Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Groundwater Level Investigation

Proposed St Marys Freight Hub
2 Forrester Road, St Marys, NSW

Prepared for
Pacific National (NSW) Pty Ltd

Project 94525.00
March 2019

Douglas Partners
Geotechnics / Environment / Groundwater

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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		8 March 2019
Reviewer	pp CCK	8 March 2019

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1. Introduction

This report presents the results of a groundwater level investigation undertaken for the proposed St Marys Freight Hub at 2 Forrester Road, St Marys, NSW. The investigation was commissioned in an email dated 27 November 2018 by Mr Guy Evans of Urbanco for Pacific National (NSW) Pty Ltd and was undertaken in accordance with Douglas Partners' proposal NWS180083.P.002.Rev0 dated 21 November 2019.

The proposed St Marys Freight Hub is a State Significant Development under the provision of Schedule 1, Clause 19(1b) of the State Environmental Planning Policy - State and Regional Development 2011. The proposed development will comprise use of the existing rail infrastructure sidings, construction of hardstand areas, new internal access roads, wash bay, repair bay, office building, fuel storage area, container shed, transport shed, vehicle parking bays and reach stacker/forklift parking bays, and other ancillary development.

The purpose of this groundwater level investigation was to determine groundwater levels on-site and if the development will potentially intersect groundwater levels requiring approval from the relevant government authority.

The investigation was carried out concurrently with a Preliminary Site Contamination Investigation (PSI) for the site. The results are presented in a report dated 6 February 2019 (Project Reference 6 February 2019. This investigation included the monitoring of five groundwater wells, installed in the previous investigation, for an approximate two month period. The details of the field work are presented in this report, together with comments on groundwater levels.

2. Site Description

2.1 Site Identification

The site is located in the suburb of St Marys within the local government area of Penrith City Council ("Council") and is identified as:

- Part Lot 2 Deposited Plan (D.P.) 876781 (Lot 2 – approximately 9.95 ha of the site)
- Part Lot 2 and 3 in D.P. 876781 (Lot 3 – approximately 0.75 ha of the site); and
- Part Lot 196 in D.P. 31912 (Lot 196 – approximately 0.35 ha of the site).

The broader site (i.e. land owned by Pacific National) is identified as Lots 2 and 3 in D.P. 876781, Lot 196 in D.P. 31912, Lot 2 in D.P. 734445 and Lot 2031 in D.P. 815293.

The location and boundary of the site (and the broader site) are shown on Drawing 1, Appendix B.

2.2 Site Description

The site was vacant at the time of this PSI. The site generally consists of cleared land with exposed filled surfaces, with over-grown vegetation present in some parts. Multiple overhead transmission lines (high and low voltage) traverse the site. Multiple stockpiles of soil and construction material are present throughout the site.

2.3 Surrounding Landuse

Land use surrounding the site comprises the following:

- East: Industrial premises;
- West: The rail corridor beyond which is a vacant lot and South Creek. Recreational facilities (Colonial Golf and Foot Golf Course, Troy Adams Archery Field and Parkes Avenue/Sporting Complex) are present further west of South Creek;
- North: A sediment basin beyond which is Little Creek, a tributary of South Creek and vacant land; and
- South: T1 Great Western Railway Line and St Marys train station. Beyond the railway are residential areas and recreational facilities, including Penrith BMX Club, Blair Oval, St Marys Senior High School, St Mary's Tennis Court Clubhouse.

Surrounding land uses are shown on Drawing 1, Appendix B.

3. Site Environmental Setting

3.1 Site Topography

The NSW Department of Lands, Topographic Map of NSW with 2 m elevation contours dated April 2009 indicates that the site is located at an elevation of approximately 24 to 30 m relative to Australian Height Datum (AHD). The site is relatively flat with an overall topographic relief of approximately 6 m descending from the south to north.

3.2 Site Geology

Reference to the Geological Survey of NSW Department of Mineral Resources (1983) *Penrith 1:100,000 Geology Sheet* indicates that the site is underlain by fluvial sediment (geological code – "Qa1") of Quaternary geological period and Bringelly Shale (geological code – "Rwb") of Middle Triassic period of Wianamatta Group.

Bringelly Shale typically comprises interlayered siltstone/claystone with some fine to medium grained sandstone layers, which weather to a residual clay profile of medium to high plasticity. Quaternary Sediments are typically fluvial (stream deposited) soils comprising sands, silts and clays.

3.3 Soil Landscape

Reference to The *Penrith 1:100,000 Soil Landscape Series Sheet* indicates that the site is located near the boundary between the Blacktown and South Creek soil landscape groups. The southern portion of the site is underlain by Blacktown residual soil landscape (soil landscape code – "bt") whereas the north-north western portion of the site is underlain by South Creek alluvial soil landscape (soil landscape code – "sc").

The Blacktown soil landscape is characterised by gentle undulating rises on Wianamatta Group shales and Hawkesbury shales with slopes usually <5% and local relief to 30 m. Broad rounded crests and ridges with gently inclined slopes are common. The soils of this group are moderately reactive with a low fertility, poor soil drainage and highly plastic subsoil.

The South Creek soil landscape is characterised by floodplains, valley flats and drainage depressions of the channels (usually flat with incised channels) on the Cumberland Plain. The soils of this group are identified as erosion hazard and are prone to frequent flooding.

3.4 Hydrology

Little Creek is present immediately north of the site which discharges into South Creek located approximately 250 m west of the site. Surface water is anticipated to follow the topographical slope with some areas of the site expected to drain towards Little Creek.

3.5 Hydrogeology

A search of groundwater bore database maintained by Bureau of Meteorology, accessed on 30 January 2019 via Australian Groundwater Explorer, indicates that there is no registered groundwater bore within a 500 m distance from the site. However, 17 registered groundwater bores (GW 075076, GW 101259, GW 101262, GW 101266, GW 109584 to GW 109588 and GW 109829 to GW 109836) were identified within 1 km distance from the site.

These bores are located to the northeast, south and southeast of the site, and are registered for monitoring/test purposes. The depth of the bores ranged from 1.5 m to a maximum of 13.5 m. The standing water level in these bores ranged from 2.4 m to 7 m bgl. DP notes that adequate information on water bearing zone is not available for some of the bores.

4. Field Work Methods

The field work, carried out concurrently with the PSI, involved the following:

- Drilling of five, 150 mm diameter, bore holes (BH 101 to BH 105) on 4 and 5 December 2018 to a maximum depth of 10.5 m using a MC-T200 truck mounted drilling rig. Augering was carrying out utilising solid flight augers and a polycrystalline diamond compact (PDC) drill bit. It is noted that BH 105 was originally carried out at a location that was originally within the proposed development footprint, however, the footprint subsequently changed.
- Installation of a groundwater monitoring well, constructed of a 50 mm diameter PVC screen and casing, in each borehole following drilling. The screened section of each well was backfilled with a washed sand filter pack to approximately 0.5 m above the screened interval. A hydrated bentonite plug generally 0.5 m thick was placed above the sand filter pack, with the remaining bore annulus filled with soil cuttings. Monitoring well construction details are shown in the bore hole logs included in Appendix C.
- Surveying of each monitoring well was undertaken using a differential GPS with a typical accuracy of 20 mm.
- Development of each groundwater monitoring well occurred on 7 December 2018 by removing up to five well volumes of water from each well, or until the well went dry.
- Installation of data-logger in each well on 10 December 2018 and retrieved on 11 February 2019. The data-loggers, which measure the groundwater head of pressure above, detect variations in groundwater levels. It is noted that over this period that a sampling event occurred between 8 and 10 January 2019 which necessarily involved disturbance of groundwater levels in the wells.
- A barometric logger was also installed on-site to take atmospheric pressures at the surface so as to allow for a correction of water pressures of the data-loggers.
- Manual measurements of groundwater levels using a dip-meter were taken during on 10 December 2018, 8 January 2018 and 11 February 2018.

DP's PSI also included test pits and surface sampling, however, these results are generally not relevant to this investigation and are therefore not referenced in this report, except in drawings and the near-surface materials for the geological model for the site.

Monitoring well locations are shown on Drawings 2 and 3, Appendix B.

5. Field Work Results

5.1 Geological Results

The borehole logs are included in Appendix C, together with notes defining classification methods and descriptive terms.

Relatively uniform conditions were encountered across most of the site. The general strata across the site is summarised as follows:

- FILLING / TOPSOIL – Slightly silty sandy gravel topsoil filling with some vegetation and rootlets to a depth of 0.12 m at some locations.
- FILLING – Typically sandy gravel, gravelly sand or clayey gravel filling with inclusions of sand, sandstone and siltstone gravel, plastic, glass, concrete and brick fragments to depths ranging between 0.4 m and 3.5 m.
- NATURAL SOILS – Typically stiff to hard, brown silty clay or gravelly clay with traces of fine gravel with some silty sand layers.
- WEATHERED BEDROCK – Generally extremely low strength shale at depths of between 7.5 m and 10 m in BH 101, BH 102 and BH 104.

5.2 Groundwater Results

The results of manual groundwater records during the drilling of the boreholes and on 10 December 2018, 8 January 2018 and 11 February 2018 are summarised in Table 1.

Table 1: Results of Manual Groundwater Measurements

Borehole	Surface RL (mAHD)	Groundwater Level measured in borehole		Groundwater Level measured in standpipe					
		4/12/18 or 5/12/18		10 /12/18		8/1/19		11/2/19	
		Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)
101	29.3	NE	-	8.6	20.7	8.6	20.7	5.6	23.7
102	26.3	7.0	19.3	4.6	21.7	5.7	20.6	5.4	20.9
103	24.2	3.5	20.7	3.2	21.0	4.4	19.8	4.0	20.2
104	25.1	NE	-	3.5	21.6	4.4	20.7	4.3	20.8
105	23.1	6.7	16.4	5.2	17.9	6.5	16.6	6.3	16.8

Notes: NE = Not encountered

The range of groundwater measurements recorded in the wells are outlined in Table 2 (excluding periods where development or sampling occurred) with the full range of results, together with rainfall data obtained from the nearest Bureau of Meteorology Weather Station, plotted on Figure 1 (both on following page).

Table 2: Range of Groundwater Readings Recorded by Data-Loggers

Well	Surface RL	Lowest Recorded Groundwater RL (m AHD)		Highest Record Groundwater RL (m AHD)	
		Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)
101	29.3	5.3	24.0	4.9	24.4
102	26.3	4.9	21.4	4.6	21.7
103	24.2	3.5	20.7	3.1	21.1
104	25.1	3.7	21.4	3.4	21.7
105	23.1	6.4	16.7	6.2	16.9

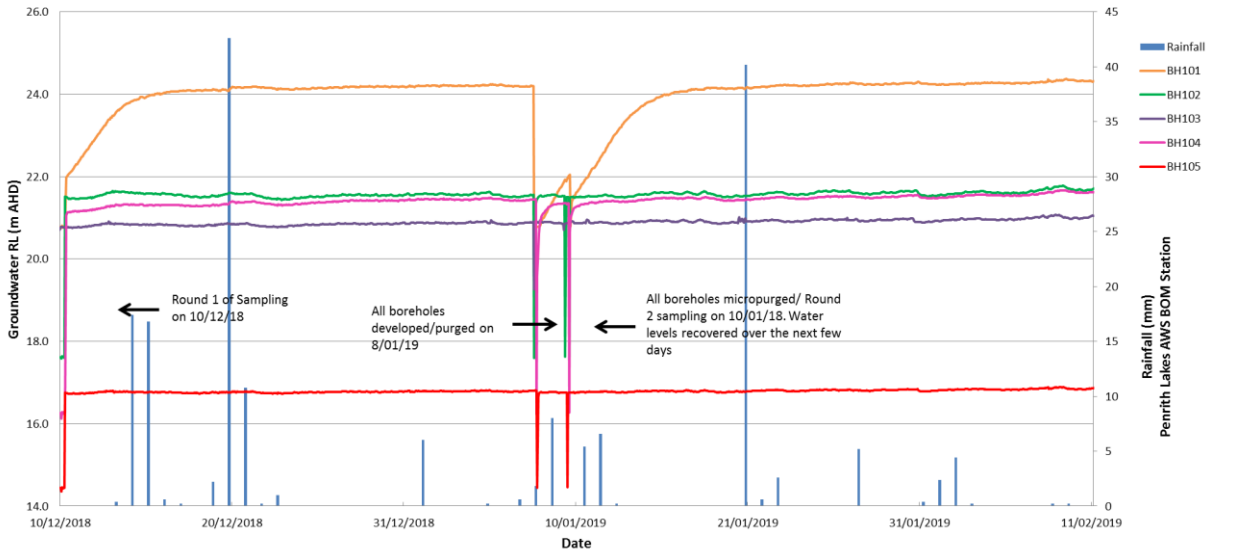

Figure 1: Results of Groundwater Data-logger Monitoring

The groundwater levels have generally been recorded within the natural clays, between approximately 1 m and 3 m above the soil/rock interface.

6. Proposed Development

The proposed development will comprise use of the existing rail infrastructure sidings, construction of hardstand areas, new internal access roads, wash bay, repair bay, office building, fuel storage area, container shed, transport shed, vehicle parking bays and reach stacker/forklift parking bays, and other ancillary development.

Construction works associated with proposed development are generally expected to be above-ground with most of the underground works comprising excavation for the installation of new services, new pavements, foundations and possibly some minor earthworks. These underground works are expected to generally be 1.5 to 2 m and potentially up to 3 m below existing surface levels. It is possible that deeper underground works may be installed for underground tanks and inspection pits and any other structures that could require a lower elevation to surface works for ongoing operation.

7. Discussion

The groundwater levels recorded by the data-loggers in the wells are considered the most reliable readings and indicate a general flow towards the creek lines to the north-west. This is shown on Figure 2 where the Reduced Levels (in m AHD) of the highest recorded groundwater levels are plotted and indicate that the highest reading is at BH 101 at RL 24.4 m AHD with the lowest reading at BH 105 at RL 16.9 m AHD. Wells in-between show a hydraulic gradient flow towards the north-west.

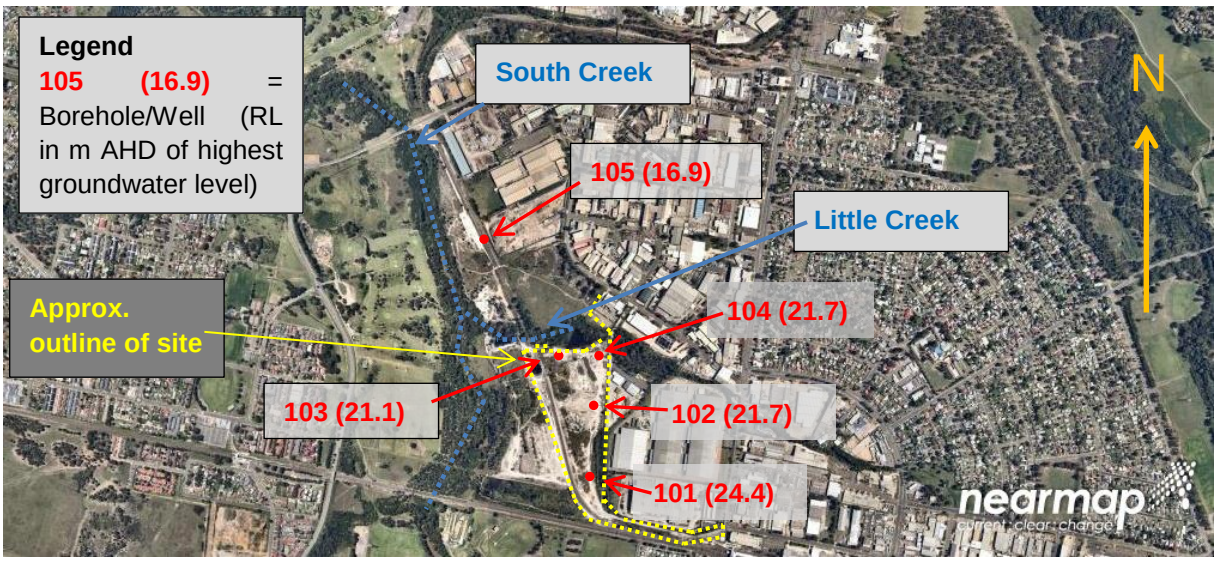

Figure 2: Groundwater Levels (Highest Recorded Data-logger readings)

8. Comments

Groundwater levels on-site have been recorded during this investigation generally at a depth of greater than 3 m below existing surface levels. These levels have been recorded to generally be consistent, however, could vary with changing climatic conditions or possible upgradient activities that could interfere with groundwater flows. Based on the levels recorded in DP's investigation, most of the proposed development is expected to be at levels above the recorded groundwater levels. Accordingly, most of the development is not expected to intersect or impact on existing groundwater flows or levels.

If some components of the development, such as underground water tanks or similar, are proposed to depths that may intersect the groundwater levels then the appropriate temporary and long-term approvals should be sought from the relevant government authority (currently Water NSW). Additional groundwater monitoring may be required at the specific locations where these deeper structures are proposed. Design and construction of structures likely to intersect groundwater must allow for the effects of groundwater flows and levels.

9. Limitations

Douglas Partners (DP) has prepared this report for this project at the proposed St Marys Freight Hub at 2 Forrester Road, St Marys, NSW in accordance with DP's proposal NWS180083.P.002.Rev0 dated 21 November 2018 and acceptance received from Mr Guy Evans of Urbanco, on behalf of Pacific National (NSW) Pty Ltd dated 27 November 2018. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Pacific National (NSW) Pty Ltd, and their agents, 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/or 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 and groundwater conditions across the site between and beyond the sampling and/or 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 notes 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 scope for work for this investigation/report did not include the assessment of groundwater for contaminants, within or adjacent to the site.

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 groundwater 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

About This Report

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.

Copyright

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

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

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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, 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.

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 Descriptions

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

Symbols & Abbreviations

Douglas Partners

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

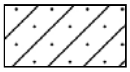
Soils


Topsoil

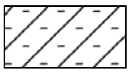

Peat


Clay

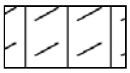

Silty clay

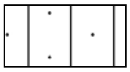

Sandy clay

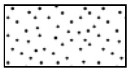

Gravelly clay

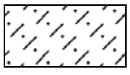

Shaly clay

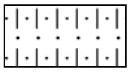

Silt


Clayey silt


Sandy silt

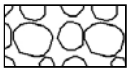

Sand

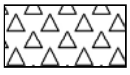

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

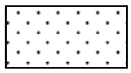

Talus

Sedimentary Rocks

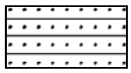

Boulder conglomerate

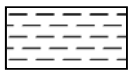

Conglomerate


Conglomeratic sandstone

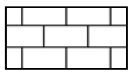

Sandstone


Siltstone


Laminite

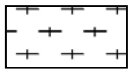

Mudstone, claystone, shale

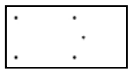

Coal


Limestone

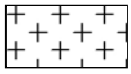
Metamorphic Rocks

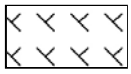

Slate, phyllite, schist

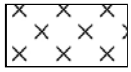

Gneiss

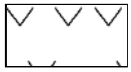

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite

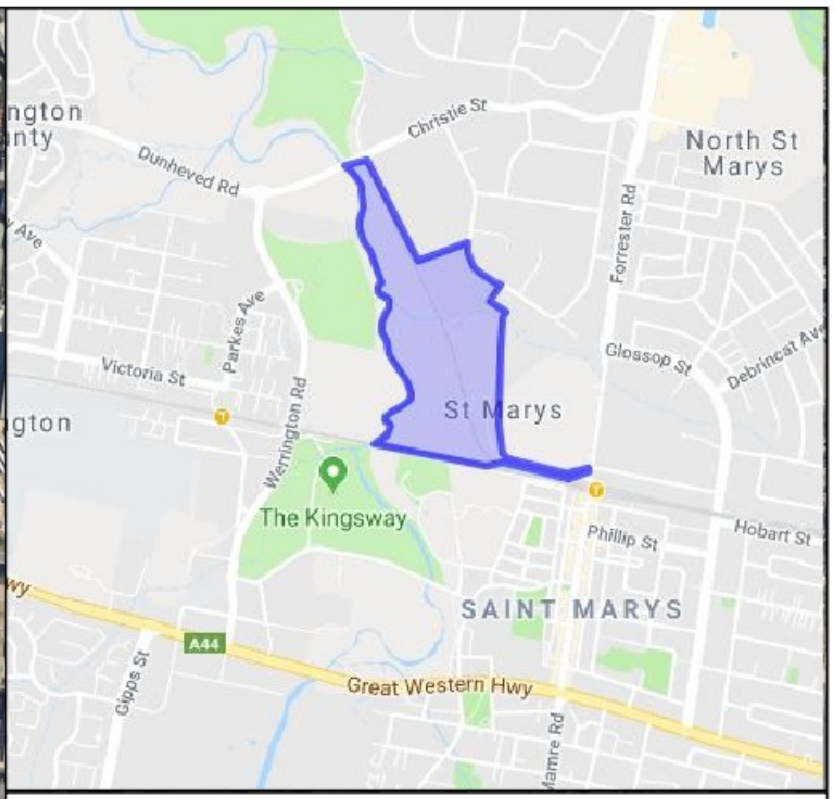

Dacite, epidote


Tuff, breccia


Porphyry

Appendix B

Drawings 1 to 3



Site Locality

Legend

- Site Boundary
- Broader Site Boundary
- Lot Boundary

Nearmap Aerial Photograph dated 29 December 2019

0 50 100 150 200 250 300 m

Douglas Partners
Geotechnics | Environment | Groundwater

TITLE: **Site Layout and Locality**
Groundwater Level Investigation
2 Forrester Rd, St Marys, NSW

N
MGA

OFFICE: Macarthur
DRAWN CKM
DATE: 28.2.19

CLIENT: Pacific National (NSW) Pty Ltd
PROJ. 94525.00
DRAWING No: 1
REVISION: 0
SCALE: As Shown

Douglas Partners Geotechnics / Environment / Groundwater	TITLE: Investigation Locations Groundwater Level Investigation 2 Forrester Rd, St Marys, NSW		N MGA	OFFICE: Macarthur DRAWN CKM DATE: 28.2.19
CLIENT: Pacific National (NSW) Pty Ltd	PROJ. 94525.00	DRAWING No: 2	REVISION: 0	SCALE: As Shown

Douglas Partners Geotechnics / Environment / Groundwater	TITLE: Investigation Locations Groundwater Level Investigation 2 Forrester Rd, St Marys, NSW		N MGA	OFFICE: Macarthur DRAWN CKM DATE: 28.2.19
CLIENT: Pacific National (NSW) Pty Ltd	PROJ. 94525.00	DRAWING No: 3	REVISION: 0	SCALE: As Shown

Appendix C

Results of Field Work

BOREHOLE LOG

CLIENT: Pacific National (NSW) Pty Ltd
PROJECT: Proposed St Marys Freight Hub
LOCATION: 2 Forrester Road, St Marys

SURFACE LEVEL: 29.2 mAHD
EASTING: 293487.5
NORTHING: 6262221.3
DIP/AZIMUTH: 90°/--

BORE No: BH/MW 101
PROJECT No: 94525.00
DATE: 5/12/2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
29	0	FILLING - brown, sandy gravel filling, humid. Sand is fine to medium grain and gravel is fine to coarse.		A/E	0.0 - 0.2		PID<1		1.05m Stick-up
				A/E	0.4 - 0.5		PID<1		
28	1	1.0m: becoming grey, gravelly sand		A/E	0.9 - 1.0		PID<1		
				A/E	1.4 - 1.5		PID<1		0-3.2m Backfill
27	2	2.0m: becoming brown, gravel fine to medium		A/E	1.9 - 2.0		PID<1		0-4.2m Casing
	2.2	FILLING - grey ripped siltstone filling, humid		A/E	2.4 - 2.5		PID<1		
26	3			A/E	2.9 - 3.0		PID<1		
	3.3	SILTY CLAY - stiff, brown, silty clay, damp		A/E	3.4 - 3.5		pp = 150		3.2-3.7m Bentonite
25	4	3.8m: becoming yellow-brown, stiff to very stiff		A/E	3.9 - 4.0		pp = 150		
24	5	5.5m: becoming brown							
23	6	6.0m: becoming brown mottled grey		A	5.9 - 6.0				3.7-9.2m Specialised Sand 4.2-9.2m Screen
22	7								
21	8	8.0m: very stiff		A	7.9 - 8.0		pp = 300		
20	9								
	10.0								

RIG: MC-T 200 **DRILLER:** Terratest **LOGGED:** JY **CASING:** PVC

TYPE OF BORING: 150mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Top casing elevation: 30.3 mAHD

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

BOREHOLE LOG

CLIENT: Pacific National (NSW) Pty Ltd
PROJECT: Proposed St Marys Freight Hub
LOCATION: 2 Forrester Road, St Marys

SURFACE LEVEL: 29.2 mAHD
EASTING: 293487.5
NORTHING: 6262221.3
DIP/AZIMUTH: 90°/--

BORE No: BH/MW 101
PROJECT No: 94525.00
DATE: 5/12/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
19		SHALE - extremely low strength, grey-brown shale							
	10.5	Bore discontinued at 10.5m							
18	11								
17	12								
16	13								
15	14								
14	15								
13	16								
12	17								
11	18								
10	19								

RIG: MC-T 200 **DRILLER:** Terratest **LOGGED:** JY **CASING:** PVC

TYPE OF BORING: 150mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Top casing elevation: 30.3 mAHD

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

BOREHOLE LOG

CLIENT: Pacific National (NSW) Pty Ltd
PROJECT: Proposed St Marys Freight Hub
LOCATION: 2 Forrester Road, St Marys

SURFACE LEVEL: 26.2 mAHD
EASTING: 293463.3
NORTHING: 6262472.6
DIP/AZIMUTH: 90°/--

BORE No: BH/MW 102
PROJECT No: 94525.00
DATE: 5/12/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
26	0	FILLING - brown-grey gravelly sand filling, humid							1.0m Stick-up
		0.5m: some gravel		E	0.9 1.0		PID<10		
25	1	1.2m: becoming grey		E	1.4 1.5		PID<10		
		1.8m: becoming light grey (possibly sandstone)		E	1.9 2.0		PID<10		0-4.0mSoil Backfill
24	2			E	2.4 2.5		PID<1		0-5.0m Casing
				E	2.9 3.0		PID<10		
23	3.2	SILTY CLAY - red-brown mottled grey silty clay, damp (possibly filling)		E	3.4 3.5		PID<10		
		3.8m: becoming brown							4-4.5m BentoniteSeal
22	4								
				E	4.9 5.0		PID<1		
21	5								
20	6								
				A	6.9 7.0				4.5-10.0mSpecialised Sand 5-10.0m Screen
19	7	7.0m: saturated with some gravel							
18	8								
	8.5	SHALE - extremely low strength, grey shale, with a trace of carbonaceous material (possibly clay)		A	8.9 9.0				
17	9				9.5				
				A					
	10.0	Bore discontinued at 10.0m			10.0				

RIG: MC-T 200 **DRILLER:** Terratest **LOGGED:** JY **CASING:** PVC

TYPE OF BORING: 150mm diameter solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 7.0m

REMARKS: Location coordinates are in MGA94 Zone 56. Top casing elevation: 27.3 mAHD

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

BOREHOLE LOG

CLIENT: Pacific National (NSW) Pty Ltd
PROJECT: Proposed St Marys Freight Hub
LOCATION: 2 Forrester Road, St Marys

SURFACE LEVEL: 24.1 mAHD
EASTING: 293329.1
NORTHING: 6262636.9
DIP/AZIMUTH: 90°/--

BORE No: BH/MW 103
PROJECT No: 94525.00
DATE: 4/12/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
24	0	FILLING - grey, sandy gravel filling, with some clay, damp		A/E	0.1-0.2		PID<10		1.1mStick up
				A/E	0.4-0.5		PID<10		0-1.0m Casing
23	1	FILLING - dark brown, silty clay filling, with some organic material, damp (possibly topsoil filling)		A/E	0.9-1.0		PID<1		0-2.0m Backfill
	1.2	FILLING - grey-brown, silty clay filling, damp		A/E	1.4-1.5		PID<10		
22	2			A/E	1.9-2.0		pp = 250 PID<10		
	2.2	SILTY CLAY - stiff, light grey mottled brown silty clay, damp		A/E	2.4-2.5		pp = 100 PID<10		2-2.5m Bentonite Seal
21	3			A/E	2.9-3.0		pp = 150 PID<10		
	3.5	SILTY CLAY - brown, slightly sandy silty clay, wet							
20	4			A/E	4.0-4.1		PID<10		
19	5	5.0m: saturated and becoming slightly gravelly		A/E	4.9-5.0				2.5-7.0m Specialised Sand 3-7.0m Screen
18	6			A/E	5.9-6.0				
17	7	7.0 Bore discontinued at 7.0m							
16	8								
15	9								

RIG: MC-T 200 **DRILLER:** Terratest **LOGGED:** JY **CASING:** PVC

TYPE OF BORING: 150mm diameter solid flight auger

WATER OBSERVATIONS: Free groundwater observed at approximately 3.5m

REMARKS: Location coordinates are in MGA94 Zone 56. Top casing elevation: 25.3 mAHD

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

BOREHOLE LOG

CLIENT: Pacific National (NSW) Pty Ltd
PROJECT: Proposed St Marys Freight Hub
LOCATION: 2 Forrester Road, St Marys

SURFACE LEVEL: 25.1 mAHD
EASTING: 293513.4
NORTHING: 6262658.8
DIP/AZIMUTH: 90°/--

BORE No: BH/MW 104
PROJECT No: 94525.00
DATE: 4/12/2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
25	0	FILLING - light brown, fine to coarse grain gravelly sand filling, humid. Gravel is fine to coarse and mostly white sandstone		A/E	0.0 0.1		PID<1		0.93m Stick-up
				A/E	0.4 0.5		PID<1		
24	1			A/E	0.9 1.0		PID<1		
				A/E	1.4 1.5		PID<1		
23	2	2.0m: becoming grey		A/E	1.9 2.0		PID<1		0-4.0m Backfill
				A/E	2.4 2.5		PID<1		0-5.0m Blank
22	2.8 3	FILLING - orange-brown silty clay filling, with some fine to medium sandstone gravel, humid		A/E	2.9 3.0		pp = 100		
	3.5	SILTY CLAY - brown silty clay, with a trace of fine gravel, damp		A/E	3.4 3.5		pp = 400		
21	4			A/E	3.9 4.0		pp = 300		4-4.5m Bentonite
				A/E	4.4 4.5		pp = 250		
20	5	5.0m: becoming moist		A/E	4.9 5.0		pp = 200		
				A/E	5.9 6.0		pp = 150		
19	6	6.0m: becoming yellow-brown, stiff		A/E			pp = 100		
		-possibly extremely low strength shale from 6.4m			6.9				
18	7								4.5-10.0m Sand
	7.5	SHALE - extremely low strength, grey shale							5-10.0m Screen
17	8								
16	9								

RIG: MCT-T 200 **DRILLER:** Terratest **LOGGED:** JY **CASING:** PVC

TYPE OF BORING: 150mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Top casing elevation: 26 mAHD

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Pacific National (NSW) Pty Ltd
PROJECT: Proposed St Marys Freight Hub
LOCATION: 2 Forrester Road, St Marys

SURFACE LEVEL: 25.1 mAHD
EASTING: 293513.4
NORTHING: 6262658.8
DIP/AZIMUTH: 90°/--

BORE No: BH/MW 104
PROJECT No: 94525.00
DATE: 4/12/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
15		SHALE - extremely low strength, grey shale *(continued)*							
	10.5	Bore discontinued at 10.5m							
14	11								
13	12								
12	13								
11	14								
10	15								
9	16								
8	17								
7	18								
6	19								

RIG: MCT-T 200 **DRILLER:** Terratest **LOGGED:** JY **CASING:** PVC

TYPE OF BORING: 150mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Top casing elevation: 26 mAHD

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Pacific National (NSW) Pty Ltd
PROJECT: Proposed St Marys Freight Hub
LOCATION: 2 Forrester Road, St Marys

SURFACE LEVEL: 23.1 mAHD
EASTING: 293075.5
NORTHING: 6263050.2
DIP/AZIMUTH: 90°/--

BORE No: BH/MW 105
PROJECT No: 94525.00
DATE: 5/12/2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
23	0.0	FILLING - brown, gravelly sand filling, humid		A/E	0.0		PID<10		1.1m Stick-up
					0.2				
				A/E	0.4		PID<10		
					0.5				
				A/E	0.9		PID<10		
22	1.0	FILLING - brown, silty clay filling, with a trace of sand and fine gravel			1.0				
				A/E	1.4		PID<10		
					1.5				
	1.8	SILTY CLAY - stiff to very stiff, brown, silty clay, damp		A/E	1.9		PID<10		0-4.0m Backfill
21	2.0				2.0				0-4.9m Casing
				A/E	2.9		pp = 200		
20	3.0				3.0		PID<10		
19	4.0	4.0m: becoming yellow-brown and moist							4-4.5m Bentonite Seal
				A/E	4.9		pp = 150		
18	5.0				5.0				
17	6.0								
		6.7m: saturated		A/E	6.9		pp = 150		4.5-9.9m Specialised Sand 4.9-9.9m Screen
16	7.0				7.0				
15	8.0	8.0m: becoming grey (possibly extremely low strength shale)							
				A	8.9				
14	9.0				9.0				
	10.0				9.9				

Bore discontinued at 10.0m

RIG: MC-T 200 **DRILLER:** Terratest **LOGGED:** JY **CASING:** PVC

TYPE OF BORING: 150mm diameter solid flight auger

WATER OBSERVATIONS: Free groundwater observed at approximately 6.7m whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Top casing elevation: 24.2 mAHD

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Pacific National (NSW) Pty Ltd
PROJECT: Proposed St Marys Freight Hub
LOCATION: 2 Forrester Road, St Marys

SURFACE LEVEL: 23.1 mAHD
EASTING: 293075.5
NORTHING: 6263050.2
DIP/AZIMUTH: 90°/--

BORE No: BH/MW 105
PROJECT No: 94525.00
DATE: 5/12/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
13				A	10.0				
12	11								11
11	12								12
10	13								13
9	14								14
8	15								15
7	16								16
6	17								17
5	18								18
4	19								19

RIG: MC-T 200 **DRILLER:** Terratest **LOGGED:** JY **CASING:** PVC

TYPE OF BORING: 150mm diameter solid flight auger

WATER OBSERVATIONS: Free groundwater observed at approximately 6.7m whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Top casing elevation: 24.2 mAHD

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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