services order dated 15 February 2018 by Andrew Osbourne of Wolin Investments Pty Ltd and was undertaken in accordance with Douglas Partners' proposal NCL180017.P.001.Rev0 dated 22 January 2018.

It is understood that the development of the site will include:

- Creation of a residential subdivision which is divided into five stages;
    - Stage 1 which includes 153 lots and approximately 2900 m of internal roadways;
    - Stage 2 which includes 42 lots and approximately 1700 m of internal roadways;
    - Stage 3 which includes 31 lots and approximately 700 m of internal roadways;
    - Stages 4 and 5 not yet designed; and
- Reconstruction of part of Viney Creek Road.

The aim of the investigation was to assess the subsurface soil conditions across the proposed Stages 2 and 3 areas in order to provide:

- Geotechnical assessment, providing comments on the following:
    - Slope instability;
    - Mine subsidence;
    - Erosion potential;
    - Earthworks preparation measures – including temporary and permanent batter stability;
    - Soil and water management (in conjunction with salinity investigation);
    - Site classification in accordance with AS2870-2011;
    - Footing options and hillside design;
    - Pavement thickness design in accordance with local council and Austroads guidelines;
    - Retaining wall design parameters;
    - Depth to rock (if encountered);
    - Suitability of reuse of onsite materials in pavement construction or general lot fill;
    - Comments on de-silting and decommissioning of existing dams.
- Preliminary Site Investigation for contamination (PSI) to support development application;

- Salinity Assessment:
    - General comments on soil and water management (in conjunction with geotechnical investigation);
    - Soil permeability (in conjunction with geotechnical investigation); and
    - Salinity management plan.

The investigation for Stages 2 and 3 included the excavation of 24 test pits and laboratory testing of selected samples. The details of field work for Stages 2 and 3 are presented in this report, together with comments and recommendations on the matters listed above. The report for Stage 1 is presented within report 81259.01.R.001.Rev0 dated 4 May 2018 (Ref 1).

For the purpose of the investigation the client supplied the following drawings:

- "Overall Site Plan, Durness Station Residential Subdivision, Lot 2 DP 1154170, Viney Creek Road, North Shearwater", Rev A, Job No. 217416, dated 15/02/18 by Tattersall Lander Pty Ltd;
- "Central RU2 Area, Concept Layout Plan, Durness Station, Viney Creek Road, Tea Gardens", Rev A dated 15/02/18 by Tattersall Lander Pty Ltd;
- "Plan of Proposed Residential Subdivision, Stage 1 Detail Plan, Lot 2 DP1154170, Viney Creek Road, North Shearwater", Rev A, Job No. 217416, dated 15/02/18 by Tattersall Lander Pty Ltd;
- "Plan of Proposed Residential Subdivision, Stage 1 Precinct Release Plan, Lot 2 DP1154170, Viney Creek Road, North Shearwater", Rev A, Job No. 217416, dated 15/02/18 by Tattersall Lander Pty Ltd;
- "Plan of Proposed Residential Subdivision, Stage 1 Layout Plan, Lot 2 DP1154170, Viney Creek Road, North Shearwater", Rev A, Job No. 217416, dated 15/02/18 by Tattersall Lander Pty Ltd;
- "Plan of Proposed Residential Subdivision, Lot 2 DP1154170, Viney Creek Road, North Shearwater", Rev A, Job No. 217416, dated 15/02/18 by Tattersall Lander Pty Ltd; and
- "Plan of Proposed Residential Subdivision, Stage 2 & 3 Layout Plan, Lot 2 DP1154170, Viney Creek Road, North Shearwater", Rev A, Job No. 217416, dated 15/02/18 by Tattersall Lander Pty Ltd.

The client also supplied an electronic copy of the site layout with site survey plan.

The scope of work for the current investigation also included an assessment of reports on the site previously undertaken by Coffey Geotechnics (refer Section 4).

The PSI was conducted with reference to the NSW EPA 'Guidelines for Consultants Reporting on Contaminated Sites' (Ref 2) and NEPC 2013 (Ref 5).

2. Site Identification

The site consists part of Lot 2, DP 1154170, Viney Creek Road, Tea Gardens, New South Wales. The approximate site extent is shown on Drawing 1, Appendix E and in Figure 1 below.

Figure 1: Approximate extent of proposed Stage 1 (red outline), Stage 2 (blue outline) and Stage 3 (yellow outline) development

The site is irregularly shaped and Stages 2 and 3 cover an area of approximately 8 and 4 hectares, respectively. The site is bound to the west by Viney Creek Road, to the north by an unnamed private road, to the east by grazing land and to the south by existing large lot residential development.

3. Regional Geology, Soil Landscape, Hydrogeology and Acid Sulphate Soil Mapping

Reference to the 1:250,000 NSW Geology sheet indicates that the site lies within the Carboniferous aged Wooton Beds which generally comprises mudstone and siltstone with interbeds of lithic sandstone and conglomerate and some limestone. Stages 2 and 3 are located within close proximity to an area mapped as comprising Quaternary Alluvium which typically comprises gravel, sand, silt and clay.

Reference to the Port Stephens 1:100,000 soil landscape map indicates that Stage 2 and the majority of Stage 3 are underlain by erosional sols of the Pindimar Road landscape. The eastern part of Stage 3 is mapped as comprising Aeolian soils of the Shoal Bay landscape.

Groundwater is expected to flow to the east to south-east towards the Myall River which is approximately 1 km east-south-east of the site. Groundwater is expected to be at depths greater than 2 m based on site observations.

Reference to the Port Stephens 1:25,000 Acid sulfate soil risk map indicates that all of Stage 2 and the majority of Stage 3 are located within in an area of “no known occurrence of acid sulfate soils”. The south eastern portion of Stage 3 is mapped within an area of “Low probability of occurrence of acid sulfate soils at depths greater than 3 m”.

Reference to the NSW Natural Resources Atlas Dryland Salinity map (2013) indicates that there are no mapped dryland salinity occurrences or indicators on the site and that the site is not within a mapped salinity hazard area.

4. Background

4.1 Introduction

Coffey Geotechnics has previously undertaken preliminary contamination and geotechnical investigations as part of the North Shearwater Land Capability Study in September 2008 (Project GEOTWARA20562AB, Refs 3 and 4). The area of investigation comprised the current site area (i.e. ‘Stage 2 and 3’) plus additional grazing and agricultural land (‘Stages 1, 4 and 5’), together with several building groups, to the east and south-east.

Sections of the previous reports relevant to the current site area are summarised in the following sections.

4.2 Coffey Geotechnics – Preliminary Environmental Site Assessment (Ref 3)

The scope of work for the preliminary environmental assessment included the following:

- Review of site history (historical aerial photos, review of Great Lakes Council, NSW WorkCover and NSW EPA records and a historical title deeds search);
- Site visit;
- Identification of areas and chemicals of concern;
- Preparation of a report.

The findings of the assessment with respect to the current site area include the following:

- The site remained relatively unchanged between 1957 and 2008, with the exception of some vegetation clearing in the subject site area;
- There is a low potential for herbicide/pesticide contamination across the site due to chemical spraying;
- No areas of environmental concern were identified in the Stage 2 and 3 areas.

The identified areas of concern (i.e. fuel storage, chemical storage, demolition of structures, filling) were generally to the east and south-east of the Stage 2 area.

4.3 Coffey Geotechnics – Geotechnical Assessment (Ref 4)

The scope of work for the geotechnical assessment included the following:

- Initial site visit and overall appraisal of site conditions;
- A broad subsurface investigation;
- Desktop study involving review of geological and topographical maps and aerial photographs, as well as reports on nearby sites held on file.

The findings of the assessment with respect to the current site area, i.e. Stages 2 and 3, which is (termed Terrain A, B and C in the Coffey report), is that the area is suitable for development.

The report found that the soils in Stage 2 and 3 areas were non-saline and no special measures for management of urban salinity were required.

5. Site History Review

5.1 Introduction

The review of site history carried out by Douglas Partners for the current assessment of Stages 2 and 3 comprised the review of recent historical aerial photos, review of previous site history information (see Section 4.2 above) and brief discussions with site personnel regarding previous site use.

5.2 Historical Aerial Photos

The following recent historical aerial photos were reviewed to supplement the previous historical aerial photo review:

- May 2010;
- November 2010;
- April 2011;
- June 2011.
- April 2012;
- September 2013;
- October 2015; and
- July 2017.

The results of the review indicated the general absence of contaminating activities at the site. The site condition indicated by the aerial photos was similar to the condition at the time of the site walkover for the current assessment. The site area was grassed and appeared to be used as grazing.

5.3 Discussion with Site Personnel

Discussions with Mr Troy Wilton of Durness Station on 4 March 2013 indicated the following with regard to the site:

- The site has historically been used for grazing;
- Mr Wilton was not aware of the site being used for cropping;
- There are no known stock burial areas within the site.

6. Site Description

The investigation site (Stages 2 and 3) is located on the southern side of Viney Creek Road, Tea Gardens and east of Stage 1 of a larger residential subdivision, with Stages 4 and 5 situated further to the east of the current investigation site. The following sections provide a detailed site description for each stage.

6.1 Stage 2

Stage 2 is located adjacent and east of Stage 1 along the southern boundary of the site. Stage 2 is bounded by a rural residential development to the south, an existing ridge line to the north and undeveloped land to the east.

Stage 2 is located along the top of a ridge with a general fall to the south with a small peak of 34 m at the eastern boundary of Stage 2. Surface RLs range from 61 m in the west to 24 m in the east along the northern boundary and 56 m in the west to 24 m in the east. Overall slopes within Stage 2 are less than approximately 5°.

During the investigation Stage 2 had a good covering of grass over the site with some rock outcrops scattered across the site. The surface also showed rock boulders/cobbles on or near the surface. There was an unsealed road running through the central and southern parts of Stage 2 (Figure 6 and Figure 7).

A surface water diversion drain had been cut into the ground surface along the southern boundary with the excavated spoil stockpiled downslope to catch and divert surface water. The base of the diversion drain exposed bedrock along the full length.

The following photos show parts of Stage 2 during the investigation.

Figure 2: View looking west from Pit 201

Figure 3: View looking east from Pit 201

Figure 4: View south towards diversion drain

Figure 5: Rock outcrop near Pit 202

Figure 6: View east along gravel road

Figure 7: View west along gravel road

Figure 8: View of existing water tanks at eastern extent of Stage 2

Figure 9: View west from eastern extent of Stage 2

6.2 Stage 3

Stage 3 is located south of Viney Creek Road and to the east of Stage 1 and North of Stage 2. Stage 3 is bounded by Viney creek road to the north, undeveloped land to the east and a gully to the east and south.

Stage 3 is located along a south sloping bank with recorded slopes of up to 24° to the south and south east. Surface slopes are highest in the western part of Stage 3. Surface levels within Stage 3 range from RL 46 m in the north to RL 8 m in the east, with the lowest level for the lots being RL 12 m.

During the investigation Stage 3 had a good covering of grass over the site with some rock outcrops scattered across the site. The surface also showed rock boulders/cobbles on or near the surface.

The following photos show parts of Stage 3 during the investigation.

Figure 10: View east from eastern extent of Stage 1

Figure 11: View west from southern extent of Stage 3

Figure 12: View west towards steep slope at extent of Stage 1

Figure 13: View east across slope on Stage 3

Figure 14: View west from Pit 319

7. Potential Contaminants

On the basis of the desktop review, available site history information and observations made during the site inspection, the following sources of potential contamination have been identified for the site:

- Agricultural activities on the site, including possible use of pesticides which may be a source of organochlorine and organophosphorus pesticides;
- The potential for runoff from upslope residences, which may be a source of hydrocarbon, heavy metal and pesticide contamination. It is understood that the adjacent sites operate on-site effluent disposal systems. The potential for microbiological contamination should be noted for the site as a result of runoff from upgradient effluent disposal areas, however widespread contamination is unlikely.

The risk of gross contamination from the above potentially contaminating activities is considered to be low.

8. Conceptual Site Model

A Conceptual Site Model (CSM) has been prepared for the site with reference to the National Environment Protection (Assessment of Site Contamination) Measure 1999 (Amendment Measure 2013) Schedule B2 (Ref 5). The CSM identifies potential contaminant sources and contaminants of concern, contaminant release mechanisms, exposure pathways and potential receptors. The CSM is presented in Table 1 below.

Table 1: Conceptual Site Model

Known and Potential Primary Sources	Primary Release Mechanism	Secondary Release Mechanism	Potential Impacted Media	Contaminants of Concern	Exposure Pathway	Potential Receptors	
						Current	Future
Agricultural Activities	Use of pesticides	Long-term leaching/transport of contaminants via runoff, rain water infiltration/percolation, crushing/weathering of bonded cement fragments	Soil, groundwater, surface water	Pesticides (OCP, OPP)	Dermal contact, inhalation (dust/vapours), ingestion	Site workers, maintenance workers, consultants, trespassers, surface water bodies, groundwater, neighbouring residents/ businesses in the case of groundwater migration	Potential site users (if development occurred), residences, site workers, maintenance workers, construction workers, consultants, trespassers, surface water bodies, groundwater
Adjacent Residential landuse and on-site effluent disposal	Runoff from adjacent properties entering the site	Long-term leaching/transport of contaminants via runoff, rain water infiltration/percolation, crushing/weathering of bonded cement fragments	Soil, groundwater, surface water	TRH, BTEX, PAH, metals, pesticides, microbiological	Dermal contact, inhalation (dust/vapours)		

9. Field Work Methods

The field work was undertaken on 6 to 8 March 2018 and comprised the following.

- Underground services check;
- Site inspection by a senior geotechnical engineer;
- Excavation of 27 test pits (Pits 201 to 213 and 301 to 314) using a Komatsu WB97R rubber tyred backhoe with 450 mm wide bucket with tiger teeth to depths ranging from 0.15 m to 3.1 m;
- Logging and sampling by a geotechnical engineer; and
- Pocket penetrometer tests and dynamic cone penetrometer tests at selected soil depths and locations within test pits.

The approximate location of the test pits are presented on the attached Test Location Plan (Drawing 1, Appendix E). Pit number designation are defined as 200 series pits are located within Stage 2 and 300 series pits are located within Stage 3.

Test pit locations were set out using a hand held GPS. The positions of the test pits are recorded on the logs in Appendix B. The accuracy of these hand held devices is ± 10m. The RLs for the test pits were interpolated from the supplied survey plan and are therefore approximate; these are also shown on the logs in Appendix B.

Samples for environmental purposes were generally collected from the near surface, and at regular depth intervals or changes in strata within each test pit. Soil samples were collected directly from the side walls of the test pits or from the backhoe bucket using disposable gloves. Care was taken to remove any extraneous material deposited on the sample.

All sampling data were recorded on DP chain of custody sheets; the general soil sampling procedure comprised:

- The use of disposable gloves for each sampling event;
- Transfer of samples into the appropriate laboratory-prepared glass jars, and capping immediately;
- Collection of 10% replicate samples for QA/QC purposes;
- Collection of replicate soil samples in zip-lock plastic bags at each depth for PID screening;
- Labelling of sample containers with individual and unique identification, including project number, sample location and sample depth;
- Placement of the sample jars and replicate sample bags into a cooled, insulated and sealed container for transport to the laboratory.

The process of obtaining samples and their transportation, storage and delivery to laboratories for analysis was documented on a DP standard chain-of-custody form. Copies of completed forms are contained in Appendix D.

Replicate samples for each sample were screened for the presence of volatile organic compounds (VOCs), using a calibrated MiniRAE Lite photo-ionisation detector (PID) with a 10.6 eV lamp, calibrated to 100 ppm Isobutylene. The PID is capable of detecting over 300 VOCs.

The work was undertaken using standard procedures for contamination assessments. A list of the procedures used and other information on quality assurance and quality control, including analysis of replicate samples, is presented in Appendix D.

The following field QA/QC procedures were implemented during the investigation:

- Standard operating procedures were followed;
- Site safety and environmental plans were developed prior to commencement of works;
- Replicate field samples were collected and analysed;
- Samples were stored under secure, temperature controlled conditions;
- Chain of custody documentation was used for the handling, transport and delivery of samples to the selected laboratories.

Table 2 summarises the Quality Assurance/Quality Control (QA/QC) data quality indicators and the procedures used to enable their achievement.

Table 2: Data Quality Indicators

Data Quality Indicator	Achievement Evaluation Procedure
Documentation completeness	Completion of field and laboratory chain of custody documentation, completion of pit/bore/sample logs.
Data completeness	Analysis of appropriate determinants and sampling locations based on site history and on-site observation. Use of appropriately trained field staff. Compliance with sample holding times. Use of appropriate laboratory methods and quantitation limits.
Data comparability	Use of NATA certified laboratory, use of consistent sampling technique, trained field staff, consistent laboratory methods and quantitation limits.
Data Representativeness	Completion of logs describing conditions encountered, collection of samples representative of materials encountered at the site, appropriate sampling methodology, analysis of a range of materials encountered, appropriate collection, handling, storage and preservation.
Precision and accuracy for sampling and analysis	Analysis of field and lab replicates, blanks, etc., achievement of acceptable levels for replicate analysis, acceptable levels for laboratory QC criteria.

Test locations were selected for a preliminary assessment of contamination as follows:

- Pits 101 and 102 – assessment of stockpiled material at the site;
- Pits 201, 203, 205, 210, 303, 304 and 310 – assessment of near surface soils across the site following historical agricultural landuse.

10. Field Work Results

10.1 Subsurface Conditions

The subsurface conditions encountered in the test pit are presented in detail in the attached test pit logs (Appendix B). These should be read in conjunction with the notes about this report in Appendix A, which explain the descriptive terms and classification methods used in the logs.

The subsurface strata have been classified into differing units encountered throughout Stages 2 and 3 and are summarised below in Table 3 and Table 4.

Table 3: Summary of Subsurface Conditions (Stage 2)

	Depth (m)		Description
	From	To	
Unit 1 – Topsoil	0.0 (Surface)	0.05/0.3	Topsoil: Generally comprising, brown, dark brown, silt, clayey silt, sandy silt, with abundant rootlets.
Unit 2 – Residual	0.05/0.2	0.3/0.9	Generally comprising a various mixture of clay, silt and sand, but more commonly clay or sandy clay, firm to hard, yellow brown, grey brown, grey white, orange brown, red brown, brown, dark brown and yellow brown.
Unit 3 – Weathered Bedrock	0.1/0.9	0.15/1.0	Generally comprising extremely low to low strength, extremely weathered to slightly weathered sandstone, generally highly fractured.
Unit 4 – Bedrock	0.15/1.0	-	Generally comprising low strength or greater, moderately to slightly weathered sandstone.

Table 4: Summary of Subsurface Conditions (Stage 3)

	Depth (m)		Description
	From	To	
Unit 1 – Topsoil	0.0 (Surface)	0.1/0.5	Topsoil: Generally comprising, brown, dark brown, clayey silt, sandy silt, with abundant rootlets.
Unit 2 – Residual	0.1/0.5	0.25/>3.1	Generally comprising a various mixture of clay, silt and sand, but more commonly clay or sandy clay, firm to hard, grey brown, orange brown, red brown, grey and yellow brown.
Unit 3 – Weathered Bedrock	0.2/2.2	0.25/2.9	Generally comprising extremely low to low strength, extremely weathered to slightly weathered siltstone, granite and sandstone, generally highly fractured.
Unit 4 – Bedrock	0.25/2.9	-	Generally comprising low strength or greater, moderately to slightly weathered siltstone, granite or sandstone.

A summary of depth to rock is presented in Table 5 below.

Table 5: Depth and Level of Rock

Bore	Approx. Surface RL (m)	Depth to Rock		Termination Depth		Reason for Termination
		Depth (m)	RL (AHD)	Depth (m)	Approx. Termination RL (AHD)	
201	47	0.10	46.9	0.6	46.4	Refusal
202	47	0.10	46.9	0.15	46.9	Refusal
203	44	0.60	43.4	0.7	43.3	Refusal
204	41	0.90	40.1	0.95	40.1	Refusal
205	37	0.75	36.3	0.95	36.1	Refusal
206	36	0.30	35.7	0.45	35.6	Refusal
207	34	0.20	33.8	0.5	33.5	Refusal
208	31	0.70	30.3	1.0	30.0	Refusal
209	32	0.30	31.7	0.35	31.7	Refusal
210	33	0.30	32.7	0.35	32.7	Refusal
211	25	0.60	24.4	0.8	24.2	Refusal
212	51	0.40	50.6	0.4	50.6	Refusal
213	38	0.30	37.7	0.55	37.5	Refusal
301	35	0.80	34.2	1.4	33.6	Refusal
302	44	0.30	43.7	0.9	43.1	Refusal
303	35	0.45	34.6	1.2	33.8	Refusal
304	24	0.55	23.5	1.1	22.9	Refusal
305	36	0.25	35.8	0.3	35.7	Refusal
306	46	0.70	45.3	1.2	44.8	Refusal
307	32	0.20	31.8	0.25	31.8	Refusal
308	18	1.50	16.5	2.7	15.3	Refusal
309	26	0.20	25.8	0.3	25.7	Refusal
310	13	2.20	10.8	2.9	10.1	Limit of Investigation
311	9	-	-	3.1	5.9	Limit of Investigation
312	8	-	-	3.1	4.9	Limit of Investigation
313	14	0.40	13.6	0.5	13.5	Refusal
314	9	-	-	2.9	6.1	Limit of Investigation

Free groundwater was observed in Pit 310 at a depth of 2.6m. Some localised seepage was observed in Pits 311 and 314 at 3.1 m, and 2.9 m depth, respectively. All remaining test pits did not encounter free groundwater during the time the pits remained open. It should be noted that groundwater conditions are dependent on factors such as soil permeability and recent weather conditions and will vary with time.

10.2 Contaminant Observations

The results of PID testing for VOC on the collected samples indicated the absence of gross volatile hydrocarbon impact. There was no observed visual or olfactory evidence to suggest the presence of gross contamination in soils encountered during test pit excavation.

11. Laboratory Testing

11.1 Geotechnical

Laboratory testing included eight 4 day soak CBR / standard compaction tests on subgrade materials for pavement design, five shrink swell tests, five Atterberg limits and linear shrinkage for site classification and 10 Emerson crumb for dispersion.

Detailed laboratory test result sheets are attached (in Appendix C) and are summarised in Table 6 below.

Table 6: Laboratory Test Results

Pit	Depth (m)	Description	FMC (%)	SOMC (%)	SMDD (t/m^3)	CBR (%)	Swell (%)	Iss (% per ΔpF)	LL (%)	PL (%)	PI (%)	LS (%)	Emerson Crumb
201	0.05	Sandy SILT: dark brown	-	-	-	-	-	-	-	-	-	-	8
203	0.2	Sandy CLAY: yellow brown	-	-	-	-	-	-	-	-	-	-	6
203	0.2-0.5	Sandy CLAY: yellow brown	19.1	-	-	-	-	2.3	-	-	-	-	-
204	0.1	Sandy SILT: brown	-	-	-	-	-	-	-	-	-	-	8
204	0.5	Clayey SILT: grey white	19.0	-	-	-	-	-	28	20	8	3.0	-
204	0.6-0.9	CLAY: orange brown and red brown	23.5	26.0	1.48	5.0	2.5	-	-	-	-	-	-
205	0.45-0.8	Sandy CLAY: grey brown and orange brown	18.3	-	-	-	-	3.4	-	-	-	-	-
206	0.1	Sandy SILT: dark brown	-	-	-	-	-	-	-	-	-	-	6
208	0.2-0.55	CLAY: grey brown and yellow brown	23.6	-	-	-	-	2.9	-	-	-	-	-
211	0.2-0.6	Sandy Clay: grey brown and dark brown	19.0	18.0	1.70	7.0	0.5	-	-	-	-	-	-
212	0.2-0.4	Sandy CLAY: yellow brown	20.7	16.0	1.71	13	0.0	-	-	-	-	-	-
213	0.2	Sandy CLAY: grey brown	26.1	-	-	-	-	-	56	19	37	11.5	6
301	0.3-0.6	Gravelly CLAY: grey brown and orange brown	22.0	21.5	1.61	12	-0.5	-	-	-	-	-	-
303	0.2-0.4	Gravelly CLAY: grey brown and orange brown	25.5	-	-	-	-	-	47	20	27	12.0	6
304	0.25	CLAY: grey brown	29.4	-	-	-	-	-	69	19	50	14.0	6
304	0.35-0.88	CLAY: grey brown	29.2	-	-	-	-	2.9	-	-	-	-	-

Table 6: Laboratory Test Results (Continued)

Pit	Depth (m)	Description	FMC (%)	SOMC (%)	SMDD (t/m^3)	CBR (%)	Swell (%)	Iss (% per ΔpF)	LL (%)	PL (%)	PI (%)	LS (%)	Emerson Crumb
306	0.4-0.7	Sandy CLAY: grey brown and red brown	12.8	17.5	1.70	16	0.0	-	-	-	-	-	-
308	0.4-0.75	CLAY: grey	17.3	-	-	-	-	1.8	-	-	-	-	-
310	0.05	Sandy SILT: brown	-	-	-	-	-	-	-	-	-	-	8
310	0.5-1.0	Silty CLAY: grey brown and orange brown	21.0	19.5	1.66	5.0	0.0	-	-	-	-	-	-
310	1.5	CLAY: grey brown and orange brown	23.5	-	-	-	-	-	83	17	66	17.5	6
312	0.7-1.0	Silty CLAY: grey	14.6	16.5	1.75	5.0	0.5	-	-	-	-	-	-
313	0.2	Clayey SILT: grey brown	-	-	-	-	-	-	-	-	-	-	6
314	0.5-0.7	CLAY: grey brown and orange brown	17.5	18.5	1.70	4.5	1.0	-	-	-	-	-	-

Notes to Table 6Table:

FMC – Field Moisture Content
SOMC – Standard Optimum Moisture Content
SMDD – Standard Maximum Dry Density
CBR – California Bearing Ratio (4 day soak), with 4.5 kg surcharge
Swell – Strain measured on CBR specimen after 4 days' soaking
Iss – Shrink Swell Index
LL – Liquid Limit
PL – Plastic Limit
PI – Plasticity Index
LS – Linear Shrinkage

Note that clays encountered in 304 and 310 have a high plasticity

11.2 Contamination

Laboratory testing for the preliminary contamination assessment was undertaken by Envirolab Services, a National Association of Testing Authorities, Australia (NATA) accredited laboratory. Analytical Methods used are shown on the laboratory sheets in Appendix C.

A total of eight soil samples (including one replicate sample) were selected to provide an assessment of soil / fill conditions at the site. The samples were selected to target the identified potential sources of contamination (See Section 7).

The selected samples were analysed for some or all of the following potential contaminants:

- Total Recoverable Hydrocarbons (TRH);
- Benzene, Toluene, Ethyl Benzene, Xylene (BTEX);
- Polycyclic Aromatic Hydrocarbons (PAH);
- OC/OP Pesticides;
- Polychlorinated Biphenyls (PCBs);
- Metals – Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), Zinc (Zn);

The results of chemical analysis undertaken on soils from the site are presented in the attached laboratory report sheets (Appendix C), and are summarised in Tables 7 to 9 below. The results of QA/QC testing are presented in Appendix C.

The site assessment criteria (SAC) used in the tables are set out in Section 12.

Table 7: Results of Laboratory Analysis on Soils – Metals

Pit	Depth (m)	PID (ppm)	As[3]	Cd	Cr[7]	Cu	Pb[4]	Hg[5,6]	Ni	Zn
13	0.1	<1	7	<0.4	8	16	11	<0.1	8	35
201	0.05	<1	<4	<0.4	2	1	6	<0.1	1	6
203	0.05	<1	<4	<0.4	2	4	6	<0.1	<1	12
205	0.05	<1	<4	<0.4	1	1	2	<0.1	<1	6
210	0.05	<1	<4	<0.4	1	<1	8	<0.1	<1	5
303	0.05	<1	<4	<0.4	5	<1	15	<0.1	2	14
D1	0.05	<1	<4	<0.4	7	2	18	<0.1	2	15
304	0.05	<1	<4	<0.4	3	<1	14	<0.1	<1	7
310	0.05	<1	<4	<0.4	3	<1	9	<0.1	<1	5
Laboratory PQL			4	0.4	1	1	1	0.1	1	1
NEPM HIL A [1] (Ref 5)			100	20	100	6000	300	40	400	7400
Ecological Investigation Levels [8] (EILs) - Urban residential/Public open space			100	NC	640	110	1100	NC	35	310
NSW EPA - General Solid Waste Guidelines - (Ref 6)			100	20	100	NC	100	4	40	NC
NSW EPA - Restricted Solid Waste Guidelines - (Ref 6)			400	80	400	NC	400	16	160	NC

Notes to Table 7:
All results in mg/kg on a dry weight basis
NC - No Criteria
PID - Photoionisation Detector
PQL - Practical Quantitation Limits
1 - Health Based Criteria for Residential Land Use
2- HIL generally applies to the top 3m of soil
3- HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer Schedule B7)
4- HIL is based on blood lead models (adult lead model where 50% bioavailability has been considered. Site-specific bioavailability may be important and should be considered where appropriate (refer Schedule B7)
5- Assessment of methyl mercury should only be considered if there is evidence of its potential source.
6- HIL does not address elemental mercury
7 - Chromium (VI) (Conservative)
8- EILs refer to contamination present in soil for at least two years
▨ exceeds NEPM Health-Based Criteria for residential landuse
Bold results exceed NSW EPA Waste Classification Guidelines for General Solid Waste without leachability testing
Underlined resutls exceed NEPM Ecological investigation limits
D1 - replicate samples of Pit 303/0.05

Table 8: Results of Laboratory Analysis on Soils – TRH, BTEX

Pit	Depth (m)	PID (ppm)	TRH				TRH (NEPM)						BTEX				
			C_6 - C_9	C_{10} - C_{14}	C_{15} - C_{28}	C_{29} - C_{36}	F1 (C_6-C_{10}-BTEX)	F2 (>C_{10}-C_{16} - Naphthalene)	C_6-C_{10}	>C_{10}-C_{16}	F3 (>C_{16}-C_{34})	F4 (>C_{34}-C_{40})	Benzene	Toluene	Ethyl Benzene	Xylenes	Naphthalene
13	0.1	<1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
201	0.05	<1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
203	0.05	<1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
205	0.05	<1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
210	0.05	<1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
303	0.05	<1	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<1
D1	0.05	<1	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<1
304	0.05	<1	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<1
310	0.05	<1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Laboratory PQL			25	50	100	100	25	50	25	50	100	100	0.2	0.5	1	3	1
NEPM HSL A [6] (Ref 5) CLAY			NC	NC			50/90 [3]	280/NL [3]	NC	NC	NC	NC	0.7/1 [3]	480/NL [3]	NL/NL [3]	110/310 [3]	5/NL [3]
NEPM ESL Residential A,B,C [4, 7] (Ref 5) - Fine Soils			NC	NC			180 *	NC	NC	120 *	1300	5600	65	105	125	45	NC
Management limits for TPH fractions in fine soils - Residential A, B, C [5]			NC	NC			NC	NC	800	1000	3500	10000	NC	NC	NC	NC	NC
NSW EPA - General Solid Waste Guidelines - (Ref 6)			650	10000 total			NC	NC	NC	NC	NC	NC	10	288	600	1000	NC
NSW EPA - Restricted Solid Waste Guidelines - (Ref 6)			2600	40000 total			NC	NC	NC	NC	NC	NC	40	1152	2400	4000	NC

Notes to Table 8:

All results in mg/kg on a dry w eight basis

NC - No Criteria

NT - Not Tested

PID - Photoionisation Detector

PQL - Practical Quantitation Limits

3- Soil HSLs for vapour intrusion (mg/kg) for CLAY samples recovered from 0 m to <1 m / 1 m to <2 m

4- ESLs are of low reliability except w here indicated by * w hich indicates that the ESLs are of moderate reliability

5- Management limits are applied after consideration of relevant ESLs and HSLs

6- Multiplication factor may be applied (for depths >2m) subject to favourable biodegradation conditions - refer to 2.4.10

7- ESLs apply from the surface to 2 m depth below finished surface/ground level

▨ exceeds NEPM HSL Health-Based Criteria for Residential Landuse

🟨 exceeds NEPM management limits for TPH fractions in fine soils - Residential Landuse

<u>Underlined</u> results exceed the NEPM ESL guideline values for Residential Landuse

Bold results exceed NSW EPA Waste Classification Guidelines for General Solid Waste w ithout leachability testing

D1 - replicate samples of Pit 303/0.05

Table 9: Results of Laboratory Analysis on Soils – PAH, PCB, OCP, OPP

Pit	Depth (m)	PID (ppm)	Total PAH	Benzo(a) Pyrene	Benzo(a) Pyrene TEQ	PCB [3]	Total OPP	Chlorpyrifos	Total OCP	Aldrin + Dieldrin	Chlordane	DDT+DDE +DDD	Endosulphan	Endrin	Heptachlor	HCB	Methoxychlor
13	0.1	<1	NT	NT	NT	NT	<0.8	<0.1	<2	<0.2	<0.2	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1
201	0.05	<1	NT	NT	NT	NT	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
203	0.05	<1	NT	NT	NT	NT	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
205	0.05	<1	NT	NT	NT	NT	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
210	0.05	<1	NT	NT	NT	NT	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
303	0.05	<1	<0.05	<0.05	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
D1	0.05	<1	<0.05	<0.05	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
304	0.05	<1	<0.05	<0.05	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
310	0.05	<1	NT	NT	NT	NT	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Laboratory PQL			0.05	0.05	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
NEPM HIL A [1] (Ref 5)			300	NC	3	1	NC	160	NC	6	50	240	270	10	6	10	300
NEPM ESL Residential A,B,C [7] (Ref 5) - Fine Soils			NC	0.7	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
NSW EPA - General Solid Waste Guidelines - (Ref 6)			200	0.8	NC	50 SCC1	NC	4	NC	NC	NC	NC	60	NC	NC	NC	NC
NSW EPA - Restricted Solid Waste Guidelines - (Ref 6)			800	3.2	NC	50 SCC2	NC	16	NC	NC	NC	NC	240	NC	NC	NC	NC

Notes to Table 9:

All results in mg/kg on a dry weight basis

NC - No Criteria

NT - Not Tested

PID - Photoionisation Detector

PQL - Practical Quantitation Limits

TEQ - Toxicity Equivalent Quotient

Total PAH - Sum of positive values

1 - Health Based Criteria for Residential Land Use

2- ESLs apply from the surface to 2 m depth below finished surface/ground level

3- PCB HILs relates to non-dioxin-like PCB only

4- Endosulphan is total of Endosulphan I, Endosulphan II and Endosulphan Sulphate

▨ exceeds NSW EPA Health-Based Criteria for Residential Landuse

Bold results exceed NSW EPA Waste Classification Guidelines for General Solid Waste without leachability testing

D1 - replicate samples of Pit 303/0.05

11.3 Salinity

Laboratory testing for the assessment of potential salinity at the site was undertaken by Envirolab Services, a National Association of Testing Authorities, Australia (NATA) accredited laboratory. Analytical Methods used are shown on the laboratory sheets in Appendix C.

A total of 19 soil samples were selected to provide assessment of soil salinity at the site.

The selected samples were analysed for one or more of the following:

- Electrical Conductivity (EC);
- Cation Exchange Capacity (CEC);
- Exchangeable Sodium Percentage (ESP).

The results of analysis undertaken on soils from the site are presented in the attached laboratory report sheets (Appendix C), and are summarised in Table 10 below.

Table 10: Results of Laboratory Analysis on Soils – EC, CEC, ESP

Pit	Depth (m)	Soil Description	EC µS/cm	ECe dS/m	Cation Exchange Capacity	ESP	Soil Salinity Class ^{1}
201	0.05	silty sandy topsoil	38	0.532	NT	NT	non-saline
203	0.05	silty sandy topsoil	120	1.68	7.1	<0.1	non-saline
203	0.2	sandy clay	35	0.2975	NT	NT	non-saline
205	0.05	silty sandy topsoil	54	0.756	NT	NT	non-saline
205	0.2	clayey sand	22	0.198	NT	NT	non-saline
207	0.1	silt topsoil	73	0.73	NT	NT	non-saline
210	0.05	sandy silty topsoil	210	2.94	NT	NT	slightly saline
210	0.25	clayey silt	150	1.35	NT	NT	non-saline
211	0.2-0.6	sandy clay	38	0.323	5.4	0.19	non-saline
213	0.2	sandy clay	54	0.459	NT	NT	non-saline
303	0.05	sandy silty topsoil	57	0.798	4.8	0.12	non-saline
303	0.15	gravelly clay	56	0.476	11	0.8	non-saline
304	0.05	sandy silty topsoil	46	0.644	2.9	0.12	non-saline
304	0.25	clay	76	0.532	8.7	0.73	non-saline
310	0.05	sandy silty topsoil	54	0.756	2.5	<0.1	non-saline
310	0.15	silty clay	25	0.2	1.3	<0.1	non-saline
312	0.7-1.0	silty clay	510	4.08	4.8	0.82	moderately saline
313	0.2	clayey sand	31	0.279	NT	NT	non-saline
314	0.5-0.7	clay	330	2.31	NT	NT	non-saline
Laboratory PQL			1	0.01	0.1	0.1	

Notes to Table 10:

CEC in meq/100g	NT - Not Tested

ESP in %

Saline Class:

non-saline <2 dS/m

slightly saline 2-4 dS/m

moderately saline 4-8 dS/m

very saline 8-16 dS/m

highly saline >16 dS/m

1 - Soil Salinity Classes from Reference 7

12. Site Assessment Criteria - Contamination

12.1 Introduction

It is understood that the site will be developed for residential purposes.

The Site Assessment Criteria (SAC) applied in the current investigation are informed by the CSM which identified human and ecological receptors to potential contamination on the site (refer to Section 8 of report). Analytical results were assessed (as a Tier 1 assessment) against the SAC comprising primarily the investigation and screening levels of Schedule B1, *National Environment Protection (Assessment of Site Contamination) Measure* 1999, as amended 2013 (NEPC, 2013). NEPC (2013) is endorsed by the NSW EPA under the CLM Act 1997.

The investigation and screening levels applied in the current investigation comprise levels adopted for a generic standard residential landuse scenario.

12.2 Health Investigation and Screening Levels

The generic Health Investigation Levels (HILs) and Health Screening Levels (HSLs) are considered to be appropriate for the assessment of contamination at the site. The adopted soil HILs and HSLs for the potential contaminants of concern are presented in Table 11.

Table 11: HIL and HSL in mg/kg Unless Otherwise

Contaminants		HIL- A and HSL-A	HSL- A [2,3]
Metals	Arsenic	100	NC
	Cadmium	20	NC
	Chromium (VI)	100	NC
	Copper	6000	NC
	Lead	300	NC
	Mercury (inorganic)	40	NC
	Nickel	400	NC
	Zinc	7400	NC
PAH	Benzo(a)pyrene TEQ[1]	3	NC
	Naphthalene	1400	5
	Total PAH	300	NC
TRH	C6 – C10 (less BTEX) [F1]	4400[4]	50
	>C10-C16 (less Naphthalene) [F2]	3300[4]	280
	>C16-C34 [F3]	4500[4]	NC
	>C34-C40 [F4]	6300[4]	NC
BTEX	Benzene	100[4]	0.7
	Toluene	14000[4]	480
	Ethylbenzene	4500[4]	NL
	Xylene	12000[4]	110

Notes to Table 11:

1 Sum of carcinogenic PAH

2 The soil saturation concentration (Csat) is defined as the soil concentration at which the porewater phase cannot dissolve any more of an individual chemical. The soil vapour that is in equilibrium with the porewater will be at its maximum. If the derived soil HSL exceeds Csat, a soil vapour source concentration for a petroleum mixture could not exceed a level that would results in the maximum allowable vapour risk for the given scenario. For these scenarios, no HSL is presented for these chemicals and the HSL is shown as ‘not limiting’ or ‘NL’.

3 The HSL have been calculated for a potential vapour intrusion pathway, a clay soil based on the conditions encountered (Section 10.1 of the report) and an assumed depth to contamination of 0 m to <1 m.

4 Direct Contact HSL for TRH fractions

NC – No Criteria

As shown in Table 11, the adopted HSLs are predicated on a potential vapour intrusion pathway, as identified in the CSM. The CSM also identifies a direct contact pathway and construction worker receptors.

12.3 Ecological Investigation Levels

Ecological Investigation Levels (EILs), where appropriate, have been derived in NEPC (2013) for only a short list of contaminants comprising As, Cu, Cr (III), DDT, naphthalene, Ni, Pb and Zn. The adopted EIL, derived using the *Interactive (Excel) Calculation Spreadsheet* (Standing Council on Environment and Water (SCEW) website (http://www.scew.gov.au/node/941)) are shown in the following Table 12.

Table 12: EIL in mg/kg

Analyte		EIL	Comments
Metals	Arsenic	100	Adopted parameters pH = 6 (conservative assumed value) CEC = 5 $cmol_c$/kg (average from lab testing); assumed clay content 40% “Aged” (>2 years) source of contamination low for traffic volumes in NSW
	Copper	110	
	Nickel	35	
	Chromium III	640	
	Lead	1100	
	Zinc	310	
DDT		180	
Naphthalene		170	

12.4 Ecological Screening Levels

ESLs are used to assess the risk of selected petroleum hydrocarbon compounds, BTEX and benzo(a)pyrene to terrestrial ecosystems. The adopted ESLs are shown in the following Table 13.

Table 13: ESL in mg/kg

Analyte		ESL[1]	Comments
TRH	$C_6 – C_{10}$ (less BTEX) [F1]	180*	All ESLs are low reliability apart from those marked with * which are moderate reliability
	$>C_{10}$-C_{16} (less Naphthalene) [F2]	120*	
	$>C_{16}$-C_{34} [F3]	1300	
	$>C_{34}$-C_{40} [F4]	5600	
BTEX	Benzene	65	
	Toluene	105	
	Ethylbenzene	125	
	Xylene	45	
PAH	Benzo(a)pyrene	0.7	

Note to Table 13:

1 The ESL have been calculated for a fine soil based on the conditions encountered (Section 10.1 of the report) and a residential landuse

12.5 Management Limits

In addition to appropriate consideration and application of the HSL and ESL, there are additional considerations which reflect the nature and properties of petroleum hydrocarbons, including:

- Formation of observable light non-aqueous phase liquids (LNAPL);
- Fire and explosion hazards;
- Effects on buried infrastructure e.g. penetration of, or damage to, in-ground services.

The adopted management limits from Schedule B1 of NEPC (2013) are shown in the following Table 14.

Table 14: Management Limits in mg/kg

Analyte		Management Limit	
TRH	$C_6 – C_{10}$ (F1) #	800	The management limits have been calculated for a fine soil based on the conditions encountered (Section 10.1 of report) and residential landuse
	$>C_{10}$-C_{16} (F2) #	1000	
	$>C_{16}$-C_{34} (F3)	3500	
	$>C_{34}$-C_{40} (F4)	10000	

Note To Table 14:

Separate management limits for BTEX and naphthalene are not available hence these have not been subtracted from the relevant fractions to obtain F1 and F2

12.6 Waste Classification

The results of chemical testing were also compared against NSW EPA Waste Classification Guidelines (Ref 6), to assess possible off-site disposal options to a licenced facility.

13. Proposed Development

It is understood that the proposed North Shearwater residential development will include:

- Creation of a residential subdivision which is divided into five stage;
    - Stage 1 which includes 153 lots and approximately 2900 m of internal roadways;
    - Stage 2 which includes 42 lots and approximately 1700 m of internal roadways;
    - Stage 3 which includes 31 lots and approximately 700 m of internal roadways;
    - Stages 4 and 5 not yet designed; and
- Reconstruction of part of Viney Creek Road.

It is also understood that sporting and recreation field's areas are proposed to the east of Stage 3 but no specific geotechnical investigation was required.

14. Comments

14.1 Geotechnical Assessment

14.1.1 Slope Stability

An area of possible slope instability was described in the Coffey report (Ref 4). That area is located to the west of Stage 3 and adjacent to the Stage1 boundary, within an area falling to the south-east at slopes of up to 40°. This are of possible slope instability has been addressed within Report 81259.01.R.001.Rev0 (Ref 1) for Stage 1 of the development.

The proposed Stage 3 is located on the side hill which slopes to the south at slopes of up to 25°, but more commonly 10° to 15°. The slopes were reducing towards the east with the highest slopes recorded near the western boundary with the lower slopes recorded near the eastern boundary.

The slopes were well vegetated with grass and with sporadic trees across the western part of the Stage 3 area, and within the north eastern part of Stage 3 area there was medium dense cover of trees.

No signs of slope instability or groundwater seepage were observed within Stage 3 at the time of fieldwork.

The site has been assessed with reference to the Australian Geomechanics Society Landslide Taskforce “Practice Note Guidelines for Landslide Risk Management” March 2007 (Ref 8).

14.1.2 Identified Hazards and Inferred Consequences

Table 15 shows the identified hazards and consequences.

Hazard 1 relates to the slow creep of the shallow soil on the steeper slopes within the western and north-western parts of the Stage 3 area. It has been assessed as ‘unlikely’. The consequences of creep to the residential development proposed for Stage 3 would be ‘minor’ provided the footings for the structures are founded on rock. It is noted that bedrock was encountered at depths ranging from 0.25 m to 1.5 m (Lots 301 to 330) in the pits excavated within these lots.

Hazard 2 relates to a slope failure of the soil and rock on the steeper slope within western and north western part of the Stage 3 area. It has been assessed to be ’rare’ owing to geological / geomorphology setting of the site, the presence of shallow residual soils of stiff to very stiff consistency and the presence of bedrock at depths of about 0.5 m in Stage 1. The consequences of a deep seated failure, would be ‘major’ as reconstruction costs would be expected to be about 60% of the value of the development.

14.1.3 Risk to Property

Table 15 below also shows the results of the assessment of risk to property, together with a qualitative assessment of the likelihood of occurrence of a landslide (after construction), or mass ground movements and its consequence and risk to property. This table presents levels of risks following construction on the proviso that structures are designed and constructed taking into account the advice and recommendations presented in this report.

Table 15: Risk Assessment for Property – If Recommendations Adopted

Hazard	Likelihood	Consequence to Proposed Development	Risk to Proposed Development
1. Slow creep of residual soil – north-western parts of Stage 3	Unlikely	Minor	Low
2. Soil or rock slope failure on within western/north-western portion of Stage 3	Rare	Major	Low

Reference to the AGS guidelines indicates the site has a low risk level which is usually acceptable to regulators and owners.

14.1.4 Mine Subsidence

Subsidence Advisory NSW (SA NSW) district maps indicate that the site is not within a proclaimed mine subsidence district. SA NSW, if asked to comment on the DA, is unlikely to impose any restrictions on building and subdivision development within Stage 1.

Coal mining is unlikely to be considered in the area, as evidenced by the following:

- Coal seam outcrops have not been mapped in the vicinity of the site (refer Section 3 above);
- Reference to the NSW Government Department of Planning and Environment mining database (MinView) indicates that there are no current coal titles (licenses/leases/applications) in the vicinity of the site.

14.1.5 Sediment Basins

Detailed geotechnical advice on sediment basins should be provided when basin wall or dam location heights are determined.

Typically, embankment heights should be limited to 3 m and have a slope of 3(H):1(V) but flatter if vegetation or maintenance is required.

Laboratory tests of site materials show that the soils indicated an Emerson class of 6 or above. Soils with an Emerson class of less than 4 are considered to have a high potential for dispersion. It is noted, however, that six of the ten samples previously tested for Stage 1 indicated an Emerson class of less than 4.

Soils with Emerson Class 1 to 4 should be treated with extra caution if they are to be used in basin wall construction or located within the basin foundation. The use of dispersive soils in embankments which are to retain water is a major contributor to piping failure within the embankments. Most dispersive soils can be rendered non dispersive through the addition of lime or gypsum.

The soils on this site should be modified by the addition of gypsum in wall foundation areas and dam embankments.

14.1.6 Site Classification

Site classification of foundation soil reactivity provides an indication of the propensity of the ground surface to move with seasonal variation in moisture. The site classification is based on procedures presented in AS 2870–2011 (Ref 9), the soil profiles revealed in the test pits and on the results of laboratory testing.

The classification of lots for the residential subdivision in their current condition is shown in Table 16 below.

Table 16: Lot Classification

<table>
<tr><th colspan="8">Stage 2 Lots</th></tr>
<tr><th>Lot</th><th>Classification</th><th>Lot</th><th>Classification</th><th>Lot</th><th>Classification</th><th>Lot</th><th>Classification</th></tr>
<tr><td>201</td><td>S</td><td>212</td><td>S</td><td>223</td><td>S</td><td>234</td><td>S</td></tr>
<tr><td>202</td><td>S</td><td>213</td><td>S</td><td>224</td><td>S</td><td>235</td><td>S</td></tr>
<tr><td>203</td><td>S</td><td>214</td><td>S</td><td>225</td><td>S</td><td>236</td><td>S</td></tr>
<tr><td>204</td><td>S</td><td>215</td><td>S</td><td>226</td><td>S</td><td>237</td><td>S</td></tr>
<tr><td>205</td><td>S</td><td>216</td><td>S</td><td>227</td><td>S</td><td>238</td><td>S</td></tr>
<tr><td>206</td><td>S</td><td>217</td><td>S</td><td>228</td><td>S</td><td>239</td><td>S</td></tr>
<tr><td>207</td><td>S</td><td>218</td><td>S</td><td>229</td><td>S</td><td>240</td><td>S</td></tr>
<tr><td>208</td><td>S</td><td>219</td><td>S</td><td>230</td><td>S</td><td>241</td><td>S</td></tr>
<tr><td>209</td><td>S</td><td>220</td><td>S</td><td>231</td><td>S</td><td>242</td><td>S</td></tr>
<tr><td>210</td><td>S</td><td>221</td><td>S</td><td>232</td><td>S</td><td></td><td></td></tr>
<tr><td>211</td><td>S</td><td>222</td><td>S</td><td>233</td><td>S</td><td></td><td></td></tr>
<tr><th colspan="8">Stage 3 Lots</th></tr>
<tr><th>Lot</th><th>Classification</th><th>Lot</th><th>Classification</th><th>Lot</th><th>Classification</th><th>Lot</th><th>Classification</th></tr>
<tr><td>301</td><td>S</td><td>309</td><td>S</td><td>317</td><td>S</td><td>325</td><td>S</td></tr>
<tr><td>302</td><td>S</td><td>310</td><td>S</td><td>318</td><td>S</td><td>326</td><td>S</td></tr>
<tr><td>303</td><td>S</td><td>311</td><td>S</td><td>319</td><td>S</td><td>327</td><td>S</td></tr>
<tr><td>304</td><td>S</td><td>312</td><td>S</td><td>320</td><td>S</td><td>328</td><td>S</td></tr>
<tr><td>305</td><td>S</td><td>313</td><td>S</td><td>321</td><td>S</td><td>329</td><td>S</td></tr>
<tr><td>306</td><td>S</td><td>314</td><td>S</td><td>322</td><td>S</td><td>330</td><td>S</td></tr>
<tr><td>307</td><td>S</td><td>315</td><td>S</td><td>323</td><td>S</td><td>331</td><td>S</td></tr>
<tr><td>308</td><td>S</td><td>316</td><td>S</td><td>324</td><td>S</td><td></td><td></td></tr>
</table>

Notes to Table 16:
S – Slightly Reactive
M – Moderately Reactive

The characteristic surface movement, y_s, is estimated to range from about 5 mm to 20 mm.

It is recommended that all footings be placed within the same material to minimise potential differential settlements. Therefore all footings should be founded within the natural clay or bedrock material. All footings should be designed in accordance with Australian Standard AS 2870–2011 (Ref 9).

Site classification, as above, has been based on the information obtained from the test pits and on the results of laboratory testing. In the event that conditions encountered during construction are different to those presented in this report, it is recommended that further advice be obtained from this office.

It should be noted that this classification is dependent on proper site maintenance, which should be carried out in accordance with the attached CSIRO BTF 18, “Foundation Maintenance and Footing Performance: A Homeowner’s Guide” and with AS 2870–2011 (Ref 9).

Design, construction and maintenance should take into account the need to achieve and preserve an equilibrium soil moisture regime beneath and around buildings. Such measures include providing an outward fall to all paved areas around buildings. These and other measures are described in AS 2870–2011 (Ref 9) and the attached CSIRO publication BTF 18.

Masonry walls should be articulated in accordance with TN 61 (Ref 10).

The above classification should be revised if any significant cutting or filling is proposed, as required by AS 2870–2011 (Ref 9). Drawing 3 indicates that cutting or filling associated with roads will affect some of the lots. Site classification should be revised to reflect the properties of the filling on completion of earthworks.

Refer to Section 14.1.10 of this report for comments on the effects of the re-use of site clay materials for lot filling.

14.1.7 Footings

14.1.7.1 Footings

Strip and pad footings or stiffened slabs founded in the natural clay, engineered filling or bedrock would be suitable for the support of residential structures. The footings should be founded at depths in the order of 0.3 m to 0.5 m.

Footings founded in stiff or better clay or extremely low strength rock may be proportioned for a maximum allowable bearing pressure of 100 kPa. Footings should not be founded in existing or proposed filling unless it has been placed and compacted under Level 1 earthworks inspection and testing in accordance with AS 3798–2007 (Ref 11).

It is anticipated that settlement of footings of 0.5 m to 1 m width, proportioned as above, would not exceed about 5 to 10 mm. Larger movements might occur due to changes in soil moisture content as discussed in Section 11.1.6. The settlements given above are separate to movement associated with reactive soils.

Footings may be founded in the underlying bedrock strata. Pad footings or bored concrete piers should be socketed into low strength or better weathered rock and proportioned for a maximum allowable end bearing pressure of 700 kPa. Larger design pressures may be available, subject to confirmation by geotechnical inspection for specific footings.

Care should be taken to ensure that the base of the bored pier holes are clean and free of all loose debris or water prior to placement of concrete. Accordingly, pier hole inspections are recommended during construction to confirm that the appropriate founding stratum is achieved.

14.1.7.2 General

All footing types should be suitably protected against decay and corrosion.

All footings for the proposed structure should be founded on the same bearing stratum. Allowance for potential shrink-swell movements should be made in the design of all proposed footings and structures.

Good hillside construction should be undertaken in accordance with Australian Geoguide LR8 (attached)

14.1.8 Pavement Thickness Design

14.1.8.1 Subgrade Conditions

Conditions expected at the subgrade level for the internal roads for Stages 2 and 3 are controlled filling, Unit 2, Unit 3 and Unit 4 materials, depending on the finished level of the roads.

It is noted that some localised groundwater seepage was observed during the investigation.

14.1.8.2 Subgrade Design Strength

The subgrade conditions along the proposed pavements are expected to comprise controlled filling, natural clay soils as well as bedrock (0.1 m to 2.2 m depth) throughout Stages 2 and 3.

The laboratory testing indicated CBR values of 5%, 7% and 13% and swell values of 2.5%, 0.5% and 0% for clay soils within Stage 2. Laboratory testing within Stage 3 indicated CBR values of 12%, 16%, 5% and 4.5% and swell values of -0.5%, 0%, 0.5% and 1.0%. The subgrade clay soils are likely to soften and swell with an increase in moisture content.

Dynamic penetrometer testing carried out at test pit locations generally indicated values ranging from 1 to 27 blows per 150 mm increment, but more commonly 2 to 7 blows. These values indicate an in situ CBR in the range of about 2% to 10% (Austroads). These values should be treated with caution as the correlation used to determine in-situ CBR from the dynamic penetrometer tests applies usually to subgrades beneath existing sealed pavements.

Based on the above, a design CBR of 5% for clay subgrade and 10% for rock subgrade has been adopted for the pavement thickness design.

When the subgrade is less than CBR 5%, an additional select layer will be required, e.g. around Pit 314 where a CBR value of 4.5% was measured, a minimum thickness of 150 mm select subgrade material would be required.

14.1.8.3 Design Traffic

The road labels were based on the supplied drawing “Plan of Proposed Residential Subdivision, Stage 1 Detail Plan” dated 15 February 2018. For the purpose of this geotechnical report the road labels are shown on Drawing 4 in Appendix E.

A design traffic loading in terms of Equivalent Standard Axle repetitions (ESA) for the proposed pavement was estimated using the procedures presented in Aus-Spec (Ref 12) and the number of lots serviced by the road. The values are presented below in Table 17.

Table 17: Design Traffic

Road	Lots	Classification	Design Traffic (ESA)
Road 2	All lots for Stages 1, 2, 4, and 5	Collector Street	1×10^6
Road 9	45 (Lots 120 to 126, 201 to 204 and 211 to 242)	Access Street	6×10^4
Roads 10 and 12	<20 (Lots 58 to 75, and 27 to 30)	Local Street	3×10^5
Road 13	31 (all lots in Stage 3)	Local Street	3×10^5

If the traffic loading is to be different from these values, the pavement thickness design should be reviewed.

14.1.8.4 Pavement Thickness Design

The following pavement thickness design has been undertaken in accordance with Council guidelines (Ref 13) and Austroads (Ref 14) and is presented below in Table 18:

Table 18: Pavement Thickness Design

	Thickness (mm)					
Description	**Collector**		**Local Street**		**Access Street**	
Road	**Road 2**		**Roads 10, 12 and 13**		**Road 9**	
Design Traffic	1 x 10^6 ESA		3 x 10^5 ESA		6 x 10^4 ESA	
Design Subgrade	CBR =5%	CBR = 10%	CBR =5%	CBR =10%	CBR =5%	CBR =10%
Wearing Course	2 coat bitumen seal or 30 mm AC(1)					
Basecourse	130		120		100(2)	
Subbase	265	120	220	100	180	90[2]
Select Subgrade	150(3)	-	150(3)	-	150(3)	-
Total	**395 plus select**	**250**	**340 plus select**	**220**	**280 plus select**	**190**

Notes to Table 18:

1 Where a 30 mm asphalt (AC) wearing course is used the thickness of the subbase course may be reduced by the thickness of asphalt to maintain the same total pavement thickness as for bitumen seal, subject to a minimum layer thickness of 100 mm. Where asphalt is to be used as a wearing course a 7 mm prime seal should be placed over the basecourse.

2 Minimum layer thickness is to be 100 mm for basecourse and subbase layers

3 Additional select material could be required dependant on subgrade moisture conditions at time of construction

14.1.8.5 General

A select layer is to be provided for the clay subgrade for possible soft or weak areas (e.g. in the area represented by Pit 314). Where soft or weak material is encountered, over-excavation of this material and replacement with a select subgrade will be required.

Where thin layers of pavement are proposed, it is DP's experience that achieving compaction of these layers will be difficult. It is therefore recommended that where thickness of a layer is less than 100mm it can be combined with the overlying layer. For example, for Road 9 for design CBR 10% the total pavement thickness is 190mm made up of 100mm basecourse and 90mm subbase, this pavement could be constructed as a single layer of 190mm of basecourse material.

The pavement thickness design presented above is dependent on the provision and maintenance of adequate surface and subsurface drainage. In this regard, surface drainage should be designed to shed water away from the pavement and also to incorporate erosion protection measures.

The pavement thickness design presented in this report refers to minimum layer thickness; no allowance has been made for construction tolerances and the like. Any changes in overall pavement thickness between adjoining sections of road should be transitioned and not abruptly stepped.

It is recommended that where the new pavement abuts the existing pavement, it should be benched / keyed in a minimum width of 0.3 m. Vertical interface / joints between the new and existing sections of pavements should not be located within wheel paths.

14.1.8.6 Material Quality and Compaction Requirements

Recommended pavement material quality and compaction requirements are presented in Table 19 below.

Table 19: Material Quality and Compaction Requirements

Pavement Layer	Material Quality	Compaction Requirements
Asphalt	Refer RTA R116	RTA R116
Basecourse	CBR >95%, 1%<PI <6%, Comply with Table C242.3 of Ref 15	Compact to at least 98% dry density ratio Modified (AS 1289.5.2.1)
Subbase	PI <12%. Comply with Table C242.4 of Ref 15	Compact to at least 95% dry density ratio Modified (AS 1289.5.2.1)
Select Subgrade	Soaked CBR >15%	Compact to 100% dry density ratio Standard (AS 1289.5.1.1)
Subgrade	Refer to section 14.1.8.2 of this Report	See comments below about compacting subgrade where applicable and if so, Compact to at least 100% dry density ratio Standard (AS 1289.5.1.1)

Due to the potential for poor constructability associated with softening of the clay subgrade soils by moisture, it may be necessary to place the select subgrade layer immediately over the natural clay, without compaction of the subgrade. If excessive moisture content is encountered within the clay subgrade soils, they should not be test rolled and test rolling should only be undertaken at the top of select subgrade layer.

It should be noted that the placement of the select layer is required for both constructability and design purposes. In the former case, it is to act as a bridging layer over the clay subgrade (with high moisture content) and hence facilitate construction and compaction of the overlying pavement layers.

14.1.8.7 Earthworks and Subgrade Preparation

Subgrade preparation for the proposed pavement construction should include the following measures:

- Excavate to design subgrade level;
- Remove any additional deleterious materials;
- Inspect subgrade soils to assess moisture conditions;
- Test roll the surface in order to determine any soft zones and assess moisture condition;
- If excess moisture conditions are encountered, test rolling should be stopped immediately and not undertaken on subgrade soils;
- Any soft / wet areas should be excavated and replaced with approved compacted fill (select subgrade);

- The design subgrade level in pavement areas should be compacted to at least 100% dry density ratio Standard (AS 1289.5.1.1) within –4% (dry) to -1% (dry) of OMC where OMC is the standard optimum moisture content, provided the clay subgrade is in a suitably dry condition which allows access for construction equipment and does not rut / heave;
- If excessively wet subgrade is encountered, it should not be compacted, and a select layer should be placed over the subgrade to allow compaction of overlying pavement layers;
- Select fill material should be placed in near horizontal layers not exceeding 300 mm loose thickness. The material should be compacted to at least 100% dry density ratio Standard, by AS 1289.5.1.1 within -4% of OMC to OMC, for granular materials;
- Pavement layers compacted as per Section, 14.1.8.6 of this report;
- The amount of subgrade area exposed at once should be minimised to avoid exposure to adverse weather conditions during construction, if subgrade is exposed to adverse weather conditions then some additional removal of material may be required before placing fill can continue;
- Maximum batter slopes of 1V:3H are recommended for proposed long term cut or fill batters. Batters up to 1V:2H would be stable but a flatter slope is recommended to allow access for maintenance purposes.

Geotechnical inspection, compaction testing and test rolling of all pavements are recommended. Geotechnical inspections and testing should be undertaken during construction in accordance with AS 3798-2007 (Ref 11).

14.1.9 Retaining Walls

Details of specific retaining wall locations and dimensions have not yet been advised to Douglas Partners. Specific geotechnical assessment should be undertaken at the design phase of the project. The following general comments could be adopted for preliminary design of retaining walls.

For permanent retaining walls, where the wall will be free to deflect, design should be based on “active” (K_a) earth pressure coefficients, assuming a triangular earth pressure distribution. This would comprise any non-propped or laterally un-restrained walls (e.g. cantilever type walls).

Where structures or services are near the crest, or if the retaining walls are laterally restrained by the structure and not free to deflect, retaining wall design should be based on “at-rest” (K_o) earth pressure coefficients.

The suggested long term (permanent) design soil parameters for ultimate load conditions are shown in Table 20 below. The earth pressure coefficients are for level backfill. Any additional surcharge loads, including those imposed by inclined slopes behind the wall, during or after construction, should be accounted for in design.

Table 20: Geotechnical Parameters for Retaining Structures

Parameter	Symbol	Engineered Fill (clay) and/or Natural Stiff or Better Clay
Bulk Density (kN/m^3)	γ	20
Effective Cohesion (kPa)	c'	5
Angle of Friction (degrees)	Φ'	25^o
Active Earth pressure coefficient – cantilever design (free to deflect)	K_a	0.4
At-rest earth pressure coefficient – propped/restrained wall	K_o	0.6
Passive earth pressure coefficient	K_p	2.5

Retaining walls not designed for hydrostatic pressure should include free draining single size (10 mm single size gravel or coarser) aggregate backfill at the rear of the wall, with slotted drainage pipe at the base of the backfill. The pipes should discharge to the stormwater drainage system. The backfill should be encapsulated within geotextile fabric.

Retaining wall footings should be founded in the very stiff to hard clay or weathered bedrock and should be proportioned for a maximum allowable bearing pressure of 150 kPa.

Specific inspections of toes and walls of retaining walls should be undertaken during construction.

14.1.10 Suitability of On-site Materials for Re-use

The testing undertaken on existing natural materials, which consisted of clay, sandy clay, gravelly clay and silty clay, indicated CBR results of 4.5%, 5%, 7%, 12%, 13% and 16%. From these results some material can be used for select subgrade and general lot fill. Use of such materials will require careful selection and quality control at the source.

Excavated rock material won from site could be used as select fill subject to CBR testing to confirm conformance to CBR ≥ 15% (as per tables above). Maximum particle size of 100 mm for excavated rock is recommended for use in engineered fill.

Clay materials won from site excavations should be used with caution as placement of this material on lots could adversely affect the site classification for filled lots.

14.1.11 Lot Fill

The following procedure is recommended for general lot filling:

- Remove all topsoil and deleterious material;
- Proof roll the excavated surface to detect for soft spots, remove soft spots and replace with compacted approved filling;

- Approved filling should be placed in layers not exceeding 200 mm loose thickness. The material should be compacted to a dry density ratio within the range from 98% Standard to 102% Standard at a moisture content within the range ±2% of Optimum Moisture Content (OMC) under Level 1 Earthworks inspection and testing as defined in AS 3798 – 2007 (Ref 11).

Clay material won from site excavations should not be used for select fill material in pavement construction and should be used with caution as general lot fill. Clay material won from around the area of pits 204, 205, 208, 213, 304, 310 and 314 is high plasticity with low 'wet strength' and should not be used for general lot fill, as this would adversely affect the site classification of the lots and the design subgrade CBR used for the pavement thickness design.

14.2 Contamination

14.2.1 Assessment of Contamination

Soil chemical analysis results were within the health based criteria for residential land use (i.e. HIL A and HSL A).

Contaminant concentrations of the samples tested were also within the adopted ecological based assessment criteria (i.e. EIL and ESL).

Contaminant concentrations of the samples tested were within 'General Solid Waste' criteria for disposal to landfill.

The results of subsurface investigation together with preliminary laboratory test results indicated the general absence of gross contamination at the locations tested.

Based on the results of the brief site history review, the site inspection and the results of preliminary laboratory testing of soils, the potential for gross contamination across the site is considered to be low.

The Stage 2 and 3 site areas are considered to be suitable for the proposed residential development from a soil contamination perspective.

If soils containing anthropogenic inclusions or staining/odours, or soils other than those found on the site during the assessment are encountered during construction, advice should be obtained from this office.

14.3 Salinity

The results of the assessment indicated the following with respect to potential soil salinity at the site:

- The Department of Lands website indicates the absence of mapped dryland or urban salinity indicators or salinity hazards across the site;
- Subsurface conditions typically comprise clayey soils underlain by shallow bedrock across the site;
- EC testing of surface waters encountered on the adjacent Stage 1 site area indicated waters are fresh;

- EC testing indicated both upper topsoils and the majority of underlying clay soils as being non-saline;
- Topsoil in Pit 210 and underlying clay in Pit 312 indicated slightly saline and moderately saline results respectively;
- No obvious indicators of salinity (e.g. salt scalds, plant distress) were observed during the site inspection.

Based on the above results, it is considered that the site poses a minimal to moderate salinity risk. It is recommended that future design and construction should be undertaken with respect to good practices as detailed in Reference 7 to minimise the potential for saline impact to occur. Typical construction practices include:

- Correctly installing a damp-proof course or equivalent within each building;
- Providing adequate floor ventilation beneath buildings if they are constructed on bearers and joists;
- Maintaining the natural water balance and maintaining good drainage to prevent rises in ground water levels;
- Maintaining good drainage and minimising excessive infiltration;
- Ensuring that paths which are provided around buildings slope away from the building;
- Careful design of landscaping and landscape watering methods;
- Adequate drainage provided behind retaining walls;
- Regular monitoring of pipes, etc. for leaks.

Most of the above features are consistent with the guidelines AS 2870-2011 (Ref 9) for standard non-saline sites.

For the construction of roads the following is recommended:

- Minimise ponding of water and the concentration of surface run-off;
- Careful selection of construction materials to minimise salt content and to maximise compaction.

15. References

1. Douglas Partners Pty Ltd “Report on Geotechnical, Preliminary Contamination and Salinity Investigation, North Shearwater Residential Subdivision, Stage 1, Viney Creek Road, Tea Gardens”, Project 81259.01, Dated 4 May 2018.
2. NSW EPA Contaminated Sites. “Guidelines for Consultants Reporting on Contaminated Sites”, August 2011.
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4. Coffey Geotechnics Pty Ltd, “ North Shearwater Land Capability Study, Geotechnical Assessment, Viney Creek Road, Tea Gardens”, prepared for GeoLINK, reference GEOTWARA20562AB-AD, dated 1 September 2008.
5. National Environment Protection Council (2013), ‘National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013’, 11 April 2013.
6. NSW EPA, “Waste Classification Guidelines – Part 1: Classifying Waste”, November 2014.
7. Department of Land and Water Conservation, “Site Investigations for Urban Salinity”, 2002.
8. Australian Geomechanics Society, *Practice Note Guidelines for Landslide Risk Management,* March 2007.
9. Australian Standard AS 2870–2011, “Residential slabs and footings”, Standards Australia, January 2011.
10. Cement Concrete & Aggregates Australia, “Articulated Walling”, TN61, August 2008.
11. Australian Standard AS 3798–2007, “Guidelines on earthworks for commercial and residential developments”, Standards Australia, March 2007.
12. Greater Taree City Council “Development Design Specification, D1, Geometric Road Design (Urban and Rural)”, AUS-SPEC, January 2006.
13. Greater Taree City Council “Development Design Specification, D2, Pavement Design”, AUS-SPEC, January 2006.
14. “Guide to Pavement Technology, Part 2: Pavement Structural Design”, Austroads Publication No AGPT02-17, Fourth Edition, December 2017.
15. Greater Taree City Council “Development Construction Specification, C242 – Flexible Pavements”, AUS-SPEC, July 1997.

16. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Viney Creek Road, Tea Gardens, prepared for Wolin Investments Pty Ltd, with reference to DP’s proposal dated 22 January 2018 and acceptance received from Andrew Osborne dated 15 February 2018. The work was carried out under DP’s Conditions of Engagement. This report is provided for the exclusive use of Wolin Investments Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP’s field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical / environmental components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

CSIRO – BTF 18
Good Hillside Construction Practice – LR8
About This Report
Sampling Methods
Soil Descriptions
Rock Descriptions
Symbols and Abbreviations

Foundation Maintenance and Footing Performance: A Homeowner's Guide

PUBLISHING
BTF 18-2011
replaces
Information
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870-2011, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume, particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.

In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes

Notes

1. Where controlled fill has been used, the site may be classified A to E according to the type of fill used.
2. Filled sites. Class P is used for sites which include soft fills, such as clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soil subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.
3. Where deep-seated moisture changes exist on sites at depths of 3 m or greater, further classification is needed for Classes M to E (M-D, H1-D, H2-D and E-D).

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay

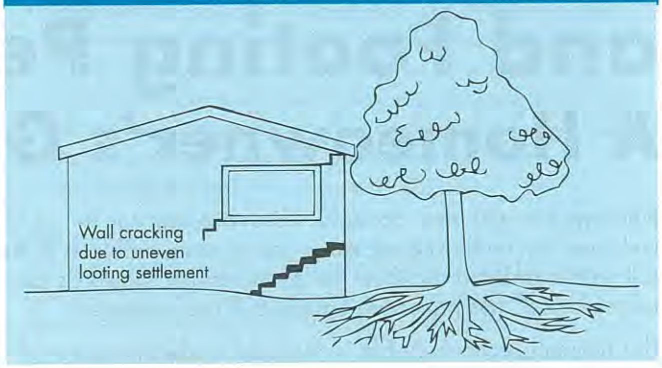
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Trees can cause shrinkage and damage



Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation causes a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem. Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870-2011.

AS 2870-2011 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

Protection of the building perimeter

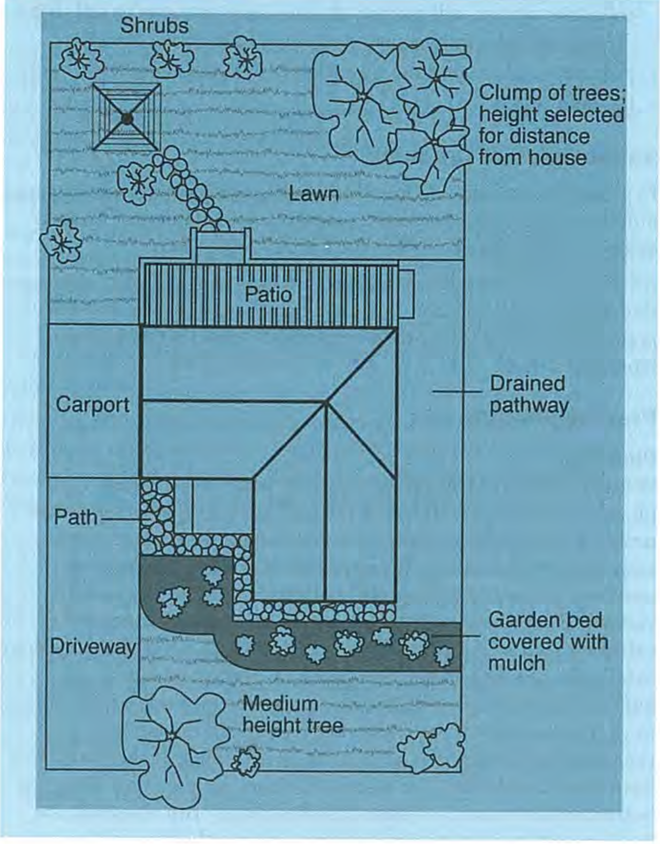
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving should

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly.	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired.	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 mm but also depends on number of cracks	4

Gardens for a reactive site



extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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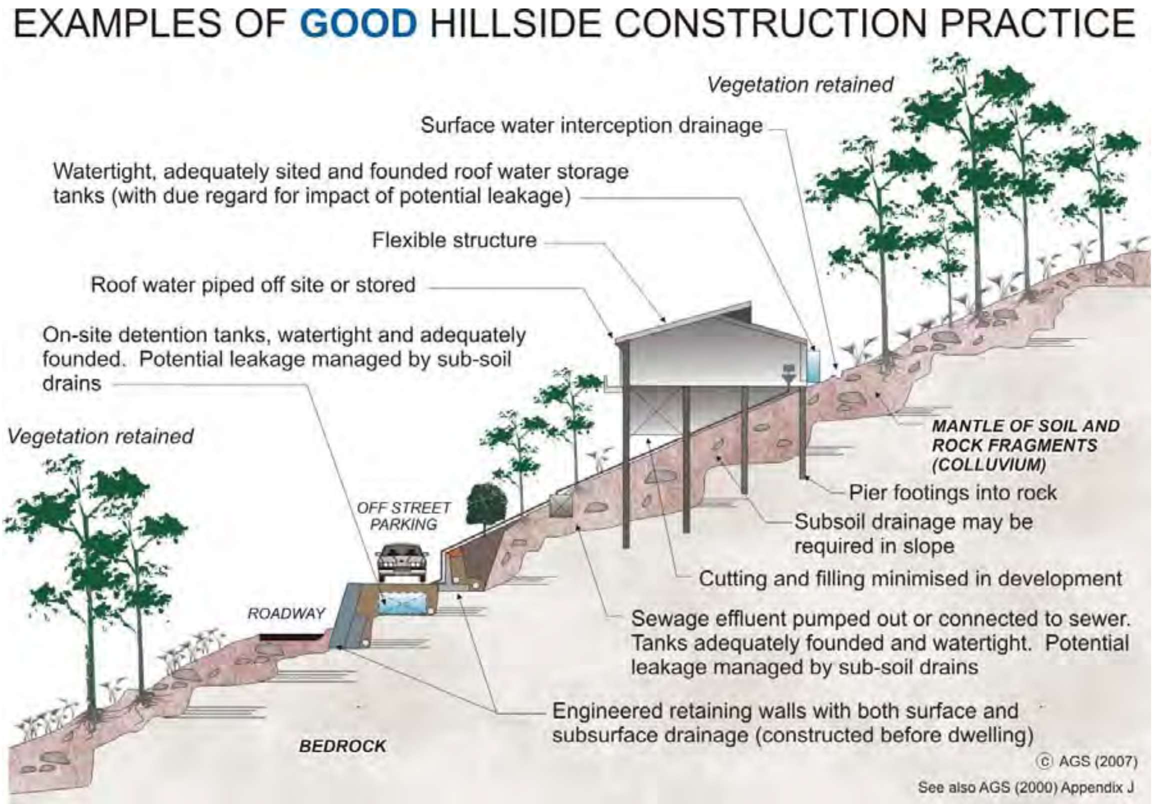
AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.



WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

Cuttings - are supported by retaining walls (GeoGuide LR6).

Retaining walls - are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down towards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

Sewage - whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

Surface water - from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LR5).

Surface loads - are minimised. No fill embankments have been built. The house is a lightweight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

Flexible structures - have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

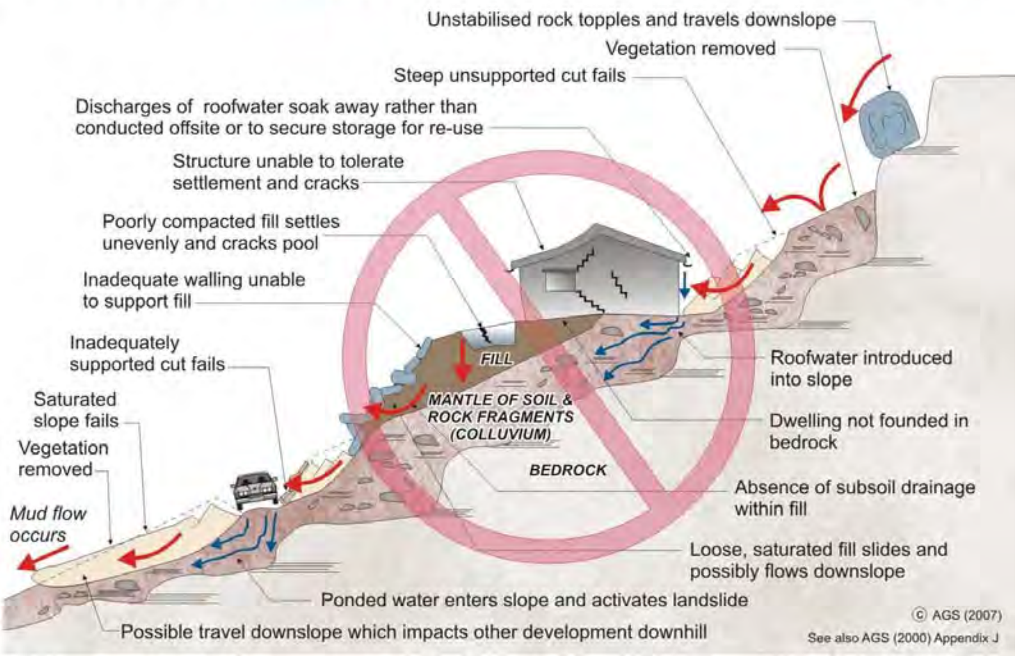
Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

ADOPT GOOD PRACTICE ON HILLSIDE SITES

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

EXAMPLES OF POOR HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES POOR?

Roadways and parking areas - are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

Cut and fill - has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

Retaining walls - have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

A heavy, rigid, house - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

Soak-away drainage - has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

Rock debris - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flow paths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

Vegetation - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER

More information relevant to your particular situation may be found in other Australian GeoGuides:

GeoGuide LR1	- Introduction
GeoGuide LR2	- Landslides
GeoGuide LR3	- Landslides in Soil
GeoGuide LR4	- Landslides in Rock
GeoGuide LR5	- Water & Drainage
GeoGuide LR6	- Retaining Walls
GeoGuide LR7	- Landslide Risk
GeoGuide LR9	- Effluent & Surface Water Disposal
GeoGuide LR10	- Coastal Landslides
GeoGuide LR11	- Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

About this Report

Douglas Partners

Introduction

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

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

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Symbols & Abbreviations

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

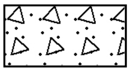
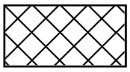
Other

fg	fragmented
bnd	band
qtz	quartz

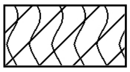
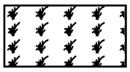
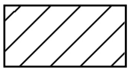
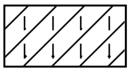
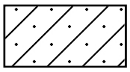
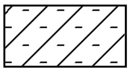
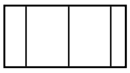
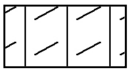
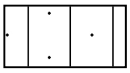
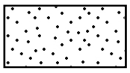
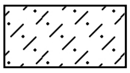
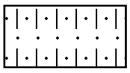
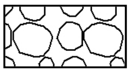
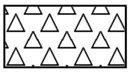
Symbols & Abbreviations

Graphic Symbols for Soil and Rock

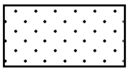
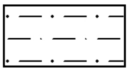
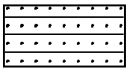
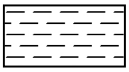
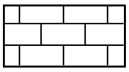
General

■	Asphalt
	Road base
	Concrete
	Filling

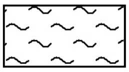
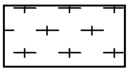
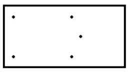
Soils

	Topsoil
	Peat
	Clay
	Silty clay
	Sandy clay
	Gravelly clay
	Shaly clay
	Silt
	Clayey silt
	Sandy silt
	Sand
	Clayey sand
	Silty sand
	Gravel
	Sandy gravel
	Cobbles, boulders
	Talus

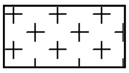
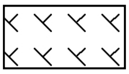
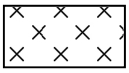
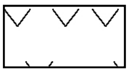
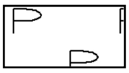
Sedimentary Rocks

	Boulder conglomerate
	Conglomerate
	Conglomeratic sandstone
	Sandstone
	Siltstone
	Laminite
	Mudstone, claystone, shale
■	Coal
	Limestone

Metamorphic Rocks

	Slate, phyllite, schist
	Gneiss
	Quartzite

Igneous Rocks

	Granite
	Dolerite, basalt, andesite
	Dacite, epidote
	Tuff, breccia
	Porphyry

Rock Descriptions

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approx Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq \text{100 mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Appendix B

Test Pit Logs (12 to 14)
Test Pit Logs (201 to 213)
Test Pit Logs (Pits 301 to 314)
Dynamic Penetrometer Test Results
Pit Photoplates

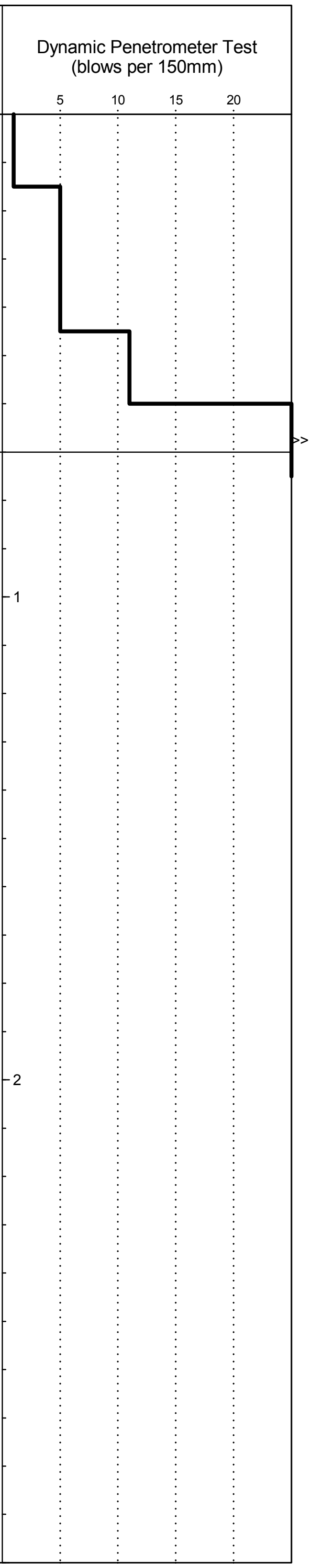
TEST PIT LOG

CLIENT: Cardno Pty Ltd
PROJECT: North Shearwater Residential Subdivision-Stage 1
LOCATION: Off Viney Creek Road, Tea Gardens

SURFACE LEVEL: 59.0m* AHD
EASTING: 420761
NORTHING: 6388969

PIT No: TP12
PROJECT No: 81259
DATE: 6/3/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - Loose, brown silty fine grained sandy topsoil with abundant rootlets, damp							
	0.4	SILTY CLAY - Stiff to very stiff, grey/brown silty clay with some fine to medium grained sand with some gravel, M>Wp		D	0.15 0.2		pp = 100-200		
	0.68	SILTY SANDY CLAY - Stiff to very stiff, brown, fine to medium grained silty sandy clay, M>Wp (extremely low strength, extremely weathered claystone)		D B	0.4 0.5 0.7		pp = 100-200		
	0.7	CLAYSTONE - (Medium to high strength) slightly weathered grey claystone, with some fine to medium grained sand							
		Pit discontinued at 0.7m, refusal							
	1								
	2								



RIG: Backhoe

LOGGED: Fulham

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * RLs interpolated from the site survey plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

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

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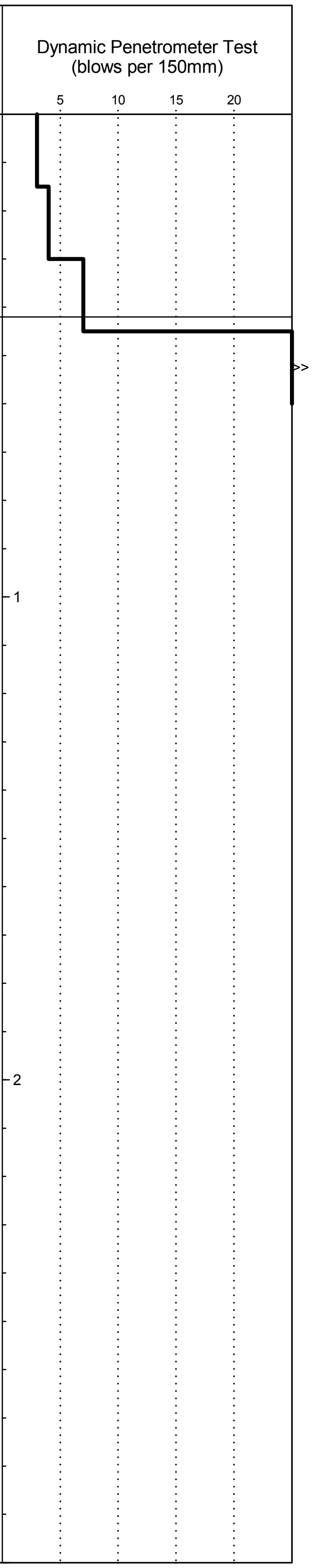
TEST PIT LOG

CLIENT: Cardno Pty Ltd
PROJECT: North Shearwater Residential Subdivision-Stage 1
LOCATION: Off Viney Creek Road, Tea Gardens

SURFACE LEVEL: 51.0m* AHD
EASTING: 420812
NORTHING: 6388915

PIT No: TP13
PROJECT No: 81259
DATE: 6/3/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - Loose to medium dense, brown silty fine grained sandy topsoil with abundant rootlets, and some gravel, damp		D	0.1			
	0.15	SANDY CLAY - Stiff, grey fine grained sandy clay with some silt, M>Wp		D U_{50}	0.2		pp = 100	
	0.4 0.42	CLAYSTONE - (Medium strength) highly to moderately weathered, orange claystone with some fine to medium grained sand			0.42			
		Pit discontinued at 0.42m, refusal						



RIG: Backhoe
LOGGED: Fulham
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * RLs interpolated from the site survey plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

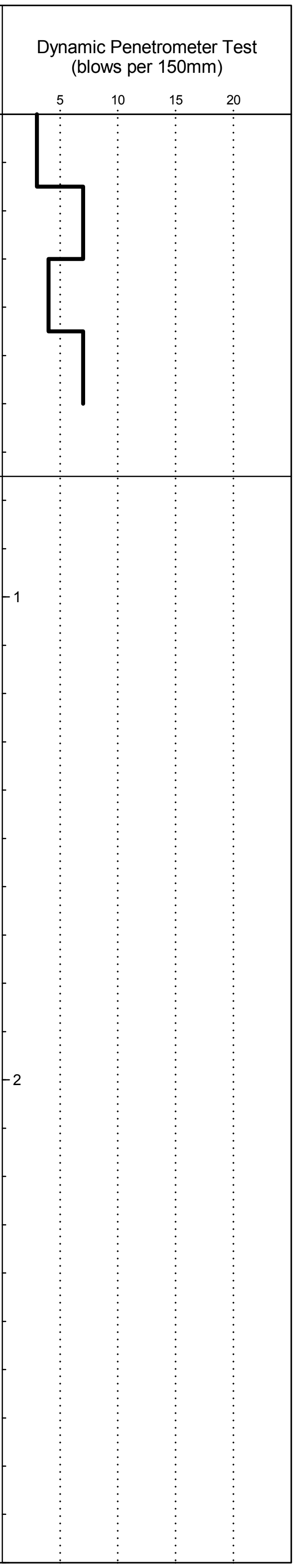
TEST PIT LOG

CLIENT: Cardno Pty Ltd
PROJECT: North Shearwater Residential Subdivision-Stage 1
LOCATION: Off Viney Creek Road, Tea Gardens

SURFACE LEVEL: 54.0m* AHD
EASTING: 420896
NORTHING: 6388949

PIT No: TP14
PROJECT No: 81259
DATE: 5/3/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - Medium dense, brown, fine grained silty sandy topsoil with abundant rootlets, moist						
	0.1	CLAYEY SAND - Medium dense, light brown, fine grained clayey sand, slightly silty, moist with some weathered sandstone cobbles		D B D	0.1 0.2 0.3			
	0.35	SANDSTONE - (Very low to low strength) extremely to highly weathered, orange fine grained sandstone From 0.7m, (medium to high strength) slightly weathered, grey						
	0.75	Pit discontinued at 0.75m, refusal						



RIG: Backhoe **LOGGED:** Fulham **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * RLs interpolated from the site survey plan

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 47.0 m
EASTING: 420942
NORTHING: 6388897
DIP/AZIMUTH: 90°/--

PIT No: 201
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed	D	E		47	0.0		TOPSOIL/SANDY SILT: dark brown; sand is fine grained; abundant rootlets	moist		
							0.10m		SANDSTONE: grey brown and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry		
							0.5					
							0.60m		Pit discontinued at 0.60m depth refusal on bedrock			
						46	1.0					
							1.5					
						45	2.0					
							2.5					
						44	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
B	Bulk sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	▷	Water seep	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▼	Water level	SPT	Standard penetration test
E	Envirnmental Sample	PID	Photo ionisation detector (ppm)	V	Shear vane (kPa)

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DPDGD 1.04 PETA SPECIAL.GLB Log DP_301.00.02_SOIL_WGATE 81259.01.L001.REV0.PITS.GPJ <<DrawingFile>> 19/06/2018 09:56 8.30.004 Datgel Lab and In Situ Tool - DGD | Lib: dpdgd 1.04.02 Prj: dpdgd 1.03.04

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 47.0 m
EASTING: 421009
NORTHING: 6388919
DIP/AZIMUTH: 90°/--

PIT No: 202
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed				47	0.0		SANDY SILT: brown; sand is fine to medium grained; abundant rootlets	moist		
							0.10m		SANDSTONE: grey brown and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry		
							0.15m		Pit discontinued at 0.15m depth refusal			
							0.5					
						46	1.0					
							1.5					
						45	2.0					
							2.5					
						44	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 44.0 m
EASTING: 421080
NORTHING: 6388920
DIP/AZIMUTH: 90°/--

PIT No: 203
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

RL	DEPTH (m)	DRILLING & CASING	WATER	GROUND WATER LEVELS	GEO	ENV	IDs and REMARKS	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
44	0.0			No free groundwater observed	D	E		TOPSOIL/SANDY SILT: brown; sand is fine grained; abundant rootlets	moist dry		
	0.15m				D	E		SANDY CLAY: yellow brown	M=Wp	VST to H	
					U						
	0.5										pp: >400 kPa
	0.60m							SANDSTONE: grey white and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry		
	0.70m							Pit discontinued at 0.70m depth refusal			
43	1.0										
	1.5										
42	2.0										
	2.5										
41	3.0										

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
B	Bulk sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	▽	Water seep	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▼	Water level	SPT	Standard penetration test
E	Envirnmental Sample	PID	Photo ionisation detector (ppm)	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 41.0 m
EASTING: 421153
NORTHING: 6388892
DIP/AZIMUTH: 90°/--

PIT No: 204
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed	D			41	0.0		TOPSOIL/SANDY SILT: brown; sand is fine grained	moist		
							0.10m		SILTY CLAY: grey brown			
							0.40m		CLAYEY SILT: grey white; clay is medium plasticity			
			D				0.5			M<Wp	VST	
							0.55m		CLAY: orange brown and red brown			
			B									
							0.90m		SANDSTONE: grey white and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry		
							0.95m		Pit discontinued at 0.95m depth refusal			
						40	1.0					
							1.5					
						39	2.0					
							2.5					
						38	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 37.0 m
EASTING: 421203
NORTHING: 6388853
DIP/AZIMUTH: 90°/--

PIT No: 205
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed	D	E		37	0.0		0.10m TOPSOIL/SILTY SAND: fine to medium; brown; abundant rootlets	moist		
			D	E					0.35m CLAYEY SAND: fine to medium; grey brown	moist	MD	
							0.5		0.65m SANDY CLAY: grey brown and orange brown; sand is fine to medium grained	M>Wp	F to ST	
			U D						0.75m CLAY: orange brown and grey brown			
									0.90m SANDSTONE: grey and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry		
									Pit discontinued at 0.90m depth refusal			
						36	1.0					
							1.5					
						35	2.0					
							2.5					
						34	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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DPDGD 1.04.PETA SPECIAL.GLB Log DP_301.00.02_SOIL_WGATE 81259.01.L.001.REV0.PITS.GPJ <<DrawingFile>> 19/06/2018 09:58 8.30.004 Datgel Lab and In Situ Tool - DGD | Lib: dpdgd 1.04.02 Prj: dpdgd 1.03.04

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 36.0 m
EASTING: 421272
NORTHING: 6388875
DIP/AZIMUTH: 90°/--

PIT No: 206
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

RL	DEPTH (m)	GROUND WATER LEVELS	GEO	DESCRIPTION OF STRATA	MOISTURE CONDITION
36	0.0	No free groundwater observed	D	TOPSOIL/SANDY SILT: dark brown; sand is fine grained; abundant rootlets	moist
	0.30m			SANDSTONE: grey white and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry
	0.45m			Pit discontinued at 0.45m depth refusal	
	0.5				
35	1.0				
	1.5				
34	2.0				
	2.5				
33	3.0				

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 34.0 m
EASTING: 421338
NORTHING: 6388880
DIP/AZIMUTH: 90°/--

PIT No: 207
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed	D			34	0.0		TOPSOIL/SILT: brown; trace fine grained sand; abundant rootlets	moist		
							0.20m		SANDSTONE: grey white and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry		
							0.5 (0.50m)		Pit discontinued at 0.50m depth refusal			
						33	1.0					
							1.5					
						32	2.0					
							2.5					
						31	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 31.0 m
EASTING: 421365
NORTHING: 6388834
DIP/AZIMUTH: 90°/--

PIT No: 208
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

DRILLING: PROGRESS – DRILLING & CASING	DRILLING: PROGRESS – WATER	GROUND WATER LEVELS	SAMPLING – GEO	SAMPLING – ENV	SAMPLING – IDs and REMARKS	RL	DEPTH (m)	MATERIAL: GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
		No free groundwater observed	U			31	0.0 – 0.20m	▨	TOPSOIL/CLAYEY SILT: brown; clay is medium plasticity; abundant rootlets	moist	F	
							0.20m – 0.70m (0.5)	▨	CLAY: grey brown and yellow brown	M>Wp	H	pp: 350 - >400 kPa
							0.70m – 1.00m	⁙	SANDSTONE: grey white and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry		
						30	1.0		Pit discontinued at 1.00m depth refusal			
							1.5					
						29	2.0					
							2.5					
						28	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 32.0 m
EASTING: 421420
NORTHING: 6388868
DIP/AZIMUTH: 90°/--

PIT No: 209
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

RL	DEPTH (m)	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	GROUND WATER LEVELS	TEST RESULTS & COMMENTS
32	0.0 – 0.10m	TOPSOIL/CLAYEY SILT: dark brown; clay is medium plasticity; abundant rootlets	moist		No free groundwater observed	
	0.10m – 0.30m	SILT: grey brown		ST		
	0.30m – 0.35m	SANDSTONE: grey white and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry			
	0.35m	Pit discontinued at 0.35m depth refusal				

RL	DEPTH (m)
32	0.0
	0.5
31	1.0
	1.5
30	2.0
	2.5
29	3.0

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
B	Bulk sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	▷	Water seep	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▼	Water level	SPT	Standard penetration test
E	Envirnmental Sample	PID	Photo ionisation detector (ppm)	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 33.0 m
EASTING: 421480
NORTHING: 6388868
DIP/AZIMUTH: 90°/--

PIT No: 210
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed	D	E		33	0.0		TOPSOIL/SANDY SILT: dark brown; sand is fine grained; abundant rootlets	moist		
							0.20m					
			D	E					CLAYEY SILT: grey brown; clay is medium plasticity; trace fine sized gravel	M<Wp	ST to VST	
							0.30m					
							0.35m		SANDSTONE: grey white and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry		
									Pit discontinued at 0.35m depth refusal			
							0.5					
						32	1.0					
							1.5					
						31	2.0					
							2.5					
						30	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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DPDGD 1.04 PETA SPECIAL.GLB Log DP_301.00.02_SOIL_WGATE 81259.01.L.001.REV0.PITS.GPJ <<DrawingFile>> 19/06/2018 09:56 8.30.004 Datgel Lab and In Situ Tool - DGD | Lib: dpdgd 1.04.02 Prj: dpdgd 1.03.04

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 25.0 m
EASTING: 421417
NORTHING: 6388943
DIP/AZIMUTH: 90°/--

PIT No: 211
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

RL	DEPTH (m)	SAMPLING GEO	GROUND WATER LEVELS	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
25	0.0 – 0.20m		No free groundwater observed	TOPSOIL/SANDY SILT: brown; sand is fine grained; abundant rootlets	moist		
	0.20m – 0.60m	B		SANDY CLAY: grey brown and dark brown; sand is fine to medium grained	M=Wp	ST	pp: 150 kPa pp: 150 - 200 kPa
	0.60m – 0.80m			SANDSTONE: grey white and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry		
	0.80m			Pit discontinued at 0.80m depth refusal			
24	1.0						
	1.5						
23	2.0						
	2.5						
22	3.0						

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 51.0 m
EASTING: 420935
NORTHING: 6388942
DIP/AZIMUTH: 90°/--

PIT No: 212
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed				51	0.0		TOPSOIL/SANDY SILT: dark brown; sand is fine grained; abundant rootlets			
							0.10m		SANDY CLAY: yellow brown; sand is fine to medium grained	M>Wp	ST to VST	
			B									pp: 200 - 250 kPa
							0.40m		Pit discontinued at 0.40m depth refusal on bedrock			
							0.5					
						50	1.0					
							1.5					
						49	2.0					
							2.5					
						48	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
B	Bulk sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	▷	Water seep	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▼	Water level	SPT	Standard penetration test
E	Envirnmental Sample	PID	Photo ionisation detector (ppm)	V	Shear vane (kPa)

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DPDGD 1.04.PETA SPECIAL.GLB Log DP_301.00.02_SOIL_WGATE 81259.01.L001.REV0.PITS.GPJ <<DrawingFile>> 19/06/2018 09:56 8.30.004 Datgel Lab and In Situ Tool - DGD | Lib: dpdgd 1.04.02 Prj: dpdgd 1.03.04

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 38.0 m
EASTING: 421208
NORTHING: 6388902
DIP/AZIMUTH: 90°/--

PIT No: 213
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed				38	0.0	0.05m	TOPSOIL/SILT: dark brown; abundant rootlets	moist		
			D					0.30m	SANDY CLAY: grey brown; sand is fine grained; trace silt	M=Wp	ST to VST	pp: 200 - 300 kPa
							0.5	0.55m	SANDSTONE: grey brown and yellow brown; very low to low strength; moderately weathered to slightly weathered	dry		
									Pit discontinued at 0.55m depth refusal			
						37	1.0					
							1.5					
						36	2.0					
							2.5					
						35	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
B	Bulk sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	▷	Water seep	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▼	Water level	SPT	Standard penetration test
E	Envirnmental Sample	PID	Photo ionisation detector (ppm)	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 35.0 m
EASTING: 420936
NORTHING: 6388925
DIP/AZIMUTH: 90°/--

PIT No: 301
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL			
PROGRESS		GROUND WATER LEVELS	SAMPLING								
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS	RL	DEPTH (m)	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
		No free groundwater observed				35	0.0	TOPSOIL/SANDY SILT: brown; sand is fine grained; abundant rootlets (0.20m)	moist		
			B				0.5	GRAVELLY CLAY: grey brown and orange brown; gravel is fine to medium sized; with silt (0.80m)	M<Wp	ST	
			D			34	1.0	SILTSTONE: grey white and orange brown; extremely low to very low strength; extremely weathered to highly weathered (1.40m)	dry		
							1.5	Pit discontinued at 1.40m depth refusal			
						33	2.0				
							2.5				
						32	3.0				

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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DPDGD 1.04 PETA SPECIAL.GLB Log DP_301.00.02_SOIL_WGATE 81259.01.L001.REV0.PITS.GPJ <<DrawingFile>> 19/06/2018 09:57 8.30.004 Datgel Lab and In Situ Tool - DGD | Lib: dpdgd 1.04.02 Prj: dpdgd 1.03.04

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 44.0 m
EASTING: 420955
NORTHING: 6389311
DIP/AZIMUTH: 90°/--

PIT No: 302
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed				44	0.0		TOPSOIL/SANDY SILT: brown; sand is fine grained; abundant rootlets			
							0.30m		SANDSTONE: red brown and grey white; very low to low strength; moderately weathered, highly fractured	dry		
			B				0.5					
							0.90m		Pit discontinued at 0.90m depth refusal			
						43	1.0					
							1.5					
						42	2.0					
							2.5					
						41	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 35.0 m
EASTING: 420994
NORTHING: 638924
DIP/AZIMUTH: 90°/--

PIT No: 303
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed	D	E		35	0.0	0.10m	TOPSOIL/SANDY SILT: brown; sand is fine grained; abundant rootlets	moist		
			D	E	D1			0.45m	GRAVELLY CLAY: grey brown and orange brown; gravel is fine to medium sized, subangular to angular	M>Wp	F to ST	pp: 200 - 250 kPa
			D									
							0.5	1.20m	SILTSTONE: grey white and orange brown and black; extremely low to low strength; extremely weathered to moderately weathered	dry		
						34	1.0					
									Pit discontinued at 1.20m depth refusal			
							1.5					
						33	2.0					
							2.5					
						32	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 24.0 m
EASTING: 421014
NORTHING: 6389183
DIP/AZIMUTH: 90°/--

PIT No: 304
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed	D	E		24	0.0		TOPSOIL/SANDY SILT: brown; sand is fine to medium grained; abundant rootlets	moist		
			D	E			0.20m		CLAY: grey brown; trace fine to medium grained sand; trace gravel	M>Wp	ST	
			U				0.5					
							0.55m		SANDSTONE: grey brown and yellow brown; extremely low to low strength; extremely weathered to slightly weathered	dry		pp: >400 kPa
						23	1.0					
							1.10m		Pit discontinued at 1.10m depth refusal			
							1.5					
						22	2.0					
							2.5					
						21	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 36.0 m
EASTING: 421072
NORTHING: 6389232
DIP/AZIMUTH: 90°/--

PIT No: 305
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed				36	0.0		TOPSOIL/SANDY SILT: brown; sand is fine grained; abundant rootlets	moist		
							0.10m		SANDY CLAY: grey brown and orange brown; sand is fine to medium grained	M>Wp	ST	
							0.25m		GRANITE: grey and orange brown; very low to low strength; moderately weathered to slightly weathered	dry		
			D				0.30m		Pit discontinued at 0.30m depth refusal			
							0.5					
						35	1.0					
							1.5					
						34	2.0					
							2.5					
						33	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 46.0 m
EASTING: 421109
NORTHING: 6389283
DIP/AZIMUTH: 90°/--

PIT No: 306
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed				46	0.0		TOPSOIL/SANDY SILT: brown; sand is fine to medium grained; abundant rootlets	moist		
			B				0.30m 0.5		SANDY CLAY: grey brown and red brown; with fine to medium grained sand	M<Wp	ST to VST	
			D			45	0.70m 1.0		SANDSTONE: grey and red brown; very low strength; highly weathered	dry		
							1.20m		Pit discontinued at 1.20m depth refusal			
							1.5					
						44	2.0					
							2.5					
						43	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 32.0 m
EASTING: 421126
NORTHING: 6389205
DIP/AZIMUTH: 90°/--

PIT No: 307
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed				32	0.0		TOPSOIL/SANDY SILT: brown; sand is fine grained; abundant rootlets	moist		
							0.20m		GRANITE: grey and white and red brown; very low to low strength; moderately weathered to slightly weathered	dry		
							0.25m		Pit discontinued at 0.25m depth refusal			
							0.5					
						31	1.0					
							1.5					
						30	2.0					
							2.5					
						29	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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DPDGD 1.04.PETA SPECIAL.GLB Log DP_301.00.02_SOIL_WGATE 81259.01.L.001.REV0.PITS.GPJ <<DrawingFile>> 19/06/2018 09:57 8.30.004 Datgel Lab and In Situ Tool - DGD | Lib: dpdgd 1.04.02 Prj: dpdgd 1.03.04

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 18.0 m
EASTING: 421129
NORTHING: 6389133
DIP/AZIMUTH: 90°/--

PIT No: 308
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 1 of 1

DRILLING							MATERIAL			
PROGRESS		GROUND WATER LEVELS	SAMPLING							
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS	RL / DEPTH (m)	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
		No free groundwater observed				18 / 0.0	TOPSOIL/SANDY SILT: brown; sand is fine grained; abundant rootlets (0.20m)	moist		
							SILTY SAND: fine to medium; grey brown (0.35m)		MD	
			U			0.5	CLAY: grey	M<Wp	ST to VST	pp: >400 kPa
			D			17 / 1.0	(1.50m)			pp: 300 - >400 kPa
						1.5	SANDSTONE: grey and red brown; extremely low to very low strength; extremely weathered to highly weathered	dry		
						16 / 2.0				
						2.5	(2.70m)			
						15 / 3.0	Pit discontinued at 2.70m depth refusal			

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
B	Bulk sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	▷	Water seep	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▼	Water level	SPT	Standard penetration test
E	Envirnmental Sample	PID	Photo ionisation detector (ppm)	V	Shear vane (kPa)

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DPDGD 1.04.PETA SPECIAL.GLB Log DP_301.00.02_SOIL_WGATE 81259.01.L001.REV0.PITS.GPJ <<DrawingFile>> 19/06/2018 09:57 8.30.004 Datgel Lab and In Situ Tool - DGD | Lib: dpdgd 1.04.02 Prj: dpdgd 1.03.04

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd		**SURFACE LEVEL:** 26.0 m	**PIT No:** 309
PROJECT: North Shearwater Residential Subdivision		**EASTING:** 421203	**PROJECT NO:** 81259.01
LOCATION: Viney Creek Road, Tea Gardens		**NORTHING:** 6389182	**DATE:** 8/3/2018
		DIP/AZIMUTH: 90°/--	**SHEET:** 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed				26	0.0		TOPSOIL/SANDY SILT: brown; sand is fine grained; abundant rootlets	moist		
							0.20m		SANDSTONE: grey white and orange brown; very low to low strength; moderately weathered to slightly weathered	dry		
							0.30m		Pit discontinued at 0.30m depth refusal			
							0.5					
						25	1.0					
							1.5					
						24	2.0					
							2.5					
						23	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 13.0 m
EASTING: 421269
NORTHING: 6389114
DIP/AZIMUTH: 90°/--

PIT No: 310
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 1 of 1

GROUND WATER LEVELS	GEO	ENV	RL	DEPTH (m)	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
Seepage observed at 2.6m	D	E	13	0.0 – 0.10m	TOPSOIL/SANDY SILT: brown; sand is fine grained; abundant rootlets			
	D	E		0.10m – 0.50m	SILTY CLAY: grey brown; abundant rootlets	moist	F to ST	
	B		12	0.50m – 1.30m	SILTY SAND: medium to coarse; grey brown and orange brown; trace fine sized gravel; trace fine to medium grained sand	M=Wp	MD to D	pp: 350 - >400 kPa
	D		11	1.30m – 2.20m	CLAY: grey brown and orange brown	M>Wp	H	pp: >400 kPa
▶	D			2.20m – 2.90m	SANDSTONE: black grey and orange brown; extremely low to very low strength; extremely weathered to highly weathered	moist		
			10	2.90m – 3.0	Pit discontinued at 2.90m depth refusal	dry		

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
B	Bulk sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	▷	Water seep	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▼	Water level	SPT	Standard penetration test
E	Envirnmental Sample	PID	Photo ionisation detector (ppm)	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 9.0 m
EASTING: 421424
NORTHING: 6389116
DIP/AZIMUTH: 90°/--

PIT No: 311
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 1 of 2

DRILLING							MATERIAL					
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		Seepage observed at 3.1m				9	0.0		TOPSOIL/CLAYEY SILT: brown; abundant rootlets and roots	M<Wp		
							0.20m		SILTY CLAY: grey brown; with some roots	M=Wp	VST to H	pp: 200 - 250 kPa
							0.40m		CLAYEY SILT: grey	M<Wp	H	pp: >400 kPa
						8	1.0					
							1.80m		CLAY: grey brown and yellow brown	M=Wp	ST to VST	pp: 200 - 250 kPa
						7	2.0					
						6	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 9.0 m
EASTING: 421424
NORTHING: 6389116
DIP/AZIMUTH: 90°/--

PIT No: 311
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 2 of 2

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
						6	3.0		CLAY: grey brown and yellow brown *(continued)*	M=Wp	ST to VST	
		▶						3.10m	Pit discontinued at 3.10m depth			
							3.5					
						5	4.0					
							4.5					
						4	5.0					
							5.5					
						3	6.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd		**SURFACE LEVEL:** 8.0 m	**PIT No:** 312
PROJECT: North Shearwater Residential Subdivision		**EASTING:** 42515	**PROJECT NO:** 81259.01
LOCATION: Viney Creek Road, Tea Gardens		**NORTHING:** 6389116	**DATE:** 8/3/2018
		DIP/AZIMUTH: 90°/--	**SHEET:** 1 of 2

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed				8	0.0		TOPSOIL/CLAYEY SILT: brown; clay is medium plasticity; abundant rootlets	moist		
							0.50m		SILTY CLAY: grey			
			B				0.5					
						7	1.0			M<Wp	H	pp: >400 kPa
							1.5					
							1.80m		CLAY: grey			
			D			6	2.0					
							2.5			M=Wp	ST to VST	pp: 200 - 250 kPa
						5	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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DPDGD 1.04.PETA SPECIAL.GLB Log DP_301.00.02_SOIL_WGATE 81259.01.L.001.REV0.PITS.GPJ <<DrawingFile>> 19/06/2018 09:57 8.30.004 Datgel Lab and In Situ Tool - DGD | Lib: dpdgd 1.04.02 Prj: dpdgd 1.03.04

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 8.0 m
EASTING: 42515
NORTHING: 6389116
DIP/AZIMUTH: 90°/--

PIT No: 312
PROJECT NO: 81259.01
DATE: 8/3/2018
SHEET: 2 of 2

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
						5	3.0	3.10m	CLAY: grey *(continued)*	M=Wp	ST to VST	
									Pit discontinued at 3.10m depth			
							3.5					
						4	4.0					
							4.5					
						3	5.0					
							5.5					
						2	6.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 14.0 m
EASTING: 421494
NORTHING: 6389000
DIP/AZIMUTH: 90°/--

PIT No: 313
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL				
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG	DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS							
		No free groundwater observed				14	0.0		SANDY SILT: brown; sand is fine grained; abundant rootlets	moist		
							0.10m		CLAYEY SAND: fine to medium; grey brown; trace silt	dry	MD	
			D									
							0.40m		SANDSTONE: grey white and orange brown; very low to low strength; moderately weathered to slightly weathered			
							0.50m					
							0.5		Pit discontinued at 0.50m depth refusal			
						13	1.0					
							1.5					
						12	2.0					
							2.5					
						11	3.0					

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Wolin Investments Pty Ltd
PROJECT: North Shearwater Residential Subdivision
LOCATION: Viney Creek Road, Tea Gardens

SURFACE LEVEL: 9.0 m
EASTING: 421509
NORTHING: 6389043
DIP/AZIMUTH: 90°/--

PIT No: 314
PROJECT NO: 81259.01
DATE: 7/3/2018
SHEET: 1 of 1

DRILLING								MATERIAL			
PROGRESS		GROUND WATER LEVELS	SAMPLING			RL	DEPTH (m)	GRAPHIC LOG / DESCRIPTION OF STRATA	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	TEST RESULTS & COMMENTS
DRILLING & CASING	WATER		GEO	ENV	IDs and REMARKS						
		Seepage observed at 2.9m				9	0.0	TOPSOIL/CLAYEY SILT: dark brown; clay is low plasticity; abundant rootlets	moist		
							0.15m	CLAYEY SILT: grey white; clay is low plasticity	M<Wp	F to ST	
							0.40m	CLAY: grey brown and orange brown; trace fine grained sand; with silt			
							0.5				
			B								pp: >400 kPa
						8	1.0				
							1.5		M=Wp	ST to VST	
						7	2.0	from 2m: grey brown and yellow brown			pp: 100 kPa
											pp: 100 - 150 kPa
							2.5	from 2.5m: with jarosite mottling			
		▶					2.90m				
						6	3.0	Pit discontinued at 2.90m depth refusal			

REFER TO EXPLANATORY NOTES FOR DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

RIG: Komatsu WB97R **DRILLER:** Lantry **LOGGED:** Cowan **CHECKED:**

REMARKS: Location co-ordinates obtained using hand held GPS, surface levels interpolated from supplied survey plan. Location and surface levels should be considered approximate only.

GRID DATUM: MGA94 Zone 56

SAMPLING & IN SITU TESTING LEGEND

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

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Douglas Partners
Geotechnics / Environment / Groundwater

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PO Box 324
Hunter Region Mail Centre NSW 2310
Phone (02) 4960 9600
Fax (02) 4960 9601

Results of Dynamic Penetrometer Tests

Client	Wolin Investments Pty Ltd c/- Tattersall Lander	**Project No.**	81259.01
Project	North Shearwater Residential Subdivision (Stage 2)	**Date**	
Location	Viney Creek Road, Tea Gardens	**Page No.**	1 of 1

Test Location	204	205	207	208	209	210	211	212		
RL of Test (AHD)	41.00	37.00	34.00	31.00	32.00	33.00	25.00	51.00		
Depth (m)	**Penetration Resistance** Blows/150 mm									
0 - 0.15	4	1	3	2	4	4	1	3		
0.15 - 0.30	9	5	4	5	7	55	4	8		
0.30 - 0.45	11	4	1	4	10/50	8/100	2	5		
0.45 - 0.60	9	3	27	7			11	6/75		
0.60 - 0.75	24	8		5/0			10/25			
0.75 - 0.90	13	bouncing								
0.90 - 1.05	14									
1.05 - 1.20	15/50									
1.20 - 1.35										
1.35 - 1.50										
1.50 - 1.65										
1.65 - 1.80										
1.80 - 1.95										
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										
3.00 - 3.15										
3.15 - 3.30										
3.30 - 3.45										
3.45 - 3.60										

Test Method	AS 1289.6.3.2, Cone Penetrometer	☑	**Tested By**	JRC
	AS 1289.6.3.3, Sand Penetrometer	☐	**Checked By**	JRC

Remarks Ref = Refusal, 24/110 indicates 25 blows for 110 mm penetration

Douglas Partners
Geotechnics / Environment / Groundwater

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Results of Dynamic Penetrometer Tests

Client Wolin Investments Pty Ltd c/- Tattersall Lander

Project No. 81259.01

Project North Shearwater Residential Subdivision (Stage 3)

Date

Location Viney Creek Road, Tea Gardens

Page No. 1 of 2

Test Location	301	302	303	304	305	306	307	308	309	310
RL of Test (AHD)	35.00	44.00	35.00	24.00	36.00	46.00	32.00	18.00	26.00	13.00
Depth (m)	**Penetration Resistance** Blows/150 mm									
0 - 0.15	4	1	4	3	3	1	4	3	3	3
0.15 - 0.30	10	7	9	6	5	8	10/25	5	13/120	4
0.30 - 0.45	16	20	10/75	2	15/125	5		4		4
0.45 - 0.60	10/20	25/100		12		25		5		6
0.60 - 0.75				16				5		13
0.75 - 0.90				25				6		15
0.90 - 1.05								5		8
1.05 - 1.20								6		9
1.20 - 1.35										
1.35 - 1.50										
1.50 - 1.65										
1.65 - 1.80										
1.80 - 1.95										
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										
3.00 - 3.15										
3.15 - 3.30										
3.30 - 3.45										
3.45 - 3.60										

Test Method AS 1289.6.3.2, Cone Penetrometer ☑
AS 1289.6.3.3, Sand Penetrometer ☐

Tested By JRC
Checked By JRC

Remarks Ref = Refusal, 24/110 indicates 25 blows for 110 mm penetration

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Results of Dynamic Penetrometer Tests

Client Wolin Investments Pty Ltd c/- Tattersall Lander
Project No. 81259.01

Project North Shearwater Residential Subdivision (Stage 3)
Date

Location Viney Creek Road, Tea Gardens
Page No. 2 of 2

Test Location	311	312	314							
RL of Test (AHD)	9.00	8.00	9.00							
Depth (m)	**Penetration Resistance** Blows/150 mm									
0 - 0.15	1	2	2							
0.15 - 0.30	3	4	5							
0.30 - 0.45	4	4	3							
0.45 - 0.60	9	5	5							
0.60 - 0.75	11	11	10							
0.75 - 0.90	11	16	16							
0.90 - 1.05	9	25	16							
1.05 - 1.20	10	25/100	17							
1.20 - 1.35										
1.35 - 1.50										
1.50 - 1.65										
1.65 - 1.80										
1.80 - 1.95										
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										
3.00 - 3.15										
3.15 - 3.30										
3.30 - 3.45										
3.45 - 3.60										

Test Method AS 1289.6.3.2, Cone Penetrometer ☑
AS 1289.6.3.3, Sand Penetrometer ☐

Tested By JRC
Checked By JRC

Remarks Ref = Refusal, 24/110 indicates 25 blows for 110 mm penetration

Pit 201

	North Shearwater Residential Subdivision, Stage 2 **Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	8
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 202

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 2 Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	9
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 203

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential**	PROJECT:	81259.01
	Subdivision, Stage 2	PLATE No:	10
	Viney Creek Road, Tea Gardens	REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 204

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential**	PROJECT:	81259.01
	Subdivision, Stage 2	PLATE No:	11
	Viney Creek Road, Tea Gardens	REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 205

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 2** **Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	12
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 206

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 2**	PROJECT:	81259.01
		PLATE No:	13
	Viney Creek Road, Tea Gardens	REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 207

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 2 Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	14
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 208

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 2** **Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	15
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 209

	North Shearwater Residential Subdivision, Stage 2 Viney Creek Road, Tea Gardens	PROJECT:	81259.01
Douglas Partners Geotechnics / Environment / Groundwater		PLATE No:	16
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 210

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential**	PROJECT:	81259.01
	Subdivision, Stage 2	PLATE No:	17
	Viney Creek Road, Tea Gardens	REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 112

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 2** **Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	19
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 213

	North Shearwater Residential Subdivision, Stage 2 **Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	20
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 301

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 3 Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	21
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 302

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential** **Subdivision, Stage 3** **Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	22
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 303

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential**	PROJECT:	81259.01
	Subdivision, Stage 3	PLATE No:	23
	Viney Creek Road, Tea Gardens	REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 304

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 3**	PROJECT:	81259.01
		PLATE No:	24
	Viney Creek Road, Tea Gardens	REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 305

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 3** **Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	25
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 306

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential**	PROJECT:	81259.01
	Subdivision, Stage 3	PLATE No:	26
	Viney Creek Road, Tea Gardens	REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 307

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 3**	PROJECT:	81259.01
		PLATE No:	27
	Viney Creek Road, Tea Gardens	REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 308

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 3** **Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	28
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 309

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 3**	PROJECT:	81259.01
		PLATE No:	29
	Viney Creek Road, Tea Gardens	REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 310

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 3 Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	30
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 311

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential**	PROJECT:	81259.01
	Subdivision, Stage 3	PLATE No:	31
	Viney Creek Road, Tea Gardens	REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 312

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 3 Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	32
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Pit 313

Douglas Partners
Geotechnics | Environment | Groundwater

North Shearwater Residential Subdivision, Stage 3
Viney Creek Road, Tea Gardens

CLIENT: Wolin Investments Pty Ltd

PROJECT: 81259.01
PLATE No: 33
REV: 0
DATE: 19-Jun-18

Pit 314

Douglas Partners Geotechnics / Environment / Groundwater	**North Shearwater Residential Subdivision, Stage 3** **Viney Creek Road, Tea Gardens**	PROJECT:	81259.01
		PLATE No:	34
		REV:	0
	CLIENT: Wolin Investments Pty Ltd	DATE:	19-Jun-18

Appendix C

Laboratory Test Results

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Newcastle Laboratory
15 Callistemon Close Warabrook Newcastle NSW 2310
Phone: (02) 4960 9600
Fax: (02) 4960 9601
Email: Peter.Gorseski@douglaspartners.com.au

Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876A
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **204 (0.6 - 0.9m)**
Material: Clay

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing

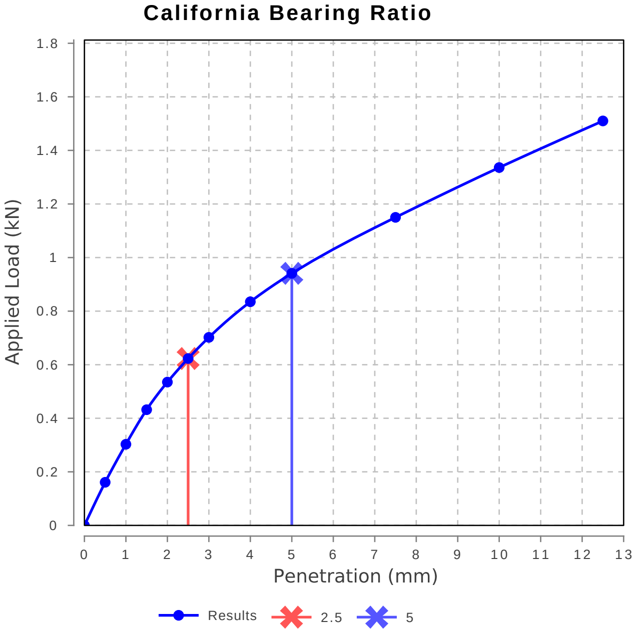
Approved Signatory: Peter Gorseski
Earthworks Manager

NATA Accredited Laboratory Number: 828

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	23.5

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)	
Mould Type	1 LITRE MOULD A
Compaction	Standard
No. Layers	3
No. Blows / Layer	25
Maximum Dry Density (t/m^3)	1.48
Optimum Moisture Content (%)	26.0
Oversize Sieve (mm)	19.0
Oversize Material (%)	2.9
Method used to Determine Plasticity	Visual
Curing Hours	48.0

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**5.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual		
Maximum Dry Density (t/m^3)	1.48		
Optimum Moisture Content (%)	26.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.45		
Field Moisture Content (%)	23.5		
Moisture Content at Placement (%)	26.0		
Moisture Content Top 30mm (%)	31.7		
Moisture Content Rest of Sample (%)	28.7		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.0		
Swell (%)	2.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	2.9		



Material Test Report

Report Number:	**81259.01-1**
Issue Number:	1
Date Issued:	03/04/2018
Client:	Wolin Investments Pty Ltd 23 Graham Hill Road, Narellen NSW 2567
Project Number:	81259.01
Project Name:	North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location:	Viney Creek Road, Tea Gardens
Work Request:	1876
Sample Number:	18-1876B
Date Sampled:	08/03/2018
Sampling Method:	Sampled by Engineering Department
Sample Location:	**211 (0.2 - 0.6m)**
Material:	Sandy Clay

Douglas Partners Pty Ltd
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Approved Signatory: Peter Gorseski
Earthworks Manager

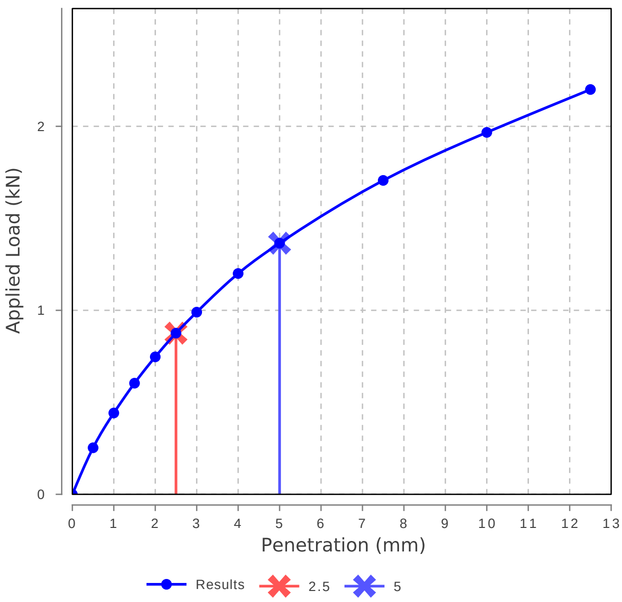
NATA Accredited Laboratory Number: 828

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	19.0

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)	
Mould Type	1 LITRE MOULD A
Compaction	Standard
No. Layers	3
No. Blows / Layer	25
Maximum Dry Density (t/m^3)	1.70
Optimum Moisture Content (%)	18.0
Oversize Sieve (mm)	19.0
Oversize Material (%)	0.0
Method used to Determine Plasticity	Visual
Curing Hours	48.0

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**7**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual		
Maximum Dry Density (t/m^3)	1.70		
Optimum Moisture Content (%)	18.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.68		
Field Moisture Content (%)	19.0		
Moisture Content at Placement (%)	17.8		
Moisture Content Top 30mm (%)	20.0		
Moisture Content Rest of Sample (%)	20.3		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.0		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		

California Bearing Ratio



Material Test Report

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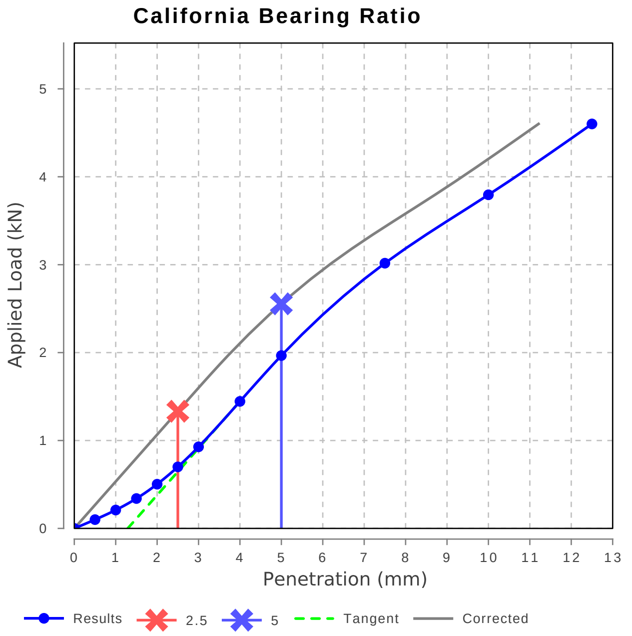
Approved Signatory: Peter Gorseski
Earthworks Manager
NATA Accredited Laboratory Number: 828

Report Number:	**81259.01-1**
Issue Number:	1
Date Issued:	03/04/2018
Client:	Wolin Investments Pty Ltd 23 Graham Hill Road, Narellen NSW 2567
Project Number:	81259.01
Project Name:	North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location:	Viney Creek Road, Tea Gardens
Work Request:	1876
Sample Number:	18-1876C
Date Sampled:	08/03/2018
Sampling Method:	Sampled by Engineering Department
Sample Location:	**212 (0.2 - 0.4m)**
Material:	Sandy Clay

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	20.7

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)	
Mould Type	1 LITRE MOULD A
Compaction	Standard
No. Layers	3
No. Blows / Layer	25
Maximum Dry Density (t/m^3)	1.71
Optimum Moisture Content (%)	16.0
Oversize Sieve (mm)	19.0
Oversize Material (%)	0.0
Method used to Determine Plasticity	Visual
Curing Hours	48.0

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**13**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual		
Maximum Dry Density (t/m^3)	1.71		
Optimum Moisture Content (%)	16.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.72		
Field Moisture Content (%)	20.7		
Moisture Content at Placement (%)	15.8		
Moisture Content Top 30mm (%)	17.2		
Moisture Content Rest of Sample (%)	17.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.0		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



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Earthworks Manager

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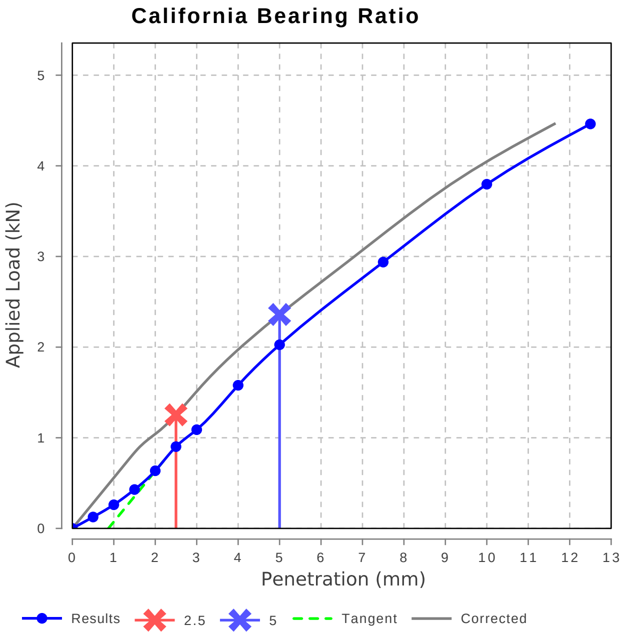
Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876D
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **301 (0.3 - 0.6m)**
Material: Gravelly Clay

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	21.6

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)	
Mould Type	1 LITRE MOULD A
Compaction	Standard
No. Layers	3
No. Blows / Layer	25
Maximum Dry Density (t/m^3)	1.61
Optimum Moisture Content (%)	21.5
Oversize Sieve (mm)	19.0
Oversize Material (%)	39.3
Method used to Determine Plasticity	Visual
Curing Hours	48.0

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**12**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual		
Maximum Dry Density (t/m^3)	1.61		
Optimum Moisture Content (%)	21.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.61		
Field Moisture Content (%)	21.6		
Moisture Content at Placement (%)	21.3		
Moisture Content Top 30mm (%)	21.9		
Moisture Content Rest of Sample (%)	22.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.0		
Swell (%)	-0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	39.3		



Material Test Report

Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876F
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **306 (0.4 - 0.7m)**
Material: Sandy Clay

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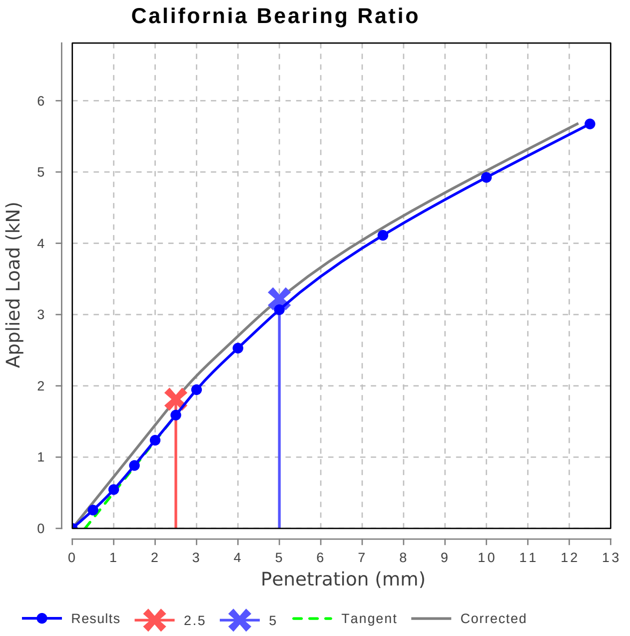
Approved Signatory: Peter Gorseski
Earthworks Manager

NATA Accredited Laboratory Number: 828

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	12.8

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)	
Mould Type	1 LITRE MOULD A
Compaction	Standard
No. Layers	3
No. Blows / Layer	25
Maximum Dry Density (t/m^3)	1.70
Optimum Moisture Content (%)	17.5
Oversize Sieve (mm)	19.0
Oversize Material (%)	0.0
Method used to Determine Plasticity	Visual
Curing Hours	48.0

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**16**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual		
Maximum Dry Density (t/m^3)	1.70		
Optimum Moisture Content (%)	17.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.70		
Field Moisture Content (%)	12.8		
Moisture Content at Placement (%)	17.5		
Moisture Content Top 30mm (%)	19.6		
Moisture Content Rest of Sample (%)	19.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.0		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

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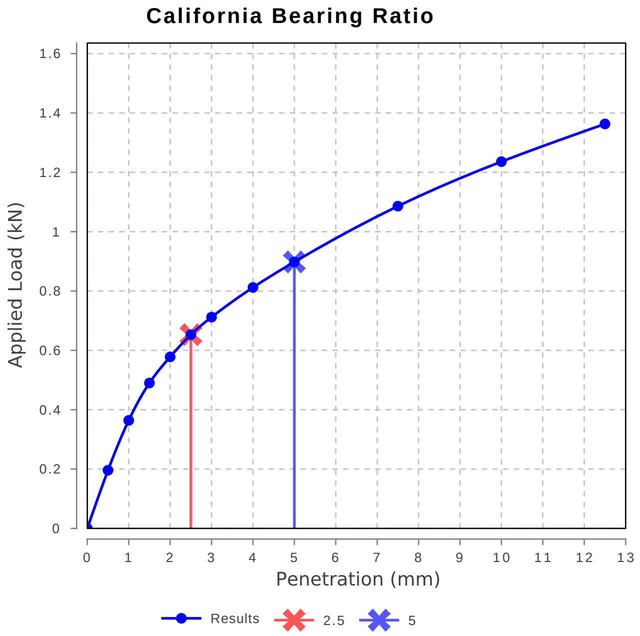
NATA Accredited Laboratory Number: 828

Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876G
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **310 (0.5 - 1.0m)**
Material: Silty Clay

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	21.0

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)	
Mould Type	1 LITRE MOULD A
Compaction	Standard
No. Layers	3
No. Blows / Layer	25
Maximum Dry Density (t/m^3)	1.66
Optimum Moisture Content (%)	19.5
Oversize Sieve (mm)	19.0
Oversize Material (%)	0.0
Method used to Determine Plasticity	Visual
Curing Hours	48.0

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**5.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual		
Maximum Dry Density (t/m^3)	1.66		
Optimum Moisture Content (%)	19.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.65		
Field Moisture Content (%)	21.0		
Moisture Content at Placement (%)	19.6		
Moisture Content Top 30mm (%)	24.6		
Moisture Content Rest of Sample (%)	21.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.0		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876H
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **312 (0.7 - 1.0m)**
Material: Silty Clay

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Earthworks Manager

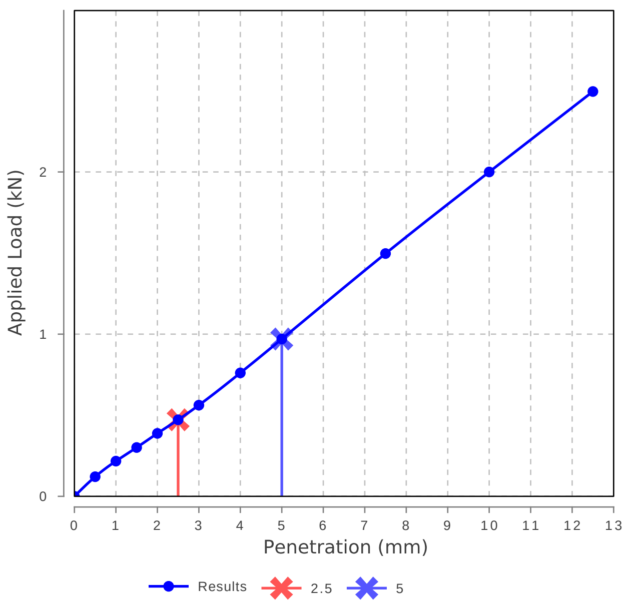
NATA Accredited Laboratory Number: 828

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	14.6

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)	
Mould Type	1 LITRE MOULD A
Compaction	Standard
No. Layers	3
No. Blows / Layer	25
Maximum Dry Density (t/m^3)	1.75
Optimum Moisture Content (%)	16.5
Oversize Sieve (mm)	19.0
Oversize Material (%)	0.0
Method used to Determine Plasticity	Visual
Curing Hours	48.0

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**5.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual		
Maximum Dry Density (t/m^3)	1.75		
Optimum Moisture Content (%)	16.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.74		
Field Moisture Content (%)	14.6		
Moisture Content at Placement (%)	16.6		
Moisture Content Top 30mm (%)	19.2		
Moisture Content Rest of Sample (%)	17.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.0		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		

California Bearing Ratio



Material Test Report

Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876I
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **314 (0.5 - 0.7m)**
Material: Clay

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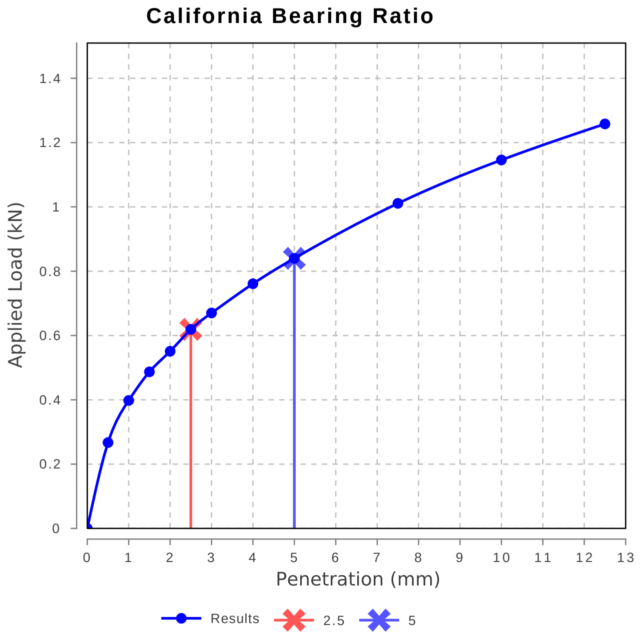
Earthworks Manager
NATA Accredited Laboratory Number: 828

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	17.5

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)	
Mould Type	1 LITRE MOULD A
Compaction	Standard
No. Layers	3
No. Blows / Layer	25
Maximum Dry Density (t/m^3)	1.70
Optimum Moisture Content (%)	18.5
Oversize Sieve (mm)	19.0
Oversize Material (%)	0.0
Method used to Determine Plasticity	Visual
Curing Hours	48.0

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**4.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual		
Maximum Dry Density (t/m^3)	1.70		
Optimum Moisture Content (%)	18.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.67		
Field Moisture Content (%)	17.5		
Moisture Content at Placement (%)	18.7		
Moisture Content Top 30mm (%)	22.4		
Moisture Content Rest of Sample (%)	20.2		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.0		
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



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Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876J
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **203 (0.2 - 0.5m)**
Material: Sandy Clay

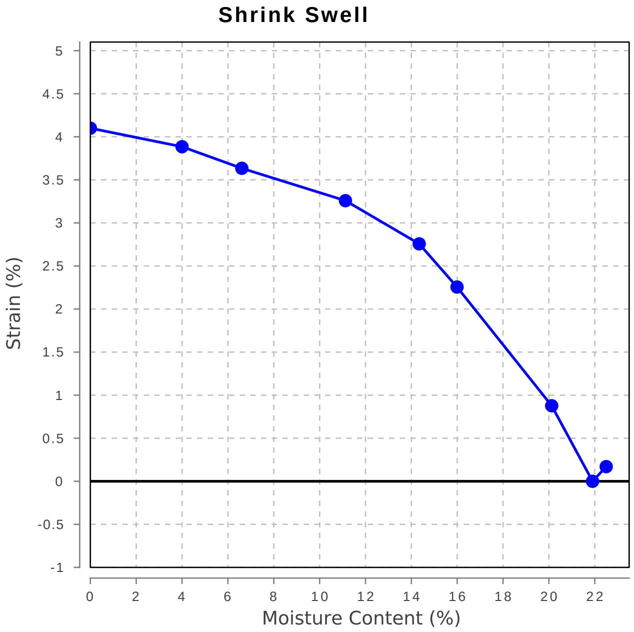
Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.3**
Visual Description	Sandy Clay

* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**4.1**
Estimated % by volume of significant inert inclusions	10
Cracking	Slightly Cracked
Crumbling	Yes
Moisture Content (%)	21.9

Swell Test	
Initial Pocket Penetrometer (kPa)	210
Final Pocket Penetrometer (kPa)	150
Initial Moisture Content (%)	19.1
Final Moisture Content (%)	22.5
Swell (%)	**-0.2**

* NATA Accreditation does not cover the performance of pocket penetrometer readings.



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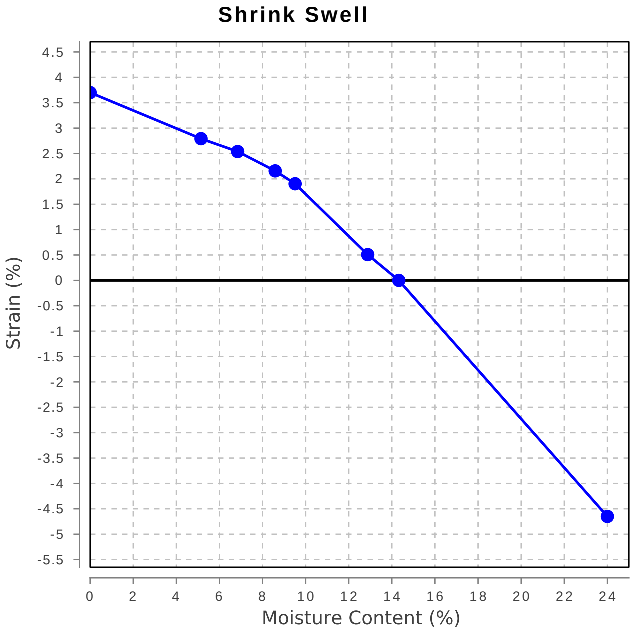
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876K
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **205 (0.45 - 0.8m)**
Material: Sandy Clay

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**3.4**
Visual Description	Sandy Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**3.7**
Estimated % by volume of significant inert inclusions	0
Cracking	Moderately Cracked
Crumbling	No
Moisture Content (%)	14.3

Swell Test	
Initial Pocket Penetrometer (kPa)	600
Final Pocket Penetrometer (kPa)	370
Initial Moisture Content (%)	18.3
Final Moisture Content (%)	24.0
Swell (%)	**4.6**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

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Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876L
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **208 (0.2 - 0.55m)**
Material: Clay

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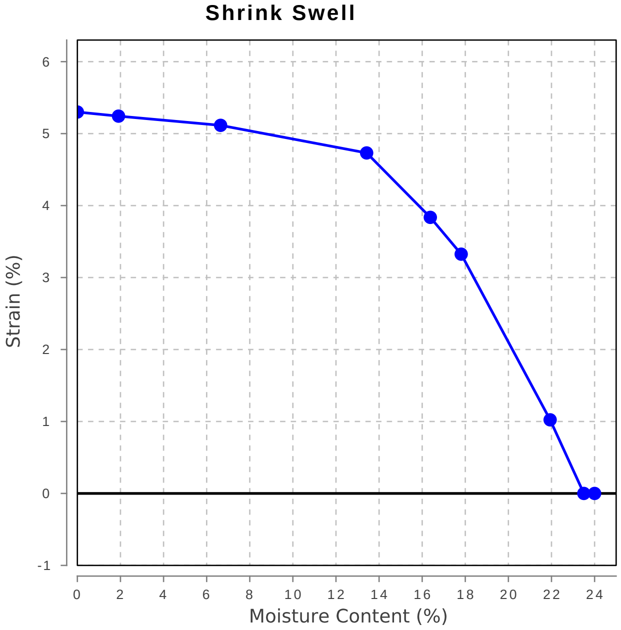
Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.9**
Visual Description	Clay

* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**5.3**
Estimated % by volume of significant inert inclusions	5
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	23.5

Swell Test	
Initial Pocket Penetrometer (kPa)	405
Final Pocket Penetrometer (kPa)	515
Initial Moisture Content (%)	23.6
Final Moisture Content (%)	24.0
Swell (%)	**0.0**

* NATA Accreditation does not cover the performance of pocket penetrometer readings.



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Report Number:	**81259.01-1**
Issue Number:	1
Date Issued:	03/04/2018
Client:	Wolin Investments Pty Ltd 23 Graham Hill Road, Narellen NSW 2567
Project Number:	81259.01
Project Name:	North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location:	Viney Creek Road, Tea Gardens
Work Request:	1876
Sample Number:	18-1876M
Date Sampled:	08/03/2018
Sampling Method:	Sampled by Engineering Department
Sample Location:	**304 (0.35 - 0.88m)**
Material:	Clay

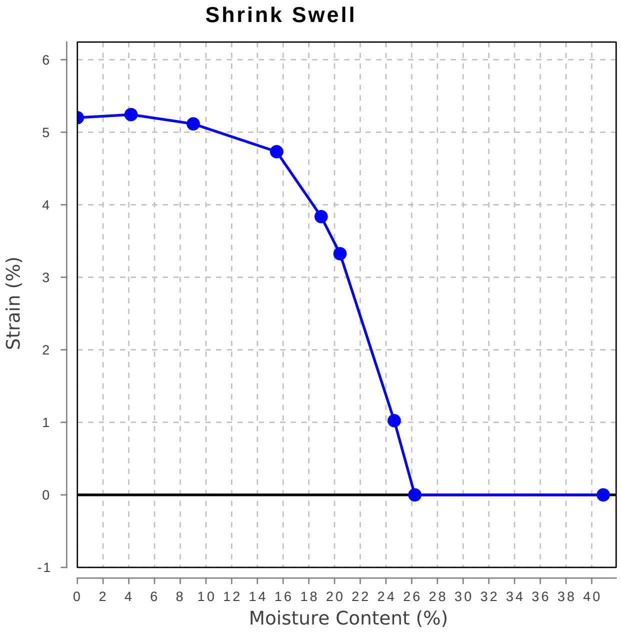
Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.9**
Visual Description	Clay

* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**5.2**
Estimated % by volume of significant inert inclusions	20
Cracking	Slightly Cracked
Crumbling	Yes
Moisture Content (%)	26.2

Swell Test	
Initial Pocket Penetrometer (kPa)	130
Final Pocket Penetrometer (kPa)	105
Initial Moisture Content (%)	29.2
Final Moisture Content (%)	40.9
Swell (%)	**0.0**

* NATA Accreditation does not cover the performance of pocket penetrometer readings.



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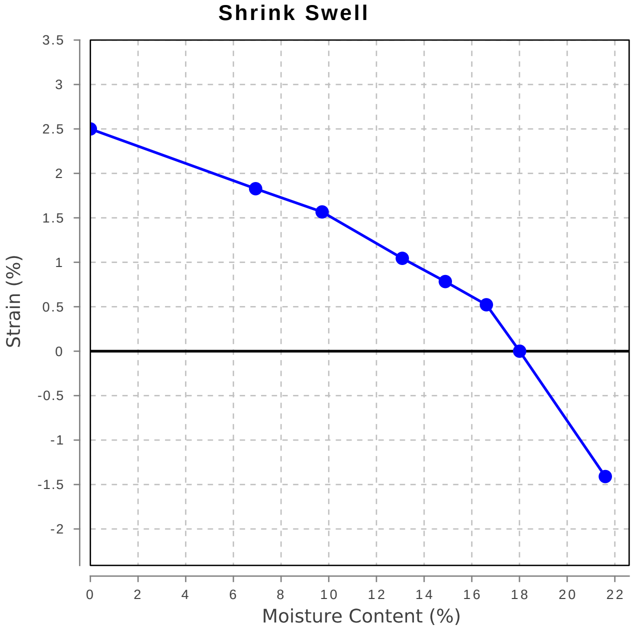
Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876N
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **308 (0.4 - 0.75m)**
Material: Clay

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**1.8**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**2.5**
Estimated % by volume of significant inert inclusions	5
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	18.0

Swell Test	
Initial Pocket Penetrometer (kPa)	600
Final Pocket Penetrometer (kPa)	350
Initial Moisture Content (%)	17.3
Final Moisture Content (%)	21.6
Swell (%)	**1.4**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876O
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **204 (0.5m)**
Material: Clayey Silt

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Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	19.0

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	28		
Plastic Limit (%)	20		
Plasticity Index (%)	**8**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	3.0		
Cracking Crumbling Curling	None		

Material Test Report

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Report Number:	**81259.01-1**
Issue Number:	1
Date Issued:	03/04/2018
Client:	Wolin Investments Pty Ltd 23 Graham Hill Road, Narellen NSW 2567
Project Number:	81259.01
Project Name:	North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location:	Viney Creek Road, Tea Gardens
Work Request:	1876
Sample Number:	18-1876P
Date Sampled:	08/03/2018
Sampling Method:	Sampled by Engineering Department
Sample Location:	**213 (0.2m)**
Material:	Sandy Clay

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	26.1

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	56		
Plastic Limit (%)	19		
Plasticity Index (%)	**37**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	11.5		
Cracking Crumbling Curling	None		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	-		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	26		

Material Test Report

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Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876Q
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **303 (0.2 - 0.4m)**
Material: Gravelly Clay

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	25.5

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	47		
Plastic Limit (%)	20		
Plasticity Index (%)	**27**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	12.0		
Cracking Crumbling Curling	None		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	-		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	26		

Material Test Report

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Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876S
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **310 (1.5m)**
Material: Clay

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	23.5

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	83		
Plastic Limit (%)	17		
Plasticity Index (%)	**66**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	17.5		
Cracking Crumbling Curling	Curling		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	-		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	26		

Material Test Report

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Report Number:	**81259.01-1**
Issue Number:	1
Date Issued:	03/04/2018
Client:	Wolin Investments Pty Ltd 23 Graham Hill Road, Narellen NSW 2567
Project Number:	81259.01
Project Name:	North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location:	Viney Creek Road, Tea Gardens
Work Request:	1876
Sample Number:	18-1876T
Date Sampled:	08/03/2018
Sampling Method:	Sampled by Engineering Department
Sample Location:	**201 (0.05m)**
Material:	Sandy Silt

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**8**		
Soil Description	-		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	26		

Material Test Report

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Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876U
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **203 (0.2m)**
Material: Sandy Clay

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Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	-		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	26		

Material Test Report

Report Number: **81259.01-1**
Issue Number: 1
Date Issued: 03/04/2018
Client: Wolin Investments Pty Ltd
23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876V
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **204 (0.1m)**
Material: Sandy Silt

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Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**8**		
Soil Description	-		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	26		

Material Test Report

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Issue Number: 1
Date Issued: 03/04/2018
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23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876W
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **206 (0.1m)**
Material: Sandy Silt

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	-		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	26		

Material Test Report

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Client:	Wolin Investments Pty Ltd 23 Graham Hill Road, Narellen NSW 2567
Project Number:	81259.01
Project Name:	North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location:	Viney Creek Road, Tea Gardens
Work Request:	1876
Sample Number:	18-1876X
Date Sampled:	08/03/2018
Sampling Method:	Sampled by Engineering Department
Sample Location:	**304 (0.25m)**
Material:	Clay

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	29.4

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	69		
Plastic Limit (%)	19		
Plasticity Index (%)	**50**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	14.0		
Cracking Crumbling Curling	Curling		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	-		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	26		

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23 Graham Hill Road, Narellen NSW 2567
Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876Y
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **310 (0.05m)**
Material: Sandy Silt

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**8**		
Soil Description	-		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	26		

Material Test Report

Report Number: **81259.01-1**
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Project Number: 81259.01
Project Name: North Shearwater Residemtial Subdivision, Stage 2 to 3
Project Location: Viney Creek Road, Tea Gardens
Work Request: 1876
Sample Number: 18-1876Z
Date Sampled: 08/03/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **313 (0.2m)**
Material: Clayey Silt

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Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	-		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	26		

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CERTIFICATE OF ANALYSIS 187303

Client Details

Client	Douglas Partners Newcastle
Attention	Joel Cowan
Address	Box 324 Hunter Region Mail Centre, Newcastle, NSW, 2310

Sample Details

Your Reference	**81259.01, Prop. North Shearwater Sub, Tea Gardens**
Number of Samples	23 Soil
Date samples received	15/03/2018
Date completed instructions received	15/03/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	22/03/2018
Date of Issue	22/03/2018

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Results Approved By
Dragana Tomas, Senior Chemist
Jeremy Faircloth, Organics Supervisor
Long Pham, Team Leader, Metals
Priya Samarawickrama, Senior Chemist

Authorised By

David Springer

David Springer, General Manager

vTRH(C6-C10)/BTEXN in Soil						
Our Reference		187303-1	187303-2	187303-14	187303-16	187303-23
Your Reference	UNITS	101	102	303	304	D1
Depth		0.5	1.0	0.05	0.05	-
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
TRH C_6 - C_9	mg/kg	<25	<25	<25	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	<25	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1	<1	<1
Total +ve Xylenes	mg/kg	<1	<1	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	102	98	97	97	100

svTRH (C10-C40) in Soil						
Our Reference		187303-1	187303-2	187303-14	187303-16	187303-23
Your Reference	UNITS	101	102	303	304	D1
Depth		0.5	1.0	0.05	0.05	-
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	17/03/2018	17/03/2018	17/03/2018	17/03/2018	17/03/2018
TRH C_{10} - C_{14}	mg/kg	<50	<50	<50	<50	<50
TRH C_{15} - C_{28}	mg/kg	<100	<100	<100	<100	<100
TRH C_{29} - C_{36}	mg/kg	<100	<100	<100	<100	<100
TRH >C_{10} -C_{16}	mg/kg	<50	<50	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50	<50	<50	<50	<50
TRH >C_{16} -C_{34}	mg/kg	<100	<100	<100	<100	<100
TRH >C_{34} -C_{40}	mg/kg	<100	<100	<100	<100	<100
Total +ve TRH (>C10-C40)	mg/kg	<50	<50	<50	<50	<50
Surrogate o-Terphenyl	%	84	86	83	85	84

PAHs in Soil						
Our Reference		187303-1	187303-2	187303-14	187303-16	187303-23
Your Reference	UNITS	101	102	303	304	D1
Depth		0.5	1.0	0.05	0.05	-
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Naphthalene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve PAH's	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Surrogate p-Terphenyl-d14	%	95	100	105	102	100

Organochlorine Pesticides in soil						
Our Reference		187303-1	187303-2	187303-4	187303-5	187303-7
Your Reference	UNITS	101	102	201	203	205
Depth		0.5	1.0	0.05	0.05	0.05
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
HCB	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	88	104	101	90	85

Organochlorine Pesticides in soil						
Our Reference		187303-10	187303-14	187303-16	187303-18	187303-23
Your Reference	UNITS	210	303	304	310	D1
Depth		0.05	0.05	0.05	0.05	-
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
HCB	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	87	100	89	98	101

Organophosphorus Pesticides						
Our Reference		187303-1	187303-2	187303-4	187303-5	187303-7
Your Reference	UNITS	101	102	201	203	205
Depth		0.5	1.0	0.05	0.05	0.05
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Azinphos-methyl (Guthion)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Bromophos-ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyriphos	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyriphos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Parathion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ronnel	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	88	104	101	90	85

Organophosphorus Pesticides						
Our Reference		187303-10	187303-14	187303-16	187303-18	187303-23
Your Reference	UNITS	210	303	304	310	D1
Depth		0.05	0.05	0.05	0.05	-
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Azinphos-methyl (Guthion)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Bromophos-ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyriphos	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyriphos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Parathion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ronnel	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	87	100	89	98	101

PCBs in Soil						
Our Reference		187303-1	187303-2	187303-14	187303-16	187303-23
Your Reference	UNITS	101	102	303	304	D1
Depth		0.5	1.0	0.05	0.05	-
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Aroclor 1016	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1221	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1232	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1242	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1248	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1254	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1260	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCLMX	%	88	104	100	89	101

Acid Extractable metals in soil						
Our Reference		187303-1	187303-2	187303-4	187303-5	187303-7
Your Reference	UNITS	101	102	201	203	205
Depth		0.5	1.0	0.05	0.05	0.05
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Arsenic	mg/kg	<4	<4	<4	<4	<4
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	3	3	2	2	1
Copper	mg/kg	<1	2	1	4	1
Lead	mg/kg	10	9	6	6	2
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	<1	1	1	<1	<1
Zinc	mg/kg	2	7	6	12	6

Acid Extractable metals in soil						
Our Reference		187303-10	187303-14	187303-16	187303-18	187303-23
Your Reference	UNITS	210	303	304	310	D1
Depth		0.05	0.05	0.05	0.05	-
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Arsenic	mg/kg	<4	<4	<4	<4	<4
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	1	5	3	3	7
Copper	mg/kg	<1	<1	<1	<1	2
Lead	mg/kg	8	15	14	9	18
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	<1	2	<1	<1	2
Zinc	mg/kg	5	14	7	5	15

Moisture						
Our Reference		187303-1	187303-2	187303-4	187303-5	187303-7
Your Reference	UNITS	101	102	201	203	205
Depth		0.5	1.0	0.05	0.05	0.05
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	19/03/2018	19/03/2018	19/03/2018	19/03/2018	19/03/2018
Moisture	%	8.3	10	10	10	9.0

Moisture						
Our Reference		187303-10	187303-14	187303-16	187303-18	187303-23
Your Reference	UNITS	210	303	304	310	D1
Depth		0.05	0.05	0.05	0.05	-
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	16/03/2018	16/03/2018	16/03/2018	16/03/2018	16/03/2018
Date analysed	-	19/03/2018	19/03/2018	19/03/2018	19/03/2018	19/03/2018
Moisture	%	8.1	13	13	15	14

Misc Inorg - Soil						
Our Reference		187303-3	187303-4	187303-5	187303-6	187303-7
Your Reference	UNITS	107	201	203	203	205
Depth		0.4	0.05	0.05	0.2	0.05
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	20/03/2018	20/03/2018	20/03/2018	20/03/2018	20/03/2018
Date analysed	-	20/03/2018	20/03/2018	20/03/2018	20/03/2018	20/03/2018
Electrical Conductivity 1:5 soil:water	µS/cm	30	38	120	35	54

Misc Inorg - Soil						
Our Reference		187303-8	187303-9	187303-10	187303-11	187303-12
Your Reference	UNITS	205	207	210	210	211
Depth		0.2	0.1	0.05	0.25	0.2-0.6
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	20/03/2018	20/03/2018	20/03/2018	20/03/2018	20/03/2018
Date analysed	-	20/03/2018	20/03/2018	20/03/2018	20/03/2018	20/03/2018
Electrical Conductivity 1:5 soil:water	µS/cm	22	73	210	150	38

Misc Inorg - Soil						
Our Reference		187303-13	187303-14	187303-15	187303-16	187303-17
Your Reference	UNITS	213	303	303	304	304
Depth		0.2	0.05	0.15	0.05	0.25
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	20/03/2018	20/03/2018	20/03/2018	20/03/2018	20/03/2018
Date analysed	-	20/03/2018	20/03/2018	20/03/2018	20/03/2018	20/03/2018
Electrical Conductivity 1:5 soil:water	µS/cm	54	57	56	46	76

Misc Inorg - Soil						
Our Reference		187303-18	187303-19	187303-20	187303-21	187303-22
Your Reference	UNITS	310	310	312	313	314
Depth		0.05	0.15	0.7-1.0	0.2	0.5-0.7
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	20/03/2018	20/03/2018	20/03/2018	20/03/2018	20/03/2018
Date analysed	-	20/03/2018	20/03/2018	20/03/2018	20/03/2018	20/03/2018
Electrical Conductivity 1:5 soil:water	µS/cm	54	25	510	31	330

ESP/CEC						
Our Reference		187303-5	187303-6	187303-12	187303-14	187303-15
Your Reference	UNITS	203	203	211	303	303
Depth		0.05	0.2	0.2-0.6	0.05	0.15
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/03/2018	19/03/2018	19/03/2018	19/03/2018	19/03/2018
Date analysed	-	19/03/2018	19/03/2018	19/03/2018	19/03/2018	19/03/2018
Exchangeable Ca	meq/100g	4.8	0.9	1.3	2.4	2.0
Exchangeable K	meq/100g	0.4	0.1	0.2	0.3	0.2
Exchangeable Mg	meq/100g	1.8	3.2	3.7	1.9	8.1
Exchangeable Na	meq/100g	<0.1	0.17	0.19	0.12	0.80
Cation Exchange Capacity	meq/100g	7.1	4.4	5.4	4.8	11
ESP	%	[NT]	4	3	3	7

ESP/CEC						
Our Reference		187303-16	187303-17	187303-18	187303-19	187303-20
Your Reference	UNITS	304	304	310	310	312
Depth		0.05	0.25	0.05	0.15	0.7-1.0
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/03/2018	19/03/2018	19/03/2018	19/03/2018	19/03/2018
Date analysed	-	19/03/2018	19/03/2018	19/03/2018	19/03/2018	19/03/2018
Exchangeable Ca	meq/100g	1.3	1.4	1.3	0.6	1.1
Exchangeable K	meq/100g	0.2	0.3	0.2	<0.1	<0.1
Exchangeable Mg	meq/100g	1.3	6.3	1.0	0.55	2.7
Exchangeable Na	meq/100g	0.12	0.73	<0.1	<0.1	0.82
Cation Exchange Capacity	meq/100g	2.9	8.7	2.5	1.3	4.8
ESP	%	4	8	[NT]	[NT]	17

Method ID	Methodology Summary
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
Metals-009	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's. Note, the Total +ve reported DDD+DDE+DDT PQL is reflective of the lowest individual PQL and is therefore simply a sum of the positive individually report DDD+DDE+DDT.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD. Note, the Total +ve PCBs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PCBs" is simply a sum of the positive individual PCBs.
Org-008	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.

Method ID	Methodology Summary
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013. For soil results:- 1. 'EQ PQL'values are assuming all contributing PAHs reported as <PQL are actually at the PQL. This is the most conservative approach and can give false positive TEQs given that PAHs that contribute to the TEQ calculation may not be present. 2. 'EQ zero'values are assuming all contributing PAHs reported as <PQL are zero. This is the least conservative approach and is more susceptible to false negative TEQs when PAHs that contribute to the TEQ calculation are present but below PQL. 3. 'EQ half PQL'values are assuming all contributing PAHs reported as <PQL are half the stipulated PQL. Hence a mid-point between the most and least conservative approaches above. Note, the Total +ve PAHs PQL is reflective of the lowest individual PQL and is therefore "Total +ve PAHs" is simply a sum of the positive individual PAHs.
Org-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	[NT]
Date extracted	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
Date analysed	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
TRH C_6 - C_9	mg/kg	25	Org-016	<25	1	<25	<25	0	90	[NT]
TRH C_6 - C_{10}	mg/kg	25	Org-016	<25	1	<25	<25	0	90	[NT]
Benzene	mg/kg	0.2	Org-016	<0.2	1	<0.2	<0.2	0	80	[NT]
Toluene	mg/kg	0.5	Org-016	<0.5	1	<0.5	<0.5	0	88	[NT]
Ethylbenzene	mg/kg	1	Org-016	<1	1	<1	<1	0	92	[NT]
m+p-xylene	mg/kg	2	Org-016	<2	1	<2	<2	0	95	[NT]
o-Xylene	mg/kg	1	Org-016	<1	1	<1	<1	0	92	[NT]
naphthalene	mg/kg	1	Org-014	<1	1	<1	<1	0	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-016	101	1	102	89	14	102	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
Date analysed	-			17/03/2018	1	17/03/2018	17/03/2018		17/03/2018	[NT]
TRH C_{10} - C_{14}	mg/kg	50	Org-003	<50	1	<50	<50	0	110	[NT]
TRH C_{15} - C_{28}	mg/kg	100	Org-003	<100	1	<100	<100	0	97	[NT]
TRH C_{29} - C_{36}	mg/kg	100	Org-003	<100	1	<100	<100	0	108	[NT]
TRH >C_{10} -C_{16}	mg/kg	50	Org-003	<50	1	<50	<50	0	110	[NT]
TRH >C_{16} -C_{34}	mg/kg	100	Org-003	<100	1	<100	<100	0	97	[NT]
TRH >C_{34} -C_{40}	mg/kg	100	Org-003	<100	1	<100	<100	0	108	[NT]
Surrogate o-Terphenyl	%		Org-003	88	1	84	84	0	96	[NT]

QUALITY CONTROL: PAHs in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
Date analysed	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
Naphthalene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	97	[NT]
Acenaphthylene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Acenaphthene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Fluorene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	95	[NT]
Phenanthrene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	101	[NT]
Anthracene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Fluoranthene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	94	[NT]
Pyrene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	99	[NT]
Benzo(a)anthracene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Chrysene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	103	[NT]
Benzo(b,j+k)fluoranthene	mg/kg	0.2	Org-012	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Benzo(a)pyrene	mg/kg	0.05	Org-012	<0.05	1	<0.05	<0.05	0	107	[NT]
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	100	1	95	99	4	118	[NT]

Client Reference: 81259.01, Prop. North Shearwater Sub, Tea Gardens

QUALITY CONTROL: Organochlorine Pesticides in soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
Date analysed	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
HCB	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	113	[NT]
gamma-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
beta-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	108	[NT]
Heptachlor	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	90	[NT]
delta-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aldrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	110	[NT]
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	112	[NT]
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
pp-DDE	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	116	[NT]
Dieldrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	124	[NT]
Endrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	105	[NT]
pp-DDD	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	92	[NT]
Endosulfan II	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
pp-DDT	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	120	[NT]
Methoxychlor	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCMX	%		Org-005	109	1	88	106	19	100	[NT]

QUALITY CONTROL: Organophosphorus Pesticides					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
Date analysed	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
Azinphos-methyl (Guthion)	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Bromophos-ethyl	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Chlorpyriphos	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	90	[NT]
Chlorpyriphos-methyl	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Diazinon	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Dichlorvos	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	83	[NT]
Dimethoate	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Ethion	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	91	[NT]
Fenitrothion	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	98	[NT]
Malathion	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	101	[NT]
Parathion	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	113	[NT]
Ronnel	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	97	[NT]
Surrogate TCMX	%		Org-008	109	1	88	106	19	104	[NT]

QUALITY CONTROL: PCBs in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
Date analysed	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
Aroclor 1016	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1221	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1232	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1242	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1248	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1254	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	101	[NT]
Aroclor 1260	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCLMX	%		Org-006	109	1	88	106	19	104	[NT]

QUALITY CONTROL: Acid Extractable metals in soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date prepared	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
Date analysed	-			16/03/2018	1	16/03/2018	16/03/2018		16/03/2018	[NT]
Arsenic	mg/kg	4	Metals-020	<4	1	<4	<4	0	101	[NT]
Cadmium	mg/kg	0.4	Metals-020	<0.4	1	<0.4	<0.4	0	93	[NT]
Chromium	mg/kg	1	Metals-020	<1	1	3	3	0	102	[NT]
Copper	mg/kg	1	Metals-020	<1	1	<1	<1	0	110	[NT]
Lead	mg/kg	1	Metals-020	<1	1	10	13	26	96	[NT]
Mercury	mg/kg	0.1	Metals-021	<0.1	1	<0.1	<0.1	0	102	[NT]
Nickel	mg/kg	1	Metals-020	<1	1	<1	<1	0	98	[NT]
Zinc	mg/kg	1	Metals-020	<1	1	2	2	0	93	[NT]

QUALITY CONTROL: Acid Extractable metals in soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-5	[NT]
Date prepared	-			[NT]	[NT]	[NT]	[NT]	[NT]	16/03/2018	[NT]
Date analysed	-			[NT]	[NT]	[NT]	[NT]	[NT]	16/03/2018	[NT]
Arsenic	mg/kg	4	Metals-020	[NT]	[NT]	[NT]	[NT]	[NT]	104	[NT]
Cadmium	mg/kg	0.4	Metals-020	[NT]	[NT]	[NT]	[NT]	[NT]	96	[NT]
Chromium	mg/kg	1	Metals-020	[NT]	[NT]	[NT]	[NT]	[NT]	105	[NT]
Copper	mg/kg	1	Metals-020	[NT]	[NT]	[NT]	[NT]	[NT]	113	[NT]
Lead	mg/kg	1	Metals-020	[NT]	[NT]	[NT]	[NT]	[NT]	98	[NT]
Mercury	mg/kg	0.1	Metals-021	[NT]	[NT]	[NT]	[NT]	[NT]	98	[NT]
Nickel	mg/kg	1	Metals-020	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
Zinc	mg/kg	1	Metals-020	[NT]	[NT]	[NT]	[NT]	[NT]	95	[NT]

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	[NT]
Date prepared	-			20/03/2018	13	20/03/2018	20/03/2018		20/03/2018	[NT]
Date analysed	-			20/03/2018	13	20/03/2018	20/03/2018		20/03/2018	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	13	54	56	4	95	[NT]

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	3	20/03/2018	20/03/2018		[NT]	[NT]
Date analysed	-			[NT]	3	20/03/2018	20/03/2018		[NT]	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	3	30	33	10	[NT]	[NT]

QUALITY CONTROL: ESP/CEC					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	[NT]
Date prepared	-			19/03/2018	5	19/03/2018	19/03/2018		19/03/2018	[NT]
Date analysed	-			19/03/2018	5	19/03/2018	19/03/2018		19/03/2018	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-009	<0.1	5	4.8	4.6	4	94	[NT]
Exchangeable K	meq/100g	0.1	Metals-009	<0.1	5	0.4	0.4	0	105	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-009	<0.1	5	1.8	1.7	6	93	[NT]
Exchangeable Na	meq/100g	0.1	Metals-009	<0.1	5	<0.1	<0.1	0	95	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

ESP: Where the exchangeable Sodium is less than the PQL and CEC is less than 10meq/100g, the ESP cannot be calculated.

Appendix D

Quality Assurance / Quality Control Report
Chain of Custody Sheets (Field and Despatch)
Sample Receipts

Quality Assurance/Quality Control Report

Geotechnical, Preliminary Site Investigation (Contamination) and Salinity Investigation

Proposed North Shearwater Residential Subdivision – Stage 2 and 3

Off Viney Creek Road, Tea Gardens

Quality Assurance (QA) was maintained by:

- Compliance with a Project Quality Plan written for the objectives of the study;
- Using qualified engineers/scientists to undertake the field supervision and sampling;
- Following the Douglas Partners Pty Ltd (DP) operating procedures for sampling, field testing and decontamination as presented in Table D1;
- Using NATA registered laboratories for sample testing that generally utilise standard laboratory methods of the US EPA, the APHA and NSW EPA.

Table D1: Field Procedures

Abbreviation	Procedure Name
FPM LOG	Logging
FPM DECONT	Decontamination of Personnel and Equipment
FPM ENVID	Sample Identification, Handling, Transport and Storage of Contamination Samples
FPM PIDETC	Operation of Field Analysers
FPM ENVSAMP	Sampling of Contaminated Soils

Notes: From DP Field Procedures Manual

Quality Control (QC) of the laboratory programme was achieved by the following means:

- Check replicate - a specific sample was split in the field, placed in separate containers and labelled with different sample numbers, and sent to the laboratory for analysis;
- Method blanks - the laboratory ran reagent blanks to confirm the equipment and standards used were uncontaminated;
- Laboratory replicates - the laboratory split samples internally and conducted tests on separate extracts;
- Laboratory spikes - samples were spiked by the laboratory with a known concentration of contaminants and subsequently tested for percent recovery;

Discussion

A. Check Replicate

The Relative Percent Difference (RPD) between replicate results is used as a measure of laboratory reproducibility and is given by the following:

$$\mathrm{RPD} = \frac{\mathrm{ABS}(\mathrm{Replicate\,result\,1} - \mathrm{Replicate\,result\,2})}{(\mathrm{Replicate\,result\,1} + \mathrm{Replicate\,result\,2})/2} \; x\,100$$

The RPD can have a value between 0% and 200%. An RPD data quality objective of up to 50% is generally considered to be acceptable for organic analysis, and 35% for inorganics (i.e. Metals).

A summary of the results of the soil replicate QA/QC testing is provided in Table D2.

Table D2: Results of Quality Control Analysis

Analyte		303/0.05	D1	RPD (%)
Metals	**As**	<4	<4	N/A
	Cd	<0.4	<0.4	N/A
	Cr	5	7	**33**
	Cu	<1	2	N/A
	Pb	15	18	18
	Hg	<0.1	<0.1	N/A
	Ni	2	2	0
	Zn	14	15	7
TRH	**C_6 - C_9**	<25	<25	N/A
	C_{10} - C_{14}	<50	<50	N/A
	C_{15} - C_{28}	<100	<100	N/A
	C_{29} - C_{36}	<100	<100	N/A
	C_6 - C_{10}	<25	<25	N/A
	$>C_{10}$ - C_{16}	<50	<50	N/A
	$>C_{16}$ - C_{34}	<100	<100	N/A
	$>C_{34}$ - C_{40}	<100	<100	N/A
BTEX	**Benzene**	<0.2	<0.2	N/A
	Toluene	<0.5	<0.5	N/A
	Ethyl Benzene	<1	<1	N/A
	Xylene	<3	<3	N/A
PAH	**Total**	<0.05	<0.05	N/A
	Benzo(a)pyrene	<0.05	<0.05	N/A
OCPs	**Total OCP**	<0.1	<0.1	N/A
	Aldrin + Dieldrin	<0.1	<0.1	N/A
	Chlordane	<0.1	<0.1	N/A
	DDT+DDE+DDD	<0.1	<0.1	N/A
	Endosulphan	<0.1	<0.1	N/A
	Endrin	<0.1	<0.1	N/A
	Heptachlor	<0.1	<0.1	N/A
	HCB	<0.1	<0.1	N/A
	Methoxychlor	<0.1	<0.1	N/A
OPPs	**Total OPP**	<0.1	<0.1	N/A
	Chlorpyrifos	<0.1	<0.1	N/A
PCBs	**Total PCB**	<0.1	<0.1	N/A

Notes to Table D2:

Results expressed in mg/kg on dry weight basis

N/A - Not Applicable

Slightly elevated RPDs were found for chromium: The elevated RPDs may be attributed to relatively low concentrations, which result in high RPDs.

B. Method Blanks

All method blanks returned results lower than the laboratory detection limit, therefore are acceptable.

C. Laboratory Duplicates

The average RPD for individual contaminants ranges from 0% to 26%, with the all of RPDs within laboratory control limits. The results are therefore considered to be acceptable.

D. Laboratory Spikes

Recoveries in the order of 70% to 130% are generally considered to be acceptable for inorganic material and 60% to 140% for organic material. The results for this assessment are within the quality control objectives. The results should however be qualified and may slightly under-estimate or over-estimate contaminant concentrations in certain samples (ie biased low or high respectively).

Conclusions

In summary, while some slightly elevated results were found, they can be attributed to the relatively low concentration of contaminants.

The accuracy and precision of the soil testing procedures, as inferred by the laboratory QA/QC data is considered to be of sufficient standard to allow the data reported to be used in interpret site contamination conditions.

Douglas Partners
Geotechnics / Environment / Groundwater

CHAIN OF CUSTODY FIELD SHEE

Project No: 81254.01
Client Project Name: Proposed Northshearwater Residential Subdivision
Client: Wolin Investments
Location: Tea Gardens
Project Manager: Joel Cowen
DP Lab Received By: JKL Date: 8/3/18
Do samples contain 'potential' HBM? Yes ☐ No ✓ (If YES, then handle, transport and store in accordance with FPM HAZID)

Field									**DP Lab**	**For Despatch to**			**Notes**
Sample ID	Depth (m)	Duplicate Sample	Sample Type	Container Type	ASS Samples	Sampling			Storage Locn *	Lab 1 ^{A}	Lab 2 ^{B}	Lab 3 ^{C}	
			S - soil W - water	G - glass P - plastic		By	Date	Time		Date	Date	Date	
101	0.05		S	G/P		JKL	7/3/18						
	0.5									✓			
	1.1												
102	1.0									✓			
	2.0												
209	0.05									✓			
203	0.05									✓			
	0.2									✓			
205	0.05									✓			
	0.2									✓			
210	0.05									✓			
	0.25									✓			
303	0.05	D1					8/3/18			✓			
	0.15									✓			
304	0.05									✓			
	0.25									✓			

* **Default storage: glass containers in fridge, plastic containers shelved, ASS in freezer, water samples in fridge**

A Provide name of Lab 1 Envirolab

B Provide name of Lab 2

C Provide name of Lab 3

Douglas Partners
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CHAIN OF CUSTODY FIELD SHEET

Project No: 81259-01

Client Project Name:

Client:

Location:

Project Manager:

DP Lab Received By: Date:

Do samples contain 'potential' HBM? Yes ☐ No ☐ (If YES, then handle, transport and store in accordance with FPM HAZID)

Field									DP Lab	For Despatch to			Notes
Sample ID	Depth (m)	Duplicate Sample	Sample Type S - soil W - water	Container Type G - glass P - plastic	ASS Samples	Sampling			Storage Locn *	Lab 1 [A]	Lab 2 [B]	Lab 3 [C]	
						By	Date	Time		Date	Date	Date	
310	0.05		S	G/P		JKC	8/3/18			✓			
	0.15		S	G/P		JKC	↓			✓			

*** Default storage: glass containers in fridge, plastic containers shelved, ASS in freezer, water samples in fridge**

A Provide name of Lab 1

B Provide name of Lab 2

C Provide name of Lab 3

Douglas Partners
Geotechnics / Environment / Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project No: 81259.01
Suburb: Tea Gardens
To: Envirolab
Project Name: Proposed North Shearwater Subdivision
Order Number 136434
Project Manager: Joel Cowan
Sampler: Joel Cowan
Attn: Simon Song
Emails: joel.cowan@douglaspartners.com.au
Phone: (02) 9910 6200
Date Required: Same day ☐ 24 hours ☐ 48 hours ☐ 72 hours ☐ Standard ✓
Email: ssong@envirolab.com.au
Prior Storage: ☐ Esky ✓ Fridge ☐ Shelved
Do samples contain 'potential' HBM? Yes ☐ No ✓ (If YES, then handle, transport and store in accordance with FPM HAZID)

Sample ID	Lab ID	Date Sampled	Sample Type	Container Type	Analytes									Notes/preservation
			S - soil W - water	G - glass P - plastic	Combo 6	OCP	OPP	Metals (8)	CEC + ESP	EC				
101/0.5	1		S	G	X									
102/1.0	2		S	G	X									
107/0.4	3		S	P						X				
201/0.05	4		S	G		X	X	X		X				
203/0.05	5		S	G		X	X	X	X	X				
203/0.2	6		S	P					X	X				
205/0.05	7		S	G		X	X	X		X				
205/0.2	8		S	P						X				
207/0.1	9		S	P						X				
210/0.05	10		S	G		X	X	X		X				
210/0.25	11		S	P						X				
211/0.2-0.6	12		S	P					X	X				
213/0.2	13		S	P						X				
303/0.05	14		S	G	X				X	X				
303/0.15	15		S	P					X	X				
PQL (S) mg/kg														

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 187303
Date Received: 15.3.2018
Time Received: 10.45
Received by: R
Temp: [✓ Cool]/Ambient
Cooling: [✓ Ice]/Icepack
Security: [✓ Intact]/Broken/None
10.2

ANZECC PQLs req'd for all water analytes ☐
PQL = practical quantitation limit. If none given, default to Laboratory Method Detection Limit
Lab Report/Reference No:
Metals to Analyse: 8HM unless specified here:
Total number of samples in container: 23 **Relinquished by:** JRC **Transported to laboratory by:** TNT
Send Results to: Douglas Partners Pty Ltd **Address:** **Phone:** **Fax:**
Signed: **Received by:** **Date & Time:** 15/3/2018 10.45

Douglas Partners
Geotechnics / Environment / Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project No:	81259.01	**Suburb:**	Tea Gardens	**To:**	Envirolab
Project Name:	Proposed North Shearwater Subdivision	**Order Number**	136434		
Project Manager:	Joel Cowan	**Sampler:**	Joel Cowan	**Attn:**	Simon Song
Emails:	joel.cowan@douglaspartners.com.au			**Phone:**	(02) 9910 6200
Date Required:	Same day ☐ 24 hours ☐ 48 hours ☐ 72 hours ☐ Standard ✓			**Email:**	ssong@envirolab.com.au

Prior Storage: ☐ Esky ✓ Fridge ☐ Shelved · Do samples contain 'potential' HBM? Yes ☐ No ✓ (If YES, then handle, transport and store in accordance with FPM HAZID)

Sample ID	Lab ID 187302	Sampling Date	Sample Type	Container Type	Analytes									Notes/preservation
			S - soil W - water	G - glass P - plastic	Combo 6	OCP	OPP	Metals (8)	CEC + ESP	EC				
304/0.05	16		S	G	X				X	X				
304/0.25	17		S	G					X	X				
310/0.05	18		S	G		X	X	X	X	X				
310/0.15	19		S	P					X	X				
312/0.7-1.0	20		S	P					X	X				
313/0.2	21		S	P						X				
314/0.5-0.7	22		S	P						X				
D1	23		S	G	X									
PQL (S) mg/kg												**ANZECC PQLs req'd for all water analytes** ☐		

PQL = practical quantitation limit. If none given, default to Laboratory Method Detection Limit

Metals to Analyse: 8HM unless specified here:

Lab Report/Reference No:

Total number of samples in container: - --- **Relinquished by:** JRC— **Transported to laboratory by:** TNT

Send Results to: Douglas Partners Pty Ltd **Address:** **Phone:** **Fax:**

Signed: **Received by:** **Date & Time:** 15/3/2018

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details

Client	Douglas Partners Newcastle
Attention	Joel Cowan

Sample Login Details

Your reference	81259.01, Prop. North Shearwater Sub, Tea Gardens
Envirolab Reference	187303
Date Sample Received	15/03/2018
Date Instructions Received	15/03/2018
Date Results Expected to be Reported	22/03/2018

Sample Condition

Samples received in appropriate condition for analysis	YES
No. of Samples Provided	23 Soil
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	10.2
Cooling Method	Ice
Sampling Date Provided	YES

Comments

Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

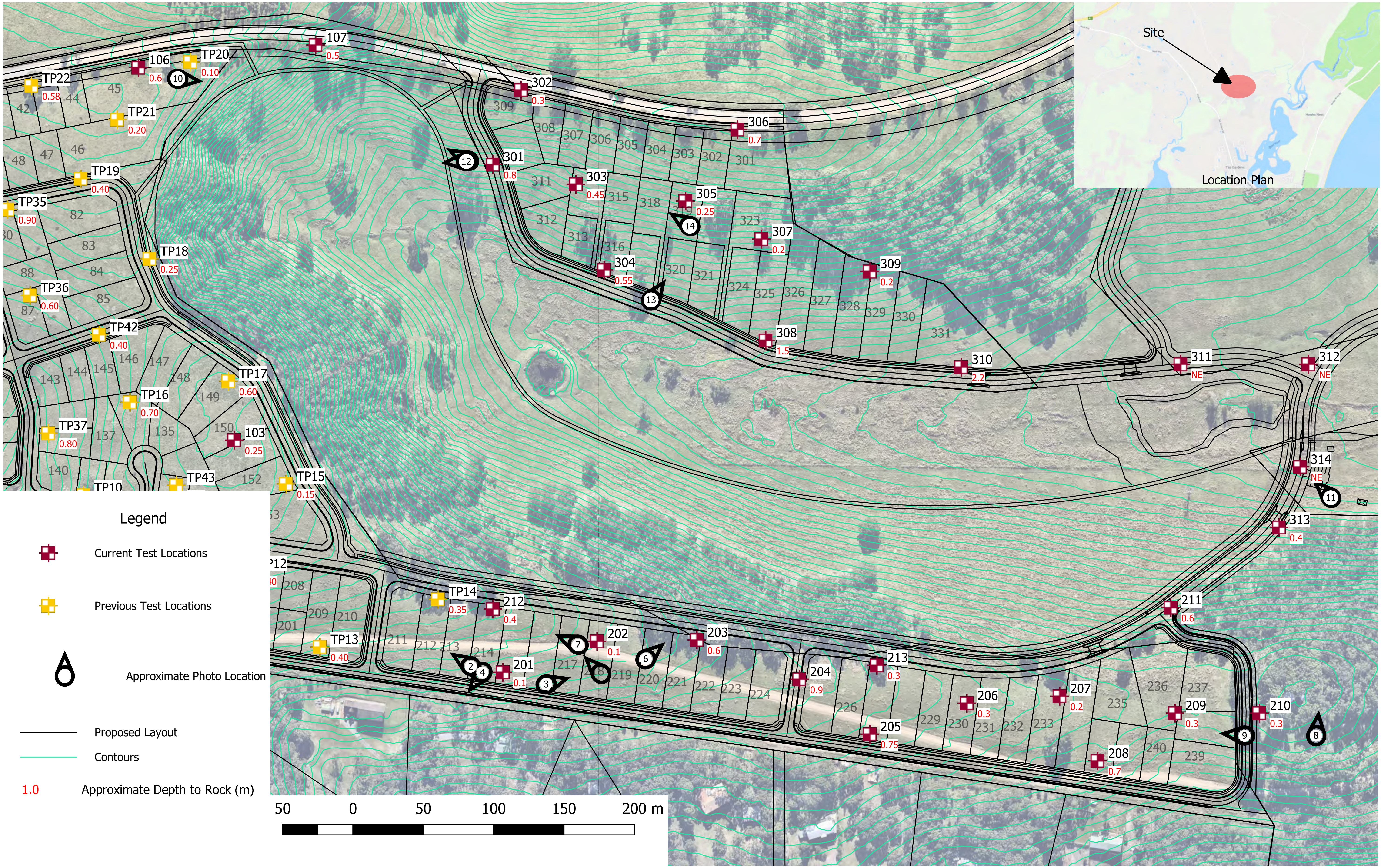
Sample ID	vTRH(C6-C10)/BTEXN in Soil	svTRH (C10-C40) in Soil	PAHs in Soil	Organochlorine Pesticidesin soil	Organophosphorus Pesticides	PCBsin Soil	Acid Extractable metalsin soil	Electrical Conductivity1:5 soil:water	ESP/CEC
101-0.5	✓	✓	✓	✓	✓	✓	✓		
102-1.0	✓	✓	✓	✓	✓	✓	✓		
107-0.4								✓	
201-0.05				✓	✓		✓	✓	
203-0.05				✓	✓		✓	✓	✓
203-0.2								✓	✓
205-0.05				✓	✓		✓	✓	
205-0.2								✓	
207-0.1								✓	
210-0.05				✓	✓		✓	✓	
210-0.25								✓	
211-0.2-0.6								✓	✓
213-0.2								✓	
303-0.05	✓	✓	✓	✓	✓	✓	✓	✓	✓
303-0.15								✓	✓
304-0.05	✓	✓	✓	✓	✓	✓	✓	✓	✓
304-0.25								✓	✓
310-0.05				✓	✓		✓	✓	✓
310-0.15								✓	✓
312-0.7-1.0								✓	✓
313-0.2								✓	
314-0.5-0.7								✓	
D1	✓	✓	✓	✓	✓	✓	✓		

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info
Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.

Appendix E

Drawing 3 – Test Location Plan
Drawing 4 – Roadway Designation and Approximate Rock Contour Level



Legend

🟥	Current Test Locations
🟨	Previous Test Locations
●	Approximate Photo Location
—	Proposed Layout
—	Contours
1.0	Approximate Depth to Rock (m)

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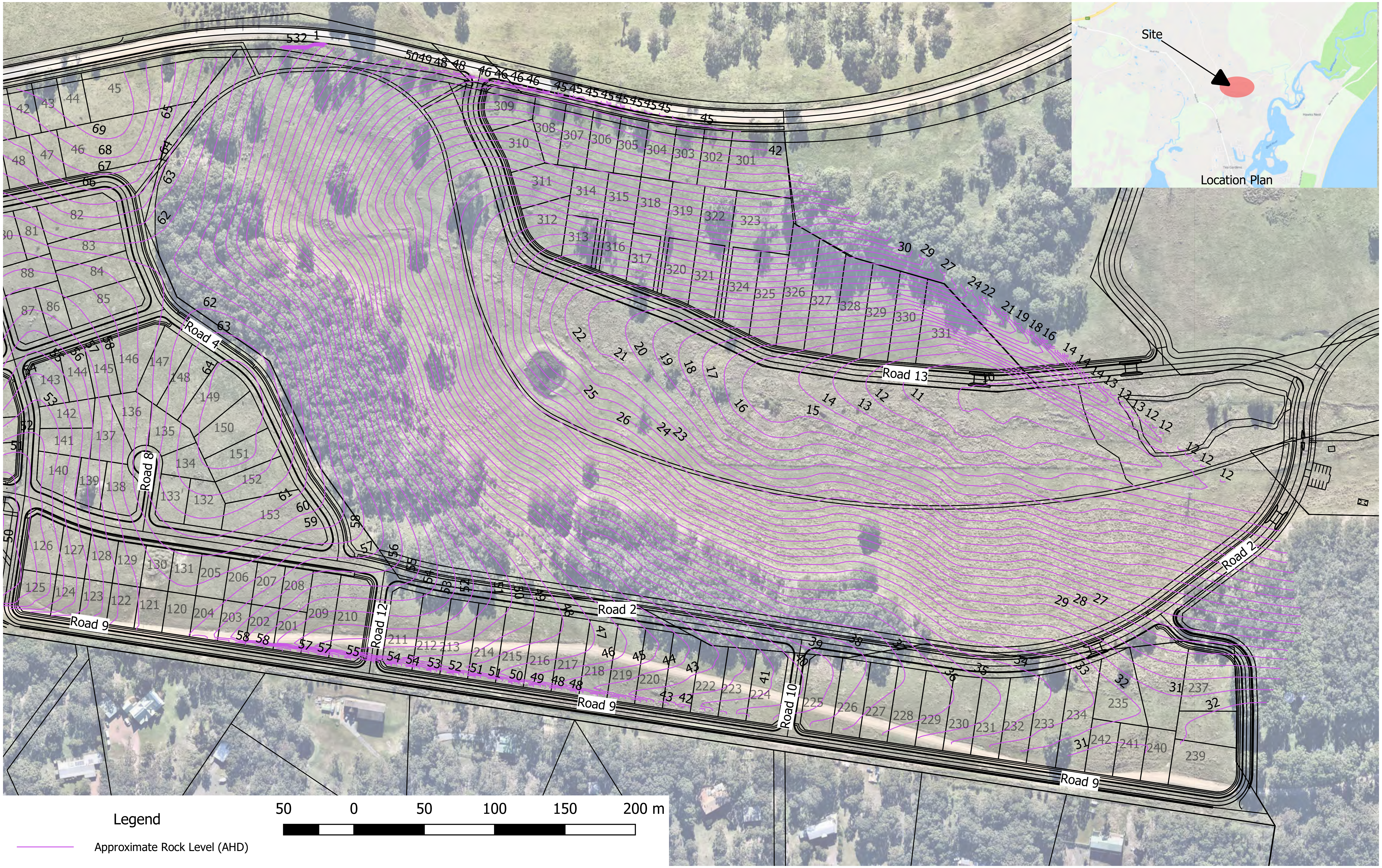
Geotechnics / Environment / Groundwater

CLIENT: Wolin Investments Pty Ltd
OFFICE: Newcastle
DRAWN BY: JRC
SCALE: 1:2,500 @ A3
DATE: 29-03-2018

TITLE: **Test Location Plan**
Proposed North Shearwater Residential Subdivision (Stages 2 and 3)
off Viney Creek Road, Tea Gardens

N

PROPOSAL: 81259.01
DRAWING No: 3
REVISION: 0



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CLIENT:	Wolin Investments Pty Ltd
OFFICE: Newcastle	DRAWN BY: JRC
SCALE: 1:2,500 @ A3	DATE: 29-03-2018

TITLE: **Road Designation and Approximate Rock Contour Level**
Proposed North Shearwater Residential Subdivision (Stages 2 and 3)
off Viney Creek Road, Tea Gardens

N

PROPOSAL:	81259.01
DRAWING No:	4
REVISION:	0