Appendix R

Part 1

Interim Geotechnical Report – Turbines

Prepared by: SLR Consulting (Aug 2022)

INTERIM INTERPRETIVE GEOTECHNICAL REPORT

Palings Yard Wind Farm – Turbine Locations

Prepared for:

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Global Power Generation Australia Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
650.30012.00000-R01-v0.2	29 August 2022	Gadha Lal, Amanda Lane	Nick Barker	DRAFT following GPG Comments
650.30012.00000-R01-v0.1	12 August 2022	Gadha Lal, Amanda Lane	Nick Barker	DRAFT for GPG Review

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1 Introduction

IMPORTANT NOTE: This interim interpretive geotechnical report has been compiled to accompany the Development Application submission in lieu of a full geotechnical report.

The eastern coast of Australia has been subjected to a series of adverse weather events during the winter of 2022 that has impacted the accessibility of the site and subsequent safety of field teams. As a result, the proposed fieldwork program has been postponed until weather conditions improve and field work can be undertaken safely.

To provide meaningful data for the submission, this report, following a detailed review, has drawn on a previous report that was completed by URS in 2011 for an alternative wind farm proposal at the same site. Once the proposed fieldwork is complete, this report will be revised to incorporate findings from the current geotechnical investigation.

1.1 Background

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Global Power Generation Australia Pty Ltd (GPG) to conduct geotechnical investigation for the purpose of informing the design of the proposed wind farm and associated transmission line at Paling Yards, NSW.

This report presents the findings of the geotechnical site investigation for the Environmental Impact Statement (EIS) submission of the proposed wind farm (wind turbines) at Paling Yards. This report should be read in conjunction with Interpretive Geotechnical Report Paling Yards - Transmission Line.

1.2 Objective

The objectives of the geotechnical investigation were as follows:

- Assessment of ground conditions to inform:
    - Geotechnical design parameters for turbine footings.
    - Geotechnical design parameters for footings (shallow, piers or piles) for site specific geology.
    - Geotechnical subgrade conditions and preparation for road and pavement design.
    - Geotechnical design parameters for pavement design.
- Seismic design parameters.
- Material reusability.
- Recommendations and commentary on the geotechnical aspects of the wind farm development.

2 Site Overview and Historical Data

2.1 Site Description

The proposed Wind Farm at Paling Yards is located approximately 56km south of Oberon, NSW, covering an area of approximately 48 km^2. The proposed investigation site referred to within this document as 'the site' is surrounded by Abercrombie River National Park to the east and south and Gurnang State Forest towards the northeast. The site includes four separate land holdings referred to as:

- Mingary Park
- Paling Yards
- Middle Station
- Hilltop

A site plan is presented in Appendix A which indicates:

- The location of the site
- Extent of property boundaries
- The current layout of the proposed windfarm
- Proposed investigation locations
- Previous investigations locations

2.2 Site Geology

Review of the Geological Survey of NSW database (Minview, accessed 24 June 2022) indicates the near-surface geology underlying the site is characterised predominantly by:

- Oberon Basalt (NM_o), weakly porphyritic basanites and alkali basalts dominated by olivine, titaniferous clinopyroxene, plagioclase and Ti-Fe oxides with minor ilmenite, nepheline, apatite, and rare volcanic glass. Miocene (23.03 - 13.82 Ma).
- *Alluvial Sediments (GN_aa) Alluvial deposits, dominantly sand & gravel; friable to unconsolidated, or cemented to sandstone or conglomerate. Massive to bedded, ranging from thin to very thick; horizontal to cross bedded. Includes some lacustrine deposits & sub-basaltic sediments. Pleistocene (66.0 - 0.0117 Ma).
- *Poidevins Sandstone (Omap) Quartz sandstone, quartzite, turbiditic quartz-lithic-micaceous sandstone and minor siltstone. Llandovery (443.8 - 440.8 Ma).
- *Bumballa Formation (Obeb) Olive to grey, buff and cream, ripple cross-laminated to graded fine-grained sandstone, interbedded with grey to black laminated siltstone + mudstone with very minor chert. Sporadic intervals of fine- to coarse-grained quartzose sandstone. Late Ordovician (460.4 - 452.9 Ma).
- *Warbisco Shale (Obew) Black, laminated to medium-bedded pyritic carbonaceous shale, commonly strongly foliated and folded. Minor quartzose sandstone. Late Ordovician (452.9 - 445.2 Ma).

- Abercrombie Formation (Oada) brown and buff to grey, thin- to thick-bedded, fine- to coarse-grained mica-quartz (±feldspar) sandstone, interbedded with laminated siltstone and mudstone. Sporadic chert-rich units. Early Ordovician (479.4 - 458.4 Ma).

* Units marked with an asterisk were only mapped in the far western section of the site where the geology appears to be more complex.

The western side of the site is also underlain by:

- Colluvium (Q_c) poorly sorted, weakly cemented to unconsolidated colluvial lenses of polymictic conglomerate with medium- to very coarse-grained sand matrix; interspersed with unconsolidated clayey and silty red brown (aeolian) sand layers, modified by pedogenesis. Quaternary (2.58 - 0.0 Ma).
- Residual Deposits (Q_r) A weakly consolidated regolithic residuum such as soil or saprolite mostly developed in-situ as a result of advanced weathering and/or pedogenesis. Quaternary (2.58 - 0.0 Ma).
- Mummel Chert Member (Oadam) Grey, brown, black and cream, laminated to thin-bedded chert, cherty mudstone and siltstone, interbedded with thin-bedded to laminated siltstone and grey to black mudstone with minor cross-laminated quartzose sandstone. Early Ordovician (477.4 - 470.0 Ma).

The site underlain by geological mapping is shown in Figure 1 below.

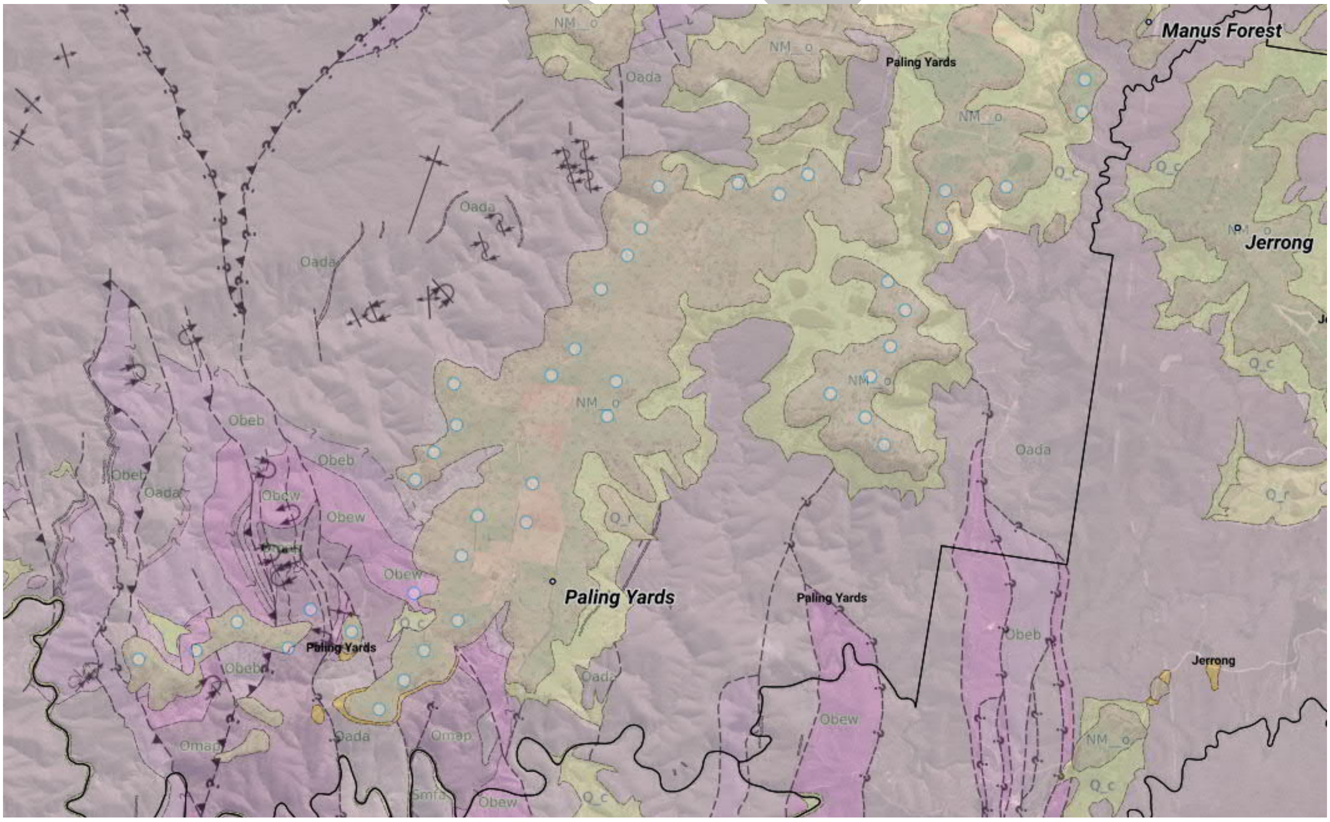


Figure 1 Local geology with turbine locations marked (blue circles)

From the mapping it is evident that the majority of the turbines will be underlain by the Oberon Basalt, a series of minor alkaline eruptions that occurred in localised areas west of the NSW Illawarra Coast. Alkaline basalts often display high strength when fresh however weather to extremely reactive and highly plastic residual soils that show high degrees of shrink swell movement.

On the fringes of the site, Ordovician sedimentary rock is present overlain by a thin veneer of residual soil. These conditions are less likely to give rise to highly plastic and highly reactive soils.

2.3 Vegetation and Land Use

The site is located upon agricultural lands currently used for mainly grazing.

At the time of investigation, sheep grazing and associated wool production was noted as the dominant agriculture type.

Vegetation overall consisted of low grasses and occasional stands of remnant woodland. The more gentle graded areas were generally well grassed with scattered mature trees. The steeper terrain was well vegetated with moderately dense native eucalypt forests.

2.4 Topography

The site consists of a large tableland area formed by localised basalt flows that sit atop Ordovician sedimentary rocks. The outline of the underlying basalt broadly matches a distinct change in topography.

Generally, slopes fall towards the east and west from a central ridge that trends northeast - southwest through the site. The elevation of the site falls from approximately 1090m AHD along the length of the proposed area to 690m AHD to the east and west.

Numerous gullies and creeks runs throughout the site, with surface flows joining the Abercrombie River to the south of the investigation area.

2.5 Hydrology

Typically, surface water follows topography and surrounding drainage paths and gullies, flowing from higher elevation towards lower elevations.

The topography of the site suggests that water flow direction is to the east and west from the elevated points towards Manus Creek and Silent Creek, which finally merge with the Abercrombie River, 500m south of the investigation area.

Several earth dams are also observed along the proposed site, with most of them at their maximum capacity, having a freeboard of approximately 0.2-0.5m due to recent rain events during the time of investigation.

2.6 Historical Data

The following list outlines the relevant available documentation for the site examined as part of this commission:

- Copies of the 2011 URS Geotechnical Report provided by GPG (ref: 20120427 - Paling Yards, FINAL Geotechnical report (URS), dated 5 September 2011).

- Cultural Heritage Documents provided by ERM (ref: F9-1_0578575s_PYWF_HER_G013_R00, F7-2_0578575s_PYWF_HER_G014_R00, F4-1_0578575s_PYWF_HER_G010_R01 dated 15 June 2021).

2.6.1 2011 URS Geotechnical Report Summary

A preliminary geotechnical investigation was undertaken by the consultants URS at the site. This investigation was targeted at an alternative proposal that incorporated 59 wind turbines predominantly across the western portion of the site.

A total of 2 boreholes, 60 test pits were excavated at select locations along with 60 DCP tests adjacent to test pits. Many of those locations are relevant to the current proposed wind turbine locations and subsequently some of the geotechnical investigation bore logs and test pit logs have been incorporated into this investigation following a detailed review.

In addition, 2 electrical resistivity surveys were undertaken across the site. Each survey consisted of Wenner Alpha, Schlumberger and Dipole-Dipole testing. Again, the results of these surveys have been considered within this investigation.

Finally following a detailed peer review of the document, select geotechnical information has been used to inform the outcomes of this interim interpretive geotechnical investigation. These data points (Test Pits and Boreholes) have been listed below, with a brief summary of near surface ground conditions, in Table 1 below.

Table 1 Summary of relevant URS test locations

URS Site ID	Relevant Turbine Location	Easting	Northing	Elevation (mRL)	Depth (m)	Summary of subsurface conditions
TP15	PY-1	750790.66	6214083.06	887	1.9 (refusal)	Shallow residual soil over BASALT
TP16	PY-2	751180.75	6214432.91	898	1.5 (refusal)	Shallow residual soil over BASALT
TP17	PY-3	751425.00	6214787.11	919	1.5 (refusal)	Shallow residual soil over BASALT
TP18	PY-4	751941.69	6215114.62	941	0.9 (refusal)	Shallow residual soil over BASALT
TP3	PY-6	748519.70	6214803.26	862	1.3 (refusal)	Shallow residual soil over SILTSTONE
TP5	PY-7	749054.78	6215129.11	869	1.4 (refusal)	Shallow residual soil over SILTSTONE
TP8	PY-8	749637.93	6214879.49	869	1.5 (refusal)	Shallow residual soil over SILTSTONE
TP9	PY-9	750045.99	6215202.86	870	0.6 (refusal)	SILTSTONE outcrop
BH1	PY-9	750045.99	6215202.86	870	20	Moderate to High strength SILTSTONE
TP12	PY-10	750521.21	6215025.33	911	2.1 (refusal)	Shallow residual soil over BASALT
TP13	PY-11	750856.37	6215277.14	903	0.5 (refusal)	SILTSTONE outcrop
TP14	PY-12	751185.00	6215411.00	903	1.8 (refusal)	Shallow residual soil over SILTSTONE
TP19	PY-13	751765.12	6215480.35	943	1.6 (refusal)	Shallow residual soil over BASALT
TP20	PY-14	751924.43	6215913.25	972	1.8 (refusal)	Shallow residual soil over BASALT
TP28	PY-15	752167.15	6216398.80	972	1.4 (refusal)	Shallow residual soil over BASALT
TP27	PY-16	752654.50	6216324.83	977	1.7 (refusal)	Shallow residual soil over BASALT
TP31	PY-18	751295.48	6216935.08	933	1.5 (refusal)	Shallow residual soil over BASALT
TP32	PY-19	751654.02	6217233.66	956	2.4 (refusal)	Residual soil over BASALT
TP33	PY-20	751942.30	6217474.14	976	1.0 (refusal)	Shallow residual soil over BASALT

URS Site ID	Relevant Turbine Location	Easting	Northing	Elevation (mRL)	Depth (m)	Summary of subsurface conditions
TP35	PY-21	751952.91	6218024.61	971	1.4 (refusal)	Shallow residual soil over BASALT
TP34	PY-22	752209.40	6217766.32	994	3.0	Residual soil over BASALT
TP36	PY-23	753234.49	6217980.31	985	1.7 (refusal)	Shallow residual soil over BASALT
TP37	PY-24	753414.26	6218295.67	1001	1.4 (refusal)	Shallow residual soil over BASALT
TP38	PY-25	753669.52	6217768.20	1000	3.4	Residual soil
BH2	PY-25	753669.52	6217768.20	1000	19.7	Residual soil over BASALT
TP39	PY-26	753790.39	6218102.49	1010	3.3	Residual soil over BASALT
TP44	PY-28	754258.21	6219702.61	1003	1.0 (refusal)	Shallow residual soil over BASALT
TP45	PY-29	754452.80	6219949.71	983	2.0 (refusal)	Residual soil over BASALT
TP47	PY-30	754672.54	6220558.81	976	1.9 (refusal)	Residual soil over BASALT
TP48	PY-31	755148.59	6220270.48	968	1.5 (refusal)	Shallow residual soil over SILTSTONE
TP49	PY-32	755526.92	62200445.70	991	1.3 (refusal)	Shallow residual soil over BASALT
TP50	PY-33	756080.37	6220346.27	1038	2.3 (refusal)	Residual soil over BASALT
TP51	PY-34	756446.50	6220552.20	1046	2.0 (refusal)	Residual soil over BASALT
TP60	PY-35	757375.27	6217236.88	1024	2.1 (refusal)	Residual soil over BASALT
TP59	PY-36	757015.67	6217565.13	1026	1.0 (refusal)	Shallow residual soil over BASALT
TP58	PY-37	756710.89	6217869.76	1031	1.6 (refusal)	Shallow residual soil over BASALT
TP57	PY-38	757116.83	6217956.78	1042	1.5 (refusal)	Shallow residual soil over BASALT
TP56	PY-39	757293.24	6218234.95	1022	1.1 (refusal)	Shallow residual soil over BASALT
TP54	PY-40	757655.77	6218768.36	1018	1.5 (refusal)	Shallow residual soil over BASALT
TP52	PY-41	757359.69	6219304.77	982	0.8 (refusal)	Shallow residual soil over BASALT

Due to the importance of this data and its use within this document at this interim stage, the full URS 2011 has been appended to this document. Please find it attached in Appendix D.

3 Scope of Services Completed as per the 12/8/2022

The following scope of services have been completed in accordance with SLR Proposal A00.08927.PROMO Palings Yard Wind Farm and Transmission Line GI, 29 March 2022.

3.1 Planning

The following works were conducted prior to commencing the geotechnical field investigation:

- Desktop review of available information including local geology maps, soil maps, groundwater maps and geomorphological maps.
- Preparation of site-specific Safe Work Method Statement (SWMS) and management of any identified risks on-site.
- Confirmation of Cultural Heritage Clearance prior to mobilisation.
- Preparation of a separate Health, Safety and Environment Management Plan (HSSE).
- Preparation of borehole and test pit location plan.
- Dial Before You Dig (DBYD) searches within the project area as well as engage all applicable subcontractors.
- Pre-Investigation site walkover by SLR staff on 4 May 2022 and 18 July 2022. During the walkover each proposed test location was inspected for potential constraints and marked using a labelled surveyors picket.

3.2 Geotechnical Site Investigation

The geotechnical site investigation was carried out over three separate mobilisations:

- 9 May to 11 May (Drilled boreholes PYWF-BH02 and PYWF-BH03).
- 18 July to 20 July (Excavated test pits for the Transmission Line Investigation – (See separate report no. 650.30012.00000-R02-v0.1-Transmission Line)).
- 26 July till 27 July. (Undertook hand auguring to collect soil samples for Agronomy testing only).

3.2.1 Borehole Excavation

Drilling of two (2) out of 8 boreholes to a maximum depth of 20.1m including rock coring using a 4x4 truck mounted Hydra Power Scout owned and operated by Rockwell Drilling Pty Ltd. The coordinates of each borehole were recorded using a hand-held GPS device accurate to +-5m. The boreholes that were completed are listed below and in Table 3:

- PYWF – BH02
- PYWF – BH03

Drilling was carried out using a solid flight auger attached with tri cone-bit until refusal on rock. The drilling system was then switched to a triple barrel HQ system to enable coring within rock and the return of core samples.

Whilst within soil strength materials, boreholes were supplemented with Standard Penetration Tests (SPTs) performed in accordance with AS1289.6.3.1 (2004) at 1.5m intervals to understand soil strengths.

Once coring commenced, point load testing of rock samples were undertaken on recovered core whilst on site at approximately 1m intervals to understand the strength of rock.

From each of the boreholes, materials were sampled and logged via the visual-tactile method in accordance with AS1726 (2017) by a suitably experienced and qualified geotechnical engineer.

Boreholes were backfilled using the drill cuttings and tamped at the surface to avoid excessive settlement.

The geotechnical site investigation results to date are presented in Table 3.

3.2.2 Test Pit Excavation

Due to difficult weather conditions at site, test pitting was unable to be undertaken safely. Subsequently SLR aims to conduct the wind turbine test pit excavation once the weather conditions improve and can facilitate safe site access.

3.3 Dynamic Cone Penetrometer (DCP) Testing

Due to difficult weather conditions at site, DCP testing was unable to be undertaken safely. Subsequently SLR aims to conduct DCP testing once the weather conditions improve and can facilitate safe site access.

3.4 Standard Penetration Testing (SPT)

SPT tests were undertaken within each borehole at 1.50m intervals. Similar to the DCP test, SPT test results are used to assess the consistency/relative density of the material through blow counts however at deeper depths beyond the reach of a DCP test.

SPT test results are presented on the geotechnical logs in Appendix B. Typically, in the hierarchy of information, SPT results take precedence over DCP results due to the better representation of in-situ conditions.

3.5 Pocket Penetrometer Testing

Pocket Penetrometer testing was undertaken for select recovered samples of cohesive soil to address the consistency of soil at various depths. Pocket penetrometer results are presented on the geotechnical logs in Appendix B.

3.6 Laboratory Testing

To assist with assessment of the geotechnical conditions and reusability of materials, a suite of laboratory testing was performed on selected undisturbed, disturbed and remoulded samples. Laboratory testing was performed by a NATA accredited laboratory.

The completed laboratory testing and the corresponding rationale are shown in Table 2 below.

Table 2 Summary of Laboratory Testing Methods

Test Method	No. of Tests	Standard	Rationale
Particle Size Distribution	2	AS 1289.3.6.2	Characterise material and assess suitability for material re-use as a general construction material.
Atterberg Limits	3	AS 1289 3.1.1, 3.2.1, 3.3.1	Assess the liquid and plastic limit of cohesive soils (clays and silts) and assess suitability for re-use and likely behaviour characteristics with moisture changes.
Shrink/Swell Index	2	AS1289 7.1.1	Assess the materials ability to expand when wet and retract when dry. Used to determine the expansion capacity of the material and provide site classification.
Emerson Class	3	AS 1289 3.8.1	Assess the materials propensity to disperse into a liquid. Used to assess susceptibility to erosion.
Point Load Index	TBC	AS 4133.4.1	Assess rock strength.
UCS	4	AS 4133.4.2.2	Assess the rock capacity to withstand axially directed compressive forces.
Moisture Content	2	AS 1289.2.1.1	Assess the amount of water present in the soil.
Soil/Rock Aggressivity	1	AS 2159	Assessing the pH, conductivity and presence of chlorides and sulfates with the material as a measure of potential corrosion to steel and concrete structures.
California Bearing Ratio (CBR)	TBC	AS 1289.6.1.1	Evaluate the strength of soil and assess the suitability of soil to use as subgrade and base course material
Laboratory Thermal Resistivity	TBC	-	Assess the ability of soil to dissipate heat. Used to design the underground transmission cables
Pinhole Dispersion	TBC	AS 1289.3.8.3	Assess the dispersive characteristics of compacted soil.

Laboratory testing results are summarised in Section 5 and presented in detail in Appendix C.

4 Results and Discussion

4.1 Site Observations and Site Investigation Findings

The ground conditions encountered during the geotechnical site investigation are presented in the geotechnical logs and key photographs in Appendix B. A summary of observations made from the test locations and visual inspections is included in the following sections.

4.1.1 Geotechnical site Investigation Results

The geotechnical site investigation borehole and test pit details and depths reached are presented in Table 3.

Table 3 Summary of test locations

Site ID	Type (TP/BH)	Easting	Northing	Elevation (mRL)	Depth (m)	Termination Criteria	Details
PYWF-BH01	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYWF-BH02	BH	198699.21	6214021.91	946	19.9	Target depth	Auger to 3.5m, coring from 3.5m to termination
PYWF-BH03	BH	199691.57	6215408.11	972	20.1	Target depth	Auger to 5.6m, coring from 5.6m to termination
PYWF-BH04	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYWF-BH06	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYWF-BH07	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYWF-BH12	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYWF-TP01	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYWF-TP02	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYWF-TP03	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYWF-TP04	TP	TBC	TBC	TBC	TBC	TBC	TBC

4.1.2 Visual Observations

Note that the initial stages of this investigation were undertaken during severe inclement weather which resulted in several demobilisations from site to allow the site to dry sufficiently so that heavy machinery could access test sites without risks to personnel, equipment and the landowners property.

The weather during the initial site visit was cloudy with periods of light showers. The region had been experiencing a very wet tropical cyclone *Karim* during the investigation. The site consisted of generally open grazing land for sheep and cattle. The land was wet and subsequently saturated during the time of inspection. During the site walkover, access to most of the test locations was very limited.

The site conditions near PYTL-BH02 were generally sloping gently from east to west. The area was grazing land with isolated patches of exposed soil. A dam was observed merely 150m from the test location.

The site conditions near PWF-BH03 were moderately sloping from southeast to northwest. The borehole location was on the ridgeline, near the fence.

4.1.3 Subsurface Conditions

The subsurface conditions encountered on site were generally consistent with the data published in geological maps, referenced sources and the report undertaken by URS (2011).

With the limited information from the excavated boreholes, SLR identified five predominant material units, with varied depths to base of each unit encountered between the two boreholes.

Note that the URS (2011) report presented three subsurface conditions, where they generalized both alluvium and residual soil as residual soil only and combined both extremely weathered basalt and slightly weathered/fresh basalt as 'bedrock'. The five material units that SLR encountered are as follows (in general order of deposition/age):

- Topsoil
- Alluvium
- Residual Soil
- Extremely Weathered Basalt
- Slightly Weathered/Fresh Basalt

A summary of encountered strata and locations is presented in Table 4:

Table 4 Summary of encountered strata

Location/ Property	Deposition Environment	Dominant Material Type	Encountered	Encountered Depth Range (mbgl)
Oberon Basalt	Topsoil	Clayey SILT, Silty sandy CLAY	PYWF-BH02, PYWF-BH03	0.00 to 0.30
	Alluvium	Silty CLAY, Sandy CLAY	PYWF-BH02, PYWF-BH03	0.20 to 1.50
	Residual Soil	CLAY, Clayey SILT, Silty CLAY, Clayey SAND	PYWF-BH02, PYWF-BH03	1.20 to 5.00
	Extremely Weathered Basalt	Mixture of cobbles and boulders of Basalt	PYWF-BH02, PYWF-BH03	3.40 to 5.60
	Slightly Weathered/Fresh Basalt	Basalt	PYWF-BH02, PYWF-BH03	3.50 +
Ordovician Sedimentary Rock	Topsoil	TBC	TBC	TBC
	Alluvium	TBC	TBC	TBC
	Residual Soil	TBC	TBC	TBC
	Extremely Weathered Rock	TBC	TBC	TBC
	Slightly Weathered/Fresh Rock	TBC	TBC	TBC

Topsoil

The site was generally covered with a thin layer of topsoil with high organic and moisture content that can be classed as Topsoil. It is likely that this horizon has undergone significant reworking due to farming practices and is likely to be very variable with regard to geotechnical properties. However, it was noted that the topsoil was generally cohesive in nature and extended to a approximate depth of 0.3 mbgl. The soil was logged as being of low plasticity with high organic contents. Consistency was variable and was observed to be relatively soft to firm however a few high strength floating cobbles and boulders were observed at the surface being of latite origin. Note that the URS report suggested the topsoil as coarse-grained material with some cohesive properties, with no data regarding organic matter on the surface at comparable SLR borehole locations.

Alluvium

Alluvium was encountered at both investigation locations due to their proximity towards Black Bett Creek and Oaky Creek, extending to an approximate maximum depth of 1.5 mbgl. The soils encountered were generally cohesive, being of medium to high plasticity. The consistency of soil was observed to be firm as inferred from the SPT blows undertaken in PYWF-BH02. It is likely that this horizon is not consistent across the site and only confined to within close proximity to drainage line sand creeks. The URS report do not have any data regarding this subsurface condition.

Residual Soil

Residual soil was encountered at depths of between 1.2 mbgl and 5mbgl and generally consisted of orange, brown. cohesive soils with a consistency that increased with depth from stiff to very stiff based on SPT blows undertaken in PYWF-BH03. Plasticity was noted as being medium to high which is expected from residual soils emanating from basalts. Note that often basaltic residual soils exhibit high levels of soil reactivity. The URS report results corresponding to residual soil matches with SLR results in terms of soil type and consistencies.

Extremely weathered Basalt

Extremely weathered basalt was encountered as a layer of cobbles and boulders to a maximum depth of 5.6 mbgl. The rock in this layer exhibited a degree of staining and evidence of chemical and physical weathering. The basalt was also noted as being vesicular in nature with some of the vesicles infilled with mineral inclusions. The strength of the weathered basalt was variable.

Slightly Weathered/Fresh Basalt

The parent rock was observed as being a vesicular basalt with occasional mineral infilling. Vesicles were confined to distinct bands that likely represent the top of individual lava flows. The strength of the basalt was noted as being high to very high, with occasional defects.

4.1.3.2 SPT, DCP and Pocket Penetrometer Test Results

SPT testing indicated that the consistency/relative density increases with depth. This result is well aligned with the pocket penetrometer values, which were undertaken on recovered samples. The drilling penetration resistance also gives a fair indication of the ground conditions at greater depths. The URS (2011) report had only very limited information regarding SPT values, but again the results increased with depth.

DCP tests have not yet been conducted in wind farm location as test pits have not been excavated due to adverse weather conditions.

SPT and pocket penetrometer results are included on the logs located within Appendix B.

4.1.4 Rock Quality

Rock quality designation (RQD) is a measure of the quality of rock recovered from a borehole. RQD signifies the degree of jointing or fracture in a rock mass measure in percentage.

Typically, RQD values ≥75% signify good quality rock with low defect densities, RQD values less than 50% typically signify highly fractured rock masses, typical of weathered, low-quality rock.

The RQD for PTWF-BH03 ranged from 0% for the upper core run (5.60m to 5.95m bgl), improving with depth to 35%, 90%, 79% and 62%.

Similarly, the RQD for PTWF-BH02 ranged from 25% for the upper core run (3.50m to 5.2m bgl), improving with depth to 97%, 71%, and 60%. However, the RQD decreases at this borehole to 10% and 48% at deeper core run(16.6m to 19.9m) due to multiple fractures.

Overall, the rock is highly fractured at shallow depths and increases quality with depth. At significant depth, even though the rock has multiple fractures, the rock strength was visually observed to be high to very high, supported by point load test results.

However, review of the previous URS (2011) report suggests that in some areas the basalt previously encountered was of low to medium strength and highly fractured. This is likely location dependent and will be confirmed once additional boreholes are drilled.

4.1.5 Ground water

Groundwater was encountered in PYWF-BH03 at 5.6 mbgl however the underlying rock was observed as being dry. Therefore, in this location it is likely that the groundwater sits atop the weathered rock layer and may be perched.

It should be noted the location and presence of groundwater level is likely to vary significantly across the site due to the topography, presence of localised drainage lines and may vary with seasonal variation and rainfall.

It was also noted that the URS (2011) report did not identify groundwater in any of the tests undertaken at that time further suggesting that the observed groundwater level is highly variable and seasonal.

4.2 Interim Geotechnical Model

From information contained within the URS (2011) report and from findings gathered on site, it is evident that the majority of the site is underlain by shallow alluvial and residual soils trending to weathered rock at depth. This is generally similar for areas overlying the Oberon Basalts or the older sedimentary rocks.

At depth, from the limited data available, it appears that the rock becomes less weathered and an increase in strength is clear.

5 Laboratory Analysis

Laboratory testing on soil samples was undertaken by the NATA accredited, Australian Soil and Concrete Testing laboratory (ASCTL), and consisted of testing detailed in Section 3.6.

5.1 Geotechnical Laboratory Results – Soils

The laboratory test results, along with the test methods followed, are presented in Appendix C. Results are summarised in Table 5.

Table 5 Summarised MC, PSD and ATT Laboratory Test Results

Location ID and Depth	Material	% Gravel (>2.36 mm)	% Sand (0.075 - 2.36 mm)	% Silt/ clay (<0.075 mm)	LL	PL	PI	LS (mm)	MC (%)
PYWF-BH02 1.00-1.50m	Silty CLAY	14	17	69	77	32	45	22	34
PYWF-BH03 3.00-3.45m	Silty CLAY	-	-	-	60	31	29	14	-
PYWF-BH03 1.00-1.50m	Silty CLAY	11	22	67	48	19	29	14.5	26

LL - Liquid Limit, PL - Plastic Limit, PI - Plastic Index, LS – Linear Shrinkage
MC – Field Moisture Content,

5.1.1 Moisture Content (MC)

The sample tested recorded a field moisture content of 34% at PYWF-BH02. This is a high moisture content for in-situ soils and indicates the soils to be approximately 15% more moist than plastic limit. For clayey soils, as moisture content increases, their shear strength decreases. The laboratory results align with field observations, which logged the soil as beyond plastic limit with low shear strength properties.

Test results are included in Appendix C. Results are summarised in Table 5.

5.1.2 Particle Size Distribution and Atterberg Limits (PSD and ATT)

The alluvium and residual materials encountered were characterised as fine-grained soils – Clay/Silt with a fines percentage of 67% to 69%. The fines are classified as highly plastic and highly sensitive to moisture as indicated by its linear shrinkage of 22%.

Test results are included in Appendix C. Results are summarised in Table 5.

5.1.3 Emerson Class

The Emerson Class laboratory testing conducted at PYWF-BH02 and PYWF-BH03 returned value of 4 and 6 respectively. An Emerson Class of 4, indicates a non-dispersive soil with the presence of gypsum or carbonate. An Emerson Class of 6 indicates the material to be completely flocculated. The results are consistent with visual surface observations made during site visit which showed limited erosion present on exposed surfaces.

Erosion is a function of run-off slope angle, run-off velocity, vegetation cover, and a materials propensity to disperse into a liquid. Emerson class is an indication to the materials susceptibility to disperse into a fluid when submerged. Considering the erosion observed on exposed surfaces, the material may therefore require treatment such as surface protection or compaction to reduce the likelihood of erosion during construction.

Test results are included in Appendix C. Test results are summarised in Table 6.

Table 6 Summarised Emerson Class Results

Location ID	Depth	Material Type	Emmerson Class
PYWF-BH02	1.00-1.50	CI-CH Silty CLAY	4
PYWF-BH03	1.00-1.50	CI-CH Silty CLAY	6
	3.00-3.45	CI Silty CLAY	4

5.1.4 Shrink Swell Test

Shrink Swell Index (Iss) is an assessment of the expansion potential of a soil due to moisture change. The shrink swell index gives a quantitative measure of the vertical strain that will occur in clay soil with change in moisture content (or rather change in suction).

The surface movement has been calculated based on the soil profiles logged in the testing locations and the shrink swell indices (Iss). The values of Iss were obtained from the laboratory testing on selected test locations on the site and as correlated with the Atterberg limits including the linear shrinkage test results for the soils. The estimated values of Iss are based on empirical relationships developed from limited material sources[1] as such should be used as a guide only. Shrink swell tests were conducted on alluvium and/or residual soil.

Test certificates are included in Appendix C. Test results are summarised in Table 7.

Table 7 Summarised Shrink Swell Test Results

Location ID	Depth	Material Type	Shrinkage Field Moisture Content (%)	Swell Field Moisture Content (%)	Swell Inundated Moisture Content (%)	Shrink Swell Index
PYWF-BH02	1.00-1.50	CI-CH Silty CLAY	34.0	34.1	36.1	3.7
PYWF-BH03	1.00-1.50	CI-CH Silty CLAY	25.9	26.0	27.4	2.2
	17.36-17.51	CH Silty CLAY	37.0	37.4	39.3	3.7

[1] Fityus et al (2005). “The shrink swell test”, Geotechnical Testing Journal, Vol. 28, No. 1, pp 1-10.

5.1.5 Soil/Rock Aggressivity Testing

Samples from test pits not yet collected, to be completed following remobilisation to site.

5.1.6 California Bearing Ratio (CBR)

Samples from test pits not yet collected, to be completed following remobilisation to site.

5.1.7 Laboratory Thermal Resistivity Testing

Samples from test pits not yet collected, to be completed following remobilisation to site.

5.1.8 Pinhole Dispersion

Samples from test pits not yet collected, to be completed following remobilisation to site.

5.2 Geotechnical Laboratory Results – Rock

5.2.1 Point Load Test (PLT)

Rock core samples were assessed for point load strength index at intervals of at least 1m of recovered core. Point loads are applied both axially and diametrically or on a core sample to derive an inferred rock strength. Point load strength index testing results are presented below along with corresponding strength classification. Detailed point load data is included in Appendix C.

Table 8 Summary of Point Load Results

Location	Depth (m bgl)	Rock Type	Point Load Index Strength (Is_{50}) MPa - Axial	Point Load Index Strength (Is_{50}) MPa - Diametrical	Point Load Index Strength (Is_{50}) MPa – Irregular	Strength Classification (AS1726)
PYWF-BH02	3.73	Basalt	-	-	3.54	Very High Strength
	4.96	Basalt	-	3.66	0.87	Very High Strength
	5.46	Basalt	3.15	-	-	Very High Strength
	5.91	Basalt	0.81	-	-	Medium Strength
	5.98	Basalt	-	1.00	-	High Strength
	6.58	Basalt	2.22	1.91	-	High Strength
	6.80	Basalt	3.08	-	-	Very High Strength
	6.95	Basalt	-	1.18	-	High Strength
	7.13	Basalt	3.81	0.36	-	Very High Strength
	8.13	Basalt	-	1.72	-	High Strength
	8.20	Basalt	2.21	-	-	High Strength
	9.14	Basalt	-	0.73	-	Medium Strength
	9.20	Basalt	2.58	-	-	High Strength
	10.20	Basalt	3.02	0.10	-	Very High Strength
	11.05	Basalt	2.04	-	-	High Strength
	11.14	Basalt	-	1.38	-	High Strength
	12.05	Basalt	-	2.57	-	High Strength
	12.12	Basalt	0.61	2.26	-	High Strength
	12.14	Basalt	2.12	-	-	High Strength
	12.48	Basalt	2.09	1.62	-	High Strength
	12.78	Basalt	2.19	0.29	-	High Strength
	13.05	Basalt	1.01	0.82	-	High Strength
	14.05	Basalt	2.27	1.12	-	High Strength
	14.10	Basalt	-	2.14	-	High Strength
	15.24	Basalt	3.44	2.54	-	Very High Strength
	16.16	Basalt	2.76	0.20	-	High Strength

Location	Depth (m bgl)	Rock Type	Point Load Index Strength (Is_{50}) MPa - Axial	Point Load Index Strength (Is_{50}) MPa - Diametrical	Point Load Index Strength (Is_{50}) MPa – Irregular	Strength Classification (AS1726)
	17.30	Basalt	-	1.24	-	High Strength
	17.40	Basalt	-	0.90	-	Medium Strength
	17.80	Basalt	3.85	-	-	Very High Strength
	18.06	Basalt	2.38	1.04	-	High Strength
	19.25	Basalt	5.97	5.03	-	Very High Strength
PYWF-BH03	6	Basalt	-	0.01	-	Extremely Low Strength
	7.16	Basalt	-	0.61	-	Medium Strength
	7.37	Basalt	1.93	-	-	High Strength
	8.23	Basalt	-	2.6	-	High Strength
	8.3	Basalt	0.23	-	-	Low Strength
	9.14	Basalt	0.54	2.28	-	High Strength
	10.25	Basalt	0.44	0.23	-	Medium Strength
	11.06	Basalt	2.33	2.41	-	High Strength
	12.07	Basalt	-	0.25	-	Low Strength
	13.4	Basalt	1.78	0.98	-	High Strength
	14.48	Basalt	1.48	-	-	High Strength
	14.63	Basalt	-	0.89	-	Medium Strength
	15.06	Basalt	2.97	3.16	-	Very High Strength
	16.11	Basalt	5.24	3.97	-	Very High Strength
	17.3	Basalt	-	3.19	-	Very High Strength
	17.52	Basalt	4.36	4.34	-	Very High Strength
	18.38	Basalt	0.46	1.84	-	High Strength
	19.05	Basalt	0.71	0.69	-	Medium Strength

5.2.2 Unconfined Compressive Strength (UCS)

Four rock core samples were assessed for unconfined compressive strength (UCS). The UCS tests applies a compressive stress axially to the rock core and provide a good indication of rock strength. The results indicate that the strength of the rock increases significantly with depth. Test results are included in Appendix C. Test results are summarised in Table 9.

Table 9 Summarised UCS Test Results

Location ID	Material	MC	UCS	Strength Classification
PYWF-BH02 6.62m-6.77m	Bedrock: BASALT	2.7	25	Low-Moderate Strength
PYWF-BH02 12.52-12.77m	Bedrock: BASALT	1.9	25	Low-Moderate Strength
PYWF-BH03 16.20-16.58m	Bedrock: BASALT	2.2	118	High Strength
PYWF-BH03 17.36-17.51m	Bedrock: BASALT	2.7	106	High Strength

6 Geotechnical Engineering Assessment

This section of the report provides an evaluation of the following:

- Geotechnical Parameters
- Trafficability
- Earthworks
- Site Classification
- Foundation design recommendations
- Earthquake classification
- Pavement
- Retaining wall design parameters
- Construction considerations and site management

6.1 Geotechnical Parameters

A summary of the characteristic geotechnical parameters is presented in Table 10.

Table 10 Summary of Geotechnical Parameters

Material	Unit Weight (kN/m3)	Angle of Friction (degrees)	Undrained Shear Strength (kPa)	Elastic Modulus (MPa)
Topsoil	18	N/A	N/A	N/A
Alluvium – silty sandy CLAY (firm)	19	22	50	20
Residual Soil – CLAY (very stiff or better)	21	26	150	25
Residual Soil – SAND (med dense or better)	18	32	-	25
Siltstone (low to medium strength)	22	38	-	500
Basalt (medium to high strength)	24	42	-	1000

6.2 Trafficability

As a result of the generally level topography of the site, provided it is managed correctly, trafficability on the site should not be an issue. Trafficability could be improved by ensuring the ground surfaces are prepared correctly in order that plant should be able to track around the site without damaging the surface too much. During heavy or prolonged rain, use of dedicated construction tracks to control site traffic is recommended.

Problems may arise when the upper-level soil is disturbed and exposed to rainfall or runoff which may result in weakening of the soil. An important aspect of maintaining trafficability is seepage/drainage control, particularly within the areas of the site where there are greater thicknesses of soil. The site will quickly become untrafficable if appropriate seepage and drainage control measures, along with construction practices appropriate for the site conditions, are not maintained. It should be ensured that runoff is diverted away from the construction area to prevent ponding of water.

Partial or complete removal of the upper-level material may be required should these soils become saturated and weakened at the time of construction. It is recommended that the earthworks contract includes an OC item to account for the partial and complete removal scenario.

It is recommended that after stripping, clearing, and grubbing, the exposed surface in the construction area be proof rolled (where appropriate) to assist in identifying weak areas and improve trafficability. In areas of cut, proof rolling may be deferred until after the cut operation.

The contractor should fully inform themselves of the ground conditions on site prior to the commencement of earthworks. The requirement should be explicit in any earthwork's specifications or contract.

6.3 Earthworks

Earthworks were not known at the time of the investigation. However, it is anticipated that minor cut and fill will be required to create the building platforms.

Earthworks procedures should be carried out in a responsible manner in accordance with AS.3798-2007 "Guidelines on Earthworks for Commercial and Residential Developments".

6.3.1 Upper-Level Soils

The upper-level soils comprised topsoil, Alluvium and residual soil. These materials were consistently encountered at variable thicknesses across the site at levels that could potentially be disturbed during earthworks.

The presence of the soil types that comprise the upper-level soils varied laterally and with depth, in their material composition, density or strength and therefore will not be a suitable founding stratum for the wind turbines.

6.3.2 Subgrade Preparation Procedures

Subgrade preparation procedures for pavement sub-grade and fill placement beneath structures and footings should include the following:

Clearing, stripping and grubbing should be carried out in areas subject to earthworks (as trafficability conditions allow). Also, all soils containing organic matter should be stripped from the construction area. This material is not considered suitable for use as structural fill.

Depressions formed by the removal of vegetation, underground elements etc. should have all weakened soil cleaned out and be backfilled with compacted select material.

The subgrade should be proof rolled (where appropriate) under the supervision of a suitably qualified geotechnical engineer using a static vehicle with a tare of at least 5 tonnes and compacted to the required degree. In areas of cut, proof rolling may be deferred until after the cut operation. Areas demonstrating excessive movement should be treated (dried and compacted) or removed and replaced with compacted fill. Treatment should be to a standard sufficient that the subgrade passes proof rolling, and that compaction can be achieved in the first layer of fill.

Backfilling should be carried out in a controlled manner and should include the removal of all organic and deleterious matter and excavation of weak, disturbed, water affected and organic rich soils together with the placement of good quality fill material (compacted to the appropriate requirements).

The on-site soils are sensitive to water and will lose strength/density if they become wet. Should this occur, additional treatment may be required.

A survey of the subgrade surface following stripping, demolition and preparation is recommended. The survey will allow for the accurate identification of the fill/natural interface and assist with the construction of the proposed development.

6.3.3 Excavation Characteristics

Excavations would be expected to comprise:

- Bulk cuts – for site stripping and excavation to create platforms and subgrade levels.
- Trenching – for underground services and high-level footings.

Excavations on site should be within the capabilities of light plant, small dozer (CAT D4C or similar) in bulk cuts and medium sized backhoe (Case 580 or similar) or small excavator (12t to 15t) in trenching, based on the investigation findings. Use of larger equipment could be used to expediate construction. Larger excavators with a rock breaker attachment will be required when excavating in the weathered rock material.

6.3.4 Material Usage

Aside from the topsoil material that is not suitable for reuse, the natural soils, where free from organic and deleterious material may be used as structural fill provided that the moisture content of the soils on placement approximates the optimum moisture content required for compaction in the cohesive material. This will require conditioning to bring the soils to optimum. It should be noted that the in-situ soils could be expected to present difficulties in handling, placement and compaction if the appropriate moisture content could not be achieved, particularly if the soils are overly moist.

The weathered rock will comprise some of the borrow material won from the site excavations. It is considered that the extremely and distinctly weathered material will break down sufficiently during the earthworks operations using large compactors. The weathered rock, where broken down on extraction, may be used as structural fill provided that no rock over 75 mm greatest dimension is included.

6.3.5 Compaction Procedures and Specifications

Provided the placement moisture content of the select on-site material approximates the optimum moisture content for compaction, suitable compaction should be achievable using typical compaction machinery, i.e. 5 t to 10 t vibrating sheepsfoot roller or 25 t to 30 t sheepsfoot compactor. For the above plant, the fill material, in accordance with AS 1289 5.1.1 (standard compaction), should be compacted in layers not exceeding 250mm, loose thickness.

However, layer thickness will be dependent on the compaction plant type and size, use of vibration, material type and composition. Final maximum placement layer thicknesses will need to be assessed when the compaction plant, material type and conditions are known. Fill batters should be overfilled and cut back to design batter angles.

The following minimum compaction values, as presented in Table 11, are recommended for building and pavement areas.

Table 11 Recommended Minimum Compaction Values

Location	Cohesive Soils	Non-Cohesive Soils
Structural Areas	98%	75%
Pavement Areas – top 300 mm below subgrade level	98%	75%
Pavement Areas – below the top 300 mm to 5.00 mm	95%	75%
Notes: The density ratios are determined by AS 1289 Test 5.1.1 (Standard Compaction for Cohesive Soils) The density ratios are determined by AS 1289 Test 5.1.1 (Standard Compaction for Cohesionless Soils)		

Field density testing should be conducted to assess the standard of compaction achieved and the placement moisture content. The frequency and extent of the testing should be carried out in accordance with AS 3798-2007, Section 8.0.

Good quality backfill material should be used for backfilling, for example, of service trenches. The backfill should be placed in uniform layers over the full width of the excavation with layers not exceeding 200 mm thickness, loosely placed using wheeled plant or 100 mm thickness using handheld vibrating plates. The backfill material should be compacted to the specifications outlined in Table 11 for in-situ cohesive or cohesionless material.

Soils encountered on the site should be with the excavation limits of a small dozer (i.e., CAT D4 or similar) in bulk earthworks and a medium sized backhoe (i.e., Case 580 or similar in trench excavations). However, large excavators (i.e. 30 tonne), possibly utilising rock breaker attachments, may be required for trenching in the weathered rock stratum.

6.3.6 Batters and Embankments

Maximum cut batter and fill embankment angles for different types of materials are presented in Table 12. The values in the table are for unsurcharged batter and embankments less than 3 m high. Where surcharges (i.e. footings, live loads etc.) are located within H (height of batter) of the top of the batter and/or embankment, then a reduction in the design angle will occur.

Fill embankment slopes are dependent on suitable compaction being achieved. Fill batters should be overfilled, compacted and cut back to alignment to achieve full compaction of the batter edge.

Table 12 Batter/Embankment Angles (for slopes less than 3 m high)

Material		Short Term (degrees)	Long Term (degrees)
Sandy Soils	Loose	30 (1V:1.75H)	18 (1V:3H)
	Medium Dense	35 (1V:1.45H)	18 (1V:3H)
	Dense to Very Dense(1)	35 (1v:1.45H)	18 (1V:3H)
Clay Soils	Soft to Firm	35 (1v:1.45H)	18 (1V:3H)
	Stiff	40 (1v:1.2H)	26 (1V:2H)
	Very Stiff to Hard(1)	45 (1V:1H)	26 (1V:2H)

Material		Short Term (degrees)	Long Term (degrees)
Basalt and Siltstone	XW/DW(1)	56 (1.5V:1H)	45 (1V:1H)

Notes:

- (1) Subject to inspection by an experienced geotechnical engineer during initial earthworks operations.
- Fill batter angles are dependent upon suitable compaction being achieved.
- These values assume no seepage. If seepage is present, the recommended angles would need to be reduced or the use of dewatering considered.
- The above batter angles are presented for stability purposes; a shallower angle could be necessary for maintenance purposes.

The orientation and spacing of the joints and defects within the weathered rock mass could affect the stability of the slopes indicating that it may not be possible to achieve the angles presented in Table 12. All batter angles should be confirmed on site by an experienced geotechnical engineer.

It is essential that permanent batters/embankments be suitably protected from erosion and scour by appropriate drainage and establishment of ground cover and shrub-type vegetation. Runoff should not be allowed to discharge directly across the batters without suitable scour protection.

6.3.7 Earthworks Supervision

Engineering supervision of the earthwork's operation by a suitably qualified and experienced geotechnical engineer is recommended. It should be made clear in any earthworks specification as to what is required in terms of certification.

It is recommended that the following objectives be incorporated into the earthwork's specification:

- Engineering certification that all general earthworks operations have been carried out in accordance with the earthwork's specification.
- Engineering certification that fill has been placed and compacted to the required minimum density in accordance with the earthwork's specification.
- If required, engineering certification that the controlled fill material is suitable to support a conventional slab on ground floor.
- Engineering certification that the quality of the imported fill complied with the earthwork's specification requirements.

6.4 Site Classification

While a site classification in accordance with AS 2870 'Residential Slabs and Footings' relates to residential type construction, it is a valuable method of classification. Preliminary results suggest that, in accordance with AS 2870, the site can be classified as Class M. A ground surface movement of 20 mm to 40 mm should be anticipated. It is highly recommended that the footing system be designed to accommodate this anticipated ground surface movement.

6.5 Preliminary Foundation Recommendations

6.5.1 General

Considering the ground conditions encountered at this site, a combination of gravity and anchored footings could be constructed to support the wind turbine generators. These options are confirmed in the URS report (2011), where a foundation recommendation for each wind turbine has been presented. These recommendations and the foundation design will be progressed further once additional ground investigation data is available.

Considering a reinforced concrete gravity (spread as per Figure 2 below) footing system supporting the wind turbine generator, the lateral loads that result from a combination of high wind and earthquake hazards form the critical loading scenario for this foundation system. Such a scenario means that the footings must be suitably sized that the maximum bearing pressure is not exceeded on one side of the footing whilst the other side is experiencing uplift due to the overturning moments. To satisfy the above scenario, the resulting footing size can be quite large.

To reduce the footprint size and resist the uplift loads, an alternative footing system comprising anchors or piles can be considered. This system is only suitable when competent rock is present from foundation level to the full depth of the anchors or piles. The reason being that the smaller footing implies that the bearing pressures are greater and therefore the anchors or piles need to be able to resist the uplift loads and overturning moments.

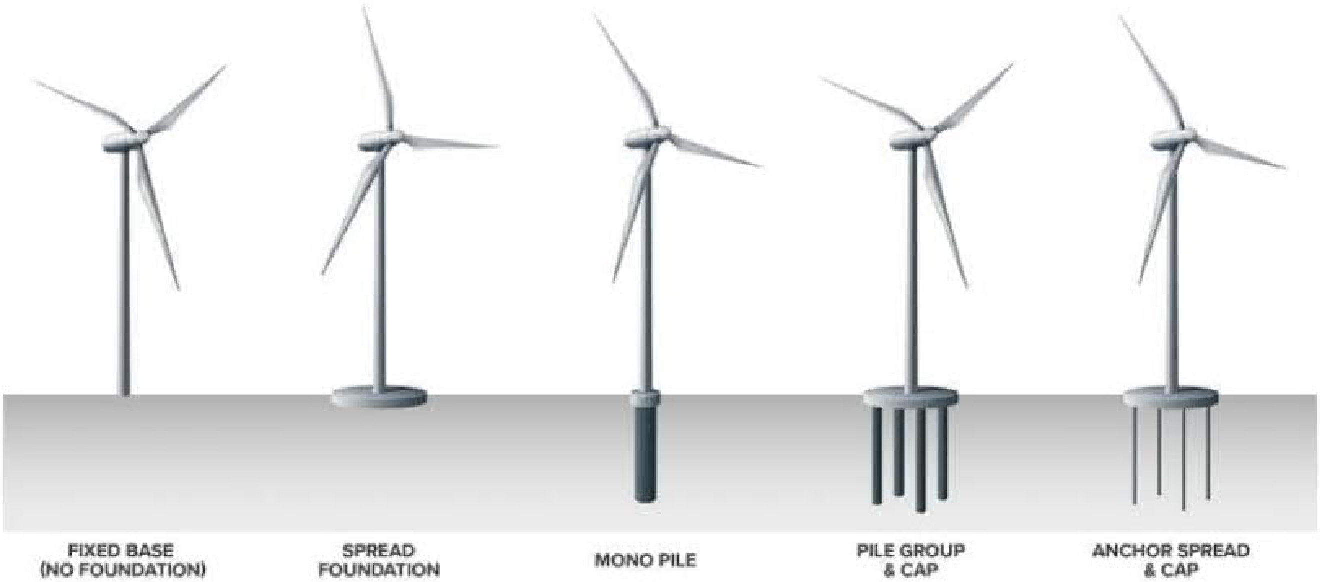


Figure 2 Wind Turbine Foundation Types

6.5.2 Shallow Footings – Gravity/Spread Footings

Based on the existing geotechnical investigation data, at a depth where gravity footings could be constructed, the ground conditions generally comprise extremely weathered to distinctly weathered basalt and siltstone. Until further geotechnical investigation is available for the site, the following foundation design parameters are recommended and presented in Table 13.

Table 13 Recommended Foundation Design Parameters

Material	Foundation Design Parameters		
	Allowable Bearing	Ultimate Bearing	Ultimate Bond Stress
Medium Strength Siltstone or Basalt	1.0 MPa	8.0 MPa	500 kPa
High Strength Basalt	3.5 MPa	30 MPa	2000 kPa

Notes:
All capacities and footing bases are subject to inspection by a geotechnical engineer.

6.5.3 Shallow Footings – Anchored Footings

The recommended foundation design parameters presented in Table 13 for High Strength Basalt can be used when designing the anchored footings. Additional site investigation comprising one or two boreholes to approximately 5 m beyond the end depth of the proposed anchor or pile will be required to confirm the ground conditions at depth.

6.6 Earthquake

In accordance with AS 1170.4-2007 'Structural design actions Part 4: Earthquake actions in Australia', the site had been assessed with the following sub-soil earthquake classification:

- Sub-soil Class: B_e
- Seismic hazard factor (Z): <0.09

6.7 Pavements

Provided that the relevant recommendations outlined in Section 6.3 are complied with, the following pavement design values, as presented in Table 14, may be adopted for the development.

Table 14 Design Values for Pavements

Material	CBR Value (%)
Sub grade materials with high clay content	2
Weathered Siltstone Bedrock	10

6.8 Retaining Walls

It is recommended that retaining walls are designed in accordance with AS 4768-2002. In conjunction with the geotechnical parameters presented in Table 15 presents geotechnical parameters for retaining wall design.

Table 15 Summary of Geotechnical Parameters for Retaining Wall Design

Material	Coefficient of Earth Pressure	Coefficient of Active Earth Pressure	Coefficient of Passive Earth Pressure
	(K_0)	(K_a)	(K_p)
Alluvial CLAY (Firm or Stiffer)	0.625	0.727	1.599
Residual Soil – Cohesive (Very Stiff or Stiffer)	0.561	0.695	1.781

Material	Coefficient of Earth Pressure	Coefficient of Active Earth Pressure	Coefficient of Passive Earth Pressure
	(K_0)	(K_a)	(K_p)
Residual Soil – Non-cohesive (Medium Dense or Denser)	0.470	0.654	2.127
XW Basalt/Siltstone	0.384	0.612	2.602

6.9 Construction Considerations

6.9.1 Adjacent Features/Excavation Characteristics

Where proposed or existing foundations are located within close proximity to proposed or existing features and/or excavations (i.e. Underground service trenches, unsupported batters etc.), the interaction between the foundation and the feature must be carefully considered. Generally, for underground service trenches, the following guidance is recommended.

- The base of the proposed footing should extend 500 mm below the base level of the trench and not be located within 1.0 m laterally from the trench.
- The base of the proposed pier should extend 1.0 m below the base level of the trench and not be located within 1.0 m laterally from the trench.

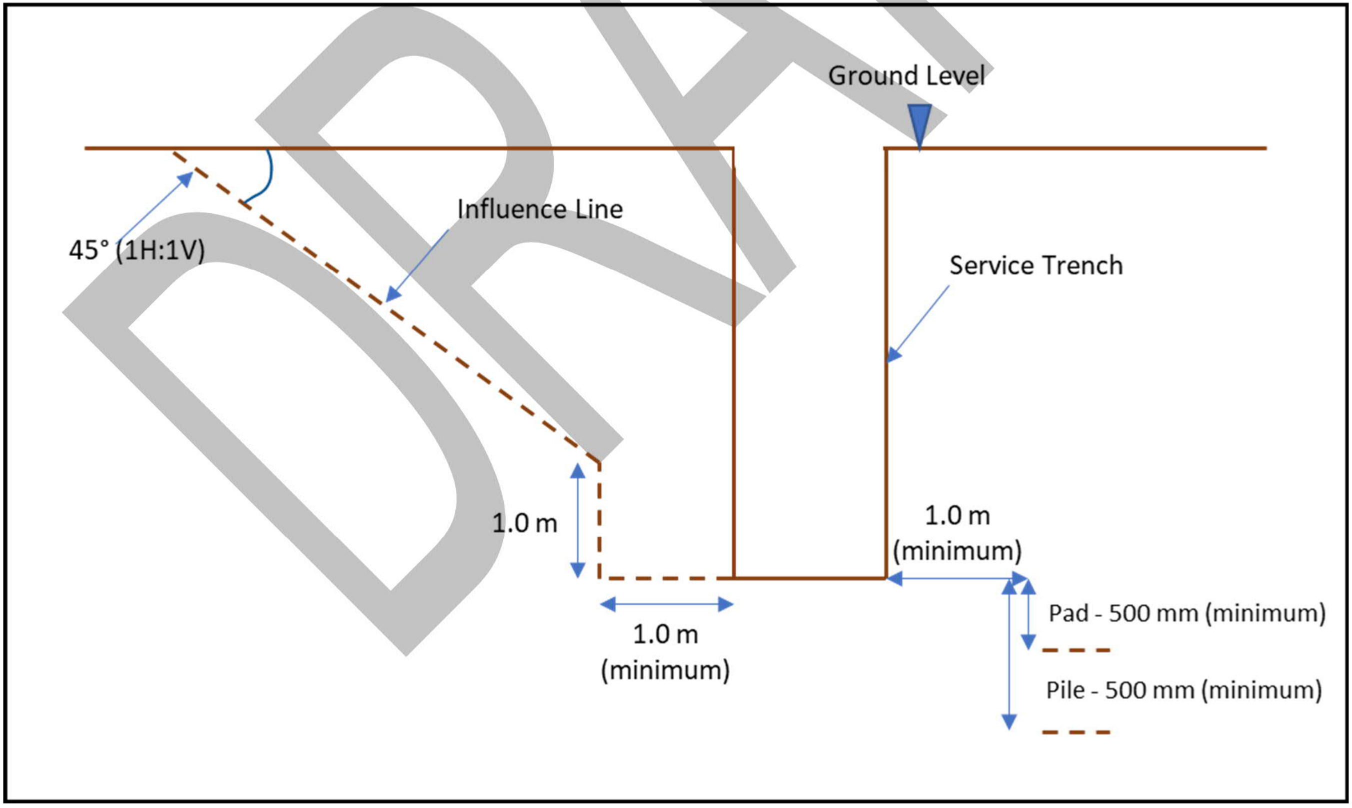


Figure 3 Service trench and foundation interaction guidance

6.9.2 High Level Footings

Given the properties of the founding materials, it is recommended that following excavation the footings be poured as soon as possible to minimise the potential for desiccation or wetting of the founding material. Where footings cannot be poured the same day as the excavation or within a short period of time, it is recommended that a blinding layer of concrete, at least 50 mm thick, be placed immediately following excavation, cleaning and inspection of the footing base by an experienced geotechnical engineer.

It is possible that shoring will be required to support the sides of the footing excavations to prevent side wall collapse. This is a risk in all material types, whether controlled, uncontrolled or natural and precautions should always be taken to ensure the pit sides are stable.

It is recommended that inspections be conducted by an experienced geotechnical engineer following footing excavations to confirm the adequacy of the founding soils, whether the material exposed at the base of footings is consistent with the geotechnical model and assumed bearing pressures. Inspections should be carried out prior to placement of reinforcing steel and ordering of concrete.

6.9.3 Anchors and Piles

Some difficulty with fall-in may occur, particularly when drilling through the non-cohesive upper-level soils. If bored piles are being constructed it should be ensured that all loose material is removed from the base of the piles prior to the pouring of concrete. The use of a ‘clean out’ bucket should be explicit in instructions to the drilling contractor.

Given the nature and strength of the subsurface material encountered, it is recommended that inspections be carried out by an experience geotechnical engineer during the pile excavation to confirm the adequacy of the founding material. Inspections should be carried out prior to placement of reinforcing steel and ordering of concrete.

Some allowance for dewatering and the use of liners should be made. In addition, it may be preferable to drill a ‘trial pile’ to fully assess construction difficulties. It is recommended that the pile holes be poured as soon as possible following boring.

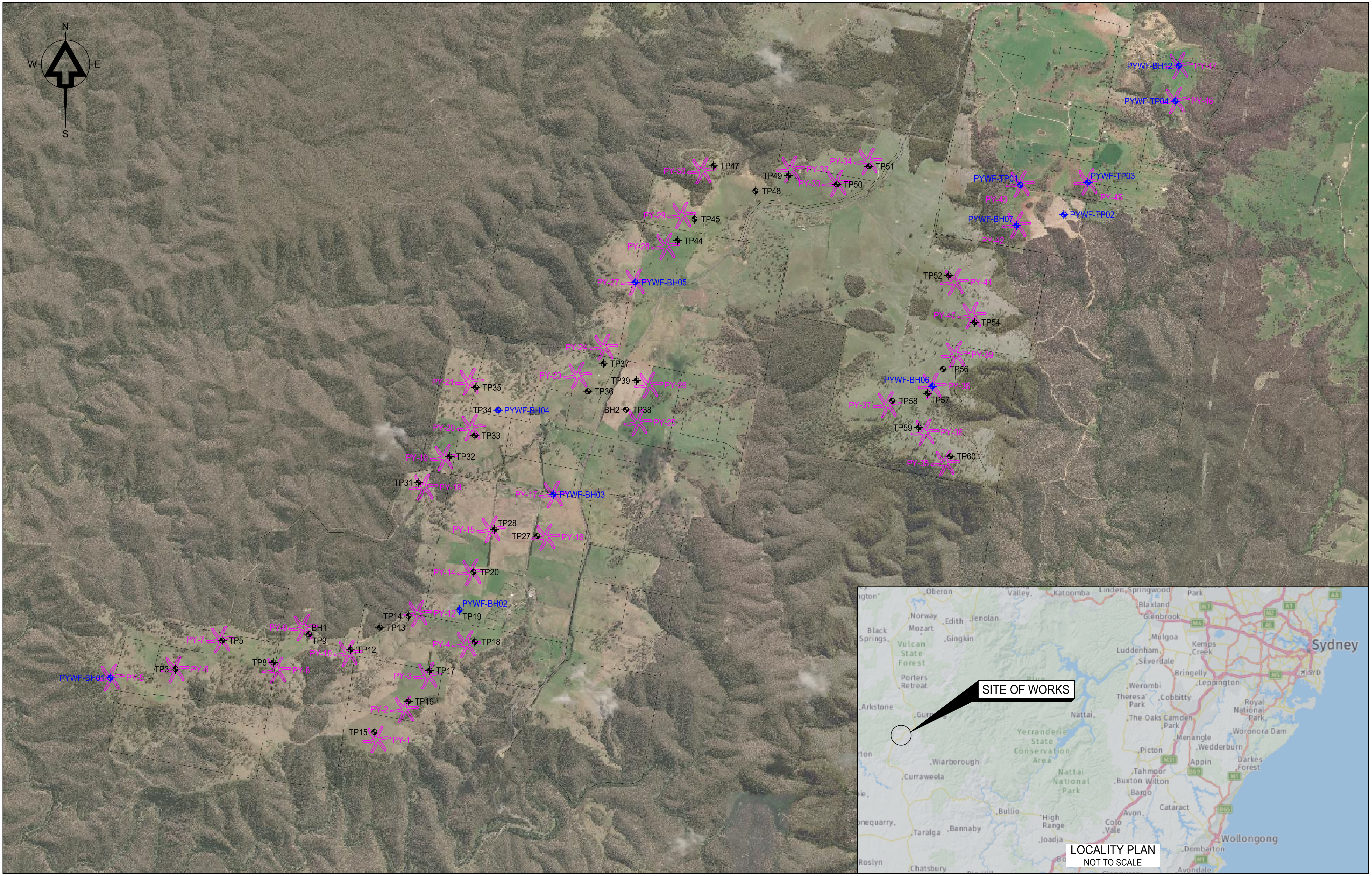
7 Feedback

At SLR, we are committed to delivering professional quality service to our clients. We are constantly looking for ways to improve the quality of our deliverables and our service to our clients. Client feedback is a valuable tool in helping us prioritise services and resources according to our client needs.

To achieve this, your feedback on the team's performance, deliverables and service are valuable and SLR welcome all feedback via https://www.slrconsulting.com/en/feedback. We recognise the value of your time and we will make a $10 donation to our 2022 Charity Partner – Lifeline, for every completed form.

APPENDIX A

Site Mapping



650.30012_Site Investigation Plan_v1.dwg

SLR

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The content contained within this document may be based on third party data.
SLR Consulting Australia Pty Ltd does not guarantee the accuracy of any such information.

Project No:	650.30012
Date:	29.08.2022
Drawn by:	JM
Scale:	1:40000
Sheet Size:	A3
Projection:	GDA94Z55

LEGEND

⌖	PROPOSED SLR TEST PIT / BOREHOLE LOCATIONS
⌖	EXISTING URS RELEVANT TEST PIT / BOREHOLE LOCATIONS
✳	PROPOSED TURBINES
-·-·	EXISTING SITE BOUNDARIES

0.0 400 800 1200 1600
METRES
SCALE 1:40000

PAILINGS YARD WIND FARM

GPG AUSTRALIA PTY LTD

SITE INVESTIGATION PLAN

FIGURE 01

APPENDIX B

Geotechnical Logs

NON-CORE BOREHOLE LOG

HOLE NO.: PYWF-BH02

PROJECT : Palings Yard Wind Farm and Transmission Line
LOCATION : Palings Yard
FILE / JOB NO.: 650.30012
DATE STARTED : 09-05-22
POSITION : E: 198699.21, N: 6214021.91 (MGA94)
SURFACE ELEVATION : 946m (AHD)
LOGGED BY : GL
DATE COMPLETED : 10-05-22
RIG TYPE : Hydrapower Scout
ANGLE FROM HORIZONTAL : 90°
CHECKED BY : BT
DATE LOGGED : 09-05-22
DRILLER : Scott, Daily
CONTRACTOR : Rockwell Drilling

DRILLING: PROGRESS – DRILLING &CASING	WATER	DRILLING PENETRATION (VE E F H)	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	RL (m)	DEPTH (m)	MATERIAL: GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION SOIL/ROCK TYPE; grain characteristics, colour, structure, minor components	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	OBSERVATION: ORIGIN	STRUCTURE & Other Observations
AD/T	Not Added						▨	ML	MIXTURE OF SOIL AND COBBLES/BOULDERS (MATRIX SUPPORTED) clayey SILT, low plasticity, dark brown; clay, low plasticity; , basalt, grey, orange brown, high strength; trace roots.	>PL	S	Topsoil	
				1.00m SPT (C) 8,14,14 N=28 1.50m	945	1	▨	CH	Silty CLAY, high plasticity, orange brown, brown; silt, high plasticity.		F - St	Alluvium	
					944	2	▨	MI	Clayey SILT, medium to high plasticity, brown, orange brown mottled, black speckled; clay, medium to high plasticity; with decomposed biotite.		VSt	Residual	1.50m: SPT Sample Length 450mm
							▨	CI - CH	Silty CLAY with sand, medium to high plasticity, brown; silt, medium to high plasticity; sand, fine to medium grained.		H		
				3.00m SPT (C) HB -	943	3	▨	SP	Clayey SAND, fine to coarse grained, red brown, yellow brown; clay, low plasticity.	D	D - VD		3.0m: pp > 600kPa high resistance 3.00m: SPT Sample Length 90mm
							▨		EXTREMELY WEATHERED BASALT, red brown, yellow brown.			Extremely Weathered Bedrock	
					942	4			See next page for rock logging below 3.50m				
					941	5							
					940	6							
					939	7							

CORED BOREHOLE LOG

HOLE NO.: PYWF-BH02

PROJECT : Palings Yard Wind Farm and Transmission Line
LOCATION : Palings Yard
FILE / JOB NO.: 650.30012

DATE STARTED : 09-05-22	POSITION : E: 198699.21, N: 6214021.91 (MGA94)	SURFACE ELEVATION : 946m (AHD)	LOGGED BY : GL
DATE COMPLETED : 10-05-22	RIG TYPE : Hydrapower Scout	ANGLE FROM HORIZONTAL : 90°	CHECKED BY : BT
DATE LOGGED : 09-05-22	DRILLER : Scott, Daily		
CASING DIAMETER : 115mm	BARREL LENGTH : 3.00m	BIT : Impreg	BIT CONDITION : Good

DRILLING

PROGRESS: DRILLING &CASING; WATER
TCR (%) / RQD (%)
SAMPLES & FIELD TESTS
RL (m)
DEPTH (m)

MATERIAL

GRAPHIC LOG
MATERIAL DESCRIPTION
SOIL/ROCK TYPE; grain characteristics, colour, structure, minor components
WEATHERING
STRENGTH Is^{50} ● - Axial ○ - Diametral (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)

DEFECT & OBSERVATION

NATURAL FRACTURE (mm) (20, 40, 100, 300, 1000)
VISUAL
STRUCTURE & Other Observations

RL / DEPTH: 945 – 1; 944 – 2; 943 – 3; 942 – 4; 941 – 5; 940 – 6; 939 – 7

0.00 – 3.50m: DRILLING &CASING: HW

See previous page for soil logging above 3.50m

3.50m onward: DRILLING &CASING: NMLC

WATER / TCR / RQD:
- 0% WATER LOSS – 100% TCR / 25% RQD
- 0% WATER LOSS – 97% TCR / 97% RQD
- 0% WATER LOSS – 100% TCR / 71% RQD

SAMPLES & FIELD TESTS:
- Is_{50}: I=3.54MPa
- **3.73m**
- **4.96m**
- Is_{50}: D=3.66MPa
- **5.46m**
- Is_{50}: A= 3.15MPa
- Is_{50}: A= 0.81MPa
- **5.91m**
- Is_{50}: D=1MPa
- **5.98m**
- Is_{50}: D=1.91MPa
- **6.58m**
- Is_{50}: A= 2.22MPa
- **6.59m**
- **6.62m**
- Is_{50}: A= 3.08MPa
- **6.80m**
- Is_{50}: D=1.18MPa
- **6.95m**
- Is_{50}:

MATERIAL DESCRIPTION:

BASALT, fine grained, red brown, amorphous, indistinct, frequent vesicles < 10mm and amygdules of olivine, elongated 10-20mm oriented at 40 degrees, medium strength, moderately weathered.

4.0m - 4.2m: Vesicles observed, 10-30mm diameter.

4.2m: Core filled with equal amount of vesicles and amygdules of olivine 10-20mm, elongated, oriented at 40 degrees, until 4.56m depth.

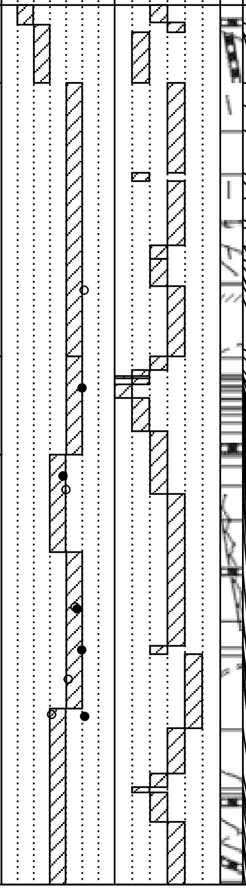
4.6m: Colour becoming dark grey, occasional quartz filled amygdules <10mm, no orientation.

5.0m: Infrequent mineral inclusions, yellow stained.

5.2m - 5.3m: Intact hairline healed fractures.

6.7m - 6.9m: Intact hairline healed fractures.

WEATHERING: MW; MW - SW; HW; MW - SW



STRUCTURE:
- 3.59m, IS, 0°-10°, IR,RF, clay
- 3.64m, JT, 20°, UN,RF, crushed rock infill
- 3.64-3.90m, IS, 80°, UN,RF, extremely weathered
- 4.01m, JT, 80°, UN,RF
- 4.14m, JT, 0°, IR,RF
- 4.36m, JT, 0°, PR, RF
- 4.40-4.49m, JT, 90°, UN,S
- 4.60-4.64m, CS, 20°, CU,RF, plagioclase
- 4.73m, JT, 20°, PR,S
- 4.73-4.80m, JT, 80°, UN,RF
- 4.84m, JT, 40°, PR,S
- 4.89-4.94m, JT, 0°-80°, CU,S, several breaks
- 5.00m, HB, 0°, PR,RF, stained
- 5.26m, DB
- 5.30m, JT, 0°, IR,RF
- 5.37m, JT, 0°, UN,RF
- 5.40m, JT, 0°, UN,RF
- 5.41m, JT, 0°, UN,RF
- 5.44m, JT, 0°, IR,RF
- 5.45m, JT, 0°, UN,RF
- 5.47m, JT, 0°-20°, UN,RF
- 5.49m, JT, 0°, PR, RF
- 5.51m, JT, 0°, PR, RF
- 5.55m, JT, 0°, PR, RF
- 5.56m, JT, 0°, PR, RF
- 5.59m, JT, 0°-10°, UN,RF
- 5.63m, JT, 0°, IR,RF, yellow stained
- 5.68m, JT, 0°, IR,RF
- 5.74-5.80m, IS, 0°, IR,RF, olivine
- 5.80m, JT, 0°, IR,RF
- 5.85m, JT, 0°, IR,RF
- 5.95m, JT, 0°, IR,RF, closed joint
- 6.00-6.70m, CS, 80°-90°, UN,RF, red mineral observed as veneer
- 6.13m, JT, 0°, IR,RF
- 6.40m, IS, 0°-90°, IR,RF, Orange brown staining, mineral infill - plagioclase
- 6.63m, JT, 0°, IR,RF, clean
- 6.78m, JT, 0°, UN,RF
- 6.82m, JT, 0°-10°, UN,RF
- 6.90m, DB
- 6.92m, DB
- 7.20m, JT, 0°-50°, IR,RF
- 7.43m, JT, 20°, CU,RF
- 7.50m, JT, 0°, IR,RF

See Symbology & Classification notes for details of abbreviations & basis of descriptions.

Generated with CORE-GS by Geroc - SLR Borehole - Soil + Rock - 09-Aug-2022 12:37:32 PM

CORED BOREHOLE LOG

HOLE NO.: PYWF-BH02

PROJECT : Palings Yard Wind Farm and Transmission Line
LOCATION : Palings Yard
FILE / JOB NO.: 650.30012
DATE STARTED : 09-05-22
POSITION : E: 198699.21, N: 6214021.91 (MGA94)
SURFACE ELEVATION : 946m (AHD)
LOGGED BY : GL
DATE COMPLETED : 10-05-22
RIG TYPE : Hydrapower Scout
ANGLE FROM HORIZONTAL : 90°
CHECKED BY : BT
DATE LOGGED : 09-05-22
DRILLER : Scott, Daily
CASING DIAMETER : 115mm
BARREL LENGTH : 3.00m
BIT : Impreg
BIT CONDITION : Good

DRILLING

DRILLING &CASING	WATER	TCR (%) / RQD (%)
NMLC	0% WATER LOSS	100% TCR / 71% RQD
	0% WATER LOSS	100% TCR / 47% RQD
	0% WATER LOSS	97% TCR / 53% RQD
	0% WATER LOSS	100% TCR / 0% RQD
	0% WATER LOSS	97% TCR / 60% RQD
	0% WATER LOSS	100% TCR / 10% RQD

SAMPLES & FIELD TESTS

D=0.36MPa
7.13m
Is_{50}: A= 3.81MPa
7.14m
8.13m
Is_{50}: D=1.72MPa
Is_{50}: A= 2.21MPa
8.20m
Is_{50}: D=0.73MPa
9.14m
9.20m
Is_{50}: A= 2.58MPa
Is_{50}: D=0.1MPa
10.20m
Is_{50}: A= 3.02MPa
10.21m
Is_{50}: A= 2.04MPa
11.05m
11.14m
Is_{50}: D=1.38MPa
Is_{50}: D=2.57MPa
12.05m
12.12m
Is_{50}: D=2.26MPa
12.13m
Is_{50}: A= 0.61MPa
Is_{50}: A= 2.12MPa
12.14m
12.48m
Is_{50}: D=1.62MPa
12.49m
Is_{50}: A= 2.09MPa
12.52m
Is_{50}: D=0.29MPa
12.78m
12.79m
Is_{50}: A= 2.19MPa
13.05m
Is_{50}: D=0.82MPa
Is_{50}: A= 1.01MPa
13.06m
Is_{50}: D=1.12MPa
14.05m
14.06m
Is_{50}: A= 2.27MPa
14.10m
Is_{50}: D=2.14MPa

RL (m)	DEPTH (m)
937	9
936	10
935	11
934	12
933	13
932	14
931	15

MATERIAL

GRAPHIC LOG

MATERIAL DESCRIPTION
SOIL/ROCK TYPE; grain characteristics, colour, structure, minor components

9.1m: Intact hairline healed fractures until 9.60m depth.

11.0m: Infrequent plagioclase inclusions<1mm until 14.10m depth.

11.0m - 11.2m: Intact hairline healed fractures.

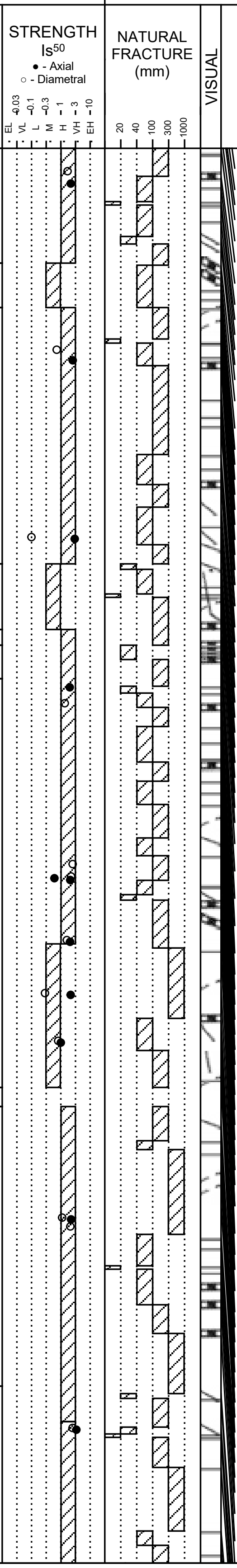
CORE LOSS

BASALT, fine grained, red brown, amorphous, indistinct, frequent vescicles < 10mm and amygdulesof olivine, elongated 10-20mm orientated at 40 degrees, medium strength, moderately weathered.

14.7m - 15.0m: Olivine amygdules observed.

WEATHERING

MW - SW
HW
MW - SW
HW
MW - SW
HW
SW
F
SW



DEFECT & OBSERVATION

STRUCTURE
& Other Observations

7.53m, JT, 0°, IR,RF
7.58m, IS, 0°, IR,RF, white mineral stains - olivine
7.68m, JT, 30°, IR,RF, red stains
7.76m, DB
7.79m, JT, 20°, UN,RF
7.90m, IS, 20°, UN,RF, stained red and orange - plagioclase
8.00m, JT, 0°, UN,RF
8.16m, IS, 0°-10°, IR,RF, red stains - plagioclase
8.22m, JT, 0°, IR,RF, red stains
8.30m, JT, 0°, IR,RF
8.32m, JT, 0°, IR,RF, closed joint
8.41m, JT, 0°, IR,RF
8.50m, JT, 30°, CU,RF, yellow stains
8.54m, JT, 30°, UN,RF
8.66m, IS, 30°, UN,RF, yellow orange stains - plagioclase
8.73m, IS, 30°, UN,RF, orange stain - plagioclase
8.80m, JT, 0°, IR,RF
8.85m, JT, 0°, UN,RF
8.90m, JT, 0°, UN,RF
8.92m, DB
9.00m, DB
9.08m, JT, 0°, CU,S
9.10m, JT, 0°, IR,RF
9.18m, JT, 0°-10°, IR,RF, red stains
9.23m, IS, 0°, UN,RF, plagioclase
9.37-9.46m, JT, 0°-90°, IR,RF
9.46-9.57m, JT, 0°-40°, highly fractured zone
9.57m, JT, 0°, IR,RF
9.73m, JT, 0°, IR,RF
9.81m, JT, 0°, IR,RF
9.90m, IS, 0°, PR, RF
10.03m, JT, 40°, PR,S
10.12m, JT, 0°, IR,RF
10.19m, JT, 40°, IR,RF
10.24m, JT, 20°, CU,S
10.35m, JT, 20°-30°, IR,RF
10.38-10.73m, JT, 80°-90°, IR,RF
10.46m, JT, 0°, IR,RF
10.52m, JT, 0°, IR,RF
10.54m, JT, 0°, IR,RF
10.59m, DB
10.70m, IS, 0°, IR,RF, plagioclase - yellow orange
10.81m, IS, 0°, IR,RF, plagioclase - yellow
10.84m, IS, 0°, IR,RF, plagioclase - yellow
10.87m, IS, 0°, IR,RF, plagioclase - yellow
10.89m, IS, 0°, IR,RF, plagioclase - yellow
11.04m, JT, 0°-10°, IR,RF
11.08m, JT, 0°, PR,S
11.16m, IS, 0°, IR,RF, plagioclase
11.27m, JT, 0°, PR,RF
11.36m, JT, 0°, IR,RF
11.41-11.47m, JT, 0°-80°, IR, RF
11.47-11.53m, IS, 0°, IR,RF, plagioclase
11.58m, JT, 0°, IR,RF
11.64m, JT, 0°, IR,RF
11.71m, JT, 0°-40°, IR,RF
11.81m, DB
11.90m, JT, 20°-30°, IR,RF
12.00m, JT, 0°, IR,RF
12.14-12.19m, JT, 0°-90°, IR, RF
12.22m, JT, 30°, PR,S
12.25-12.32m, IS, 0°-80°, UN,RF, plagioclase - red stain
12.37m, IS, 20°-30°, UN,RF, plagioclase - red stain
12.52m, JT, 0°, IR,RF
12.74m, DB
12.92m, IS, 0°, IR,RF, plagioclase - red orange stain
13.00m, JT, 50°, IR,RF
13.10-13.23m, JT, 80°, PR,RF
13.25m, JT, 0°, IR,RF
13.28m, DB
13.50m, JT, 20°, IR,RF
13.61m, JT, 0°-90°, IR,RF
13.66-13.71m, JT, IR,RF
13.82-13.97m, DB
13.82m, DB
14.14-14.18m, JT, 0°, IR,RF
14.22m, JT, 0°, IR,RF
14.32m, JT, 0°, IR,RF
14.34m, JT, 0°, IR,RF
14.44m, IS, 0°, IR,RF, plagioclase - red stain
14.54m, IS, 0°, IR,RF, plagioclase - red stain

See Symbology & Classification notes for details of abbreviations & basis of descriptions.

CORED BOREHOLE LOG

HOLE NO.: PYWF-BH02

PROJECT : Palings Yard Wind Farm and Transmission Line
LOCATION : Palings Yard
FILE / JOB NO.: 650.30012
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ANGLE FROM HORIZONTAL : 90°
CHECKED BY : BT
DATE LOGGED : 09-05-22
DRILLER : Scott, Daily
CASING DIAMETER : 115mm
BARREL LENGTH : 3.00m
BIT : Impreg
BIT CONDITION : Good

DRILLING

PROGRESS: DRILLING &CASING | WATER — TCR (%) / RQD (%) — SAMPLES & FIELD TESTS — RL (m) — DEPTH (m)

DRILLING &CASING: NMLC

WATER / TCR (%) / RQD (%):

WATER	TCR (%) / RQD (%)
0% WATER LOSS	100% TCR / 10% RQD
0% WATER LOSS	100% TCR / 10% RQD
0% WATER LOSS	100% TCR / 48% RQD

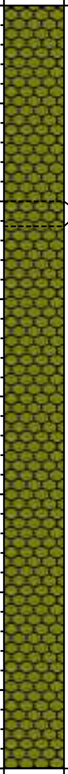
SAMPLES & FIELD TESTS:

15.24m
Is_{50}: D=2.54MPa
Is_{50}: A= 3.44MPa
15.25m
16.16m
Is_{50}: D=0.2MPa
16.17m
Is_{50}: A= 2.76MPa
Is_{50}: D=1.24MPa
17.30m
17.40m
Is_{50}: D=0.9MPa
17.80m
Is_{50}: A= 3.85MPa
18.06m
Is_{50}: D=1.04MPa
Is_{50}: A= 2.38MPa
18.07m
19.25m
Is_{50}: A= 5.03MPa
Is_{50}: A= 5.97MPa
19.26m

RL (m)	DEPTH (m)
929	17
928	18
927	19
926	20
925	21
924	22
923	23

MATERIAL

GRAPHIC LOG



MATERIAL DESCRIPTION
SOIL/ROCK TYPE; grain characteristics, colour, structure, minor components

17.0m - 17.1m: Plagioclase inclusions.

EOH: 19.90m - Target depth

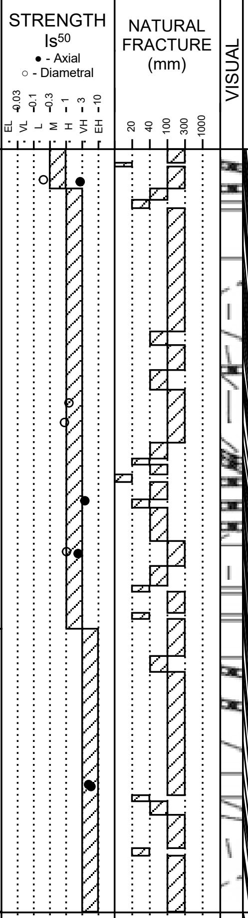
WEATHERING: SW; F

STRENGTH Is^{50}
● - Axial
○ - Diametral

DEFECT & OBSERVATION

NATURAL FRACTURE (mm)

VISUAL



STRUCTURE & Other Observations

14.70m, IS, 0°, IR,RF, plagioclase - yellow stain
15.04m, JT, 30°, IR,RF
15.07m, JT, 0°, IR,RF
15.23m, JT, 30°, IR,RF
15.27m, JT, 0°, IR,RF
15.29m, JT, 0°, IR,RF
15.46m, JT, 0°, IR,RF
15.82m, JT, 0°, UN,RF
15.90-16.00m, JT, 0°, UN,RF
16.07m, JT, 10°, IR,RF
16.09m, IS, 10°, IR,RF, plagioclase - yellow stain
16.20m, IS, 0°, IR,RF
16.26m, JT, 0°, IR,RF
16.30m, JT, 0°, IR,RF
16.50-16.60m, JT, 0°, IR,RF
16.67-16.75m, DB
16.79-16.87m, JT, 90°, IR,RF
16.93m, JT, 20°, UN,RF
17.00-17.13m, JT, 80°, IR,RF
17.13m, IS, 0°, IR,RF, plagioclase
17.18m, JT, 40°, CU,RF
17.23-17.40m, JT, 90°, PR,RF
17.50m, JT, 40°, UN,RF
17.58m, IS, 20°, PR,RF, plagioclase
17.61m, IS, 20°, PR,RF, plagioclase
17.66m, JT, 0°, PR,RF
17.68m, JT, 0°, PR,RF
17.70m, IS, 0°, ST,RF, plagioclase - red stain
17.79m, JT, 0°, UN,RF, plagioclase
17.83m, IS, 0°, UN,RF, plagioclase
17.93m, IS, 0°, UN,RF, plagioclase
17.97m, DB
18.00m, JT, 0°, PR,S
18.13-18.20m, JT, 90°, UN,RF
18.23m, JT, 0°, CU,RF
18.26m, JT, 0°, UN,RF
18.37m, JT, 0°, IR,RF
18.40m, JT, 0°, PR,S
18.59m, JT, 0°, PR,S
18.67m, IS, 10°, UN,RF, plagioclase
18.84m, IS, 10°, UN,RF, plagioclase
19.03m, JT, 20°, UN,RF
19.18m, JT, 0°, IR,RF
19.30m, JT, 0°, PR,S
19.33m, JT, 20°, PR,S
19.40m, JT, 10°, UN,RF
19.57m, JT, 80°, IR,RF
19.61-19.90m, DB

See Symbology & Classification notes for details of abbreviations & basis of descriptions.

PYWF-BH02 3.50m to 7.00m

PYWF-BH02 7.00m to 11.00m

File Location: \\AU.SLR.Local\Corporate\Projects-SLR\650-ADL\650.30012.00000 Palings Yard Wind Farm and Transmission\06 SLR Data\07 Core GS

LEVEL 1, THE CENTRAL BUILDING
UOW INNOVATION CAMPUS,
SQUIRES WAY
WOLLONGONG
NEW SOUTH WALES 2500
AUSTRALIA
T: 61 2 9428 8100
F: 61 2 9428 8100
www.slrconsulting.com

Title:	PYWF BH02 CORE	Drawn:	GL
Client:	GPG	Reviewed:	NB
Project:	Paling Yards Wind Farm and Transmission Line	Size:	A4
Project No.:	650.30012.00000	Datum:	None
Status:	Final	Version:	1.0
Date:	13/05/2022		

GPG
Naturgy Group

CLIENT NAME: GPG
PROJECT: WIND FARM GI
LOCATION: PALING YARDS
JOB NUMBER: 650·30012
LOGGED BY: G·L
BOREHOLE ID: PYWF-BH02
DEPTH: 11·00m - 15·00m
CORE TRAY NO: 3/5
DATE: 10-05-22

PYWF-BH02 11.00m to 15.00m

CLIENT NAME: GPG
PROJECT: WIND FARM GI
LOCATION: PALING YARDS
JOB NUMBER: 650·30012
LOGGED BY: G·L
BOREHOLE ID: PYWF-BH02
DEPTH: 15·00m - 19·00m
CORE TRAY NO: 4/5
DATE: 10-05-22

PYWF-BH02 15.00m to 19.00m

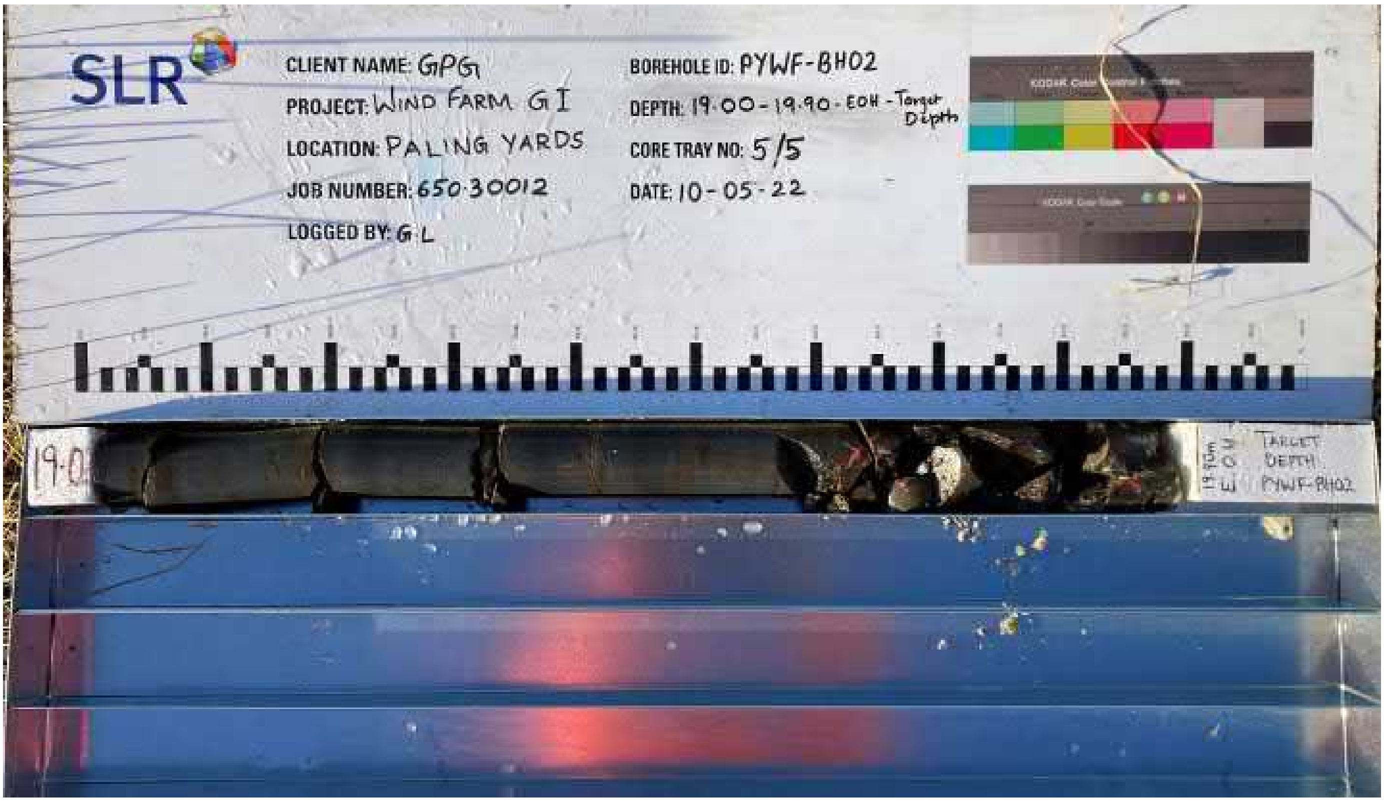
File Location: \\AU.SLR.Local\Corporate\Projects-SLR\ 650-ADL\650.30012.00000 Palings Yard Wind Farm and Transmission\06 SLR Data\07 Core GS

LEVEL 1, THE CENTRAL BUILDING
UOW INNOVATION CAMPUS,
SQUIRES WAY
WOLLONGONG
NEW SOUTH WALES 2500
AUSTRALIA
T: 61 2 9428 8100
F: 61 2 9428 8100
www.slrconsulting.com

Title: PYWF BH02 CORE
Client: GPG
Project: Paling Yards Wind Farm and Transmission Line
Project No.: 650.30012.00000
Status: Final
Date: 13/05/2022

Drawn: GL
Reviewed: NB
Size: A4
Datum: None
Version: 1.0

GPG
Naturgy Group



DM00472-BH01 7.50m to 11.00m

File Location: \\AU.SLR.Local\Corporate\Projects-SLR\650-ADL\650.30012.00000 Palings Yard Wind Farm and Transmission\06 SLR Data\07 Core GS

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F: 61 2 9428 8100
www.slrconsulting.com

Title:	PYWF BH02 CORE	Drawn:	GL
Client:	GPG	Reviewed:	NB
Project:	Paling Yards Wind Farm and Transmission Line	Size:	A4
Project No.:	650.30012.00000	Datum:	None
Status:	Final	Version:	1.0
Date:	13/05/2022		

GPG
Naturgy Group

NON-CORE BOREHOLE LOG

HOLE NO.: PYWF-BH03

PROJECT : Palings Yard Wind Farm and Transmission Line
LOCATION : Palings Yard
FILE / JOB NO.: 650.30012

DATE STARTED : 11-05-22	POSITION : E: 199691.57, N: 6215408.11 (MGA94)	SURFACE ELEVATION : 972m (AHD)	LOGGED BY : GL
DATE COMPLETED : 11-05-22	RIG TYPE : Hydrapower Scout	ANGLE FROM HORIZONTAL : 90°	CHECKED BY : BT
DATE LOGGED : 11-05-22	DRILLER : Scott, Daily	CONTRACTOR : Rockwell Drilling	

DRILLING

PROGRESS: DRILLING &CASING	PROGRESS: WATER	DRILLING PENETRATION (VE E F H)	GROUND WATER LEVELS
AD/T	Not Added		

SAMPLES & FIELD TESTS
0.50m
SPT (C) 5,7,8 N=15 1.50m
SPT (C) 5,7,15 N=22 3.00m
SPT (C) 8,12,20 N=41 4.50m

RL (m)	DEPTH (m)
971	1
970	2
969	3
968	4
967	5
966	6
965	7

MATERIAL

CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION SOIL/ROCK TYPE; grain characteristics, colour, structure, minor components	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	ORIGIN
CL	Silty sandy CLAY trace organic matter (root fibres less than 2mm diameter), low plasticity, dark brown; silt, low plasticity, sand, fine grained.	<PL	F	Topsoil
CI - CH	Sandy CLAY, low to medium plasticity, orange brown; sand, fine to medium grained.		F - St	Alluvium
CH	CLAY with sand trace gravel, high plasticity, grey, yellow and mottled orange; sand, fine to coarse grained; gravel, fine grained, sub-rounded, 3mm. 1.2m - 2.7m: Colour changes to dark brown and transition back to grey, mottled orange.	>>PL <LL	St	Residual
	CLAY, high plasticity, grey, mottled orange and white.			
CI	Silty CLAY with sand, medium plasticity, yellow brown, mottled orange; silt, medium plasticity; sand, fine to medium grained; trace rock fragments, 3-5mm size. 4.0m: Colour changes to grey and transition back to brown, mottled orange.		VSt	
ML	Clayey SILT with sand, low plasticity, orange brown, yellow grey; clay, low plasticity; sand, fine to medium grained.		H	
CI	Silty CLAY with sand, medium plasticity, orange brown; silt, medium plasticity; sand, fine grained.			
	EXTREMELY WEATHERED BASALT, grey, high strength, moderately weathered.	D		Extremely Weathered Bedrock

See next page for rock logging below 5.60m

OBSERVATION

STRUCTURE & Other Observations

1.5m - 2.0m: pp = 200-300kPa
1.50m: SPT Sample Length 450mm

3.0m - 3.5m: pp = 200-250kPa
3.00m: SPT Sample Length 450mm

4.5m - 5.0m: pp = 400-500kPa
4.50m: SPT Sample Length 450mm

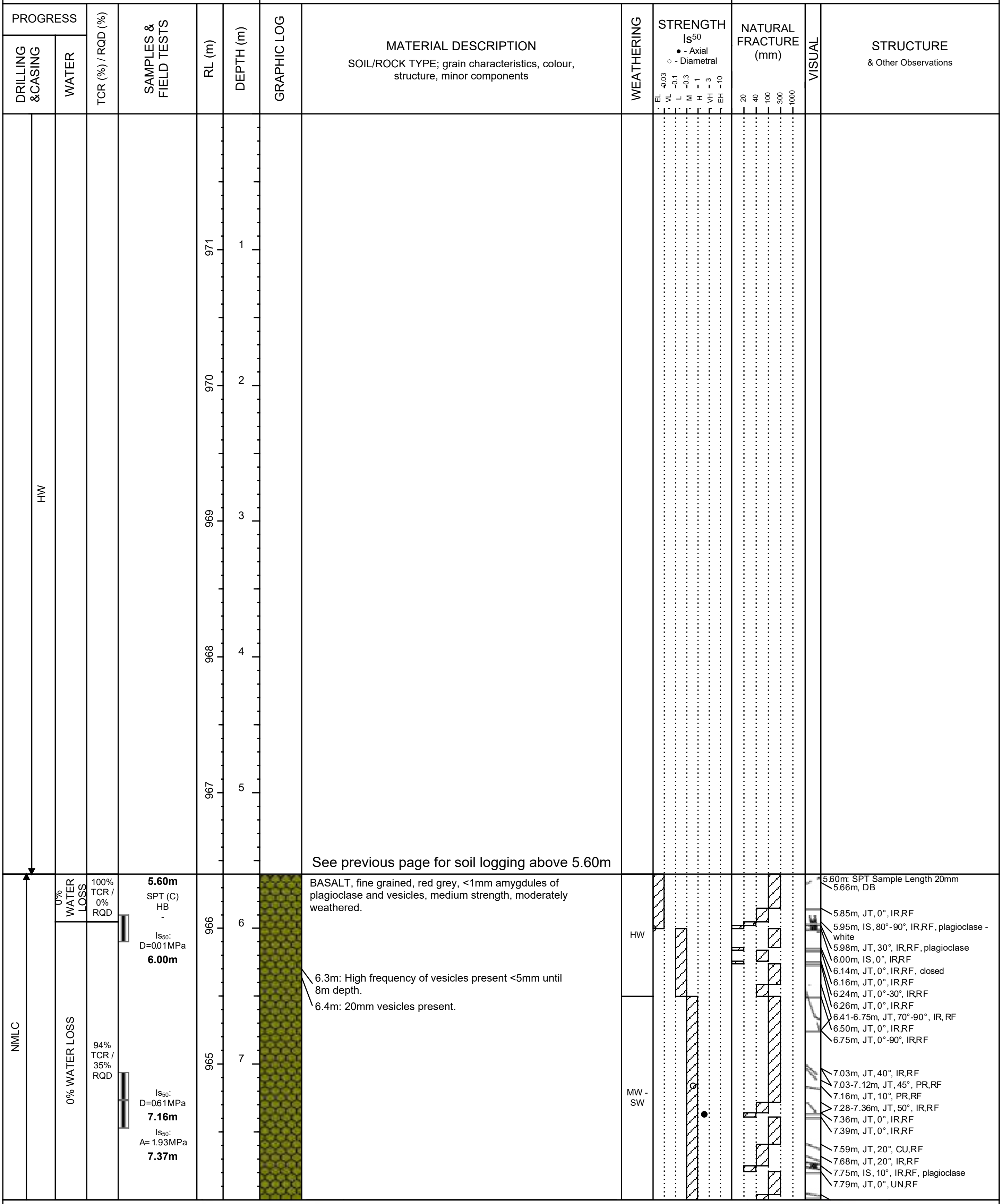
5.60m: SPT Sample Length 20mm

See Symbology & Classification notes for details of abbreviations & basis of descriptions.

CORED BOREHOLE LOG

HOLE NO.: PYWF-BH03

PROJECT : Palings Yard Wind Farm and Transmission Line
LOCATION : Palings Yard
FILE / JOB NO.: 650.30012
DATE STARTED : 11-05-22
POSITION : E: 199691.57, N: 6215408.11 (MGA94)
SURFACE ELEVATION : 972m (AHD)
LOGGED BY : GL
DATE COMPLETED : 11-05-22
RIG TYPE : Hydrapower Scout
ANGLE FROM HORIZONTAL : 90°
CHECKED BY : BT
DATE LOGGED : 11-05-22
DRILLER : Scott, Daily
CASING DIAMETER : 115mm
BARREL LENGTH : 3.00m
BIT : Impreg
BIT CONDITION : Good



See previous page for soil logging above 5.60m

DRILLING & CASING	WATER	TCR (%) / RQD (%)	SAMPLES & FIELD TESTS	WEATHERING
HW (to 5.60m)				
NMLC	0% WATER LOSS	100% TCR / 0% RQD	**5.60m** SPT (C) HB - Is_{50}: D=0.01MPa **6.00m**	HW
	0% WATER LOSS	94% TCR / 35% RQD	Is_{50}: D=0.61MPa **7.16m** Is_{50}: A= 1.93MPa **7.37m**	MW - SW

BASALT, fine grained, red grey, <1mm amygdules of plagioclase and vesicles, medium strength, moderately weathered.

6.3m: High frequency of vesicles present <5mm until 8m depth.

6.4m: 20mm vesicles present.

5.60m: SPT Sample Length 20mm
5.66m, DB
5.85m, JT, 0°, IR,RF
5.95m, IS, 80°-90°, IR,RF, plagioclase - white
5.98m, JT, 30°, IR,RF, plagioclase
6.00m, IS, 0°, IR,RF
6.14m, JT, 0°, IR,RF, closed
6.16m, JT, 0°, IR,RF
6.24m, JT, 0°-30°, IR,RF
6.26m, JT, 0°, IR,RF
6.41-6.75m, JT, 70°-90°, IR, RF
6.50m, JT, 0°, IR,RF
6.75m, JT, 0°-90°, IR,RF
7.03m, JT, 40°, IR,RF
7.03-7.12m, JT, 45°, PR,RF
7.16m, JT, 10°, PR,RF
7.28-7.36m, JT, 50°, IR,RF
7.36m, JT, 0°, IR,RF
7.39m, JT, 0°, IR,RF
7.59m, JT, 20°, CU,RF
7.68m, JT, 20°, IR,RF
7.75m, IS, 10°, IR,RF, plagioclase
7.79m, JT, 0°, UN,RF

See Symbology & Classification notes for details of abbreviations & basis of descriptions.

CORED BOREHOLE LOG

HOLE NO.: PYWF-BH03

PROJECT : Palings Yard Wind Farm and Transmission Line
LOCATION : Palings Yard
FILE / JOB NO.: 650.30012

DATE STARTED : 11-05-22
POSITION : E: 199691.57, N: 6215408.11 (MGA94)
SURFACE ELEVATION : 972m (AHD)
LOGGED BY : GL

DATE COMPLETED : 11-05-22
RIG TYPE : Hydrapower Scout
ANGLE FROM HORIZONTAL : 90°
CHECKED BY : BT

DATE LOGGED : 11-05-22
DRILLER : Scott, Daily

CASING DIAMETER : 115mm
BARREL LENGTH : 3.00m
BIT : Impreg
BIT CONDITION : Good

DRILLING

DRILLING &CASING	WATER	TCR (%) / RQD (%)	SAMPLES & FIELD TESTS
NMLC	0% WATER LOSS	94% TCR / 35% RQD	Is50: D=2.6MPa **8.23m** Is50: A=0.23MPa **8.30m**
	0% WATER LOSS	69% TCR / 40% RQD	**9.14m** Is50: D=2.28MPa Is50: A=0.54MPa **9.15m**
	0% WATER LOSS	100% TCR / 62% RQD	**10.25m** Is50: D=0.23MPa **10.26m** Is50: A=0.44MPa **11.06m** Is50: D=2.41MPa **11.07m** Is50: A=2.33MPa
	0% WATER LOSS	100% TCR / 90% RQD	Is50: D=0.25MPa **12.07m** Is50: A=0.12MPa **12.24m** Is50: D=0.98MPa **13.40m** Is50: A=1.78MPa **13.41m** **14.48m** Is50: A=1.48MPa **14.63m**
	0% WATER LOSS	100% TCR / 79% RQD	Is50: D=0.89MPa **15.06m** Is50: D=3.16MPa Is50: A=2.97MPa **15.07m**

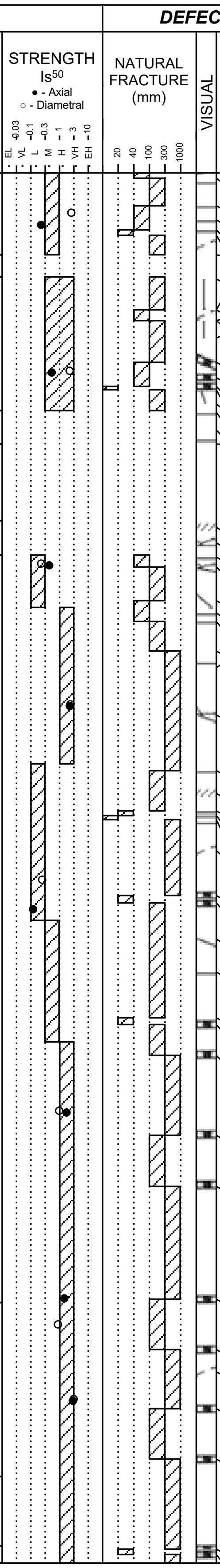
RL (m): 963 (9), 962 (10), 961 (11), 960 (12), 959 (13), 958 (14), 957 (15)

MATERIAL

MATERIAL DESCRIPTION
SOIL/ROCK TYPE; grain characteristics, colour, structure, minor components

DEPTH (m)	MATERIAL DESCRIPTION	WEATHERING
		MW - SW
	CORE LOSS.	
9	BASALT, fine grained, reddish brown, amygdules of plagioclase, medium strength, moderately weathered. 8.6m: Veins of red minerals present; intact healed micro fractures observed until 8.79m depth. 9.4m: Rock colour transitions to reddish brown. 9.4m: Plagioclase evident in the form of lenses and in amygdule form, 0-20 degrees oriented, orange-white colour until 13.6m depth.	MW - SW
	9.5m - 9.6m: Clayey SAND, fine to coarse grained, white; clay, low plasticity; Behaves as soil .	EW
	CORE LOSS.	
10	BASALT, fine grained, reddish brown to grey, vesicles and amygdules of plagioclase, medium strength, moderately weathered.	EW
11	10.5m: Infilled seam of olivine observed. 10.9m: Frequent vesicles 3-10mm until 16.60m depth.	HW
12–14	13.0m: 15mm vesicle observed. 13.1m: Thin lens of plagioclase runs through core, oriented at 80-90 degrees until 13.40m depth. 13.4m: Infrequent 15-20mm vesicles until 15.50m depth.	HW
15		MW - SW
		F
		MW -

DEFECT & OBSERVATION



STRUCTURE
& Other Observations

- 7.96m, JT, 10°-20°, UN, RF
- 8.03m, JT, 0°-90°, UN,RF
- 8.19m, JT, 0°, PR, S
- 8.27m, JT, 0°-10°, PR, S
- 8.33m, JT, 0°, UN,RF
- 8.36-8.47m, DB
- 8.61-8.79m, JT, 90°, IR,RF, closed joint
- 8.79-8.85m, DB
- 8.85-8.95m, JT, 90°, IR,RF, closed joint
- 9.09m, IS, 20°-30°, UN,RF, plagioclase
- 9.18m, IS, 0°-30°, IR,RF, plagioclase
- 9.23m, IS, 0°-30°, IR,RF, plagioclase
- 9.25-9.33m, JT, 70°-80°, IR, RF
- 9.38m, JT, 0°, IR,RF
- 9.48-9.56m, JT, 0°, IR,RF
- 10. 04m, HB
- 10. 13m, CS, 0°, IR,RF, plagioclase
- 10. 21m, JT, 0°, IR,RF
- 10. 27m, CS, 10°, IR,RF, plagioclase
- 10. 46m, JT, 40°-50°, IR,RF
- 10. 53m, JT, 0°, IR,RF
- 10. 58m, JT, 0°, IR,RF, olivine
- 10. 75-10.85m, JT, 0°, IR,RF
- 11. 12m, CS, 20°, CU,RF, plagioclase
- 11. 44m, JT, 0°, UN,RF
- 11. 57m, HB
- 11. 67m, JT, 0°, IR,RF, plagioclase
- 11. 70m, JT, 0°, IR,RF, plagioclase
- 11. 72m, JT, 0°, IR,RF, plagioclase
- 11. 90m, DB
- 12. 16m, IS, 0°, IR,RF, plagioclase
- 12. 20m, IS, 0°, IR,RF, plagioclase
- 12. 41m, JT, 20°, IR,RF, closed joint
- 12. 60m, JT, 0°, IR,RF
- 12. 86m, JT, 0°, IR,RF
- 12. 90m, IS, 0°, IR,RF, olivine
- 13. 08m, IS, 0°, IR,RF, plagioclase and olivine
- 13. 54m, IS, 0°, IR,RF, plagioclase
- 13. 83m, IS, 0°, IR,RF, plagioclase
- 14. 48m, IS, 0°, IR,RF, olivine
- 14. 77m, IS, 0°, IR,RF, olivine
- 14. 90m, DB
- 15. 11m, IS, 0°, IR,RF, plagioclase
- 15. 40m, IS, 0°, IR,RF, plagioclase
- 15. 92m, IS, 0°, IR,RF, plagioclase

See Symbology & Classification notes for details of abbreviations & basis of descriptions.

Palings Yard Wind Farm and Transmission Line

Generated with CORE-GS by Geroc - SLR Borehole - Soil + Rock - 09-Aug-2022 12:37:34 PM

CORED BOREHOLE LOG

HOLE NO.: PYWF-BH03

PROJECT : Palings Yard Wind Farm and Transmission Line
LOCATION : Palings Yard
FILE / JOB NO.: 650.30012
DATE STARTED : 11-05-22
POSITION : E: 199691.57, N: 6215408.11 (MGA94)
SURFACE ELEVATION : 972m (AHD)
LOGGED BY : GL
DATE COMPLETED : 11-05-22
RIG TYPE : Hydrapower Scout
ANGLE FROM HORIZONTAL : 90°
CHECKED BY : BT
DATE LOGGED : 11-05-22
DRILLER : Scott, Daily
CASING DIAMETER : 115mm
BARREL LENGTH : 3.00m
BIT : Impreg
BIT CONDITION : Good

DRILLING

PROGRESS: DRILLING &CASING	PROGRESS: WATER	TCR (%) / RQD (%)	SAMPLES & FIELD TESTS
NMLC	0% WATER LOSS	100% TCR / 79% RQD	Is₅₀: D=3.97MPa 16.11m Is₅₀: A=5.24MPa 16.12m 16.20m Is₅₀: D=3.19MPa 17.30m 17.36m 17.52m
	0% WATER LOSS	100% TCR / 62% RQD	Is₅₀: D=4.34MPa 17.53m Is₅₀: A=4.36MPa 18.38m Is₅₀: D=1.84MPa Is₅₀: A=0.46MPa 18.39m Is₅₀: D=0.69MPa 19.05m Is₅₀: A=0.71MPa 19.06m

RL (m)	DEPTH (m)
955	17
954	18
953	19
952	20
951	21
950	22
949	23

MATERIAL

GRAPHIC LOG

MATERIAL DESCRIPTION
SOIL/ROCK TYPE; grain characteristics, colour, structure, minor components

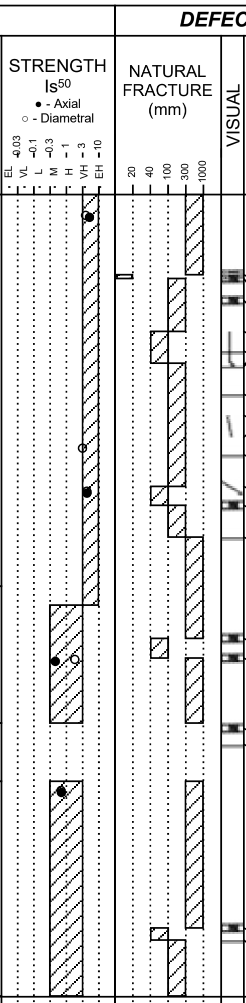
EXTREMELY WEATHERED BASALT, behaves like soil.

BASALT, fine grained, reddish brown to grey, vesicles and amygdules of plagioclase, medium strength, moderately weathered.

EOH: 20.10m - Target depth

WEATHERING
SW
HW
EW
MW - SW

DEFECT & OBSERVATION



STRUCTURE
& Other Observations

- 15.95m, IS, 0°, IR,RF, plagioclase
- 16.41m, IS, 0°, IR,RF, plagioclase
- 16.43m, IS, 0°, IR,RF, plagioclase
- 16.54m, IS, 0°, IR,RF, plagioclase
- 16.70-16.88m, JT, 90°, IR,RF
- 16.80m, JT, 0°, IR,RF
- 16.86m, JT, 0°, IR,RF
- 17.02m, JT, 0°, IR,RF
- 17.13-17.24m, JT, 80°-90°, IR,RF
- 17.33m, JT, 0°, IR,RF
- 17.49m, JT, 30°, IR,RF
- 17.59m, IS, 0°, IR,RF, plagioclase
- 17.75m, JT, 0°, IR,RF
- 18.27m, IS, 0°, IR,RF, plagioclase
- 18.37m, IS, 0°, IR,RF, plagioclase
- 18.73m, IS, 0°, IR,RF, plagioclase
- 18.81m, JT, 0°, IR,RF
- 19.75m, IS, 0°, IR,RF
- 19.81m, JT, 0°, IR,RF

See Symbology & Classification notes for details of abbreviations & basis of descriptions.

Generated with CORE-GS by Geroc - SLR Borehole - Soil + Rock - 09-Aug-2022 12:37:34 PM

PYWF-BH03 5.60m to 9.00m

PYWF-BH03 9.00m to 13.00m

File Location: \\AU.SLR.Local\Corporate\Projects-SLR_650-ADL\650.30012.00000 Palings Yard Wind Farm and Transmission\06 SLR Data\07 Core GS

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Title:	PYWF BH03 CORE	Drawn:	GL
Client:	GPG	Reviewed:	NB
Project:	Paling Yards Wind Farm and Transmission Line	Size:	A4
Project No.:	650.30012.00000	Datum:	None
Status:	Final	Version:	1.0
Date:	13/05/2022		

PYWF-BH03 13.00m to 17.00m

PYWF-BH03 17.00m to 20.10m

File Location: \\AU.SLR.Local\Corporate\Projects-SLR\ 650-ADL\650.30012.00000 Palings Yard Wind Farm and Transmission\06 SLR Data\07 Core GS

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Title: PYWF BH03 CORE
Client: GPG
Project: Paling Yards Wind Farm and Transmission Line
Project No.: 650.30012.00000
Status: Final
Date: 13/05/2022

Drawn: GL
Reviewed: NB
Size: A4
Datum: None
Version: 1.0

APPENDIX C

Laboratory Test Certificates

AUSTRALIAN SOIL AND CONCRETE TESTING
A.S.C.T.

ASCT Illawarra
2/15 Miall Way, Albion Park Rail NSW 2527

Telephone: +61 (02) 4208 3186
E-Mail: illawarra@asct.com.au
Mobile: +61 (0) 497 979 929
A.B.N. 34 635 062 609

WB080 - Rev 15, 26/04/2022

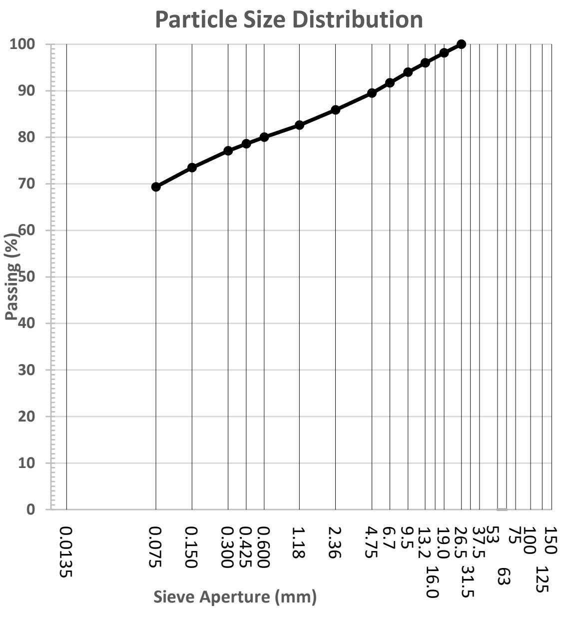
Report on Aggregate Quality

Client:	SLR Consulting Australia Pty Ltd	Report No:	**4-231-A**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	24/05/2022
Project:	Geotechnical Testing	Report Page:	Page 1 of 2
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Request/Order:	650.30012.00000
Material Description:	Silty CLAY	Lot Number:	-
Lot Comments:	-	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 17/05/2022 to 18/05/2022	Control Line:	PYWF-BH02

Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
48200	**9/05/2022**	**-**	**-**	**PYWF-BH02**	**1.00-1.50**

Particle Size Distribution	Units	Result	Specification Limits
Passing 150mm Sieve	%		
Passing 125mm Sieve	%		
Passing 100mm Sieve	%		
Passing 75.0mm Sieve	%		
Passing 63.0mm Sieve	%		
Passing 53.0mm Sieve	%		
Passing 37.5mm Sieve	%		
Passing 31.5mm Sieve	%		
Passing 26.5mm Sieve	%	**100**	
Passing 19.0mm Sieve	%	**98**	
Passing 16.0mm Sieve	%		
Passing 13.2mm Sieve	%	**96**	
Passing 9.5mm Sieve	%	**94**	
Passing 6.7mm Sieve	%	**92**	
Passing 4.75mm Sieve	%	**90**	
Passing 2.36mm Sieve	%	**86**	
Passing 1.18mm Sieve	%	**83**	
Passing 0.600mm Sieve	%	**80**	
Passing 0.425mm Sieve	%	**79**	
Passing 0.300mm Sieve	%	**77**	
Passing 0.150mm Sieve	%	**73**	
Passing 0.075mm Sieve	%	**69**	
Passing 0.0135mm Sieve	%		

Graphical Representation



Plasticity	Units	Result	Specification Limits	Remarks
Liquid Limit	%	**77**		Oven Dried & Dry Sieved
Plastic Limit	%	**32**		Oven Dried & Dry Sieved
Plastic Index	%	**45**		Oven Dried & Dry Sieved
Linear Shrinkage	%	**22.0**		

ASCT Illawarra
2/15 Miall Way, Albion Park Rail NSW 2527

Telephone:	+61 (02) 4208 3186
E-Mail:	illawarra@asct.com.au
Mobile:	+61 (0) 497 979 929
A.B.N.	34 635 062 609

WB080 - Rev 15, 26/04/2022

Report on Aggregate Quality

Client:	SLR Consulting Australia Pty Ltd	Report No:	**4-231-A**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	24/05/2022
Project:	Geotechnical Testing	Report Page:	Page 2 of 2
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Request/Order:	650.30012.00000
Material Description:	Silty CLAY	Lot Number:	-
Lot Comments:	-	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 17/05/2022 to 18/05/2022	Control Line:	PYWF-BH02

Sampling & Test Methods (Results relate only to the items sampled/tested) **(** NATA accreditation does not cover the performance of this service)**

Sampled by Customer: Results apply to the sample/s as received. **	AS 1289.1.1: (2001)Preparation of disturbed soil samples
AS 1289.3.6.1 Coarse: (2009)Determination of the particle size distribution of a soil	AS 1289.3.6.1 Fine: (2009)Determination of the particle size distribution of a soil
AS 1289.3.1.2: (2009)Determination of Liquid Limit (1 point Casagrande)	AS 1289.3.2.1: (2009) Determination of the Plastic Limit
AS 1289.3.3.1: (2009)Calculation of the Plastic Index of a soil	AS 1289.3.4.1: (2008)Determination of the Linear Shrinkage of a soil

Report Remarks & Endorsement

Accredited for compliance with ISO/IEC 17025 - Testing.
NATA Accreditation number: 20656

Issued By: L.Romano
L.Romano
Approved Signatory

AUSTRALIAN SOIL AND CONCRETE TESTING
A.S.C.T.

ASCT Illawarra
2/15 Miall Way, Albion Park Rail NSW 2527

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Mobile: +61 (0) 497 979 929
A.B.N. 34 635 062 609

WB080 - Rev 15, 26/04/2022

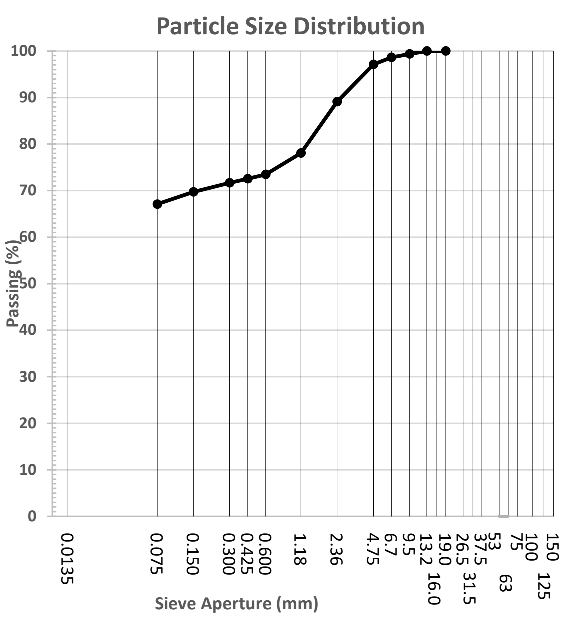
Report on Aggregate Quality

Client:	SLR Consulting Australia Pty Ltd	Report No:	**4-235-A**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	24/05/2022
Project:	Geotechnical Testing	Report Page:	Page 1 of 2
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Request/Order:	650.30012.00000
Material Description:	CLAY	Lot Number:	-
Lot Comments:	-	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 17/05/2022 to 23/05/2022	Control Line:	PYWF-BH03

Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
48204	**11/05/2022**	**-**	**-**	**PYWF-BH03**	**1.00 - -1.50**

Particle Size Distribution	Units	Result	Specification Limits
Passing 150mm Sieve	%		
Passing 125mm Sieve	%		
Passing 100mm Sieve	%		
Passing 75.0mm Sieve	%		
Passing 63.0mm Sieve	%		
Passing 53.0mm Sieve	%		
Passing 37.5mm Sieve	%		
Passing 31.5mm Sieve	%		
Passing 26.5mm Sieve	%		
Passing 19.0mm Sieve	%	**100**	
Passing 16.0mm Sieve	%		
Passing 13.2mm Sieve	%	**100**	
Passing 9.5mm Sieve	%	**99**	
Passing 6.7mm Sieve	%	**99**	
Passing 4.75mm Sieve	%	**97**	
Passing 2.36mm Sieve	%	**89**	
Passing 1.18mm Sieve	%	**78**	
Passing 0.600mm Sieve	%	**73**	
Passing 0.425mm Sieve	%	**73**	
Passing 0.300mm Sieve	%	**72**	
Passing 0.150mm Sieve	%	**70**	
Passing 0.075mm Sieve	%	**67**	
Passing 0.0135mm Sieve	%		

Graphical Representation



Plasticity	Units	Result	Specification Limits	Remarks
Liquid Limit	%	**48**		Oven Dried & Dry Sieved
Plastic Limit	%	**19**		Oven Dried & Dry Sieved
Plastic Index	%	**29**		Oven Dried & Dry Sieved
Linear Shrinkage	%	**14.5**		

AUSTRALIAN SOIL AND CONCRETE TESTING
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WB080 - Rev 15, 26/04/2022

Report on Aggregate Quality

Client:	SLR Consulting Australia Pty Ltd	Report No:	**4-235-A**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	24/05/2022
Project:	Geotechnical Testing	Report Page:	Page 2 of 2
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Request/Order:	650.30012.00000
Material Description:	CLAY	Lot Number:	-
Lot Comments:	-	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 17/05/2022 to 23/05/2022	Control Line:	PYWF-BH03

Sampling & Test Methods (Results relate only to the items sampled/tested) **(** NATA accreditation does not cover the performance of this service)**

Sampled by Customer: Results apply to the sample/s as received. **	AS 1289.1.1: (2001)Preparation of disturbed soil samples
AS 1289.3.6.1 Coarse: (2009)Determination of the particle size distribution of a soil	AS 1289.3.6.1 Fine: (2009)Determination of the particle size distribution of a soil
AS 1289.3.1.2: (2009)Determination of Liquid Limit (1 point Casagrande)	AS 1289.3.2.1: (2009) Determination of the Plastic Limit
AS 1289.3.3.1: (2009)Calculation of the Plastic Index of a soil	AS 1289.3.4.1: (2008)Determination of the Linear Shrinkage of a soil

Report Remarks & Endorsement

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.
NATA Accreditation number: 20656

Issued By: L.Romano
L.Romano
Approved Signatory

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Report on Moisture Content, Emerson Class, Soil pH, EC, PASS/AASS and Foreign Material

Client:	SLR Consulting Australia Pty Ltd	Report No:	**231B**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	24/05/2022
Project:	Geotechnical Testing	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Test Request/Order:	650.30012.00000
Material Description:	Silty CLAY	Lot Number:	-
Lot Boundaries:	Chainage - to -. Offsets - to -.	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 17/05/2022 to 18/05/2022	Control Line:	PYWF-BH02

Sample Number:		**48200**	**48202**	**48204**	**48207**	-
Field Sample/Test Date:		9/05/2022	11/05/2022	11/05/2022	9/05/2022	-
Chainage / Location:	(m)	-	-	-	0.00000	-
Offset from control line:	(m)	-	-	-	0.00000	-
Level of Test:	(m)	PYWF-BH02	PYWF-BH03	PYWF-BH03	PYTL - BH15	-
Test Depth:	(mm)	1.00-1.50	3.00 - 3.45	1.00 - -1.50	1.00-1.50	-

Lab Test Date (Moisture):		17/05/2022	-	17/05/2022	17/05/2022	-
Moisture Content:	**(%)**	**34.0**	**-**	**26**	**40**	**-**

Test Water Used:		Distilled	Distilled	Distilled	Distilled	-
Temperature of Water:	(°C)	19	19	19	19	-
Soil Description:		CI-CH, Silty CLAY	CI, Silty CLAY	CI-CH, Silty CLAY	CH, Silty CLAY	-
Emerson Class Number:		**CLASS 4**	**CLASS 4**	**CLASS 6**	**CLASS 6**	**-**

Soil-suspension made of 30g soil & :		-	-	-	-	-
pH Value of Soil-suspension:	**(pH)**	-	-	-	-	-

Electrical Conductivity:	**0**	-	-	-	-	-

Field pH:	**(pH_F)**	-	-	-	-	-
Field pH Oxidised:	**(pH_{FOX})**	-	-	-	-	-
Acid Sulfate Soil Indication:		-	-	-	-	-

Foreign Material - Type III	**(%)**	-	-	-	-	-

Sampling & Test Methods (Results relate only to the items sampled/tested)

Sampled by Customer: Results apply to the sample/s as received. **
AS 1289.1.1: (2001)Preparation of disturbed soil samples
AS 1289.2.1.1: (2005)Moisture Content (Oven Drying)
AS 1289.3.8.1: (2017)Emerson Class number of a soil

(NATA accreditation does not cover the performance of this service)**

Report Remarks & Endorsement

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.
NATA Accreditation number: 20656

Issued By: L.Romano

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Approved Signatory

WB054 - Rev 1, 09/05/2022

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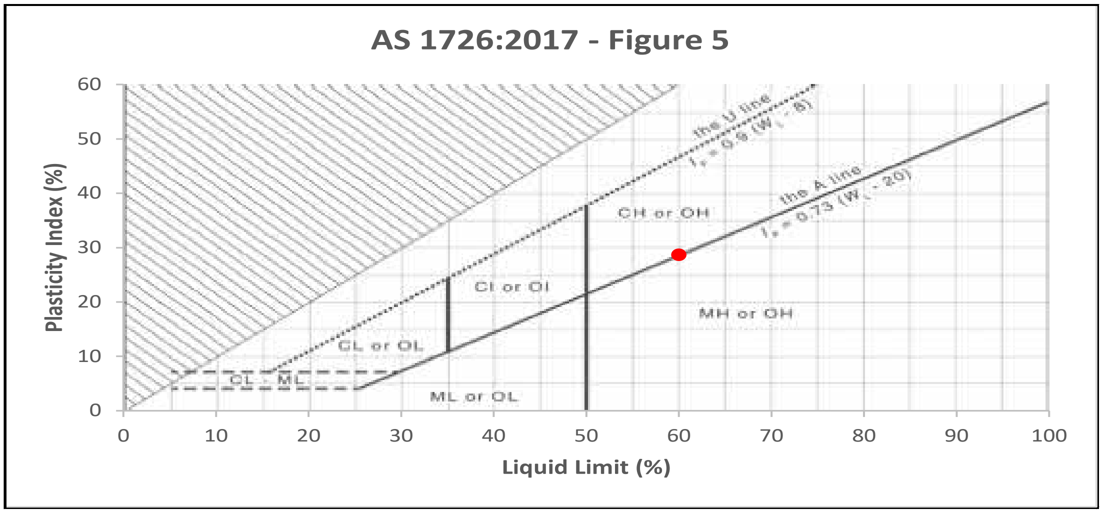
Report on Plastic Properties

Client:	SLR Consulting Australia Pty Ltd	Report No:	**233A**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	24/05/2022
Project:	Geotechnical Testing	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Test Request:	650.30012.00000
Material Description:	CLAY	Lot Number:	-
Lot Comments:	-	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 19/05/2022	Control Line:	PYWF-BH03

Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
48202	**11/05/2022**	**-**	**-**	**PYWF-BH03**	**3.00 - 3.45**

Specification Name	

Pretreatment	Units	Result	Specification Limits	Remarks
Retained 53.0mm Sieve	%			
Pretreatment by Weathering	--			
Pretreatment by Compaction	--			
Plasticity	**Units**	**Result**	**Specification Limits**	**Remarks**
Liquid Limit	%	**60**		Oven Dried & Dry Sieved
Plastic Limit	%	**31**		Oven Dried & Dry Sieved
Plastic Index	%	**29**		Oven Dried & Dry Sieved
Linear Shrinkage	%	**14.0**		Oven Dried & Dry Sieved. Cracked/Broken Bar



Sampling & Test Methods (Results relate only to the items sampled/tested)	Report Remarks & Endorsement
Sampled by Customer: Results apply to the sample/s as received. ** AS 1289.1.1: (2001)Preparation of disturbed soil samples for testing AS 1289.3.1.2: (2009)Liquid Limit, One point Casagrande AS 1289.3.2.1: (2009)Plastic Limit of a soil AS 1289.3.3.1: (2009)Plasticity Index of a soil AS 1289.3.4.1: (2008)Linear Shrinkage of a soil	

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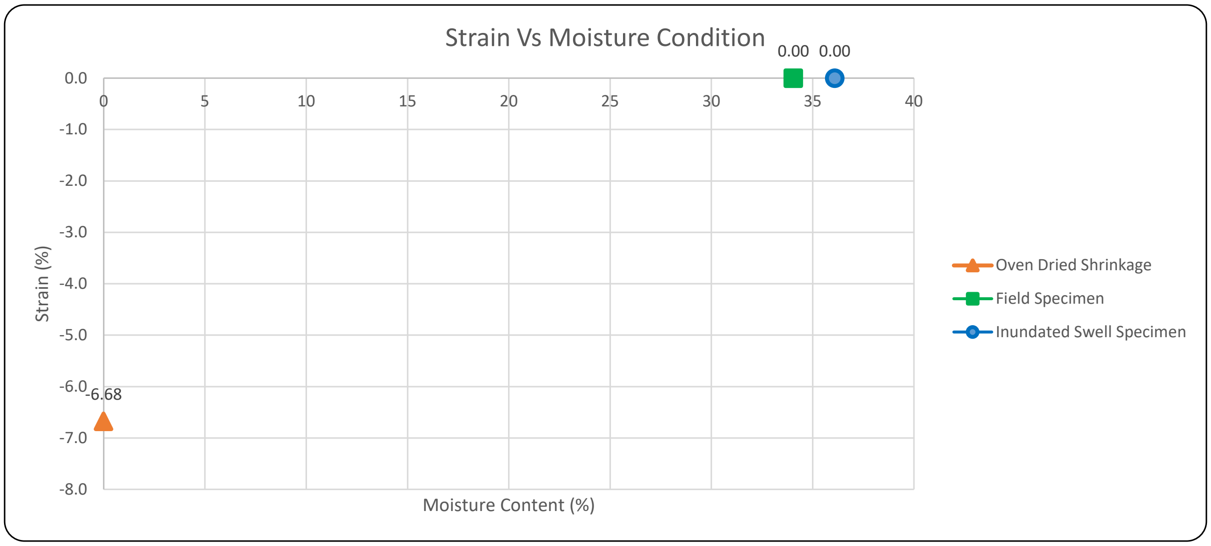
Report on Shrink / Swell Index of a Soil

Client:	SLR Consulting Australia Pty Ltd	Report No:	**231**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	24/05/2022
Project:	Geotechnical Testing	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Test Request/Order:	650.30012.00000
Material Description:	Silty CLAY	Lot Number:	-
Lab Test Date/s:	Testing commenced 17/05/2022 and was completed 18/05/2022.	ITP/PCP Number:	-
Lot Comments:	-	Control Line:	PYWF-BH02

Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
48200	**9/05/2022**	**-**	**-**	**PYWF-BH02**	**1.00-1.50**

Parameters	Units	Test Results	Soil Description
Shrinkage - Field Moisture Content	%	34.0	CI-CH,Silty CLAY
Swell - Field Moisture Content	%	34.1	
Swell - Inundated Moisture Content	%	36.1	
Inert Inclusions in the soil	%	10	
Extent of Soil Crumbling	-	None	
Extent of Soil Cracking	-	Minor	
Shrink-Swell Index	**%**	**3.7**	



Sampling & Test Methods (Results relate only to the items sampled/tested)	Report Remarks & Endorsement
AS 1289.7.1.1, Cl 4: Shrink Swell Index - Thin wall sampler (U50) AS 1289.7.1.1: Shrink Swell Index of a Soil	

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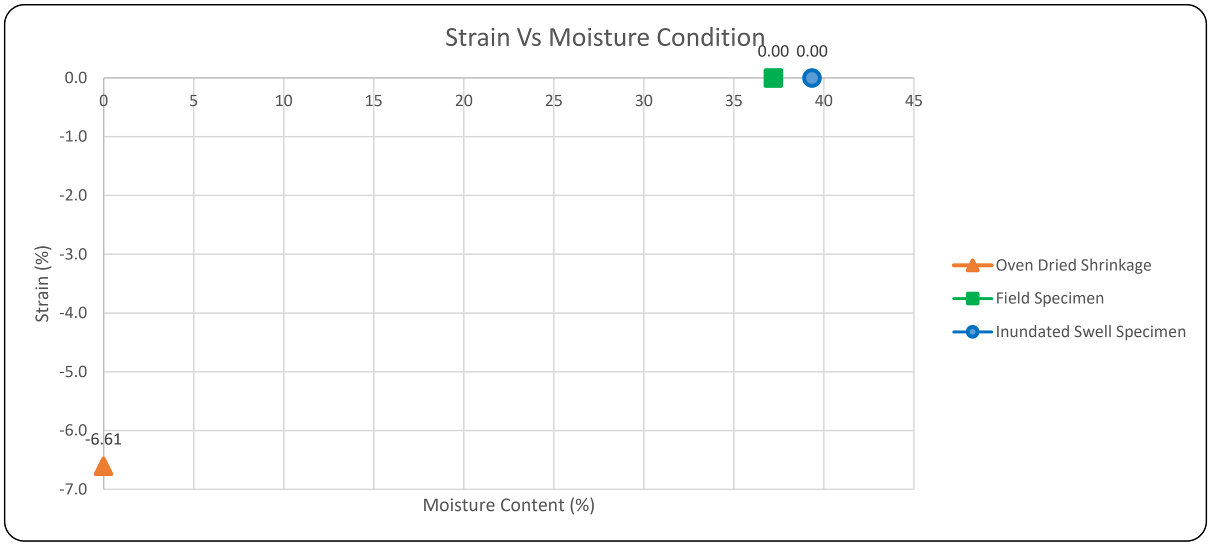
Report on Shrink / Swell Index of a Soil

Client:	SLR Consulting Australia Pty Ltd	Report No:	**237**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	24/05/2022
Project:	Geotechnical Testing	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Test Request/Order:	650.30012.00000
Material Description:	BASALT	Lot Number:	-
Lab Test Date/s:	Testing commenced 17/05/2022 and was completed 18/05/2022.	ITP/PCP Number:	-
Lot Comments:	-	Control Line:	PYWF-BH03

Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
48206	**11/05/2022**	**-**	**-**	**PYWF-BH03**	**17.36 - 17.51**

Parameters	Units	Test Results	Soil Description
Shrinkage - Field Moisture Content	%	37.0	CH,Silty CLAY
Swell - Field Moisture Content	%	37.4	
Swell - Inundated Moisture Content	%	39.3	
Inert Inclusions in the soil	%	10	
Extent of Soil Crumbling	-	None	
Extent of Soil Cracking	-	Minor	
Shrink-Swell Index	**%**	**3.7**	



Sampling & Test Methods (Results relate only to the items sampled/tested)	Report Remarks & Endorsement
AS 1289.7.1.1, Cl 4: Shrink Swell Index - Thin wall sampler (U50) AS 1289.7.1.1: Shrink Swell Index of a Soil	

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NATA Accreditation number: 20656

Issued By: L.Romano
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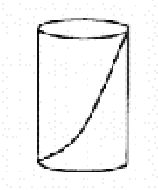
Report on Uniaxial Compressive Strength (UCS)

Client:	**SLR Consulting Australia Pty Ltd**	Report No:	**229**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	26/05/2022
Project:	**Geotechnical Testing**	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Test Request:	650.30012.00000
Material Description:	BASALT	Lot Number:	-
Lot Comments:	Length to Diameter Ratio less than 2.5	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 17/05/2022	Control Line:	PYWF-BH02
Sample Date:	10/05/2022	**Sample Number:**	**48198**

Uniaxial Compressive Strength

Client ID Number	
Borehole	**BH-02**
Depth	**6.62-6.77**
Lithological Description	Igneous
Type of Testing Machine	ILLACON02
Date of Test	17/05/2022
Height (mm)	120.3
Diameter (mm)	60.9
Test Duration (mins)	4.10
UCS (Mpa)	**25**

Failure Mode	(SS) Single Shear
Failure Sketch	
Rate Displacement (mm/min)	0.10
Moisture Content (%)	2.7

Specimen - Before Testing

Specimen - After Testing

Sampling & Test Methods (Results relate only to the items sampled/tested)

Sampled by Client: Results apply to the sample/s as received. **
Client: Test specimens selected by the client.
As Received: Samples stored & Tested in as received condition.
AS4133.4.2.2: (2013) Determination of Uniaxial Compressive Strength (<50MPa)
AS4133.1.1.1: (2005) Determination of moisture content of rock, oven drying.

(NATA accreditation does not cover the performance of this service)**

Report Endorsement

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.
NATA Accreditation number: 20656

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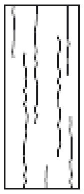
Report on Uniaxial Compressive Strength (UCS)

Client:	**SLR Consulting Australia Pty Ltd**	Report No:	**230**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	26/05/2022
Project:	**Geotechnical Testing**	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Test Request:	650.30012.00000
Material Description:	BASALT	Lot Number:	-
Lot Comments:	-	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 18/05/2022	Control Line:	PYWF-BH02
Sample Date:	10/05/2022	**Sample Number:**	**48199**

Uniaxial Compressive Strength

Client ID Number	
Borehole	**BH02**
Depth	**12.52-12.77**
Lithological Description	Igneous
Type of Testing Machine	ILLACON02
Date of Test	18/05/2022
Height (mm)	154.7
Diameter (mm)	60.9
Test Duration (mins)	8.50
UCS (Mpa)	**25**

Failure Mode	(d) Tensile Dominated
Failure Sketch	
Rate Displacement (mm/min)	0.10
Moisture Content (%)	1.9

Specimen - Before Testing	Specimen - After Testing
	

Sampling & Test Methods (Results relate only to the items sampled/tested)	Report Endorsement
Sampled by Client: Results apply to the sample/s as received. ** Client: Test specimens selected by the client. As Received: Samples stored & Tested in as received condition. AS4133.4.2.2: (2013) Determination of Uniaxial Compressive Strength (<50MPa) AS4133.1.1.1: (2005) Determination of moisture content of rock, oven drying. **(** NATA accreditation does not cover the performance of this service)**	NATA Accredited for compliance with ISO/IEC 17025 - Testing. NATA Accreditation number: 20656 Issued By: P.Baltoski P.Baltoski Approved Signatory

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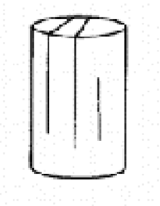
Report on Uniaxial Compressive Strength (UCS)

Client:	**SLR Consulting Australia Pty Ltd**	Report No:	**236**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	26/05/2022
Project:	**Geotechnical Testing**	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Test Request:	650.30012.00000
Material Description:	BASALT	Lot Number:	-
Lot Comments:	-	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 24/05/2022	Control Line:	PYWF-BH03
Sample Date:	11/05/2022	**Sample Number:**	**48205**

Uniaxial Compressive Strength

Client ID Number	
Borehole	**BH03**
Depth	**16.20-16.58**
Lithological Description	Igneous
Type of Testing Machine	ILLACON02
Date of Test	24/05/2022
Height (mm)	153
Diameter (mm)	60.9
Test Duration (mins)	4.50
UCS (Mpa)	**118.0**

Failure Mode	(AM) Axial Multiple
Failure Sketch	
Rate Displacement (mm/min)	0.08
Moisture Content (%)	2.2

Specimen - Before Testing

Specimen - After Testing

Sampling & Test Methods (Results relate only to the items sampled/tested)

Sampled by Client: Results apply to the sample/s as received. **
Client: Test specimens selected by the client.
As Received: Samples stored & Tested in as received condition.
AS4133.4.2.1: (2007) Determination of Uniaxial Compressive Strength (50MPa & greater)
AS4133.1.1.1: (2005) Determination of moisture content of rock, oven drying.

(NATA accreditation does not cover the performance of this service)**

Report Endorsement

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NATA Accreditation number: 20656

Issued By: P.Baltoski
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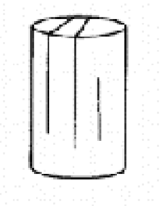
Report on Uniaxial Compressive Strength (UCS)

Client:	**SLR Consulting Australia Pty Ltd**	Report No:	**237**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	24/05/2022
Project:	**Geotechnical Testing**	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Test Request:	650.30012.00000
Material Description:	BASALT	Lot Number:	-
Lot Comments:	Length to Diameter Ratio less than 2.5	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 23/05/2022	Control Line:	PYWF-BH03
Sample Date:	11/05/2022	**Sample Number:**	**48206**

Uniaxial Compressive Strength

Client ID Number	
Borehole	**BH03**
Depth	**17.36-17.51**
Lithological Description	Igneous
Type of Testing Machine	ILLACON02
Date of Test	23/05/2022
Height (mm)	129
Diameter (mm)	61.1
Test Duration (mins)	5.10
UCS (Mpa)	**106.0**

Failure Mode	(AM) Axial Multiple
Failure Sketch	
Rate Displacement (mm/min)	0.15
Moisture Content (%)	2.7

Specimen - Before Testing

Specimen - After Testing

Sampling & Test Methods (Results relate only to the items sampled/tested)

Sampled by Client: Results apply to the sample/s as received. **
Client: Test specimens selected by the client.
As Received: Samples stored & Tested in as received condition.
AS4133.4.2.1: (2007) Determination of Uniaxial Compressive Strength (50MPa & greater)
AS4133.1.1.1: (2005) Determination of moisture content of rock, oven drying.

(NATA accreditation does not cover the performance of this service)**

Report Endorsement

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NATA Accreditation number: 20656

Issued By:

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APPENDIX D

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Appendix R

Part 2

Interim Geotechnical Report – Transmission Line

Prepared by: SLR Consulting (Sept 2022)

INTERIM INTERPRETIVE GEOTECHNICAL REPORT

Paling Yards - Transmission Line

Prepared for:

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SLR Ref: 650.30012.00000-R02
Version No: -v0.2
September 2022

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Global Power Generation Australia Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
650.30012.00000-R01-v0.2	2 September 2022	Gadha Lal, Amanda Lane	Nick Barker	DRAFT following GPG Comments
650.30012.00000-R01-v0.1	12 August 2022	Gadha Lal, Amanda Lane	Nick Barker	DRAFT for GPG Review

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1 Introduction

IMPORTANT NOTE: This interim geotechnical report has been compiled to accompany the Development Application submission in lieu of a full geotechnical report. The eastern coast of Australia has been subjected to a series of adverse weather events during 2022 that has seriously impacted the safety of field teams and as a result, the proposed fieldwork program has been postponed until weather conditions improve and field work can be undertaken safely.

To provide meaningful data for the submission, this report, following a detailed review, has drawn from a previous report that was completed by URS in 2011 for an alternative wind farm proposal at the same site. Once proposed fieldwork is complete, this report will be revised to incorporate findings from the current geotechnical investigation.

1.1 Background

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Global Power Generation Australia Pty Ltd (GPG) to conduct geotechnical investigation for the purpose of informing the design of the proposed Wind Farm transmission line at Paling Yards, NSW. This report presents the findings of the geotechnical site investigation for the Development Application submission of the proposed wind farm (Transmission Line) at Paling Yards. This report should be read in conjunction with Interpretive Geotechnical Report Paling Yards – Turbine Locations.

1.2 Objective

The objectives of the geotechnical investigation were as follows:

- Assessment of ground conditions to inform:
  - Geotechnical design parameters for transmission tower footings (shallow, piers or piles) for site specific geology.
  - Electrical resistivity survey for the substation site.
- Seismic design parameters.
- Recommendations and commentary on the geotechnical aspects of the transmission line development.

2 Site overview and Historical Data

2.1 Site Description

The proposed Transmission Line at Paling Yards is located approximately 56km south of Oberon, NSW, extending a distance of approximately 10 km from a collector substation in the western portion of the wind farm to a substation located on the eastern extremity of the site. The proposed investigation site referred to within this document as ‘the site’ is surrounded by Abercrombie River National Park to the east and south and Gurnang State Forest towards the northeast. The site includes four separate land holdings referred to as:

- Mingary Park
- Paling Yards
- Middle Station
- Hilltop

A site plan is presented in **Appendix A** which indicates:

- The location of the site.
- Extent of property boundaries.
- The current alignment of the proposed transmission line.
- Proposed investigation locations.

2.2 Site Geology

Review of the Geological Survey of NSW database (Minview, accessed 24 June 2022) indicates the near-surface geology underlying the site is characterised predominantly by:

- Colluvium (Qc) poorly sorted, weakly cemented to unconsolidated colluvial lenses of polymictic conglomerate with medium- to very coarse-grained sand matrix; interspersed with unconsolidated clayey and silty red brown (aeolian) sand layers, modified by pedogenesis. Quaternary (2.58 - 0.0 Ma).
- Oberon Basalt (NMo), weakly porphyritic basanites and alkali basalts dominated by olivine, titaniferous clinopyroxene, plagioclase and Ti-Fe oxides with minor ilmenite, nepheline, apatite, and rare volcanic glass. Miocene (23.03 - 13.82 Ma).
- Abercrombie Formation (Oada) brown and buff to grey, thin- to thick-bedded, fine- to coarse-grained mica-quartz (±feldspar) sandstone, interbedded with laminated siltstone and mudstone. Sporadic chert-rich units. Early Ordovician (479.4 - 458.4 Ma).

The site underlain by geological mapping is shown in **Figure 1** overleaf.

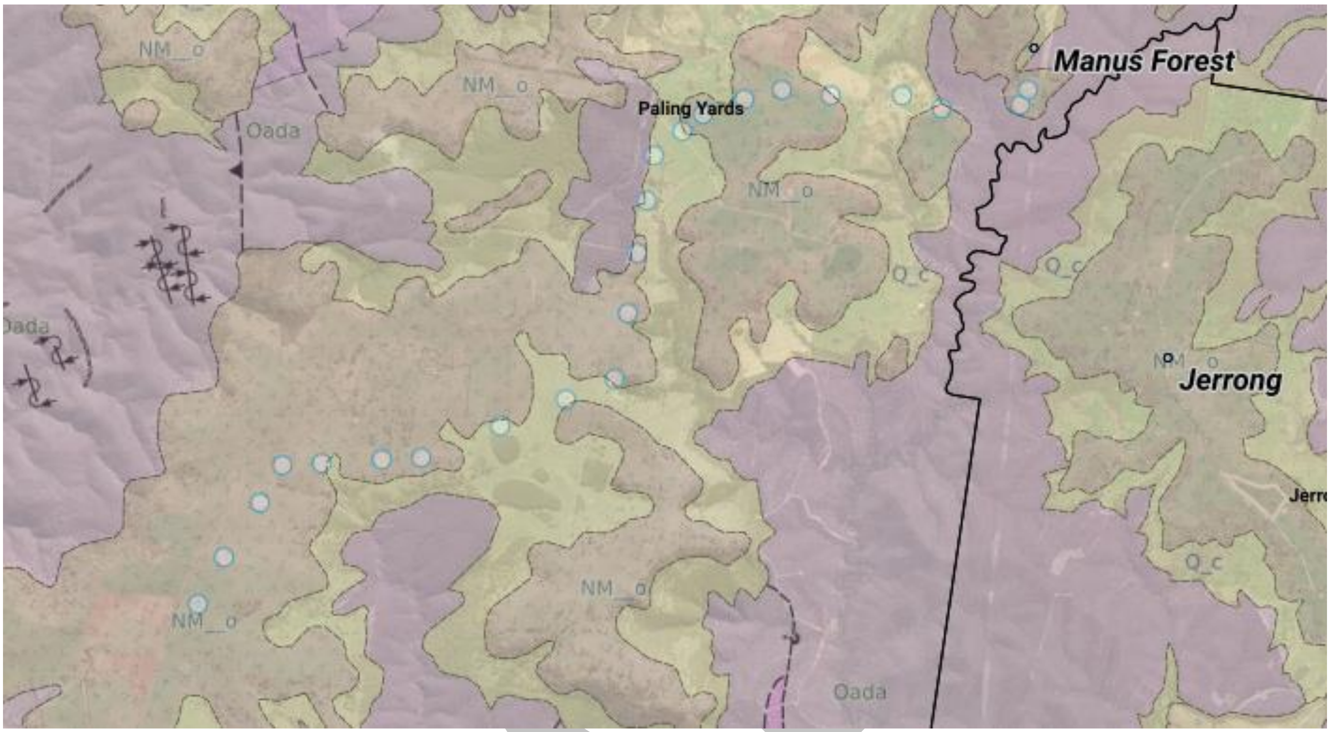


Figure 1 Local geology with transmission tower locations in blue

2.3 Vegetation and Land Use

The site is located upon agricultural lands currently used for mainly grazing.

At the time of investigation, sheep grazing and associated wool production was noted as the dominant agriculture type.

Vegetation overall consisted of low grasses and occasional stands of remnant woodland. The gentler graded areas were generally well grassed with scattered mature trees. The steeper terrain was well vegetated with moderately dense native eucalypt forests.

2.4 Topography

The site consists of a large tableland area formed by localised basalt flows that sit atop Ordovician sedimentary rocks. The outline of the underlying basalt broadly matches a distinct change in topography.

Generally, slopes fall towards the east and west from a central ridge that trends northeast - southwest through the site. The elevation of the site falls from approximately 1090 m AHD along the length of the proposed area to 690 m AHD to the east and west.

Numerous gullies and creeks flow throughout the site, with surface flows joining the Abercrombie River to the south of the investigation area.

2.5 Hydrology

Typically, the surface water follows the topography and surrounding drainage paths and gullies, flowing from higher to lower elevations.

The topography of the site suggests that water flow direction is to the east and west from the elevated points towards Manus Creek and Silent Creek, which finally merge with the Abercrombie River, 500 m south of the investigation area.

Several earth dams are also observed along the proposed site, with many of the dams currently at their maximum capacity, comprising a freeboard of approximately 0.2 m to 0.5 m, due to recent rain events occurring at the time of site investigation.

2.6 Historical Data

The following list outlines the relevant available documentation for the site:

- Copies of the 2011 URS Geotechnical Report provided by GPG (ref: 20120427 - Paling Yards, FINAL Geotechnical report (URS), dated 5 September 2011).
- Cultural Heritage Documents provided by ERM (ref: F9-1_0578575s_PYWF_HER_G013_R00, F7-2_0578575s_PYWF_HER_G014_R00, F4-1_0578575s_PYWF_HER_G010_R01 dated 15 June 2021).

2.7 Summary of Historical Data

2.7.1 2011 URS Geotechnical Report

A preliminary geotechnical investigation was undertaken by the consultants URS at the site. This investigation was targeted at an alternative proposal that incorporated 59 wind turbines predominantly across the western portion of the site.

A total of two boreholes and sixty test pits were excavated at select locations along with sixty Dynamic Cone Penetrometer tests adjacent to test pits. Many of those locations are relevant to the current proposed wind turbine locations and have been used to inform the general condition at site. However, they do not correlate with the proposed transmission line alignment.

In addition, two electrical resistivity surveys were undertaken across the site. Each survey consisted of Wenner Alpha, Schlumberger and Dipole-Dipole testing. Again, the results of these surveys have been considered within this investigation.

3 Scope of Services

The following scope of services were completed in accordance with SLR Proposal A00.08927.PROMO: Palings Yard Wind Farm and Transmission Line GI, 29 March 2022.

3.1 Planning

The following works were conducted prior to commencing the geotechnical field investigation:

- Desktop review of available information including local geology maps, soil maps, groundwater maps and geomorphological maps.
- Preparation of site-specific Safe Work Method Statement (SWMS) and management of any identified risks on-site.
- Confirmation of Cultural Heritage Clearance prior to mobilisation.
- Preparation of a separate Health, Safety and Environment Management Plan (HSSE).
- Preparation of borehole and test pit location plan.
- Dial Before You Dig (DBYD) searches within the project area as well as engage all applicable subcontractors.
- Pre-Investigation site walkover by SLR staff on 4 May 2022 and 18 July 2022. During the walkover each proposed test location was inspected for potential constraints and marked using a labelled surveyor's picket.

3.2 Geotechnical Site Investigation

The geotechnical site investigation was carried out over three separate mobilisations:

- 9 May to 11 May (Drilled borehole PYTL-BH15 and additional boreholes for the wind turbine locations – (See separate report no. 650.30012.00000-R01-v0.1-Wind Turbines)).
- 18 July to 20 July (Excavated test pits for the Transmission Line Investigation PYTL-TP11 and PYTL-TP12).
- 26 July till 27 July. (Undertook hand auguring to collect soil samples for Agronomy testing only).

3.2.1 Borehole Drilling

- Drilling of one (1) out of eleven (11) boreholes to a maximum depth of 5.64 metres below ground level at the time of the investigation (mbgl) using a 4x4 truck mounted Hydra Power Scout owned and operated by Rockwell Drilling Pty Ltd. The coordinates of the borehole (PYTL-BH15) were recorded using a hand-held GPS device accurate to +/-5m.

Drilling was carried out using a solid flight auger attached with tri cone-bit until target depth including penetration into the rock to at least 1 m thickness.

- Whilst within soil strength materials, boreholes were supplemented with Standard Penetration Tests (SPTs) performed in accordance with AS1289.6.3.1 (2004) at 1.5m intervals to understand soil strengths.
- From each of the boreholes, materials were sampled and logged via the visual-tactile method in accordance with AS1726 (2017) by a suitably experienced and qualified geotechnical engineer.

- Boreholes were backfilled using the drill cuttings and tamped at the surface to avoid excessive settlement.
- The geotechnical site investigation results to date are presented in **Appendix B** with an exploratory hole location plan presented in **Appendix A**.

3.2.2 Test Pit Excavation

- Two (2) test pits (PYTL-TP11 and PYTP-TP12) were excavated to a maximum depth of 2.3 mbgl using a backhoe excavator with a 250mm tiger toothed bucket, which was owned and operated by Allman Excavations Pty Ltd.
- The coordinates of the test pits were recorded using a hand-held GPS device accurate to +/-5 m.
- Dynamic Cone Penetrometer (DCP) testing was carried out adjacent to each test pit, performed in accordance with AS1289.6.3.2 (1997) to a maximum depth of 1.5 mbgl.
- From each of the boreholes, materials were sampled for geotechnical and environmental testing, and logged via the visual-tactile method in accordance with AS1726 (2017) by a suitably experienced and qualified geotechnical engineer.
- The test pits were backfilled using the excavated material when rolled using the backhoe to avoid excessive settlement.
- The geotechnical site investigation results to date are presented in **Appendix B.**

3.2.3 Electrical Resistivity Survey

Due to difficult weather conditions at site, an electrical resistivity survey was unable to be undertaken safely. Subsequently SLR aims to conduct the electrical resistivity survey once the weather conditions improve and can facilitate safe site access.

3.3 Dynamic Cone Penetrometer (DCP) Testing

DCP testing was undertaken adjacent to the investigated test pits to assess the sub-surface consistency/ relative density profile. The DCP tests were undertaken in accordance with AS1289.6.3.2: Soil strength and consolidation tests – Determination of the penetration resistance of a soil – 9 kg dynamic cone penetrometer test.

All DCPs were progressed to a target depth of 1.5m or refusal (>20 blows per 100mm increment or three consecutive 100mm increments with >10 blows per 100mm).

The DCP test results are presented on the test pit logs included in **Appendix B**. The results are presented in a graph in **Figure 2**.

3.4 Standard Penetration Test (SPT)

SPT tests were undertaken within each borehole at 1.50m intervals. Similar to the DCP test, SPT test results are used to assess the consistency/relative density of the material through blow counts however at deeper depths beyond the reach of a DCP test.

SPT test results are presented on the geotechnical logs in **Appendix B**. Typically, in the hierarchy of information, SPT results take precedence over DCP results due to the better representation of in-situ conditions.

3.5 Pocket Penetrometer Testing

Pocket Penetrometer testing was undertaken for select recovered samples of cohesive soil to address the consistency of soil at various depths. Pocket penetrometer results are presented on the geotechnical logs in **Appendix B**.

3.6 Laboratory Testing

To assist with assessment of the geotechnical conditions and reusability of materials, a suite of laboratory testing was performed on selected undisturbed, disturbed and remoulded samples. Laboratory testing was performed by a NATA accredited laboratory.

The completed laboratory testing and the corresponding rationale are shown in **Table 1** below.

Table 1 Summary of Laboratory Testing Methods

Test Method	No. of Tests	Standard	Rationale
Particle Size Distribution	1	AS 1289.3.6.2	Characterise material and assess suitability for material re-use as a general construction material.
Atterberg Limits	1	AS 1289 3.1.1, 3.2.1, 3.3.1	Assess the liquid and plastic limit of cohesive soils (clays and silts) and assess suitability for re-use and likely behaviour characteristics with moisture changes.
Shrink/Swell Index	2	AS1289 7.1.1	Assess the materials ability to expand when wet and retract when dry. Used to determine the expansion capacity of the material and provide site classification.
Emerson Class	TBC	AS 1289 3.8.1	Assess the materials propensity to disperse into a liquid. Used to assess susceptibility to erosion.
Moisture Content	TBC	AS 1289.2.1.1	Assess the amount of water present in the soil.
Soil/Rock Aggressivity	TBC	AS 2159	Assessing the pH, conductivity and presence of chlorides and sulfates with the material as a measure of potential corrosion to steel and concrete structures.
California Bearing Ratio (CBR)	1	AS 1289.6.1.1	Evaluate the strength of soil and assess the suitability of soil to use as subgrade and base course material
Laboratory Thermal Resistivity	TBC	-	Assess the ability of soil to dissipate heat. Used to design the underground transmission cables
Pinhole Dispersion	TBC	AS 1289.3.8.3	Assess the dispersive characteristics of compacted soil.

Laboratory testing results are summarised in **Section 3.6** and presented in detail in **Appendix C**.

4 Results and Discussion

4.1 Site Observations and Site Investigation Findings

The ground conditions encountered during the geotechnical site investigation are presented in the geotechnical logs and key photographs in **Appendix B**. A summary of observations made from the test locations and visual inspections is included in the following sections.

4.1.1 Intrusive Investigation Results

The intrusive investigation borehole and test pit details and depths reached are presented in **Table 2**.

Table 2 Summary of Test Locations

Site ID	Type (TP/BH)	Easting	Northing	Elevation (mRL)	Depth (m)	Termination Criteria	Details
PYTL-BH03	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-BH06	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-BH07	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-BH08	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-BH09	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-BH10	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-BH11	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-BH12	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-BH13	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-BH14	BH	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-BH15	BH	200422.16	6216586.5	1008	5.64	Target Depth	Auger to moderately weathered bedrock
PYTL-TP01	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-TP02	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-TP03	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-TP04	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-TP05	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-TP06	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-TP07	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-TP08	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-TP09	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-TP10	TP	TBC	TBC	TBC	TBC	TBC	TBC
PYTL-TP11	TP	200943.3	6217445.8	965	1.8	Refusal	Excavated to refusal
PYTL-TP12	TP	200644	6216989.8	1000	2.3	Refusal	Excavated to refusal

Notes:
mbgl = metres below ground level at the time of the investigation
TBC = To Be Confirmed

4.1.2 Visual Observations

Note that the initial stages of this investigation were undertaken during severe inclement weather which resulted in several demobilisations from site to allow the site to dry sufficiently so that heavy machinery could access test sites without risks to personnel, equipment and the landowner's property.

The weather during the initial site visit was cloudy with periods of light showers. The region had been experiencing a very wet tropical cyclone *Karim* during the investigation. The site consisted of generally open grazing land for sheep and cattle. The land was wet and subsequently saturated during the time of inspection. During the site walkover, access to most of the test locations was very limited.

The site conditions surrounding PYTL-BH15 were generally level to gently undulating trending south approximately 1 to 5 degrees. The area encompassed agricultural grazing land with isolated patches of exposed soil.

A spoil heap of recovered of rock, predominantly latite, was found approximately 100m from the test location. It is assumed that this spoil heap consisted of floating cobbles and boulders from the ground surface collected by the landowner.

The site conditions surrounding PYTL-TP11 were generally sloping towards northeast at approximately 8 to 18 degrees. The area consisted of grazing land, with a dam approximately 100m north of the test location.

Similarly, surrounding PYTL-TP12, the general surface profile sloped towards northeast and was approximately 150m south of a nearby dam.

4.1.3 Subsurface Conditions

The subsurface conditions encountered on site were generally consistent with the data published in geological maps, referenced sources and the report undertaken by URS (2011).

With the limited information from the excavated borehole and test pits, SLR identified four predominant material units, with varied depths to base of each unit encountered between the two boreholes.

Note that the URS (2011) report presented three subsurface conditions, where they generalised both alluvium and residual soil as residual soil only and combined both extremely weathered basalt and slightly weathered/fresh basalt as 'bedrock'. The four material units that SLR encountered are as follows (in general order of deposition/age):

- Topsoil
- Alluvium
- Residual Soil
- Extremely Weathered Basalt

A summary of encountered strata and locations is presented in **Table 3**.

Table 3 Summary of the Subsurface Conditions Encountered

Location/ Property	Deposition Environment	Dominant Material Type	Encountered	Encountered Depth Range (mbgl)
Oberon Basalt	Topsoil	Clayey sandy SILT, Clayey SILT, SILT	PYTL-BH15, PYTL-TP11, PYTL-TP12	0.00 to 0.40
	Alluvium	Silty CLAY	PYTL-BH15, PYTL-TP11, PYTL-TP12	0.25 to 1.50
	Residual Soil	Silty CLAY, Clayey GRAVEL	PYTL-BH15, PYTL-TP11, PYTL-TP12	0.90 to 2.80
	Extremely Weathered Basalt	Mixture of cobbles and boulders of Basalt	PYTL-BH15, PYTL-TP11, PYTL-TP12	1.00 to 5.64+
Ordovician Sedimentary Rock	Topsoil	TBC	TBC	TBC
	Alluvium	TBC	TBC	TBC
	Residual Soil	TBC	TBC	TBC
	Extremely Weathered Rock	TBC	TBC	TBC

Topsoil

The site was generally covered with a thin layer of soil with high organic and moisture content that can be classed as Topsoil. It is likely that this horizon has undergone significant reworking due to farming practices and is likely to be very variable with regard to geotechnical properties. However, it was noted that the topsoil was generally varying cohesive in nature and extended to an approximate depth of 0.4 mbgl. The soil was logged as being of low to high plasticity with high organic contents.

Consistency was variable and was observed to be relatively soft to firm however a few high strength floating cobbles and boulders were observed at the surface being of latite origin. Note that the URS report suggested the topsoil as coarse-grained material with some cohesive properties, with no data regarding organic matter on the surface at comparable SLR borehole locations.

Alluvium

Alluvium was encountered at all three investigation locations, extending to an approximate maximum depth of 1.5 mbgl. The soils encountered were generally cohesive, being of medium plasticity. The consistency of soil was observed to be firm to stiff as inferred from the SPT blows undertaken in PYTL-BH15 and DCP blows at PYTL-TP11 & PYTL-TP12.

It is likely that this horizon is not consistent across the site and only confined to within close proximity to drainage line sand creeks. The URS report does not have any data regarding this soil type.

Residual Soil

Residual soil was encountered at depths of between 0.9 mbgl and 2.8 mbgl and generally consisted of orange/brown cohesive soils, with a consistency that increased with depth from firm to stiff, based on SPT blows undertaken in PYTL-BH15 and very stiff to hard, based on the DCP blows at PYTL-TP11 & PYTL-TP12.

Plasticity was noted as being medium to high which is expected from residual soils emanating from basalts. Note that often basaltic residual soils exhibit high levels of soil reactivity. The URS report results corresponding to residual soil matches with SLR results in terms of soil type and consistencies.

Extremely weathered Basalt

Extremely weathered basalt was encountered as a layer of cobbles and boulders to a maximum depth of 5.6 mbgl. The rock in this layer exhibited a degree of staining and evidence of chemical and physical weathering. The basalt was also noted as being vesicular in nature with some of the vesicles infilled with mineral inclusions. The strength of the weathered basalt was variable.

4.1.4 SPT, DCP and Pocket Penetrometer Test Results

SPT testing in PYTL-BH15 indicated that the consistency/relative density increases with depth. This result is well aligned with the pocket penetrometer values, which were undertaken on recovered samples. The drilling penetration resistance also gives a fair indication of the ground conditions at greater depths.

DCP tests also indicated that the soil consistency increased with depth in both excavated test pits as per **Figure 2**.

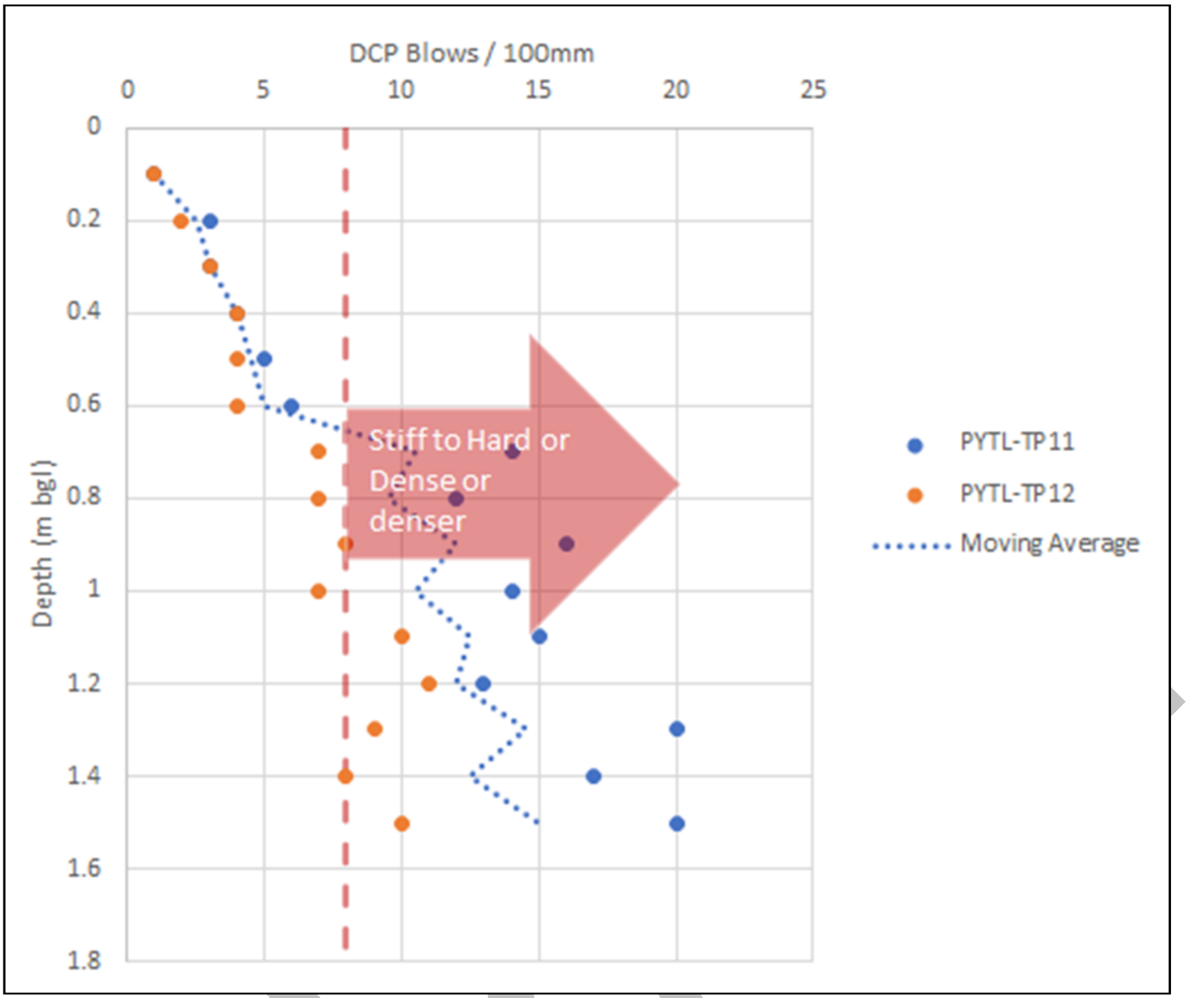


Figure 2 DCP test results

4.1.5 Ground water

Groundwater was encountered in PYTL-BH15 at 2.7 mbgl and the underlying layer was observed as being moist. Due to the ongoing adverse weather during the investigation and the wet seasons experienced by the region, it is likely that this groundwater is a perched layer and its prevalence will vary with rainfall.

It should be noted the location and presence of groundwater level is likely to vary significantly across the site due to the topography, presence of localised drainage lines and may vary with seasonal variation and rainfall.

It was also noted that the URS (2011) report did not identify groundwater in any of the tests undertaken at that time further suggesting that the observed groundwater level is highly variable and seasonal.

4.2 Interim Geotechnical Model

From information contained within the URS (2011) report and from findings gathered on site, it is evident that the majority of the transmission line tower locations are underlain by shallow alluvial and residual soils trending to weathered Basalt at depth. This is likely to be similar for the small section of transmission line overlying Ordovician Sedimentary rocks as shown in **Table 3**.

5 Laboratory Analysis

Laboratory testing on soil samples was undertaken by the NATA accredited, Australian Soil and Concrete Testing laboratory (ASCTL), and consisted of testing detailed in **Section 3.6**.

The laboratory test certificates are presented in **Appendix C**. Results are summarised in **Table 4**.

Table 4 Laboratory Results Summary

Location ID and Depth	Material	% Gravel (>2.36 mm)	% Sand (0.075 - 2.36 mm)	% Silt/ clay (<0.075 mm)	LL	PL	PI	LS (mm)	MC (%)
PYTL-BH15 1.00-1.50m	Silty CLAY	-	-	-	69	35	34	17	40
PYTL-TP11 0.50-1.00m	Silty CLAY	9	15	76	90	36	54	18	-

LL - Liquid Limit, PL - Plastic Limit, PI - Plastic Index, LS – Linear Shrinkage
MC – Field Moisture Content,

5.1 Moisture Content

The sample tested recorded a field moisture content of 40% at PYTL-BH15. This is a high moisture content for in-situ soils and indicates the soils to be approximately 15% more moist than plastic limit. For clayey soils, as moisture content increases, their shear strength decreases. The laboratory results align with field observations, which logged the soil as beyond plastic limit with low shear strength properties.

Test results are included in **Appendix C**. Results are summarised in **Table 4**.

5.2 Particle Size Distribution and Atterberg Limits (PSD and ATT)

The alluvium/residual materials encountered were characterised as fine-grained soils – Clay/Silt with a fines percentage of 76%. The fines are classified as highly plastic and highly sensitive to moisture as indicated by its linear shrinkage of 18%.

Test results are included in **Appendix C**. Results are summarised in **Table 4**.

5.3 Emerson Class

The Emerson Class laboratory testing conducted at PYTL-TP11 returned a value of 5. An Emerson Class of 5, indicates the material to be non-dispersive. The results are consistent with visual surface observations made during site visit which showed limited erosion present on exposed surfaces.

Erosion is a function of run-off slope angle, run-off velocity, vegetation cover, and a materials propensity to disperse into a liquid. Emerson class is an indication to the materials susceptibility to disperse into a fluid when submerged. Considering the limited to minor erosion observed on exposed surfaces, the material may therefore require treatment such as surface protection or compaction to reduce the likelihood of erosion.

Test results are included in **Appendix C**. Test results are summarised in **Table 5**.

Table 5 Summarised Emerson Class Test Results

Location ID	Depth	Material Type	Emerson Class
PYTL-TP11	0.50-1.00	CI-CH Silty CLAY	5

5.4 Shrink-Swell Test

Shrink Swell Index (Iss) is an assessment of the expansion potential of a soil due to moisture change. The shrink swell index gives a quantitative measure of the vertical strain that will occur in clay soil with change in moisture content (or rather change in suction).

The surface movement has been calculated based on the soil profiles logged in the testing locations and the shrink swell indices (Iss). The values of Iss were obtained from the laboratory testing on selected test locations on the site and correlated with the Atterberg limits including the linear shrinkage test results for the soils. The estimated values of Iss are based on empirical relationships developed from limited material sources[1] as such should be used as a guide only. Shrink swell tests were conducted on alluvium/residual soil.

Test certificates are included in **Appendix C**. Test results are summarised in **Table 6**.

Table 6 Summarised Shrink Swell Test Results

Location ID	Depth	Material Type	Shrinkage Field Moisture Content (%)	Swell Field Moisture Content (%)	Swell Inundated Moisture Content (%)	Shrink Swell Index
PYTL-TP11	0.50-1.00	CI-CH Silty CLAY	35.9	36.2	38.3	2

[1] Fityus et al (2005). "The shrink swell test", Geotechnical Testing Journal, Vol. 28, No. 1, pp 1-10.

5.5 California Bearing Ratio (CBR)

CBR testing was conducted on samples remoulded to 95% Standard Maximum Dry Density and near optimum moisture content. CBR values are used in the assessment of pavement design. Summary of test results are presented in **Table 7**.

Table 7 Summarised CBR Test Results

Borehole	Depth (mbgl)	Field Moisture (%)	Optimum Moisture Content (%)	Dry Density (t/m^3)	CBR% @ 2.5mm	Swell (%)
PYTL-TP11	0.50m – 1.00m	-	38.3	1.305	2.5	2.5

---

[1] Fityus et al (2005). "The shrink swell test", Geotechnical Testing Journal, Vol. 28, No. 1, pp 1-10.

5.6 Compaction

Compaction tests were used to aid in the assessment of the engineering properties of the on-site materials. Compaction tests (Proctor Tests) were undertaken to calculate maximum dry density (MDD) and the optimum moisture content (OMC). Results are summarised below.

Table 8 Summarised Compaction Testing

Location	Depth (mbgl)	OMC (%)	MDD (t/m^3)
PYTL-TP11	0.50m – 1.00m	38.3	1.305

6 Geotechnical Engineering Assessment

This section of the report provides an evaluation of the following:

- Geotechnical Parameters
- Trafficability
- Earthworks
- Site Classification
- Foundation design recommendations
- Earthquake classification
- Pavement
- Retaining wall design parameters
- Construction considerations and site management

6.1 Geotechnical Parameters

A summary of the characteristic geotechnical parameters is presented in **Table 9.**

Table 9 Summary of Geotechnical Parameters

Material	Unit Weight (kN/m^3)	Angle of Friction (degrees)	Undrained Shear Strength (kPa)	Elastic Modulus (MPa)
Topsoil	18	N/A	N/A	N/A
Alluvium – silty sandy CLAY (firm)	19	22	50	15
Residual Soil – CLAY (stiff or better)	21	24	75	20
Basalt – XW (cobbles and boulders)	24	38	-	750

6.2 Trafficability

As a result of the generally level topography of the site, provided it is managed correctly, trafficability on the site should not be an issue. Trafficability could be improved by ensuring the ground surfaces are prepared correctly in order that plant should be able to track around the site without damaging the surface too much. During heavy or prolonged rain, use of dedicated construction tracks to control site traffic is recommended.

Problems may arise when the upper-level soil is disturbed and exposed to rainfall or runoff which may result in weakening of the soil. An important aspect of maintaining trafficability is seepage/drainage control, particularly within the areas of the site where there are greater thicknesses of soil. The site will quickly become untrafficable if appropriate seepage and drainage control measures, along with construction practices appropriate for the site conditions, are not maintained. It should be ensured that runoff is diverted away from the construction area to prevent ponding of water.

Partial or complete removal of the upper-level material may be required should these soils become saturated and weakened at the time of construction. It is recommended that the earthworks contract includes an OC item to account for the partial and complete removal scenario.

It is recommended that after stripping, clearing, and grubbing, the exposed surface in the construction area be proof rolled (where appropriate) to assist in identifying weak areas and improve trafficability. In areas of cut, proof rolling may be deferred until after the cut operation.

The contractor should fully inform themselves of the ground conditions on site prior to the commencement of earthworks. The requirement should be explicit in any earthwork's specifications or contract.

6.3 Earthworks

Earthworks were not known at the time of the investigation. However, it is anticipated that minor cut and fill will be required to create the building platforms.

Earthworks procedures should be carried out in a responsible manner in accordance with AS.3798-2007 “Guidelines on Earthworks for Commercial and Residential Developments”.

6.3.1 Upper-Level Soils

The upper-level soils encountered in the relevant exploratory holes comprised topsoil, Alluvium and residual soil. These materials were consistently encountered at variable thicknesses at levels that could potentially be disturbed during earthworks.

Based on a review of the site investigation data for the wind turbines and from the limited site investigation carried out to date with the proposed alignment of the transmission towers, the upper-level soils are expected to vary laterally and with depth, in their material composition, density or strength and therefore may not be a suitable founding stratum for the transmission towers.

6.3.2 Subgrade Preparation Procedures

Subgrade preparation procedures for pavement sub-grade and fill placement beneath structures and footings should include the following:

Clearing, stripping and grubbing should be carried out in areas subject to earthworks (as trafficability conditions allow). Also, all soils containing organic matter should be stripped from the construction area. This material is not considered suitable for use as structural fill.

Depressions formed by the removal of vegetation, underground elements etc. should have all weakened soil cleaned out and be backfilled with compacted select material.

The subgrade should be proof rolled (where appropriate) under the supervision of a suitably qualified geotechnical engineer using a static vehicle with a tare of at least 5 tonnes and compacted to the required degree. In areas of cut, proof rolling may be deferred until after the cut operation. Areas demonstrating excessive movement should be treated (dried and compacted) or removed and replaced with compacted fill. Treatment should be to a standard sufficient that the subgrade passes proof rolling, and that compaction can be achieved in the first layer of fill.

Backfilling should be carried out in a controlled manner and should include the removal of all organic and deleterious matter and excavation of weak, disturbed, water affected and organic rich soils together with the placement of good quality fill material (compacted to the appropriate requirements).

The on-site soils are expected to be sensitive to water and will lose strength/density if they become wet. Should this occur, additional treatment may be required.

A survey of the subgrade surface following stripping, demolition and preparation is recommended. The survey will allow for the accurate identification of the fill/natural interface and assist with the construction of the proposed development.

6.3.3 Excavation Characteristics

Excavations would be expected to comprise:

- Bulk cuts – for site stripping and excavation to create platforms and subgrade levels.
- Trenching – for underground services and high-level footings.

Excavations on site should be within the capabilities of light plant, small dozer (CAT D4C or similar) in bulk cuts and medium sized backhoe (Case 580 or similar) or small excavator (12t to 15t) in trenching, based on the investigation findings. Use of larger equipment could be used to expediate construction. Larger excavators with a rock breaker attachment will be required when excavating in the weathered rock material.

6.3.4 Material Usage

Aside from the topsoil material that is not suitable for reuse, the natural soils, where free from organic and deleterious material may be used as structural fill provided that the moisture content of the soils on placement approximates the optimum moisture content required for compaction in the cohesive material. This will require conditioning to bring the soils to optimum. It should be noted that the in-situ soils could be expected to present difficulties in handling, placement and compaction if the appropriate moisture content could not be achieved, particularly if the soils are overly moist.

The weathered rock will comprise some of the borrow material won from the site excavations. It is considered that the extremely and distinctly weathered material will break down sufficiently during the earthworks operations using large compactors. The weathered rock, where broken down on extraction, may be used as structural fill provided that no rock over 75 mm greatest dimension is included.

6.3.5 Compaction Procedures and Specifications

Provided the placement moisture content of the select on-site material approximates the optimum moisture content for compaction, suitable compaction should be achievable using typical compaction machinery, i.e. 5 t to 10 t vibrating sheepsfoot roller or 25 t to 30 t sheepsfoot compactor. For the above plant, the fill material, in accordance with AS 1289 5.1.1 (standard compaction), should be compacted in layers not exceeding 250mm, loose thickness.

However, layer thickness will be dependent on the compaction plant type and size, use of vibration, material type and composition. Final maximum placement layer thicknesses will need to be assessed when the compaction plant, material type and conditions are known. Fill batters should be overfilled and cut back to design batter angles.

The following minimum compaction values, as presented in **Table 10**, are recommended for building and pavement areas.

Table 10 Recommended Minimum Compaction Values

Location	Cohesive Soils	Non-Cohesive Soils
Structural Areas	98%	75%
Pavement Areas – top 300 mm below subgrade level	98%	75%
Pavement Areas – below the top 300 mm to 5.00 mm	95%	75%

Notes:
The density ratios are determined by AS 1289 Test 5.1.1 (Standard Compaction for Cohesive Soils)
The density ratios are determined by AS 1289 Test 5.1.1 (Standard Compaction for Cohesionless Soils)

Field density testing should be conducted to assess the standard of compaction achieved and the placement moisture content. The frequency and extent of the testing should be carried out in accordance with AS 3798-2007, Section 8.0.

Good quality backfill material should be used for backfilling, for example, of service trenches. The backfill should be placed in uniform layers over the full width of the excavation with layers not exceeding 200 mm thickness, loosely placed using wheeled plant or 100 mm thickness using handheld vibrating plates. The backfill material should be compacted to the specifications outlined in **Table 10** for in-situ cohesive or cohesionless material.

Soils encountered on the site should be with the excavation limits of a small dozer (i.e., CAT D4 or similar) in bulk earthworks and a medium sized backhoe (i.e., Case 580 or similar in trench excavations). However, large excavators (i.e. 30 tonne), possibly utilising rock breaker attachments, may be required for trenching in the weathered rock stratum.

6.3.6 Batters and Embankments

Maximum cut batter and fill embankment angles for different types of materials are presented in Table 11. The values in the table are for unsurcharged batter and embankments less than 3 m high. Where surcharges (i.e. footings, live loads etc.) are located within H (height of batter) of the top of the batter and/or embankment, then a reduction in the design angle will occur.

Fill embankment slopes are dependent on suitable compaction being achieved. Fill batters should be overfilled, compacted and cut back to alignment to achieve full compaction of the batter edge.

Table 11 Batter/Embankment Angles (for slopes less than 3 m high)

Material		Short Term (degrees)	Long Term (degrees)
Sandy Soils	Loose	30 (1V:1.75H)	18 (1V:3H)
	Medium Dense	35 (1V:1.45H)	18 (1V:3H)
	Dense to Very Dense(1)	35 (1v:1.45H)	18 (1V:3H)
Clay Soils	Soft to Firm	35 (1v:1.45H)	18 (1V:3H)
	Stiff	40 (1v:1.2H)	26 (1V:2H)
	Very Stiff to Hard(1)	45 (1V:1H)	26 (1V:2H)
Basalt and Siltstone	XW/DW(1)	56 (1.5V:1H)	45 (1V:1H)

Notes:
(1) Subject to inspection by an experienced geotechnical engineer during initial earthworks operations.
Fill batter angles are dependent upon suitable compaction being achieved.
These values assume no seepage. If seepage is present, the recommended angles would need to be reduced or the use of dewatering considered.
The above batter angles are presented for stability purposes; a shallower angle could be necessary for maintenance purposes.

The orientation and spacing of the joints and defects within the weathered rock mass could affect the stability of the slopes indicating that it may not be possible to achieve the angles presented in Table 11. All batter angles should be confirmed on site by an experienced geotechnical engineer.

It is essential that permanent batters/embankments be suitably protected from erosion and scour by appropriate drainage and establishment of ground cover and shrub-type vegetation. Runoff should not be allowed to discharge directly across the batters without suitable scour protection.

6.3.7 Earthworks Supervision

Engineering supervision of the earthwork's operation by a suitably qualified and experienced geotechnical engineer is recommended. It should be made clear in any earthworks specification as to what is required in terms of certification.

It is recommended that the following objectives be incorporated into the earthwork's specification:

- Engineering certification that all general earthworks operations have been carried out in accordance with the earthwork's specification.
- Engineering certification that fill has been placed and compacted to the required minimum density in accordance with the earthwork's specification.
- If required, engineering certification that the controlled fill material is suitable to support a conventional slab on ground floor.
- Engineering certification that the quality of the imported fill complied with the earthwork's specification requirements.

6.4 Site Classification

While a site classification in accordance with AS 2870 'Residential Slabs and Footings' relates to residential type construction, it is a valuable method of classification. Preliminary results from the site investigation carried out at the proposed wind turbine locations suggest that, in accordance with AS 2870, the site can be classified as **Class M**. A ground surface movement of 20 mm to 40 mm should be anticipated. It is highly recommended that the footing system be designed to accommodate this anticipated ground surface movement.

6.5 Preliminary Foundation Recommendations

6.5.1 General

The foundations to transmission towers are normally subject to the three types of forces. These are:

- The compression or downward thrust.
- The tension or uplift.
- The lateral forces of side thrusts in both transverse and longitudinal directions.
- To design the foundations to the towers, the following geotechnical parameters are required. The bearing capacity parameters are presented in **Section 6.5.2**.
- Bearing Capacity.
- Soil Density.
- Angle of Earth Frustrum (to be calculated by the transmission tower designer).

6.5.2 Recommended Geotechnical Design Parameters

Based on the existing geotechnical investigation data, at a depth where gravity footings could be constructed, the ground conditions generally comprise extremely weathered to distinctly weathered basalt and siltstone. Until geotechnical investigation is available for the site, the following foundation design parameters are recommended and presented in **Table 12.**

Table 12 Recommended Foundation Design Parameters

Material	Foundation Design Parameters		
	Allowable Bearing	Ultimate Bearing	Ultimate Bond Stress
Very stiff (or stiffer) Clay	250 kPa	750 kPa	-
Medium Strength Siltstone or Basalt	1.0 MPa	8.0 MPa	500 kPa
High Strength Basalt	3.5 MPa	30 MPa	2000 kPa
Notes: All capacities and footing bases are subject to inspection by a geotechnical engineer.			

6.6 Earthquake

In accordance with AS 1170.4-2007 ‘Structural design actions Part 4: Earthquake actions in Australia’, the site had been assessed with the following sub-soil earthquake classification:

- Sub-soil Class: B_e
- Seismic hazard factor (Z): <0.09

6.7 Pavements

Provided that the relevant recommendations outlined in **Section 6.7** are complied with, the following pavement design values, as presented in **Table 13,** may be adopted for the development.

Table 13 Design Values for Pavements

Material	CBR Value (%)
Sub grade materials with high clay content	2
Weathered Bedrock	10

6.8 Construction Considerations

6.8.1 Adjacent Features/Excavation Characteristics

Where proposed foundations are located within close proximity to proposed or existing features and/or excavations (i.e. Underground service trenches, unsupported batters etc.), the interaction between the foundation and the feature must be carefully considered. Generally, for underground service trenches, the following guidance is recommended.

- The base of the proposed footing should extend 500 mm below the base level of the trench and not be located within 1.0 m laterally from the trench.
- The base of the proposed pier should extend 1.0 m below the base level of the trench and not be located within 1.0 m laterally from the trench.

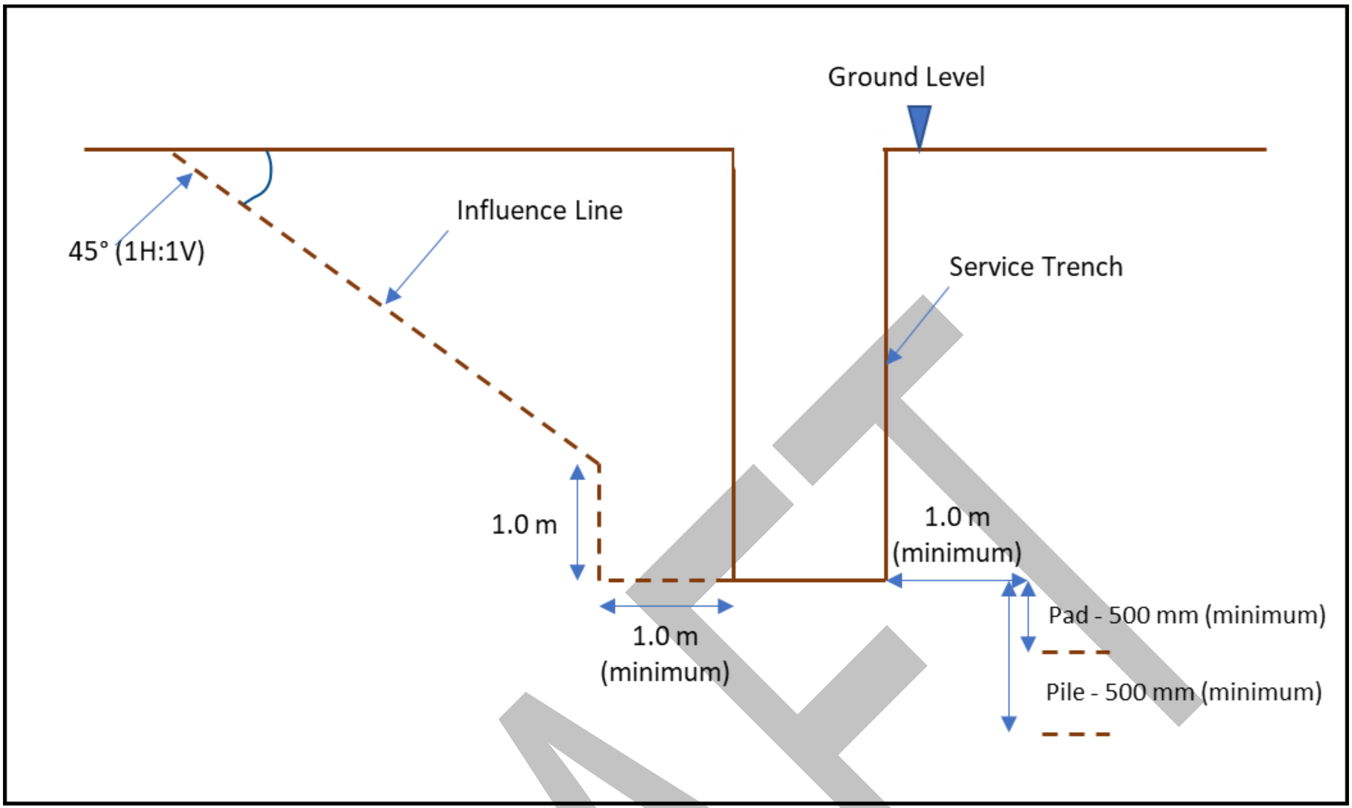


Figure 3 **Service trench and foundation interaction guidance**

6.8.2 High Level Footings

Given the properties of the founding materials, it is recommended that following excavation the footings be poured as soon as possible to minimise the potential for desiccation or wetting of the founding material. Where footings cannot be poured the same day as the excavation or within a short period of time, it is recommended that a blinding layer of concrete, at least 50 mm thick, be placed immediately following excavation, cleaning and inspection of the footing base by an experienced geotechnical engineer.

It is possible that shoring will be required to support the sides of the footing excavations to prevent side wall collapse. This is a risk in all material types, whether controlled, uncontrolled or natural and precautions should always be taken to ensure the pit sides are stable.

It is recommended that inspections be conducted by an experienced geotechnical engineer following footing excavations to confirm the adequacy of the founding soils, whether the material exposed at the base of footings is consistent with the geotechnical model and assumed bearing pressures. Inspections should be carried out prior to placement of reinforcing steel and ordering of concrete.

6.8.3 Deep Foundations

Some difficulty with fall-in may occur, particularly when drilling through the upper-level soils. If bored piles are being constructed it should be ensured that all loose material is removed from the base of the piers prior to the pouring of concrete. The use of a ‘clean out’ bucket should be explicit in instructions to the drilling contractor.

Given the nature and strength of the subsurface material encountered, it is recommended that inspections be carried out by an experience geotechnical engineer during the pier excavation to confirm the adequacy of the founding material. Inspections should be carried out prior to placement of reinforcing steel and ordering of concrete.

Some allowance for dewatering and the use of liners should be made. In addition, it may be preferable to drill a 'trial pile' to fully assess construction difficulties. It is recommended that the pier holes be poured as soon as possible following boring.

6.9 Electrical Resistivity

SLR will be carrying out an electrical resistivity study. In the meantime, refer to study already carried out in the URS report.

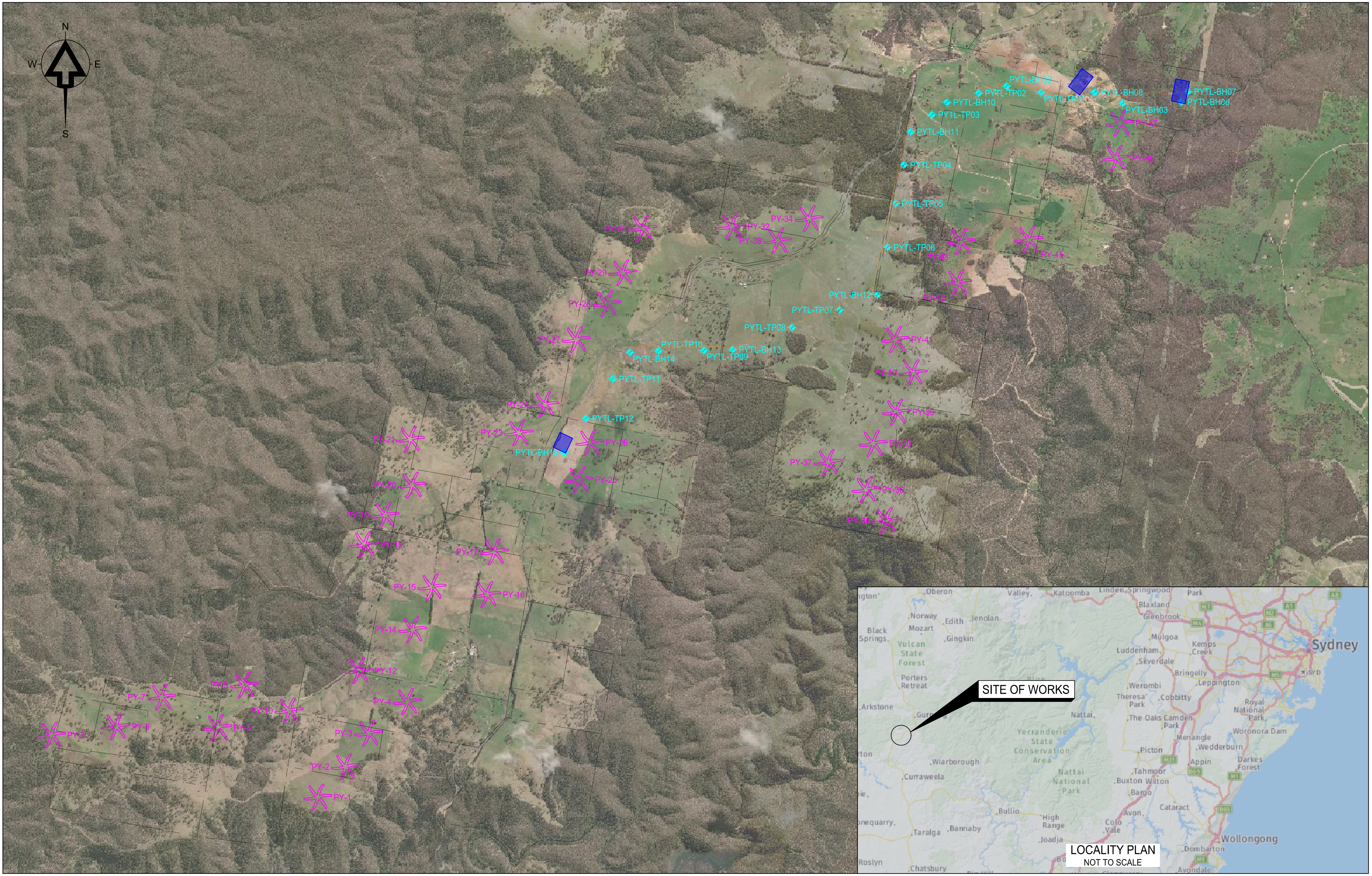
7 Feedback

At SLR, we are committed to delivering professional quality service to our clients. We are constantly looking for ways to improve the quality of our deliverables and our service to our clients. Client feedback is a valuable tool in helping us prioritise services and resources according to our client needs.

To achieve this, your feedback on the team's performance, deliverables and service are valuable and SLR welcome all feedback via https://www.slrconsulting.com/en/feedback. We recognise the value of your time and we will make a $10 donation to our 2022 Charity Partner – Lifeline, for every completed form.

APPENDIX A

Site Mapping



650.30012_Site Investigation Plan_v1.dwg

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SLR Consulting Australia Pty Ltd does not guarantee the accuracy of any such information.

Project No:	650.30012
Date:	29.08.2022
Drawn by:	JM
Scale:	1:40000
Sheet Size:	A3
Projection:	GDA94Z55

LEGEND

✦	PROPOSED SLR TEST PIT / BOREHOLE LOCATIONS
✳	PROPOSED TURBINES
▭	PROPOSED SUBSTATION OPTIONS
—	PROPOSED TRANSMISSION LINE
-·-·-	EXISTING SITE BOUNDARIES

0.0 400 800 1200 1600
METRES
SCALE 1:40000

PAILINGS YARD WIND FARM

GPG AUSTRALIA PTY LTD

SITE INVESTIGATION PLAN TRANSMISSION LINE

FIGURE 02

APPENDIX B

Geotechnical Logs

NON-CORE BOREHOLE LOG

HOLE NO.: PYTL-BH15

PROJECT : Palings Yard Wind Farm and Transmission Line
LOCATION : Palings Yard
FILE / JOB NO.: 650.30012

DATE STARTED : 09-05-22	POSITION : E: 200422.16, N: 6216586.51 (MGA94)	SURFACE ELEVATION : 1008m (AHD)	LOGGED BY : GL
DATE COMPLETED : 09-05-22	RIG TYPE : Hydrapower Scout	ANGLE FROM HORIZONTAL : 90°	CHECKED BY : BT
DATE LOGGED : 09-05-22	DRILLER : Scott, Daily	CONTRACTOR : Rockwell Drilling	

DRILLING

PROGRESS: DRILLING &CASING: AD/T (0.00–5.64 m); WATER: Not Added
DRILLING PENETRATION: VE E F H
GROUND WATER LEVELS: ▽ at approx. 2.7 m

SAMPLES & FIELD TESTS	Depth (m)
1.00m (D)	1.00
SPT (C) 4,4,4 N=8	1.50
SPT (C) 6,11,17 N=28	3.00
SPT (C) 25,26,4/150mm N=RF	4.50
SPT (C) HB -	5.60

MATERIAL

DEPTH (m)	RL (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION SOIL/ROCK TYPE; grain characteristics, colour, structure, minor components	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	ORIGIN
0.00–0.25	1008.0–1007.75	ML	MIXTURE OF SOIL AND COBBLES/BOULDERS (MATRIX SUPPORTED) SILT, low plasticity, dark orange brown; sub-angular, latite, grey, 100-400mm, high strength, slightly weathered; trace roots.	>PL <LL	F	Topsoil
0.25–1.50	1007.75–1006.5	CI	Silty CLAY, medium plasticity, dark orange brown; silt, medium plasticity; with ironstone, coarse grained, rounded.	=PL		Alluvium
1.50–2.80	1006.5–1005.2	CI - CH	Silty CLAY, medium to high plasticity, red brown, grey, orange brown; silt, medium to high plasticity; rock structure evident, tending towards extremely weathered Basalt.	>>PL <LL	F - St	Residual
2.80–5.30	1005.2–1002.7		EXTREMELY WEATHERED BASALT recovered as CLAY, low plasticity, greeny grey, grey with dark grey speckled, red brown and dark grey mottled.	M		Extremely Weathered Bedrock
5.30–5.64	1002.7–1002.36		BASALT, dark grey, high strength, moderately weathered, highly fractured. EOH: 5.64m - Target Strata			Bedrock

OBSERVATION

STRUCTURE & Other Observations

1.50m: SPT Sample Length 450mm

3.0m - 3.5m: pp > 600kPa

3.00m: SPT Sample Length 450mm

4.5m - 5.0m: pp > 600kPa

4.50m: SPT Sample Length 280mm

5.60m: SPT Sample Length 150mm

See Symbology & Classification notes for details of abbreviations & basis of descriptions.

BOREHOLE PHOTOS

BH NO.: PYTL-BH15

JOB NO.: 650.30012.00000

Site - looking east

TEST PIT EXCAVATION LOG

HOLE NO.: PYTL-TP11

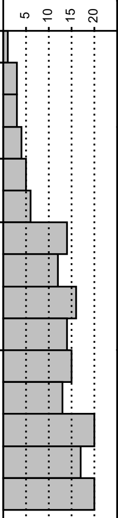
PROJECT : Palings Yard Wind Farm and Transmission Line
LOCATION : Palings Yard
FILE / JOB NO.: 650.30012

DATE STARTED : 19-07-22
POSITION : E: 200943.3, N: 6217445.8 (MGA94)
SURFACE ELEVATION : 965m (AHD)
LOGGED BY : GL

DATE COMPLETED : 19-07-22
RIG TYPE : Backhoe
STABILITY : Stable
CHECKED BY : BT

DATE LOGGED : 19-07-22
OPERATOR : Jai Wonson

DRILLING						MATERIAL						OBSERVATION	
METHOD& BUCKET TYPE	PENETRATION (VE E F H)	WATER	SAMPLES TESTS REMARKS	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION SOIL/ROCK TYPE; grain characteristics, colour, structure, minor components	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	DCP RESULTS (5 10 15 20)	ORIGIN	STRUCTURE & Other Observations
Backhoe bucket 250mm Toothed Bucket		Groundwater Not Encountered	0.29m (ES) 0.30m (ES)				MI	Clayey sandy SILT with organic matter (roots greater than 2mm diameter) trace gravel, medium plasticity, reddish brown; clay, medium plasticity, sand, fine to medium grained; gravel, fine grained.	>>PL <LL	F St		Topsoil	
			0.50m (B) 0.50m (ES) 0.51m (ES)	964.5	0.5		CH	Silty CLAY with sand, high plasticity, reddish brown; silt, high plasticity; sand, fine grained.	>PL <LL	VSt H		Alluvium/ Residual	
				964.0 963.5	1.0 1.5			MIXTURE OF SOIL AND COBBLES/BOULDERS (MATRIX SUPPORTED) clayey GRAVEL, fine grained, sub-rounded, 50-150mm diameter cobbles, dark brown; clay, low plasticity; tends towards extremely weathered basalt.	M	VD		Residual	
								EOH: 1.80m - Refusal on bedrock					
				963.0	2.0								
				962.5	2.5								
				962.0	3.0								
				961.5	3.5								
				961.0	4.0								
				960.5	4.5								



See Symbology & Classification notes for details of abbreviations & basis of descriptions.

TESTPIT PHOTOS

BH NO.: TP11

JOB NO.: 650.30012.00000

SLR

TEST PIT EXCAVATION LOG

HOLE NO.: PYTL-TP12

PROJECT : Palings Yard Wind Farm and Transmission Line
LOCATION : Palings Yard
FILE / JOB NO.: 650.30012
DATE STARTED : 19-07-22
POSITION : E: 200644.77, N: 6216989.84 (MGA94)
SURFACE ELEVATION : 1000m (AHD)
LOGGED BY : GL
DATE COMPLETED : 19-07-22
RIG TYPE : Backhoe
STABILITY : Stable
CHECKED BY : BT
DATE LOGGED : 19-07-22
OPERATOR : Jai Wonson

DRILLING

METHOD& BUCKET TYPE: Backhoe bucket, 250mm Toothed Bucket

PENETRATION: VE F H

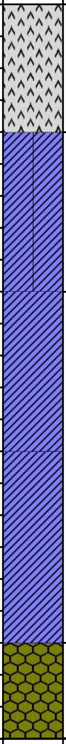
WATER: Groundwater Not Encountered

SAMPLES TESTS REMARKS:
0.30m (ES)
0.31m (ES)
0.40m (B)
0.50m (ES)
0.51m (ES)

RL (m): 999.5, 999.0, 998.5, 998.0, 997.5, 997.0, 996.5, 996.0, 995.5

DEPTH (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

MATERIAL

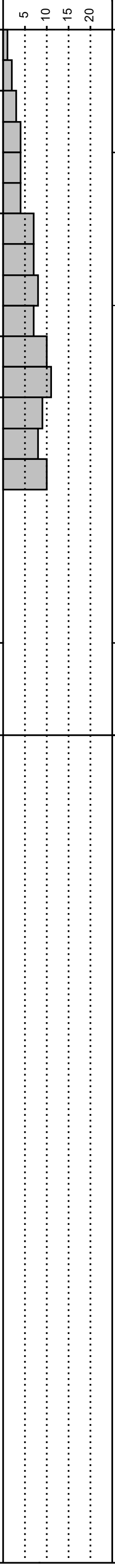


CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION SOIL/ROCK TYPE; grain characteristics, colour, structure, minor components	MOISTURE CONDITION	ORIGIN
MH	Clayey SILT with organic matter (roots greater than 2mm diameter), high plasticity, reddish brown, brown; clay, high plasticity.	>>PL <LL	Topsoil
CL-CI	Silty CLAY, low to medium plasticity, reddish brown; silt, low to medium plasticity.		Alluvium
	Silty CLAY with gravel, medium plasticity, reddish brown; silt, medium plasticity; gravel, fine grained, sub-rounded.	D - M	Residual
CI	Silty gravelly CLAY, medium plasticity, reddish brown, grey, white mottled; silt, medium plasticity, gravel, fine grained, sub-rounded.		
	MIXTURE OF SOIL AND COBBLES/BOULDERS (MATRIX SUPPORTED) EXTREMELY WEATHERED BASALT , reddish brown; sub-rounded to sub-angular, 50-100mm; low strength, iron staining.	D	Extremely Weathered Bedrock

EOH: 2.30m - Refusal on bedrock

CONSISTENCY / RELATIVE DENSITY:
F
St
VSt
H
VSt

DCP RESULTS



OBSERVATION

STRUCTURE & Other Observations

TESTPIT PHOTOS

BH NO.: TP12

JOB NO.: 650.30012.00000

APPENDIX C

Laboratory Test Certificates

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2/15 Miall Way, Albion Park Rail NSW 2527

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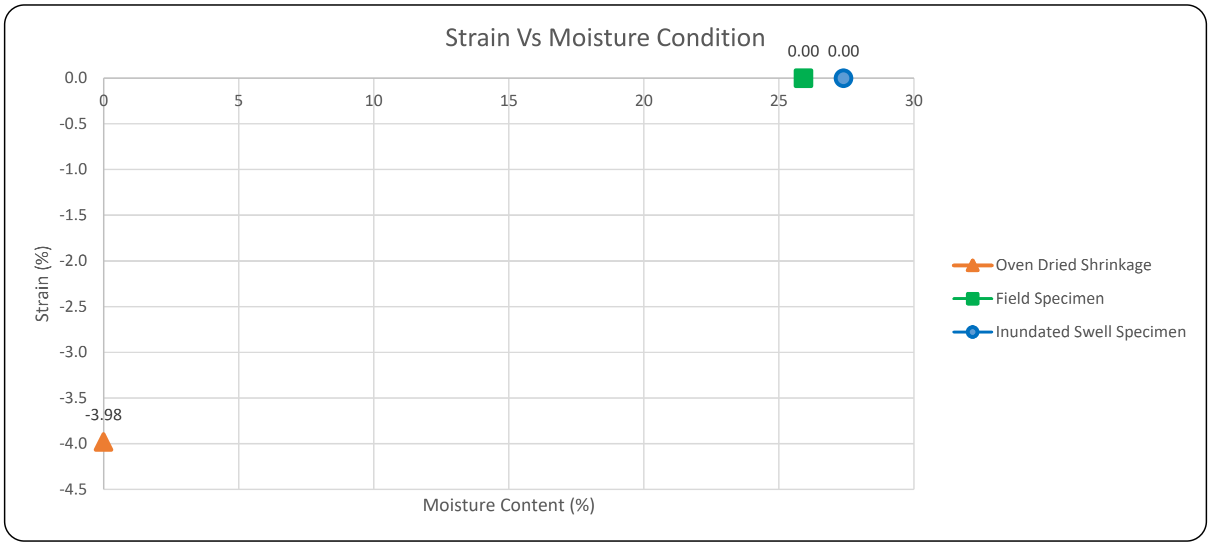
Mobile: +61 (0) 497 979 929
A.B.N. 34 635 062 609

Report on Shrink / Swell Index of a Soil

Client:	SLR Consulting Australia Pty Ltd	Report No:	**235**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	24/05/2022
Project:	Geotechnical Testing	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Test Request/Order:	650.30012.00000
Material Description:	CLAY	Lot Number:	-
Lab Test Date/s:	Testing commenced 17/05/2022 and was completed 18/05/2022.	ITP/PCP Number:	-
Lot Comments:	-	Control Line:	PYWF-BH03

Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
48204	**11/05/2022**	**-**	**-**	**PYWF-BH03**	**1.00 - -1.50**

Parameters	Units	Test Results	Soil Description
Shrinkage - Field Moisture Content	%	25.9	CI-CH,Silty CLAY
Swell - Field Moisture Content	%	26.0	
Swell - Inundated Moisture Content	%	27.4	
Inert Inclusions in the soil	%	15	
Extent of Soil Crumbling	-	None	
Extent of Soil Cracking	-	Minor	
Shrink-Swell Index	**%**	**2.2**	



Sampling & Test Methods (Results relate only to the items sampled/tested)	Report Remarks & Endorsement
AS 1289.7.1.1, Cl 4: Shrink Swell Index - Thin wall sampler (U50) AS 1289.7.1.1: Shrink Swell Index of a Soil	

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NATA Accreditation number: 20656

Issued By: L.Romano
L.Romano
Approved Signatory

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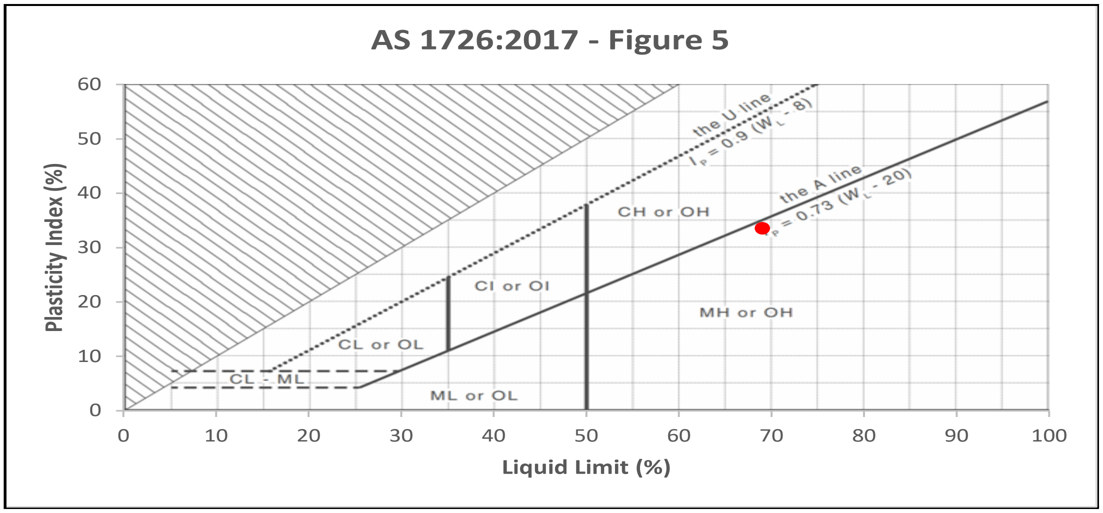
Report on Plastic Properties

Client:	SLR Consulting Australia Pty Ltd	Report No:	**238A**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	24/05/2022
Project:	Geotechnical Testing	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Test Request:	650.30012.00000
Material Description:	Silty CLAY	Lot Number:	-
Lot Comments:	-	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 19/05/2022	Control Line:	PYTL - BH15

Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
48207	**9/05/2022**	**0.0**	**0.0**	**PYTL - BH15**	**1.00-1.50**

Specification Name	

Pretreatment	Units	Result	Specification Limits	Remarks
Retained 53.0mm Sieve	%			
Pretreatment by Weathering	--			
Pretreatment by Compaction	--			
Plasticity	**Units**	**Result**	**Specification Limits**	**Remarks**
Liquid Limit	%	**69**		Oven Dried & Dry Sieved
Plastic Limit	%	**35**		Oven Dried & Dry Sieved
Plastic Index	%	**34**		Oven Dried & Dry Sieved
Linear Shrinkage	%	**17.0**		Oven Dried & Dry Sieved. Cracked/Broken Bar



Sampling & Test Methods (Results relate only to the items sampled/tested)	Report Remarks & Endorsement
Sampled by Customer: Results apply to the sample/s as received. ** AS 1289.1.1: (2001)Preparation of disturbed soil samples for testing AS 1289.3.1.2: (2009)Liquid Limit, One point Casagrande AS 1289.3.2.1: (2009)Plastic Limit of a soil AS 1289.3.3.1: (2009)Plasticity Index of a soil AS 1289.3.4.1: (2008)Linear Shrinkage of a soil	

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ISO/IEC 17025 - Testing.
NATA Accreditation number: 20656

Issued By: L.Romano
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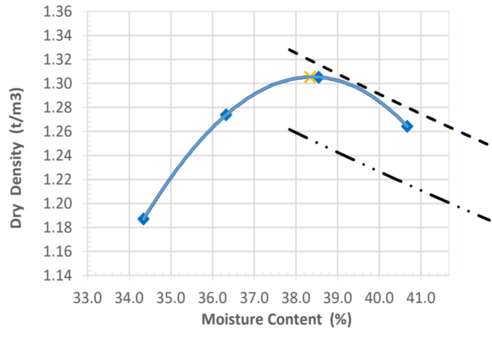
Report on AS CBR and MDD

Client:	SLR Consulting Australia Pty Ltd	Report No:	**4-258-CBR**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	3/08/2022
Project:	Geotechnical Testing	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used(Source):	-	Test Request/Order:	**650.30012.00000**
Material Description:	Silty CLAY	Lot Number:	-
Lot Boundaries:	-	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 22/07/2022 to 03/08/2022	Control Line:	PYTL-TP11

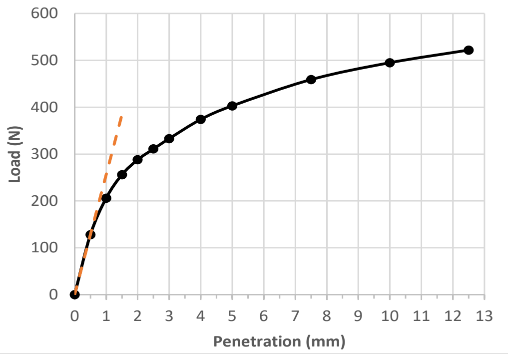
Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
49955	**21/07/2022**	**-**	**-**	**PYTL-TP11**	**0.50-1.00m**

Parameters	Units	Test Results		Information
Pretreatment Regime	--	No Pretreatment		
Portion Retained on AS Sieve	%	1% on 19mm		Retained material excluded from CBR
Material Plasticity (Liquid Limit)	--	High (More than 50%)		By Technician's Assessment
Sample Curing Time	hrs	142		
Soil Particle Density	t/m3	2.67		Estimated value only**
Maximum Dry Density (MDD)	t/m3	1.305		Standard compactive effort
Optimum Moisture Content (OMC)	%	38.3		
Field/Prep Moisture Content	%	Field 39.6 %	Prep 39.6 %	Passing 19.0mm portion
Compaction Moisture Content	%	Achieved 38.8 %	LMR = 101.0%	Specified LMR = 100%
Compaction Dry Density	t/m3	Achieved 1.3 t/m3	LDR = 99.0%	Specified LDR = 100%
Surcharge Load	kg	4.5		
Period of Soaking	Days	Soaked - 4 Days		Dry Density (after soaking) = 1.27 t/m3.
Specimen Swell	%	2.5		
Moisture Content - Top 30mm	%	42.8		After Penetration
Moisture Content - Remaining	%	40.1		After Penetration

Dry Density Vs Moisture Content



Load-Penetration Curve



Material CBR Value (%)

2.5

California Bearing Ratios

$\text{CBR}_{2.5} =$ 2.5

$\text{CBR}_{5.0} =$ 2.0

Including an Applied Correction of
0.0 mm

Sampling & Test Methods (Results relate only to the items sampled/tested)

Sampled by Customer: Results apply to the sample/s as received. **
AS 1289.1.1: (2001)Preparation of disturbed soil samples
AS1289.2.1.1: (2005) Moisture Content of a Soil (Oven Drying)
AS1289.5.1.1: (2017)Dry Density/Moisture content relation of a soil (Standard)
AS1289.6.1.1: (2014)California Bearing Ratio of a soil (remoulded specimen)

Report Remarks & Endorsement

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NATA Accreditation number: 20656

Issued By: P.Baltoski
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Approved Signatory

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WB080 - Rev 17, 08/07/2022

Report on Material Quality

Client:	SLR Consulting Australia Pty Ltd	Report No:	**4-258-MQ**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	3/08/2022
Project:	Geotechnical Testing	Report Page:	Page 1 of 2
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Request/Order:	650.30012.00000
Material Description:	Silty CLAY	Lot Number:	-
Lot Comments:	-	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 22/07/2022 to 27/07/2022	Control Line:	PYTL-TP11

Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
49955	**21/07/2022**	**-**	**-**	**PYTL-TP11**	**0.50-1.00m**

Sampling & Test Methods (Results relate only to the items sampled/tested) **(** NATA accreditation does not cover the performance of this service)**

Sampled by Customer: Results apply to the sample/s as received. **
AS 1289.1.1: (2001)Preparation of disturbed soil samples
AS 1289.3.6.1 Coarse: (2009)Determination of the particle size distribution of a soil
AS 1289.3.6.1 Fine: (2009)Determination of the particle size distribution of a soil
AS 1289.3.1.2: (2009)Determination of Liquid Limit (1 point Casagrande)
AS 1289.3.2.1: (2009) Determination of the Plastic Limit
AS 1289.3.3.1: (2009)Calculation of the Plastic Index of a soil
AS 1289.3.4.1: (2008)Determination of the Linear Shrinkage of a soil
AS 1289.3.8.1: (2017) Emerson Class number of a soil **

Report Remarks & Endorsement

Issued By: L.Romano

L.Romano
Approved Signatory

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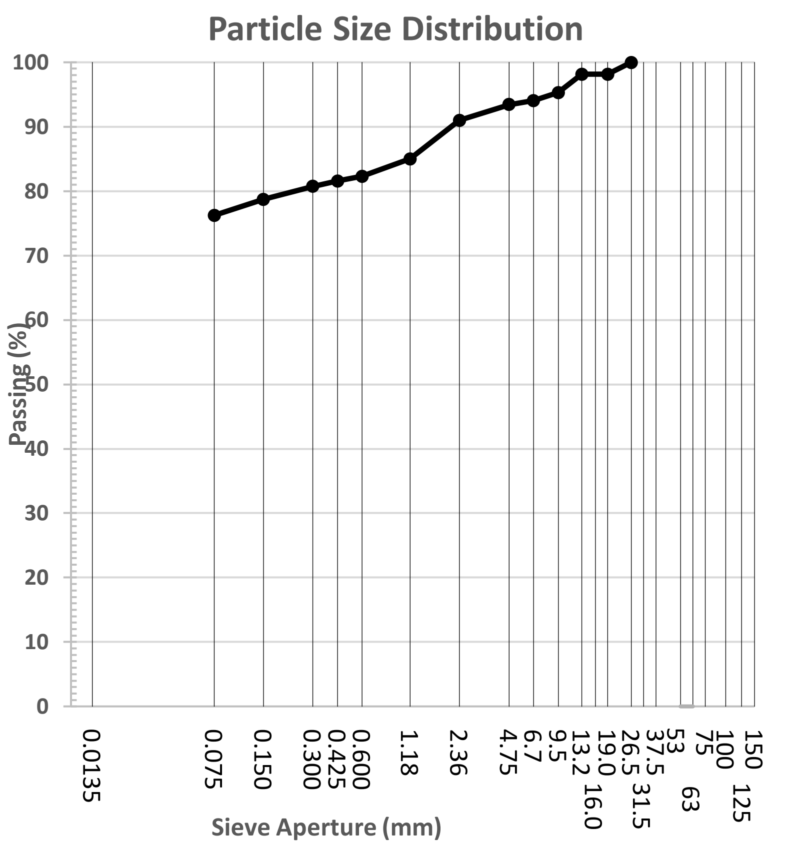
NATA Accreditation number: 20656

Specification Name			
Particle Size Distribution	Units	**Result**	**Specification Limits**
Passing 150mm Sieve	%		
Passing 125mm Sieve	%		
Passing 100mm Sieve	%		
Passing 75.0mm Sieve	%		
Passing 63.0mm Sieve	%		
Passing 53.0mm Sieve	%		
Passing 37.5mm Sieve	%		
Passing 31.5mm Sieve	%		
Passing 26.5mm Sieve	%	**100**	
Passing 19.0mm Sieve	%	**98**	
Passing 16.0mm Sieve	%		
Passing 13.2mm Sieve	%	**98**	
Passing 9.5mm Sieve	%	**95**	
Passing 6.7mm Sieve	%	**94**	
Passing 4.75mm Sieve	%	**93**	
Passing 2.36mm Sieve	%	**91**	
Passing 1.18mm Sieve	%	**85**	
Passing 0.600mm Sieve	%	**82**	
Passing 0.425mm Sieve	%	**82**	
Passing 0.300mm Sieve	%	**81**	
Passing 0.150mm Sieve	%	**79**	
Passing 0.075mm Sieve	%	**76**	
Passing 0.0135mm Sieve	%		

Graphical Representation



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WB080 - Rev 17, 08/07/2022

Report on Material Quality

Client:	SLR Consulting Australia Pty Ltd	Report No:	**4-258-MQ**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	3/08/2022
Project:	Geotechnical Testing	Report Page:	Page 2 of 2
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Request/Order:	650.30012.00000
Material Description:	Silty CLAY	Lot Number:	-
Lot Comments:	-	ITP/PCP Number:	-
Lab Test Date/s:	Laboratory testing 22/07/2022 to 27/07/2022	Control Line:	PYTL-TP11

Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
49955	**21/07/2022**	**-**	**-**	**PYTL-TP11**	**0.50-1.00m**

Plasticity	Units	**Result**	**Specification Limits**	**Remarks**
Liquid Limit	%	**90**		Oven Dried & Dry Sieved
Plastic Limit	%	**36**		Oven Dried & Dry Sieved
Plastic Index	%	**54**		Oven Dried & Dry Sieved
Linear Shrinkage	%	**18.0**		
Emerson Class	Units	**Result**	**Specification Limits**	**Remarks**
Temperature of Test Water	°C	**16**		Distilled test water used
Emerson Class Number	-	**CLASS 5**		CH,Silty CLAY, Red brown

AUSTRALIAN SOIL AND CONCRETE TESTING
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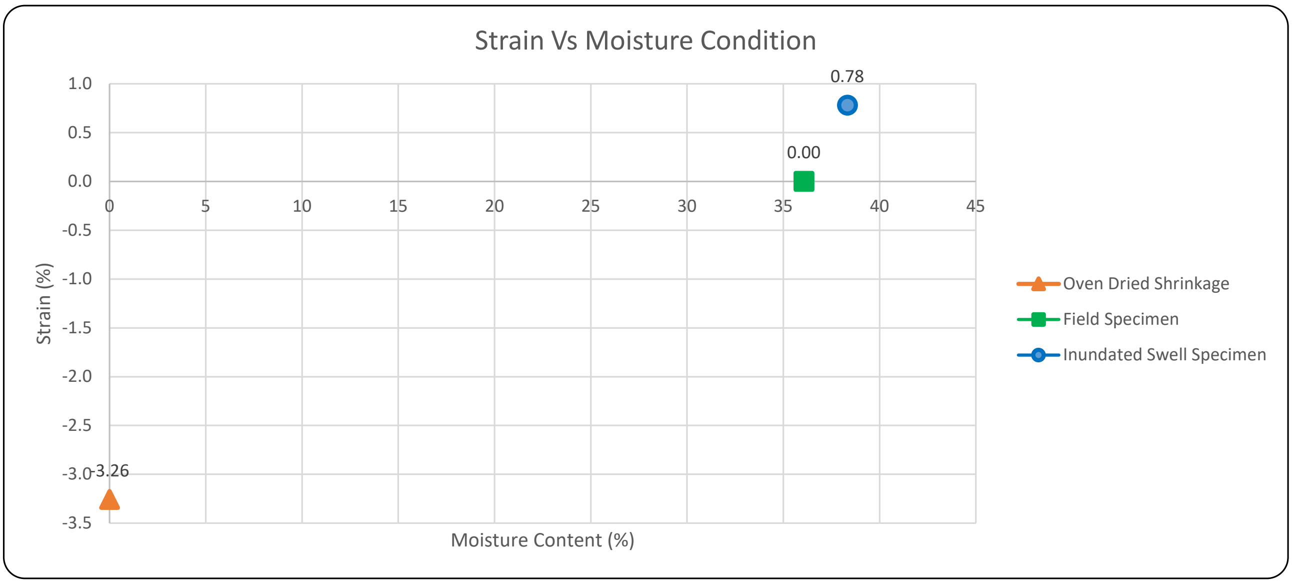
Report on Shrink / Swell Index of a Soil

Client:	SLR Consulting Australia Pty Ltd	Report No:	**258**
Client Address:	Level 1 Central Building, Innovation Campus. North Wollongong	Report Date:	3/08/2022
Project:	Geotechnical Testing	Report Page:	Page 1 of 1
Works Component:	Palings Yard Wind Farm and Transmission	Project No:	4
Material Used:	-	Test Request/Order:	650.30012.00000
Material Description:	Silty CLAY	Lot Number:	-
Lab Test Date/s:	Testing commenced 27/07/2022 and was completed 28/07/2022.	ITP/PCP Number:	-
Lot Comments:	-	Control Line:	PYTL-TP11

Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
49955	**21/07/2022**	**-**	**-**	**PYTL-TP11**	**0.50-1.00m**

Parameters	Units	Test Results	Soil Description
Shrinkage - Field Moisture Content	%	35.9	CH,Silty CLAY
Swell - Field Moisture Content	%	36.2	
Swell - Inundated Moisture Content	%	38.3	
Inert Inclusions in the soil	%	5	
Extent of Soil Crumbling	-	None	
Extent of Soil Cracking	-	Significant	
Shrink-Swell Index	**%**	**2.0**	



Sampling & Test Methods (Results relate only to the items sampled/tested)	Report Remarks & Endorsement
AS 1289.7.1.1, Cl 4: Shrink Swell Index - Thin wall sampler (U50) AS 1289.7.1.1: Shrink Swell Index of a Soil	AS1289.7.1.1 was compacted to 98% compaction in accordance to AS1289.5.1.1 (004-R258-CBR)

NATA

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NATA Accreditation number: 20656

Issued By: P.Baltoski
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Appendix R

Part 3

Geotechnical Exploration Review and Advice

Prepared by: AECOM (June 2022)

Prepared for
Global Power Generation Australia
ABN: 74130542031

Geotechnical Exploration, Review and Advice

Paling Yards Wind Farm

09-Jun-2022
Geotechnical Exploration, Paling Yards Preliminary Geotechnical Investigation (Reissue of URS 2011 Report)
Doc No. 43167888
Commercial-in-Confidence

Geotechnical Exploration, Review and Advice

Paling Yards Wind Farm

Client: Global Power Generation Australia

ABN: 74130542031

Prepared by

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ABN 46 000 691 690

09-Jun-2022

Job No.: 43167888

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 and ISO45001.

Quality Information

Document	Geotechnical Exploration, Review and Advice
	43167888
Ref	https://aecomaus-my.sharepoint.com/personal/laura_pickering_aecom_com/documents/documents/task for rajesh/paling yards geotechnical report.docx
Date	09-Jun-2022
Prepared by	Terence Huang
Reviewed by	Devi Tulasi / Tim Rannard

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	25-Jul-2011	Draft for client review	Devi Tulasi Project Manager	
1	05 Sep-2011	Final	Devi Tulasi Project Manager	
2	09-Jun-2022	Reissued	Rajesh Arora Technical Director	

Table of Contents

1.0 Introduction

1.1 General

This report contains the information AECOM had found during a geotechnical assessment for the proposed Paling Yards Wind Farm, NSW in 2011. The assessment was commissioned by Global Power Generation Australia, through its wholly owned subsidiary, Paling Yards Development Pty Ltd (PYDPL), and was carried out in general accordance with the AECOM fee proposal referenced 3091144/01/02, revision B, dated 2 March 2011.

The subject site is located on the NSW Central Tablelands, 60km south of Oberon, 30km north of Taralga and about 140km west of Sydney. The surrounding area consists predominantly of large rural properties and National Park with the eastern edge of the site in the proximity of Kanangra Boyd National Park and Abercrombie National Park to the west and south. The site is situated in the Oberon Local Government Area (LGA).

The site is approximately 40km to the northeast of the existing Crookwell 1 & 2 Wind Farms and the approved Crookwell 3 Wind Farm.

The proposed Paling Yards Wind Farm Project will comprise up to 47 wind turbine generators (WTGs) associated with a new cable network, a temporary concrete batching plant, upgrading the local road infrastructure, new control buildings, a new electrical collector substation, a new switch yard and other associated infrastructure. The proposed WTGs have a maximum height of up to 240m to blade tip and up to 6.1MW capacity each.

The report presents findings on a number of geotechnical aspects relevant to the proposed wind farm. These include the following:

- Details of the investigation
- Subsurface conditions and geotechnical considerations for the proposed wind turbine sites.
- Groundwater issues
- Potential slope stability considerations
- Construction considerations
- Recommendations for future investigations

1.2 Safety on Site

Prior to the commencement of the geotechnical investigation, AECOM prepared a Safe Work Method Statement (SWMS) that included a Health, Environmental & Safety Plan (HESP)

Prior to conducting fieldwork, AECOM carried out a “Dial Before You Dig (DBYD)” services search for existing services at all turbine/test pit locations. In addition to DBYD, the proposed test pit locations were checked on site for any services that may not have picked up on DBYD plans by an experienced AECOM Geotechnical Engineer with cross reference from the landowners and signed off that all locations are clear of services.

Prior to commencing work, all personnel working on site were given a Health & safety talk and required to sign off an “induction register” ensuring that each person was aware of their responsibilities and safety procedures. A daily toolbox meeting was conducted at the start of the day, which covered all activities and risks associated with the day’s work.

1.3 Scope of Work

Preliminary geotechnical investigations were carried out between 11 April 2011 and 21 July 2011 to identify and characterise the main geologic units at the site. All the geotechnical investigation work was carried out by an experienced AECOM geotechnical engineer. The following works were carried out to characterise the soil and rock properties of the main geologic units across the site.

- A walk over inspection of the site and surroundings.
- Drilling of two (2) geotechnical boreholes up to a depth of 20m.
- Excavation of sixty (60) test pits.
- A total of sixty (60) Dynamic Cone Penetrometer (DCP) tests were carried out, ensuring a DCP test adjacent to each test pit
- Collection of representative soils samples for laboratory testing The Test Pit and DCP locations are shown on Figure 1, Appendix A.

1.4 General Site Geology and Topography

1.4.1 Topography

The site is located on the western extent of the Great Diving Range, 60km south of the town of Oberon, 60km north of the city of Goulburn and comprises two separate land holdings totalling 4,600 hectares referred to as Mingary Park and Paling Yards. The majority of the site comprises farmland with farm houses and stock sheds present. The site is accessible via a network of unsealed farm roads and the existing Abercrombie road.

The site topography comprises plateau and hillcrest areas at an elevation of between 900m and 1065m surrounded by steeply sloping gullies and creek lines that flow to the Abercrombie River. The gently sloping plateau areas are generally cleared and used for grazing, while the more steeply sloping areas are generally uncleared and heavily vegetated.

1.4.2 Geology

Available geological information indicates that the plateau areas are underlain by Tertiary aged Volcanics which typically comprises residual clay, frequently with cobbles and boulders, overlying variably weathered basalt at relatively shallow depths. Tertiary aged alluvial deposits underlie the Tertiary Volcanics at depth, overlying Ordovician aged meta-siltstone basement.

Please see Figure 1, Appendix A for a site geological map.

2.0 Test Pit Excavation

Test pit were excavated at each turbine location to provide an assessment of the likely subsurface materials and relevant geotechnical considerations. A total of sixty (60) test pits were excavated at/near along the proposed alignment of WTG across the site. The test pitting program was carried out between 11 April 2011 and 15 April 2011.

The test pits were excavated using a 5.5t small sized excavator which was operated by qualified personnel from Acclaimed Excavation Pty Ltd, fitted with an interchangeable 450mm wide toothed bucket. All test pits were terminated at effective refusal or targeted depth. Upon completion of test pit excavation, each test pit was made safe by backfilling with the excavated spoil and tamped with the excavator bucket.

The subsurface conditions encountered in the test pits, were logged and sampled by an experienced AECOM geotechnical engineer for visual assessment. The test pits were located using a handheld GPS unit to confirm the GPS co-ordinates provided by GPGA. The GPS co-ordinates of the test pit locations are recorded on the test pit logs. Test Pits TP1, TP10, TP11, and TP14 were offset from the proposed coordinates due to site accessibility issues.

Test Pit Logs and Photographs are attached in Appendix C together with notes regarding soil description and test methods.

2.1 Dynamic Cone Penetration (DCP) Testing

A total of sixty (60) Dynamic Cone Penetrometer (DCP) tests were performed along the proposed alignment of the WTG, ensuring a DCP test at/near each test pit location. The in-situ testing comprised the measurement of the consistency and in-situ strength of the subsurface materials to a steel rod driven into the ground by a dropped weight. The in-situ testing procedures are in accordance to AS 1289.F3.2. The equipment utilises a 9kg sliding weight with a drop height of 510mm and the rod is fitted with a conical tip. The test data are generally recorded as the number of blows (n) per 50mm of penetration. The test data are then processed by our in-house computer software.

DCP Logs are attached in Appendix D.

2.2 Borehole Drilling

The fieldwork for the geotechnical assessment included the drilling of two boreholes at WTG 9 and 38, as requested by GPGA. The selection of boreholes was based on GPGA’s consultation with landowners, and it was perceived that these two locations may have significantly different subsurface conditions. The borehole drilling program was carried out between 18 July 2011 and 22 July 2011.

Drilling was carried out using a 2010 Model CME 55LC track mounted drilling rig which was operated by qualified personnel from Strategic Drilling Services Pty Ltd. The boreholes were drilled initially using a TC-bit attached to solid flight augers (150mm diameter) to refusal in bedrock, with standard penetration tests (SPTs) carried out in the soils at regular depth intervals (approximately 1.5m). The boreholes were subsequently cased then extended into the underlying bedrock to a depth of approximately 20m using NMLC diamond coring. Further details of the methods and procedures employed in the investigations are presented in Appendix B, Report Explanatory Notes.

Borehole logs with core photographs are presented in Appendix E.

2.3 Electrical Resistivity Survey

The purpose of the Electrical Resistivity Survey (ERS) is to determine the electrical resistivity of the subsurface by means of ground measurements. The apparent ground resistivity is dependent on geological parameters such as mineral type, moisture content, porosity and degree of water saturation.

AECOM carried out an Electrical Resistivity Survey on the 18th of July 2011 at turbines WTG 9 and 38. The machine used for resistivity sounding was called an Automatic Resistivity System (ARES) made by GF instruments. To measure the resistivity of the subsurface soils at the site, a total of 40 stainless steel rods (in a straight line) with a spacing of 2m each were inserted to a depth of roughly 200mm into the ground. Upon completion of the set-up, ARES equipment estimated the electrical resistivity of the subsurface soils using Wenner Alpha, Schlumberger and Dipole-Dipole models.

The subsurface profile based on Wenner Alpha, Schlumberger and Dipole-Dipole models was estimated after processing the data collected at the site using software RES2DINV. The location of Electrical Resistivity testing was shown on Figures presented in Appendix G.

2.4 Laboratory Testing

Soil and rock testing were conducted on disturbed bulk soil and rock samples collected during the geotechnical field investigation. The results are summarised in the following section and attached in Appendix F.

Table 1 Lab Testing Schedule

Test	No. Tests
Moisture Content	20
Standard Compaction	10
California Bearing Ratio	10
Emerson Crumb	20
Soil thermal conductivity	10
Electrical Resistivity	6
Soil Aggressivity	10
Point Load Strength Index (Rock)	8

3.0 Test Pits Results

Based on the test pit investigations, two generalised soil profiles were inferred. Table 2 provides a summary of the Tertiary Volcanics encountered across the majority of the site.
provides a summary of Ordovician materials encountered across the site.

Table 2: Subsurface Conditions - Tertiary Volcanic Profile

Unit	Unit Description	Depth to Top of Unit (m)	Unit Thickness (m)
Tertiary Volcanics Profile	**Topsoil:** Silty SAND, fine grained, pale brownto dark brown, moist, medium dense to dense, few test pits encountered some gravel, cobble, and boulder basalt	0.0	0.2 to 0.4
	Residual Soils: Clayey SAND and Gravely SAND, fine grained, brown and pale brown, dry to moist, dense to very dense, with some fine to coarse grained sub-angular gravel, cobble, and boulder basalt or Sandy CLAY and CLAY, medium to high plasticity, brown, red, pale brown, and pale grey, dry to moist, friable/very stiff to hard, withsome fine to coarse grained sub-angular graveland cobble basalt, Residual	0.2 to 0.4 0.2 to 0.4	0.6 to 1.8 0.4 to 3.1
	Bedrock: BASALT, medium to high strength, distinctly toextremely weathered, grey, dark grey, and greenish grey, Bedrock	0.4 to 3.2	NOT PENETRATED

Table 2 is based on investigations TP4, TP12, TP15-TP45, TP47, and TP49-TP60. Variations to the above-generalised sequence were encountered in TP38, TP45, TP54 and TP60, where the Basalt bedrock stratum was deeper and not encountered within the investigation depths.

In-situ testing the Dynamic Cone Penetrometer (DCP) was carried out adjacent to each test pit location. The results of testing indicated that the strength of the subsurface residual soils profile to be of stiff to very stiff consistency, hence becoming hard with depth, underlain by weathered basalt bedrock.

Table 3 Subsurface Conditions - Ordovician Materials

Unit	Unit Description	Depth to Top of Unit (m)	Unit Thickness (m)
Ordovician Materials	**Topsoil:** Silty SAND, fine grained, pale brown, brown, and dark brown, moist, medium dense to dense,few test pits encountered some cobble basalt, Topsoil	0.0	0.2 to 0.3
	Residual Soil: Sandy CLAY, medium to high plasticity, brown,pale brown, orange, dry to moist, very stiff to hard, with a trace of fine to medium grained sub-rounded gravel basalt or Clayey SAND, fine grained, pale brown, dry to moist, dense to very dense, with a trace of fineto medium grained subrounded gravel basalt	0.2 to 0.3 0.2 to 0.8	0.6 to 1.4 0.2 to 0.6
	Bedrock: SILTSTONE, low to medium strength, distinctlyto extremely weathered, pale grey and pale brown, Bedrock	0.2 to 1.7	NOT PENETRATED

Table 3 is based on investigations TP1-TP3, TP5-TP11, TP13-TP14, TP46, and TP48. The subject test pits are generally with relative lower elevation level and located closer to the Abercrombie River.
In-situ testing of the Dynamic Cone Penetrometer (DCP) was carried out adjacent to each test pit location. The results of testing indicated that the consistency of the subsurface residual soils varied from stiff to very stiff, underlain by weathered basalt bedrock.

3.1 Boreholes Results

Based on the findings of the geotechnical borehole drilling, two generalised profiles were inferred. Table 4 provides a summary of the Ordovician Aged Alluvial Deposits encountered in BH1 (WTG location 8), and Table 5 provides a summary of Tertiary Aged Volcanics encountered in BH2 (WTG location 38).

Table 4 Subsurface Conditions in BH1 - Ordovician Materials

Unit	Unit Description	Depth to Top of Unit (m)	Unit Thickness (m)
Ordovician Materials	**Topsoil:** Clayey SAND, fine grained, dark brown, with some crushed sandstone and gravel with organics	0	0.4
	Bedrock: SILTSTONE, low to high strength, distinctly toslightly weathered, with some extremely weathered zones, pale brown to brown, with some fine to coarse grained sand, with some medium to gravel size quartz, with some clayinfilling joints	0.4	BH1 terminated at 20m, targeted depth reached, no further penetrated

Table 5 Subsurface Conditions in BH2 - Tertiary Volcanics Profile

Unit	Unit Description	Depth to Top of Unit (m)	Unit Thickness(m)
Tertiary Volcanics Profile	**Topsoil:** Silty SAND, fine grained, pale brown, withorganics	0	0.3
	Residual Soil: Sandy Silty CLAY, medium to high plasticity,pale brown and brown, with a trace of gravel	0.3	5.1
	Bedrock: BASALT, medium to high strength, slightly weathered to fresh rock, with some extremelyweathered zones grey, dark grey to grey, massive, with a trace of iron staining and clay infilling along joints	5.1	BH2 terminated at 19.72m, targeted depth reached, no further penetrated

3.2 Groundwater Conditions

Groundwater was not observed in the test pits or boreholes during drilling. It should be noted that these observations were made at the time of the field investigation and actual groundwater levels may fluctuate significantly in response to seasonal effects, regional rainfall, and other factors that are not related to this investigation.

Based on past experience it is anticipated that the fractured Basalt and the underlying Tertiary sediments are typically water bearing and can form perched water tables on weathered Ordovician basement. The regional water table in fractured Ordovician bedrock is anticipated to be at a considerable depth.

3.3 Materials Properties of Geotechnical Soil Units

The soil unit distribution within this study area generally comprises the Tertiary Volcanics profiles and the Ordovician materials. The units are summarised and described based on analysis of the study area using a number of methods including field observation, test pits, borehole data and topographic analysis.

The soil unit distribution is listed in Table 6. Observations from field test pits along with laboratory results is summarised for each geotechnical soil unit in the following sections.

Table 6 Soil Unit Distribution

Soil Unit Description	Test Location Number	Sample Depth Range (m) below ground level
Tertiary Volcanics	TP4, TP12, TP15 - TP45, TP47, andTP49 - TP60	0.4m to 1.7m
Ordovician Materials	TP1 - TP3, TP5 - TP11, TP13 - TP14,TP46, and TP48	0.4m to 0.7m

3.3.1 Tertiary Volcanics Profiles

The Tertiary Volcanics profiles generally comprise residual soils and cover most of the valley floor areas within the subject site. Soils identified as residual soil unit in these areas are generally relatively shallow, typically less than 2.5m. However, exceptions to this would be expected, for example test pit TP39 excavated in the central portion of the site, encountered 3.3m clay residual soils overlying basalt bedrock.

Residual soils observed at the site were predominantly high plasticity clays, with gravelly sandy clays usually encountered before underlying Basalt bedrock. Table 7 presents lab testing results for this unit.

Table 7 Tertiary Volcanics Results Summary

Properties	Moisture Content (%)	Optimum Moisture Content (%)	Max. Dry Density (t/m³)	CBR Value	Chloride (mg/kg)	Sulphate (mg/kg)	pH	Emerson Class Number
Max Value	40	41	1.75	10	56	47	7	6
Min Value	14.4	17	1.25	1.5	2.4	0.5	5.7	3
No. of tests	18	9	9	9	9	9	9	18
Average	26.11	27.56	1.53	4.75	13.81	13.81	6.4	5

3.3.2 Ordovician Materials

The Ordovician materials encountered within the study area comprise clay dominated soils, with exceptions such as sands and gravels. The clays soils were characteristically medium to high plasticity, brown-pale brown, and orange. The underlying siltstone bedrock is relative shallow, typically less than 1m. Table 8 presents lab testing results for this unit.

Table 8 Ordovician Aged Alluvial Deposits Results Summary

Properties	Moisture Content (%)	Optimum Moisture Content (%)	Max. Dry Density (t/m³)	CBR Value	Chloride (mg/kg)	Sulphate (mg/kg)	pH	Emerson Class Number
Max Value	26.1	34	1.67	2.5	22	6.4	7	5
Min Value	17.6	18	1.38	2	22	6.4	7	5
No. of tests	2	2	2	2	1	1	1	2
Average	21.85	26	1.53	2.25	22	6.4	7	5

4.0 Subsoil Class for Earthquake Design

In accordance with AS 1170.4 – 2007, site's specific class parameters are as follows:

- Hazard factor (Z) of <0.09
- Sub-soil class of Be – Rock

4.1.1 Geomorphology, Tectonics and Fracturing

The site geomorphology comprises a dissected upland plateau at an elevation of between 900m and 1065m surrounded by steeply sloping gullies and creek lines that fall to the Abercrombie River. The plateau is covered by Tertiary Basaltic Volcanics that erupted onto a plateau formed in Ordovician Siltstones. Uplift occurred post Tertiary and has resulted in the weathering and erosion of both Basalt and Siltstone.

No major faults of shear zones cross the site and the boundaries between the rock units are erosional.

Both the Basalt and Siltstone are fractured on a regional scale, the Basalt due to cooling and the Siltstone due to folding and low grade metamorphism.

4.2 Geotechnical Recommendations

4.2.1 Bedrock Characteristics

Selected rock core samples recovered from boreholes were sent to a NATA accredited laboratory, SGS Australia Pty Ltd for Point Load Strength Index Testing. The point Load Strength indices of the rock cores and the estimated rock strength, in accordance with the Australian Standards (AS4133.4.1 2007), are summarised in the following Table 9.

Table 9 Bedrock Point Load Strength Index Summary

Sample ID	Sample Source(m)	Lithology	Standard Deviation PointLoad Strength Index I_s50(MPa)		Rock Strength
			Diametric	Axial	
BH1-1	5.67 to 5.75	Siltstone, slightly weathered, pale brown and pale grey	0.39	0.77	Medium
BH1-2	9.23 to 9.34	Siltstone, slightly weathered, pale brown and pale grey	0.58	N/A	Medium
BH1-3	12.79 to 13	Siltstone, slightly weathered, pale brown and pale grey	1.68	1.46	High
BH1-4	15.6 to 17	Siltstone, slightly weathered, pale brown and pale grey	0.41	0.88	Medium
BH1-1	6.83 to 6.97	Basalt, fresh rock, dark grey to black	1.92	3.83	Medium to High
BH1-2	8.83 to 8.91	Claystone, extremely weathered, brown and red	0.18	0.21	Low
BH1-3	13.56 to 13.68	Basalt, distinctly weathered, grey to dark grey	0.6	0.69	Medium
BH1-4	18.68 to 18.8	Basalt, distinctly weathered, grey to dark grey	0.92	N/A	Medium

4.2.2 Wind Turbine Generators (WTGs) Foundation Design - General

The conventional WTGs foundations are reinforced concrete gravity footings founded 1.5m to 3m below the existing ground surface. The critical loading for this foundation system are lateral loads from a combination of wind and earthquake events. The footings are sized such that the maximum allowable bearing pressure is not exceeded on one side of the footing while the other side of the footing experiences uplift loads.

An alternative foundation system is to reduce the size of the footing and resist the uplift loads by installing anchors or piles below foundation level. As the footings are smaller, bearing pressures are greater, and this system is only suitable where sound rock extends from foundation level to the depth of the anchors.

Based on the current geotechnical investigation the potential foundation systems suitable for each WTG site has been summarised in Table 10:

Table 10 Potential Foundation Systems for WTGs

Test Pit	Founding Conditions	Potential Foundation System
TP-1 (50m offset)*	Basalt/Siltstone – Strength unknown	Anchored Footings/Gravity Footings
TP2	Siltstone- Low to medium strength	Gravity Footings
TP3	Siltstone- Low to medium strength	
TP4	Basalt – Medium to High Strength	Anchored Footings
TP5	Siltstone- Low to medium strength	Gravity Footings
TP6	Siltstone- Low to medium strength	
TP7	Siltstone- Low to medium strength	
TP8	Siltstone- Low to medium strength	
TP9	Siltstone- Low to medium strength	
TP10	Siltstone- Low to medium strength	
TP11	Siltstone- Low to medium strength	
TP12	Basalt – Medium to High Strength	Anchored Footings
TP13	Siltstone- Low to medium strength	Gravity Footings
TP14	Siltstone- Low to medium strength	
TP15	Basalt – Medium to High Strength	Anchored Footings
TP16	Basalt – Medium to High Strength	
TP17	Basalt – Medium to High Strength	
TP18	Basalt – Medium to High Strength	
TP19	Basalt – Medium to High Strength	
TP20	Basalt – Medium to High Strength	
TP21	Basalt – Medium to High Strength	
TP22	Basalt – Medium to High Strength	
TP23	Basalt – Medium to High Strength	
TP24	Basalt – Medium to High Strength	
TP25	Basalt – Medium to High Strength	
TP26	Basalt – Medium to High Strength	
TP27	Basalt – Medium to High Strength	
TP28	Basalt – Medium to High Strength	
TP29	Basalt – Medium to High Strength	
TP30	Basalt – Medium to High Strength	
TP31	Basalt – Medium to High Strength	
TP32	Basalt – Medium to High Strength	
TP33	Basalt – Medium to High Strength	
TP34	Basalt – Medium to High Strength	
TP35	Basalt – Medium to High Strength	
TP36	Basalt – Medium to High Strength	
TP37	Basalt – Medium to High Strength	
TP38	Clay –Soil depth 5m	Gravity Footing

Test Pit	Founding Conditions	Potential Foundation System
TP39	Basalt – Medium to High Strength	Anchored Footings
TP40	Basalt – Medium to High Strength	
TP41	Basalt – Medium to High Strength	
TP42	Basalt – Medium to High Strength	
TP43	Basalt – Medium to High Strength	
TP44	Basalt – Medium to High Strength	
TP45	Gravelly Sand – Soil depth >2.0m	Gravity Footings
TP46	Siltstone- Low to medium strength	
TP47	Basalt – Medium to High Strength	Anchored Footings
TP48	Siltstone- Low to medium strength	Gravity Footing
TP49	Basalt – Medium to High Strength	Anchored Footings
TP50	Basalt – Medium to High Strength	
TP51	Basalt – Medium to High Strength	
TP52	Basalt – Medium to High Strength	
TP53	Basalt – Medium to High Strength	
TP54	Gravelly Sand – Soil depth >1.5m	Gravity Footing
TP55	Basalt – Medium to High Strength	Anchored Footings
TP56	Basalt – Medium to High Strength	
TP57	Basalt – Medium to High Strength	Anchored Footings
TP58	Basalt – Medium to High Strength	
TP59	Basalt – Medium to High Strength	
TP60	Sandy Clay –Soil depth >2.1m	Gravity Footing

*TP-1 was offset by 50m due to accessibility issues and foundation conditions at WTG1 cannot be assessed from current geotechnical investigations

It is not clear at this stage of the design process if anchored foundations represent a major cost saving over gravity foundations. It is recommended that a number of preliminary foundation designs for a range of tower heights be costed so that the most cost-effective foundation system can be selected for each site and tower combination.

4.2.3 Wind Turbine Generators (WTGs) Foundation Design – Gravity Footings

Based on the current geotechnical investigation, distinctly to extremely weathered basalt and siltstone may be anticipated at the depth of about 1.5m to 3m. Gravity Footings may be designed based on the parameters given in Table 11:

Table 11: Foundation Design Parameters

Material	Allowable Bearing	Ultimate Bearing	Ult. Bond Stress
Medium Strength Siltstone orBasalt	1.0MPa	8.0MPa	500kPa
High Strength Basalt	3.5MPa	30MPa	2000kPa

It should be noted that at ultimate bearing capacity settlement values can exceed 5% of footing dimension and this needs to be taken into account in the design. Settlement values under allowable loading are not anticipated to exceed 1% of footing dimension.

It is possible that weaker materials (low strength rock) may be encountered locally within this depth range and all footings must be inspected by an experienced Geotechnical Engineer or Engineering Geologist to confirm appropriate founding materials and achievement of design socket lengths, that the recommended serviceability bearing pressures could be met and to ensure that all soft and wet materials have been removed from the foundation footprint prior to concrete placement.

4.2.4 Wind Turbine Generators (WTGs) Foundation Design – Anchored Footings

Anchored footing may be designed using the parameters for high strength Basalt in Table 11. The capacity of the anchors in uplift need to satisfy both the bond stress requirements and cone pull out assuming a 60 degree cone with its apex at the centre of the anchor bond zone. The impact of interfering cones may also need to be taken into account.

WTG sites with anchored footings require additional geotechnical investigation to confirm the anchor can be installed into sound rock. This generally comprises one bore within the foundation footprint to 1m below the maximum anchor depth.

4.2.5 Proposed Foundations for Turbines

Based on borehole drilling significantly different subsurface conditions were encountered at WTG38 in comparison to WTG9. AECOM understands that the preferred location for the substation is WTG38. However, recommendations on foundations at both the locations (WTG38 & WTG9) were provided in this section. The ground conditions at WTG38 and WTG9 are summarised in Table 12.

Table 12 Ground Conditions at WTG28 and WTG9

Location	Test Pits	Bores	Subsurface Conditions
1	TP9	BH 1	Low to medium strength siltstone from shallow depth
2	TP38	BH 2	Stiff to very stiff clays over high strength Basalt at 5m depth

At Location 1, relevant infrastructure may generally be supported by shallow footings (pad or strip footings) founded in medium strength siltstone bedrock. The appropriate foundation parameters in Table 11 may be used for footing design.

At location 2 lightly loaded structures may be founded on Stiff Clays with an allowable bearing capacity of not less than 100kPa. For heavily loaded or settlement sensitive structures it is recommended that the loads be transferred to the high strength basalt bedrock using bored piles.

All footings must be inspected by an experienced Geotechnical Engineer or Engineering Geologist to confirm appropriate founding materials and achievement of recommended serviceability bearing pressures could be met and to ensure that all soft and wet materials have been removed from the foundation footprint prior to concrete placement.

With regards to shallow footings supported on the deep clay soils, it should be noted that such clays encountered in the study area are of high plasticity and are generally considered to have a high potential for expansion and swelling as a result of variation in moisture condition. The requirements of AS 2870 should be included in the design of shallow footings supported on the natural high plasticity clays.

4.2.6 Elastic Properties of Soils

Based on current geotechnical investigation, indicative preliminary values of geotechnical parameters that may be used for preliminary design purposes are provided in this section. The parameters estimated based on geotechnical investigations and our experience with similar materials are presented in Table 13 below.

Table 13 Geotechnical Design Parameters

Material	Undrained Shear Strength (kPa)	Elastic Modulus (MPa)	Friction Angle (Degree)	Bulk Density (kN/m^3)
Topsoil Silty Sand or Clayey Sand, medium dense	n/a	20 to 30	27 to 30	17 to 19
Residual Sandy Clay, Clayey Sand, very stiff to high, with gravel	150 to 250	25 to 50	n/a	20
Siltstone, low to medium strength	n/a	500	n/a	22
Basalt, medium to high strength	n/a	1000	n/a	24

The range of parameter in Table 13 reflects the variation and localised differences encountered at all the sixty test pit locations.

4.2.7 Soil Thermal Conductivity

Thermal resistivity testing was carried out on selected soil samples recovered from test pits by Chadwick T&T Pty Ltd. Summary of testing results are presented in Table 14. Full results are attached in Appendix F.

Table 14 Thermal Conductivity Testing Results

Sample ID	Sample Source (m)	Lithology	Moisture (%)	Compacted Density (t/m^3)	Thermal Conductivity* (W/mK)
TP8	0.5 – 0.8	Sandy Clay, brown and pale brown	27	1.582	0.76
TP15	0.5 – 0.8	Sandy Clay, pale grey and pale brown	29	1.546	0.68
TP17	0.4 – 0.7	Sandy Clay, brown and pale brown	32.3	1.392	0.75
TP21	0.4 – 0.7	Sandy Clay, brown	32.3	1.529	0.95
TP25	0.5 – 0.8	Sandy Clay, brown and red	19.2	1.947	2.51
TP30	0.5 – 0.8	Sandy Clay, brown and pale brown	17.1	1.6	0.55
TP39	0.4 – 0.7	Sandy Clay, brown and red	13.7	1.82	1.36
TP41	0.5 – 0.8	Sandy Clay, brown	31	1.642	0.68
TP48	0.4 – 0.7	Sandy Clay and Siltstone, pale brown and orange	No Result received**	No Result received**	No Result received**
TP57	0.4 – 0.7	Sandy Clay, brown	32.3	1.596	0.86

* The subjected samples were tested in 100% compaction standard at the received moisture content.

** No result was received on TP48 sample as siltstone component.

4.2.8 Electrical Resistivity Survey

AECOM undertook a total of three resistivity surveys at each of the two proposed locations (near WTG 9 and 38). The purpose of this survey was to provide information about the existing ground resistivity for the design of the earthing grid at the proposed substation locations. The results and figures are available in Appendix G. These tests include the Wenner Alpha array which is reliable for determining depth variations in 1-D earth, while Schlumberger Array is more sensitive to lateral variation in Earth and Dipole-Dipole array is reliable in estimating sensitivity to lateral variation at depth.

The first proposed substation location surveyed was at borehole 1 near WTG9. Due to the sloping area and out cropping rock in the way, the survey line had to be offset approximately 50 meters away from the borehole. The resistivity survey indicates areas of low resistivity within the first few meters of the ground subsurface. All the three tests indicate a consistent pocket of high resistivity near the north eastern region of the survey line (refer to figures in appendix G). The siltstone in this region is highly fractured, as a result water is able to seep through the voids and create pockets of low resistivity.

The second proposed substation location surveyed was at borehole 2 near WTG38. This site was relatively flat and the survey line was laid immediately adjacent to the borehole.

The electrical resistivity results at Borehole 2 are similar to the electrical resistivity results obtained at Borehole 1. In both locations areas of low resistivity exist within the first few meters of the strata.

At borehole 2 all three tests indicate a pocket of high resistive material around the borehole location.

The Wenner Alpha results of borehole 2 indicate a large continuous zone of low resistivity past a depth of approximately 2.5 meters. A possible explanation for this is the substantial amount of rain the area has received in the weeks leading up to our testing. Given that the first few meters of the strata is residual soil, the water would have soaked through the ground and settled on the top layers and the faults and defects of the basalt. This soaking of the ground could be a possible explanation for the anomalously low resistivity of the deeper strata.

The results of the electrical resistivity tests are presented in Table 15.

Table 15 Electrical Resistivity Results

Location	Description of Soil/Rock Layer	Lowest (Ohm.m)	Highest (Ohm.m)	Average (Ohm.m)	Anomaly (Ohm.m)
BH1	Siltstone and Sandstone, medium strength, distinctly weathered, slightly fractured	5.13	750	280	+ 15000
BH2	Sandy Clay and Silty Clay, medium plasticity	100	350	175	+ 2000

5.0 Construction Considerations

5.1 Excavation Conditions

Based on the subsurface conditions assessed from the test pits, excavations for access roads, construction platform and foundations for the proposed WTGs would likely encounter a variable thickness of sandy clay/clayey sand with some basalt cobble and boulder, weathered basalt and siltstone bedrock.

Excavations within soil materials may be carried out using tracked excavators or bulldozers. Some basalt boulders may be encountered when excavating within first few meters, which may require larger plant and some over excavation to remove.

Bulk excavation in the extremely to distinctly weathered basalt or siltstone may be generally carried out using large excavation plant such as a heavy bulldozer or a heavy hydraulic excavator.

5.2 Cut Batter Slope Stability

For unsupported cuts, up to a height of 3m, the recommended batter slopes are presented in the following Table 16.

Table 16 Recommended Batter Slopes for Unsupported Cuts

Materials	Temporary (Horizontal: Vertical)		Permanent (Horizontal : Vertical)	
	Exposed	Protected	Exposed	Protected
Topsoil, Residual and Alluvial Soils	1.5H: 1.0V (34^{o})	1.0H : 1.0V (45^{o})	2.0H : 1.0V (27^{o})	1.5H : 1.0V (34^{o})
Weathered Basalt and Siltstone	1.0V: 1.0V (45^{o})	1.0H : 1.5V (56^{o})	1.0H : 1.5V (56^{o})	1.0H : 2.0V (63^{o})

Subjected to the frequency of rainfall at site during construction, temporary surface protection may be provided for temporary cuts. All batter slopes will need to be assessed and confirmed on site as construction work proceeds.

The stability of batter slopes within the basalt and siltstone rock will depend on the orientation and spacing of joints and defects, which should be assessed during construction phase. For preliminary design purposes batter slopes within weathered basalt and siltstone may be adopted based on the recommended parameters presented in Table 16 above.

5.3 Fill Batter Stability

Fill batters up to 10m high may be supported by battering at 2H:1V. On sloping ground they shall be keyed into the slope using terraces not less than 1.0m high and 1.0m wide.

The footprint of embankments shall be inspected and proof rolled as per Section 5.5 to ensure they are founded on sound material and unsuitable material is not present.

5.4 Re-use of In-Situ Materials

The following comments are provided on the potential re-use of excavated materials for engineered fill:

- The performance of the residual sandy clay and clayey sand soils is likely to be sensitive to changes in moisture content and there is potential to heave or fail to compact under high moisture conditions. Careful moisture conditioning and compaction will be required to compact these materials effectively, all as indicated in Section 5.5 below.
- The extremely to distinctly weathered basalt and siltstone rock may be re-used as engineered fill if, during excavation, handling and re-compaction, the rock breaks down to fragments in the order of 100mm or less. Generally, zones of rock fragments that are larger than 100mm, may only be used

as rock fill. Alternatively, these materials may be used as engineered fill following processing of rock into an aggregate of particle size 100mm or less.

5.5 Sub-grade Preparation and Fill Placement

It is recommended that the following site preparation be carried out for pavement sub-grade and fill placement beneath structures and footings using predominantly residual sandy clay and clayey sand soils and broken up basalt and siltstone rock.

5.5.1 Bulk Earth Filling (Residual Soils and Extremely Low to Low Strength Rock)

- Remove any soft, wet, and highly compressible material or topsoil material and organics.
- Assess moisture contents of the bulk excavated soils and weathered rock. For compaction of any materials other than free draining sands, the moisture content should be in range OMC +/-2% (wet/dry), where OMC is the optimum moisture content at Standard Compaction.
- Test roll the complete surface of the sub-grade in order to detect the presence of any soft or loose
- zones, which should be excavated out and replaced with approved filling. Test rolling should be carried out with a smooth drum roller with a minimum static weight of 8 tonne.
- For pavements, compact the natural foundation soil to a minimum dry density ratio of 98%
- Standard for clay soils or a minimum density index of 75% for sand soils.
- For pavements, approved filling excavated from site, should be placed in layers not exceeding 250mm loose thickness, with each layer compacted to a minimum dry density ratio of 98% Standard or a minimum density index of 75% for filling greater than 0.5m below top of finished sub-grade level. It is recommended that the final upper 0.5m of filling sub-grade be compacted to a minimum dry density ratio of 100% Standard or 80% density index. Where filling has a clay content, moisture content within the filling should be maintained within OMC -2% (dry) to OMC +2% (wet) during and after compaction.
- All filling beneath structures and footings should be compacted to a dry density ratio of at least 100% Standard or relative density index of at least 80%. This compaction should apply to all filling extending from a nominal horizontal distance of 2m at the edge of each structure with a nominal zone of influence of 1H:1V down and away from the proposed sub-grade level.
- Any compaction of silty or sandy clay foundation soils at or close to footing formation level should be sealed or covered as soon as practicable, to reduce the opportunity for occurrence of desiccation and cracking.
- Level 1 testing and supervision of filling, in accordance with AS3798, is recommended where the filling is to be used for support of structural loads, within the 2m horizontal distance and spread from structures as outlined above.
- All weathered rock, excavated from site for re-use beneath structures and as pavement sub-grade
- filling, should be processed so that individual particles are in the order of 100mm or less.

5.5.2 Bulk Rock Filling (Medium to High Strength Rock)

For general bulk rock filling placed outside the area of influence of the various structures (refer Section 5.5.1 above), it is recommended that the following site preparation be carried out for sub-grade preparation and rock fill placement:

- Remove any soft, wet, and highly compressible material or topsoil material rich in organics or root matter.
- Assess moisture contents of the bulk excavated soils and weathered rock. For compaction of any materials other than free draining sands, the moisture content should be in range OMC -2% (dry) to OMC +2% (wet), where OMC is the optimum moisture content at Standard Compaction.
- Test roll the complete surface of the sub-grade in order to detect the presence of any soft or loose

- zones, which should be excavated out and replaced with approved filling. Test rolling should be carried out with a smooth drum roller with a minimum static weight of 8-tonne.
- All weathered rock, excavated from site for re-use beneath structures and as pavement sub-grade
- filling, should be processed so that individual particles are in the order of 100mm or less.
- Approved rock filling excavated from site should be placed in layers not exceeding 300mm loose thickness with care taken to minimise the occurrence of voids. Fine sands and dispersive clays should not be included in the fill due to the susceptibility to erosion.

Difficulty to measure the density of bulk rock fill layer using conventional earthworks testing equipment (ie. nuclear densometer and laboratory compaction testing) must be recognised and it may be necessary to establish a suitable roller routine to achieve ‘acceptable’ compaction level. It follows that, where strict settlement criteria are imposed on the proposed structure, there is a higher risk of settlement under bulk rock filling due to the potential of void creation during placement and due to the lack of conventional earthworks testing to confirm density levels.

5.5.3 Pavements over Bulk Rock Filling

- Where pavements are proposed over bulk rock filling placed in accordance with Section 5.5.2 above, it is recommended that the rock fill be covered with a non-woven, needle punched, continuous filament polyester geofabric of sufficient strength to avoid punching failure.
- Place a minimum 0.5m thick cover of granular bridging on the geofabric in two layers of 250mm loose thickness, to provide sub-grade support for the pavement. The bridging layers should be compacted to a minimum dry density ratio of 100% Standard or 80% density index.
- Granular bridging or sub-grade filling should comprise engineered fill material supplied and placed in accordance with Section 5.5.1 above.

5.6 Pavement Sub-grade

The results of limited soaked CBR tests conducted on selected sub-grade samples of residual sandy clay, sandy or gravelly sand, indicated CBR values of between 1.5% and 10%.

Based on the findings of investigations, it is recommended that a CBR value of 2% to be adopted for sub-grade materials with a high clay content (such as where the Basalt outcrops), and a CBR value of 10% adopted for predominantly weathered siltstone bedrock in the design of flexible sealed or unsealed granular pavement.

These values are estimated to be close to a lower bound value of these materials and are based on the assumption that the topsoil will be stripped prior to pavement construction. It is also contingent upon adequate site preparation by proof rolling (to detect any unsuitable soft or loose materials) and sub-grade compaction procedures as recommended in Section 5.5 above.

Different values may be found where clay or rock fill is imported from elsewhere on the site and used in the road embankment. Such values can only be determined after a representative sample comprising similar plasticity content and particle size, as proposed to be used, is subjected to additional CBR testing.

The above recommendations are based on the provision and maintenance of adequate surface and subsurface drainage.

5.7 Slope Stability Assessment and Erosion

Slope instability issues have been found along the Abercrombie Road, adjacent to the southern central boundary of the site. The subject area and its hilly surrounds support mature, healthy native forest vegetation. Numerous mature trees surrounding and down and up slope of the Abercrombie Road have curved and leaning trunks, showing continued down slope soil creep. Small slope failure has occurred during the investigation period (refer to site photographs attached in Appendix C). No evidence of major slope instability was observed.

Slope instability issues are likely to be confined to steeply sloping land at the head of a gully. In generally the access roads should be designed to stay on the ridge crests and remain clear of potential land slips.

If crossing a potential land slip is required then the road formation should be designed to remove any potentially unstable material and found on stable bedrock.

The results of a limited number of laboratory Emerson Class dispersity tests on selected near surface samples of residual soils indicate there is a low dispersion potential under acidic conditions.

It should be recognised, however, that there is a relatively high proportion of silty sands across the site, which can potentially scour under concentrated water flows. It is therefore recommended that site works, including excavation and filling, be planned accordingly to reduce the risk of high concentrated surface water runoff.

AECOM understands a Soil Erosion Management Plan will be prepared as part of the Construction Environmental Management Plan.

6.0 Further Geotechnical Investigations

The current study presents an appraisal of likely conditions across the Paling Yards Wind Farm site. Access at this relatively early stage in the project has been limited, to the extent that a fully representative sample of site conditions may not have been obtained. It is recommended that further detailed subsurface geotechnical investigation and analysis be conducted to provide information for the detailed design of footings, access road, slope stability, and other associated infrastructure.

7.0 Closure

This preliminary geotechnical investigation has provided a better understanding of the geological setting and its impacts on the proposed Paling Yards Wind Farm. It has revealed that from the investigations carried out, there are no major geological issues that would potentially prevent the construction of the proposed development, provided the recommendations of this study are followed and further investigation is undertaken at a later stage where warranted.

The attached document titled “Appendix B - Report Explanatory Notes” presents additional information on the uses and limitations of this report.

8.0 References

Bowles, Joseph. E, 1997, Foundation Analysis and Design, Fifth Edition. Budhu, Muni, 2007, Soil Mechanics and Foundations, 2nd Edition.

AS3798, Guidelines on Earthworks for Commercial and Residential Developments, 2007. AS1170.4, Structural Design Actions, Part 4: Earthquake Actions in Australia, 2007.

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Goulburn, 1:250.000 Geological Series Sheet S1 55-12, First Edition, 1970. Geological Survey of New South Wales, Sydney.

AUSTROADS Pavement Design Manual (1992). URS Field Manual for Geotechnical Site Exploration.

NSW WorkCover: Code of Practice – Excavation March 2000.

9.0 Limitations

AECOM has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Global Power Generation Australia and only those third parties who have been authorised in writing by AECOM to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 2nd March 2011.

The methodology adopted and sources of information used by AECOM are outlined in this report. AECOM has made no independent verification of this information beyond the agreed scope of works and AECOM assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to AECOM was false.

The content of this report was prepared between 22nd April 2011 and 18th August 2011 and is based on the site conditions encountered and information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing or other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. The borehole logs indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of conditions as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented in this report and our experience. Future advances in regard to the understanding of chemicals and their behaviour, and changes in regulations affecting their management, could impact on our conclusions and recommendations regarding their potential presence on this site.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, AECOM must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time. Therefore this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.