



Appendix I. Preliminary Geotechnical Investigation (Golder Associates, 17 January 2017)



17 January 2017

PRELIMINARY GEOTECHNICAL INVESTIGATION

Hedley, Gelliondale, Alberton (HGA) Wind Farm, South Gippsland, Victoria

Submitted to:

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REPORT

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Table of Contents

1.0	INTRODUCTION	1
2.0	PROPOSED DEVELOPMENT	1
3.0	AIMS OF THE INVESTIGATION	1
4.0	PRELIMINARY INVESTIGATION WORKS	2
4.1	Desk Study	2
4.1.1	Geological Information	2
4.1.2	Groundwater Information	2
4.1.3	Aerial Photography	2
4.2	Site Walkover Visit	3
4.3	Test Pit Investigation	3
5.0	RESULTS OF PRELIMINARY GEOTECHNICAL INVESTIGATION	3
5.1	General Conditions within HGA Wind Farm Area	3
5.1.1	Site Geology	3
5.1.2	Groundwater	5
5.2	Site Conditions within each Zone	5
5.2.1	Zone 1	5
5.2.2	Zone 2	6
5.2.3	Zone 3	7
5.2.4	Zone 4	8
5.2.5	Zone 5	9
6.0	DISCUSSION AND RECOMMENDATIONS	10
6.1	Wind Turbine Generator Footings	10
6.1.1	Site Subsurface Conditions	10
6.1.2	Footing Options	11
6.1.3	Preliminary Footing Design Parameters	11
6.1.4	Possible founding conditions by zone	12
6.2	Crane Pads	13
6.3	Road Design	13
6.4	Further Investigations	14
7.0	IMPORTANT INFORMATION	14



TABLES

Table 1: Wind turbine zone 4
Table 2: Geology at (or near) surface based on Alberton 1:50,000 scale mapsheet..... 4
Table 3: Groundwater levels measured in bores 5
Table 4: Indicative Maximum Ultimate Bearing Pressures (Unfactored) 12
Table 5: Wind turbine zone and possible founding conditions/options 13

FIGURES

- Figure 1: Site location and layout
- Figure 2: Test pit location plan
- Figure 3: Wind turbine location and regional geology

PHOTOGRAPHS

Photograph 1: Looking in a southerly direction towards T05 and T04 locations from just east of T06 location..... 6
Photograph 2: Looking in a southerly direction towards T10 and T11 from South Gippsland Highway and Coal Mine Road Intersection 7
Photograph 3: Looking in a westerly direction towards T18 and T22 from northern boundary of Gelliondale State Forest and Ti Tree Road 8
Photograph 4: Looking in a north easterly direction towards WTG T25 from gate off Old Alberton Drive 9
Photograph 5: Looking in a north direction towards T20, T21 and T23 from private access road..... 10

APPENDICES

APPENDIX A

- Reports of Test Pits TP1 and TP3 to TP7
- Photographs of Test Pits TP1 and TP3 to TP7
- Explanation of notes, abbreviations and terms used on borehole and test pit reports
- Method of soil description used on borehole and test pit reports

APPENDIX B

- Important information



1.0 INTRODUCTION

Synergy Wind Pty Ltd (Synergy Wind) has engaged Golder Associates Pty Ltd (Golder) to perform a preliminary geotechnical investigation for the proposed Hedley, Gelliondale, Alberton (HGA) Wind Farm (HGA WF) to be located near Gelliondale township in South Gippsland, Victoria. The investigation was undertaken in general accordance with our proposal (reference: P1666035-001-Rev0) dated 29 September 2016. Authorisation to proceed with the investigation was provided by Synergy Wind in an email dated 3 October 2016.

We understand the proposed wind farm will be located near Gelliondale in Gippsland. The site is located about 170 km south east of Melbourne.

This report presents the results and findings of a desktop study of expected subsurface conditions and a site visit performed, and a preliminary geotechnical investigation performed for the proposed wind farm development. The report includes discussion on geotechnical considerations for the proposed wind farm development, and includes discussion and preliminary comment regarding the design and construction of wind turbine footings at the site.

2.0 PROPOSED DEVELOPMENT

We understand the proposed wind farm will be located about 170 km south east of Melbourne and will include 34 wind turbine generators which will be located both north and south of the South Gippsland Highway at various locations within an approximate 8 km radius of Gelliondale township. The location of the HGA WF development is presented in Figure 1 – Site location and layout.

Based upon the preliminary information provided by Synergy, we understand the HGA WF will be located across a number of individual properties held by various landowners. At this stage we have not been provided with details of the proposed turbine structures or the locations of substations and other supporting infrastructure.

3.0 AIMS OF THE INVESTIGATION

Based on our understanding of the proposed development, the aims of the preliminary geotechnical investigation are as follows:

- Assess the expected subsurface and groundwater conditions to allow characterisation of the expected subsurface units and hydrogeological conditions at the sites relevant to the proposed wind turbine developments.
- Assess the foundation materials in which the wind turbines footings will be constructed and provide preliminary information relevant to the design of the footings.
- Provide commentary on indicative foundation design parameters.
- Provide preliminary comment on suitability of the site materials for hardstand, cable trench and access road construction.
- Provide comment on other likely geotechnical issues which may impact upon the design of the proposed wind farm.



4.0 PRELIMINARY INVESTIGATION WORKS

4.1 Desk Study

As part of the preliminary geotechnical investigation a desk study has been undertaken to review readily available information regarding the site. This work included the following:

- A search of relevant geological information including geological maps, published information and previous studies.
- A search of the Australian Groundwater Explorer database maintained by the Bureau of Meteorology.
- Review of available aerial photography of the site.

4.1.1 Geological Information

Geological information from a number of sources has been assessed, including:

- The Department of Economic Development, Jobs, Transport and Resources 'GeoVic' online database.
- The 1:31,680 scale 'Alberton West' geological mapsheet published by the Geological Survey of Victoria.
- The 1:50,000 scale 'Alberton' geological mapsheet published by the Geological Survey of Victoria.
- The 1:250,000 scale 'Warragul' geological mapsheet published by the Geological Survey of Victoria.
- Birch W.D. (Editor), 2003. 'Geology of Victoria'. Geological Society of Australia. Special Publication 23. Geological Society of Australia (Victoria Division).
- Geological Survey of Victoria Report No. 57 'Explanatory Notes on the Warragul 1:250,000 Geological Map.

4.1.2 Groundwater Information

A search was conducted within publically available groundwater databases for registered bores in the vicinity of the site. The information available for individual groundwater bores can include:

- The date of bore completion.
- The location of the bores in AMG coordinates.
- Ground surface level of the bore.
- The depth of the bore, depth range of the bore screened interval and depth to water in the bore.
- Basic lithological information.
- Results of bore pumping tests (test type, pump depth, flow rate, electrical conductivity and test duration).

4.1.3 Aerial Photography

Using available aerial photography the following has been assessed as part of the preparation of this report:

- Evidence of previous slope instability including slip scars, scarps and landslide debris.
- Surficial evidence of the underlying geology. This information can be useful in assessing potential borrow areas.
- Evidence of erosion.



4.2 Site Walkover Visit

A senior geological engineer from Golder Associates visited the site of the proposed HGA WF development on 14 October 2016 to undertake a general assessment of site access, site topography, surface geology exposures, slope stability and observe evidence of surface and ground water. Visits were made to selected wind turbine generator sites on the basis of information obtained during the desk study.

4.3 Test Pit Investigation

A total of six test pits (TP1 and TP3 to TP7) were excavated in general areas of proposed wind turbines as part of the preliminary geotechnical investigation of the site. The locations of test pits are shown on Figure 2 – Test pit location plan. The test pits were excavated on 17 November, 2016.

Test pits were excavated using a backhoe supplied and operated by a specialist contractor to depths ranging from about 2.5 m to 2.7 m. Upon completion, the test pits were backfilled with the excavated spoil, tamped using the excavator bucket and wheel rolled at the surface.

A Dynamic Cone Penetrometer (DCP) test was performed at each test pit location to assess the in situ strength of near surface soil. These tests were performed to depths ranging from about 1.0 m to 1.7 m.

A geotechnical engineer from Golder located the test pits using a hand held GPS unit, described the materials encountered in the test pits, performed field tests including the DCP tests and photographed the test pit excavations and test pit spoil.

The subsurface conditions encountered in the test pits are presented in Appendix A as Reports of Test Pits TP1 and TP3 to TP7. Photographs of the test pit excavations and test pit spoil, and DCP test results, are included in the reports along with the following information sheets relevant to the interpretation of the reports:

- Explanation of notes, abbreviations and terms used on borehole and test pit reports
- Method of soil description used on borehole and test pit reports

5.0 RESULTS OF PRELIMINARY GEOTECHNICAL INVESTIGATION

5.1 General Conditions within HGA Wind Farm Area

5.1.1 Site Geology

At a regional scale, the location of the proposed HGA WF lies within the south eastern area of the Gippsland Basin. At a more local scale, the site is within the Alberton Depression, on the south western fringe of the Strzelecki Ranges (Southern Uplands of Victoria).

Geological maps indicate the surface geology mostly includes Quaternary age sediments where the wind turbines are proposed. These sediments include the following:

- Stream alluvium deposits;
- River and coastal terraces and flood plain deposits;
- Swamp and lagoonal deposits;
- Dune, beach and estuarine deposits; and
- Aeolian sand sheets.

The surface geology of the site, as shown on the Geological Survey of Victoria Alberton 1:50,000 scale mapsheet, along with the positions of the proposed wind turbines, is presented on Figure 3, Wind turbine location and regional geology.



HGA WIND FARM PRELIMINARY GEOTECHNICAL INVESTIGATION

For the purpose of the following discussion the wind farm area has been sub-divided into five geographic zones, as shown on Figure 3. The wind turbine locations falling within each zone are presented in Table 1.

Table 1: Wind turbine zone

Zone	Zone location description	Wind Turbine Number
1	South of South Gippsland Highway, east of Birds Road	T01 to T07
2	North and south of South Gippsland Highway, east of Coal Mine Road	T08 to T11
3	South of South Gippsland Highway, west of Ti Tree Road	T12 to T16, T18, T19, T22, T27, T31 to T34
4	North of South Gippsland Highway, adjacent to Old Alberton West Road	T17, T24 to T26, T29
5	North of Pound Road West	T20, T21, T23, T28, T30

A summary of the geological units expected at or near ground surface throughout the proposed wind farm area (based on the Alberton 1:50,000 scale mapsheet) is presented in Table 2.

Table 2: Geology at (or near) surface based on Alberton 1:50,000 scale mapsheet

Geological Unit	Summary Description	Zones where mapped at Surface
Qra	Stream Alluvium and very low level terraces. Grey carbonaceous clay, silt, fine sand and peat. Minor basaltic clay, basalt and quartz gravels.	3, 4 and 5
Qrm	Swamp and marsh deposits. Black carbonaceous muds with organic material, extensive peats.	1, 2 and 3
Qd	Coastal barrier deposits of low irregular beach and dune ridges and hummocks consisting of fine to medium quartz sand with minor carbonate.	1 and 3
Qpa	High level alluvium, grey carbonaceous clay, silty clay and minor sand.	1, 2, 3, 4 and 5
Tvo (Older Volcanics)	Basalt and tuff often extremely weathered. Claystone and siltstone possibly present.	4

The surficial alluvial deposits described in Table 2 are expected to be generally of low thickness across the site, typically being less than about 5 m thick.

Across the wind farm site, the surficial alluvium deposits are expected to be mostly underlain by Tertiary age Haunted Hill Gravels (Tph) materials which typically include clayey and sandy gravel, coarse sand, minor clay, fine sand and silt. These deposits are expected to be mostly between about 5 m and 10 m thick beneath the site area.

Underlying the Haunted Hill Gravels, Tertiary age Latrobe Valley Coal Measures (Tel) materials are expected to be present beneath some areas of the site, particularly beneath Zones 1 to 4. Figure 3 shows the extent of the 'Gelliondale Coalfield' area, where numerous historical boreholes were drilled to investigate the extent of the coal reserve. This formation includes thick brown coal seams, ligneous clay, sand and minor gravel. Historical records and the Alberton mapsheet suggest that the top of this formation is at an average depth of about 8 m in the area of the proposed T08, T10 and T11 turbines. This coal formation is indicated to be about 60 m thick in the area of these proposed turbines.

Beneath the Latrobe Valley Coal Measures formation, Tertiary age Older Volcanics (Tvo) basalt and Cretaceous age Strezleki Group (Kls) sandstone, siltstone and mudstone is expected. It is noted that the Older Volcanics are expected at ground level in the area immediately south of the proposed T17 turbine in



Zone 4. The Strezleki Group materials are expected to be at least 20 m depth below ground level over the site.

5.1.2 Groundwater

Table 3 presents groundwater levels recorded in bores within close proximity to proposed wind turbine locations (from publically available databases). The bores listed in Table 3 have been measured at various intervals (bi-monthly to quarterly) over a period of seventeen years.

Table 3: Groundwater levels measured in bores

Bore ID	Depth to Groundwater (m)			Comment on vicinity to proposed wind Turbine location
	May 2016	Minimum recorded	Maximum recorded	
WRK957612	1.8	0.1 (Jul 2001)	2.78 (Apr 2001)	In Zone 2, within a distance of about 0.5 km - 0.75 km from T08 to T11.
WRK957613	1.7	0.07 (Jul 2001)	2.72 (Apr 2000)	
WRK957539	1.8	0.07 (Aug 2001)	2.22 (Aug 2008)	
WRK957540	1.6	0.04 (Jul 2001)	2.42 (Jul 2008)	
WRK957607	0.7	+0.06 (Jun 2013)	1.32 (Feb 2007)	In Zone 2, within a distance of about 0.5 km - 1 km from T31 to T34.
WRK957608	0.6	+0.05 (Jun 2013)	1.32 (Oct 2008)	
WRK957609	0.4	0.8 (Aug 2008)	+0.3 (Jan 2013)	
WRK957601	4.8	1.9 (Jan 2007)	5.28 (Sept 2007)	In Zone 4, within a distance of about 0.5 km from T17
WRK957602	7.3	2.99 (Oct 2000)	7.6 (July 2014)	
WRK957603	7.1	2.43* (Jun 2002)	7.3 (Mar 2013)	

Note: *Bore WRK957603 recorded 0 m depth in June 2013 and 0.05 m in August 2009. These readings appears to be an anomalous reading given observed trends and measurements in nearby bores.

The available groundwater data indicates that the groundwater levels can be relatively high (less than 1 m below ground level), particularly south of the South Gippsland Highway. Some areas where the WTGs are proposed may be subject to seasonal flooding. Evidence of this was observed during the site visit where extensive areas of saturated ground and surface water were evident, making some areas inaccessible for vehicles.

5.2 Site Conditions within each Zone

Based on observations of the wind farm area made from air photos, during the site inspection and test pit investigations, the following sections summarise the conditions expected within each zone.

5.2.1 Zone 1

A total of seven wind turbines are proposed within Zone 1.

The topography of Zone 1 has an overall gentle slope in a north to south direction, ranging from an elevation of about RL 12 m AHD at the north (south of South Gippsland Highway) to an elevation of about RL 6 m AHD in the south area around the proposed T01 location.



An inferred alluvial terrace extends across the zone, extending from immediately south of Birds Road South, in a north easterly direction to south of T06 where a gravel road on the eastern boundary terminates (see Figure 3). In places there is a reduction in elevation of about 2 m to the south, and the ground appeared to be wet (at the time of our site visit) where this elevation reduction occurs and where it is closer proximity to Nine Mile Creek (oriented east-west in the southern end of the property).

No evidence of slope instability was observed in this zone during our site visit.

The area is currently agricultural land used for livestock and cropping. The area is well grassed with trees on the boundaries of paddocks. The area is mostly bounded to the east by the Gelliondale State Forest.

The subsurface materials encountered in Test Pit TP1 located near the proposed T02 comprised high plasticity clay ranging from firm to stiff consistency to the maximum investigation depth of 2.7 m. Sandy silty clay (topsoil) was encountered to 0.2 m depth. Groundwater was encountered at 2.4 m depth.

Photograph 1 below shows the ground surface condition looking in a southerly direction towards the proposed T05 and T04 locations from just east of the proposed T06 location.



Photograph 1: Looking in a southerly direction towards T05 and T04 locations from just east of T06 location

5.2.2 Zone 2

A total of four wind turbines are proposed within Zone 2.

The topography in Zone 2 has an overall gentle slope in a north to south direction. The area around the proposed T09 location is at an elevation of about RL 16 m AHD, and drops to an elevation of about RL 10 m AHD above sea level to the south around the proposed wind turbines T08, T10 and T11 locations.

No evidence of slope instability was observed in this zone.

Some surface water ponding was present at the time of our site visit as shown in Photograph 2. Site observations suggest that the proposed T08 location could be positioned in a low lying marsh type feature. Vehicle access to near this site was not possible during the site visit due to wet ground surface conditions.

The area is currently agricultural land used for livestock and cropping. The paddocks are thickly grassed and is bounded to the south and west by the Gelliondale State Forest.



The subsurface materials encountered in Test Pit TP3 located near the proposed T10 and T11 comprised high plasticity clay of mostly firm consistency to the maximum investigation depth of 2.6 m. Sandy silty clay (topsoil) was encountered to 0.2 m depth. Groundwater was encountered at 1.9 m depth.

Photograph 2 below shows the ground surface condition looking in a southerly direction towards the proposed T10 and T11 locations from the South Gippsland Highway and Coal Mine Road intersection.



Photograph 2: Looking in a southerly direction towards T10 and T11 from South Gippsland Highway and Coal Mine Road Intersection

5.2.3 Zone 3

A total of thirteen wind turbines are proposed within Zone 3.

The topography in Zone 3 has an overall gentle slope in a north to south direction, ranging from about RL 8 m AHD to RL 5 m AHD.

No evidence of slope instability was observed in this zone. The ground surface was observed to become wetter to the south.

The area is currently agricultural land used for livestock and possibly cropping. The area is mostly bounded to the south by the Gelliondale State Forest.

The subsurface materials encountered in Test Pit TP4 located near the proposed T18 included silty sand (topsoil) to 0.2 m depth, overlying medium dense to dense sand to 0.5 m depth. Stiff sandy clay of high plasticity clay was then encountered to 1.4 m depth, overlying very dense sand and clayey sand to the maximum investigation depth of 2.5 m.

The subsurface materials encountered in Test Pit TP5 located near the proposed T34 encountered silty sandy clay of high plasticity to 0.4 m depth, overlying stiff high plasticity clay to 2.4 m, then very dense clayey sand to the maximum investigation depth of 2.6 m.

No groundwater was encountered Test Pit TP4. Groundwater was encountered in Test Pit TP5 at a depth of 2.4 m.



Photograph 3 below shows the ground surface condition looking in a westerly direction towards the proposed T18 and T22 locations from the intersection of the northern boundary of Gelliondale State Forest and Ti Tree Road.



Photograph 3: Looking in a westerly direction towards T18 and T22 from northern boundary of Gelliondale State Forest and Ti Tree Road

5.2.4 Zone 4

A total of five wind turbines are proposed within Zone 4.

The topography within Zone 4 is relatively flat with local undulations and gentle slopes towards localised drainage channels. Overall the ground surface between elevations of about RL 6 m AHD to RL 10 m AHD. Albert River is located on the north boundary of this zone, and is oriented in a northwest to southeast orientation.

The area is currently agricultural land used for livestock and possible cropping.

No evidence of slope instability was observed in this zone.

The subsurface materials encountered in Test Pit TP6 located near the proposed T17 and T25 encountered silty sandy clay of high plasticity to 0.3 m depth, overlying stiff high plasticity clay to the maximum investigation depth of 2.5 m.

No groundwater was observed in Test Pit TP6.

Photograph 4 below shows the ground surface condition looking in a north easterly direction towards the proposed T25 location from the entrance gate off Old Alberton Drive.



Photograph 4: Looking in a north easterly direction towards WTG T25 from gate off Old Alberton Drive

5.2.5 Zone 5

A total of five wind turbines are proposed within Zone 5.

The topography in Zone 5 undulates due to the presence of numerous drainage channels that feed into Stony Creek. In general the ground surface elevation ranges from about RL 14 m AHD to RL 18 m AHD. During the site visit sections of this zone had ponded surface water present.

The area is currently agricultural land used for livestock and possible cropping. The proposed northern most T21 and T23 locations were not accessible with a vehicle during the site visit due to the presence of saturated and 'boggy' ground surface conditions. These proposed wind turbine positions are located in a lower lying area of the site.

No evidence of slope instability was observed in this zone.

The subsurface materials encountered in Test Pit TP7 located near the proposed T28 encountered sandy silty clay (topsoil) of high plasticity to 0.2 m depth, overlying high plasticity clay having a consistency increasing with depth, ranging from firm to very stiff to the maximum investigation depth of 2.5 m.

No groundwater was encountered in Test Pit TP7.

Photograph 5 below shows the ground surface condition looking in a north direction towards the proposed T20, T21 and T23 locations from a private access road.



Photograph 5: Looking in a north direction towards T20, T21 and T23 from private access road

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 Wind Turbine Generator Footings

6.1.1 Site Subsurface Conditions

The preliminary geotechnical investigations performed at the proposed wind farm site show that the near surface conditions comprise mostly alluvial high plasticity clay ranging from firm to stiff consistency to a depth of about 2.5 m. In the Zone 3 area, the high plasticity clay was interbedded with sand and clayey sand layers ranging from medium dense to very dense. Alluvial soils are expected to be mostly less than about 5 m thick at the site.

The alluvial soils are expected to be mostly underlain by Haunted Hill Gravel materials comprising clayey and sandy gravel, coarse sand, minor clay, fine sand and silt. We anticipate that these deposits will likely be mostly between about 5 m and 10 m thick beneath the site area. Materials expected beneath the Haunted Hill Gravel materials include materials of the Latrobe Valley Coal Measures (brown coal, ligneous clay, sand), Older Volcanics (basalt) and Strezleki Group (sandstone, siltstone, and mudstone).

The desktop review and preliminary geotechnical investigations show the presence of a generally high groundwater at some locations, particularly on the lower lying areas located south of the South Gippsland Highway. Historical measurements of borehole standpipes indicate the groundwater level to be close to ground surface during wetter months in the areas south of the South Gippsland Highway. The recent test pit investigations in this area (TP1, TP3 to TP5) mostly showed groundwater to be present at depths ranging from 1.9 m to 2.4 m. North of the railway line, historical measurements in borehole standpipes showed groundwater to be at a minimum depth of about 2 m below ground level. The recent test pit investigations in this area (TP6 and TP7) did not encounter groundwater (during the period that test pits remained open) within a 2.5 m depth.



6.1.2 Footing Options

The design of footings for wind turbines needs to take into account a number of factors that are not always significant for other structures. The wind turbines, by their nature, are relatively light structures that are subjected to extreme overturning loads due to their height and the applied wind loads. As a result, resisting over turning under the ultimate wind load is a major function of the foundation system and this aspect generally governs the size of footing required.

A number of footing options are available. The traditional footing system is a large concrete pad footing buried below the surface. This option provides additional weight, from the concrete footing and the overlying soil, to resist the overturning forces. In our experience square footings are often adopted to simplify the layout of the reinforcement in the footing. Octagonal or round footings are also commonly used instead of square footings to save on concrete. Concrete pad footings for support of wind turbines are typically founded at a depth of about 2 m, having a nominal thickness of about 1.5 m and overlain by 0.5 m thickness of soil. The width of pad footings can be up to 20 m, or greater.

Alternate footing systems involve the use of anchors or piles to increase overturning resistance and stiffness or where mass gravity footings are unsuitable. These alternatives are less common and require certain subsurface conditions. Ground anchors are usually only suitable where rock foundation conditions occur, and used to reduce the size of a mass gravity footing. Pile footings are suitable when low strength founding materials are present near the surface which preclude the use of a mass gravity footing. These options can result in use of a smaller footing, but they require careful attention to the structural design to ensure that the loads are transmitted through the footing.

The preliminary geotechnical investigations performed indicate that pad footings may not be a suitable footing option for many of the turbine sites, particularly those where a high ground water level is expected and where low strength soils are present. We expect that pad footings will only be a suitable footing option when soil foundations comprise clay of at least stiff consistency or sand which is at least medium dense. The foundation conditions encountered at Test Pits TP1 (Zone 1) and TP3 (Zone 2) which included firm clay are unlikely to be suitable for use of pad footings to support wind turbines.

Where pad footings are an unsuitable footing option, it is envisaged that either driven precast concrete piles or Continuous Flight Auger (CFA) piles could be used, with the turbine being supported on a pile cap. Given the likely magnitude of the loads it is expected that multiple piles would be required for each footing. Based upon the results of the desktop review and preliminary geotechnical investigation the Quaternary alluvial soils may be expected to be only generally shallow, of less than about 5 m thickness. We would therefore expect that the piles will need to be installed to found into the expected underlying higher strength soil or rock, possibly being installed to reach effective refusal into dense or very dense Haunted Hill Gravels materials or into rock of the Older Volcanics or Strezleki Group formations. Turbine locations where foundations are expected to comprise a shallow thickness of alluvial soil and Haunted Hill Gravels materials overlying Latrobe Valley Coal Measures materials (e.g. coal) are expected to require special consideration. We would expect that founding piles in the Haunted Hill Gravels materials will be preferable to founding in the underlying expected lower strength Latrobe Valley Coal Measures materials.

6.1.3 Preliminary Footing Design Parameters

6.1.3.1 Pad Footings

Table 4 presents indicative maximum ultimate bearing pressures that may be considered for preliminary design of pad footings for support of wind turbines. It should be noted that these pressures are related to the footing dimensions and the values will need to be confirmed once the actual loads on the structure are known and the footing sizes are assessed. These pressures are unfactored and appropriate geotechnical strength reduction factors or factors of safety will need to be applied for design of the footing.



Table 4: Indicative Maximum Ultimate Bearing Pressures (Unfactored)

Founding Material	Maximum Ultimate Bearing Pressure (kPa)
At least Medium Dense Sand/Silty Sand/Clayey Sand	400
Stiff or stronger Clay	300

6.1.3.2 Pile Footings

Given the presence of lower strength soils at typical pad founding depths and the relatively shallow groundwater level piles could be used to increase the stiffness of the profile below the pad footing and to increase the available bearing pressures (thereby reducing pad sizes). Either driven precast concrete piles or CFA piles could be used which are installed to effective refusal into dense or very dense soil or rock or potentially shallower depending upon the subsurface profile. Precast concrete piles in Victoria are typically supplied with either 350 mm or 400 mm square cross sections. CFA piles are mostly constructed using 600 mm, 750 mm or 900 mm diameter augers. CFA piles therefore have the advantage of a larger cross sectional area which increases the capacity of the piles.

For preliminary design of precast driven concrete piles installed to effective refusal, we recommend a maximum allowable design working load of 1.5 MN for 350 mm square piles and 2 MN for 400 mm square piles.

The successful installation of CFA piles and their ability to achieve stated design loads relies on the nature and size of the equipment and procedures used in their installation. For preliminary design purposes, for individual 600 mm, 750 mm and 900 mm diameter CFA piles installed to effective refusal we recommend maximum design geotechnical strengths (factored ultimate axial load capacity) of 3 MN, 4.5 MN and 6 MN, respectively.

The design loads achieved for driven precast piles and CFA piles will need to be confirmed by dynamic load testing and subsequent CAPWAP analysis.

6.1.4 Possible founding conditions by zone

We understand Synergy Wind is considering potential turbine footing options including shallow pad or deeper piled footings. The selection of a preferred footing option at each turbine location will depend on a number of factors including the design loads to be supported, the likely founding materials for shallow and deep founding options, groundwater conditions and constructability considerations. As requested by Synergy Wind we have made a preliminary assessment of potential founding conditions that may be encountered in each of the zones referred to in Section 5 with respect to the following founding options/conditions:

- pad footing with deep groundwater level
- pad footing with shallow ground water level
- pad footing combined with piles

For the purpose of assessing the likely shallow founding and groundwater conditions in each area we have primarily relied on information obtained from the test pits excavated in each area. We note that the subsurface conditions within each zone are likely to vary between turbine locations so the following assessment should be considered preliminary only. Furthermore the pits, by their nature, have only intersected the shallow soil profile. Table 5 presents a summary of turbine locations within each zone, a summary of near surface soil and groundwater conditions encountered during the preliminary geotechnical investigation and possible founding options that may be satisfactory.



Table 5: Wind turbine zone and possible founding conditions/options

Zone	Wind Turbine Numbers	Summary shallow subsurface conditions	Possible founding options
1	T01 to T07	Firm to stiff clay Shallow groundwater	Pad footing combined with piles



The materials used for road construction are likely to consist of materials won from local borrow areas.

6.4 Further Investigations

The subsurface conditions across the site at the proposed wind turbine locations are expected to be generally highly variable. To date, the geotechnical investigations performed have only extended to about 2.5 m depth. It is recommended that prior to detailed design borehole investigations are undertaken at each turbine site to assess foundation conditions. The boreholes will need to extend to sufficient depth to investigate suitable founding layers for the turbine footings. The investigations should include measurement of groundwater depths.

7.0 IMPORTANT INFORMATION

Your attention is drawn to the document - 'Important Information' (LRG04, RL2) which is included in Appendix B of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Golder, but rather to ensure that all parties who may use this report aware of the responsibilities each assumes in so doing.

We would be pleased to answer any questions the reader may have regarding this 'Important Information'.



Report Signature Page

GOLDER ASSOCIATES PTY LTD

A handwritten signature in black ink that reads "Andrew Russell".

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IJH/ASR/ijh

A.B.N. 64 006 107 857

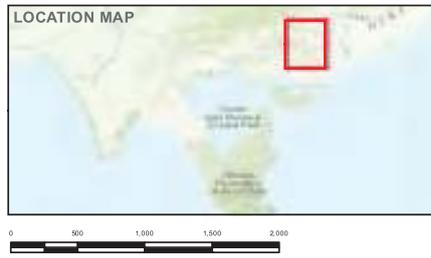
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j:\geo\2016\1666035 - synergy-wind, windfarm, gippsland\correspondence out\1666035-001-r-rev1.docx



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

- LEGEND**
-  Proposed Wind Turbine
 -  Site Property Boundary

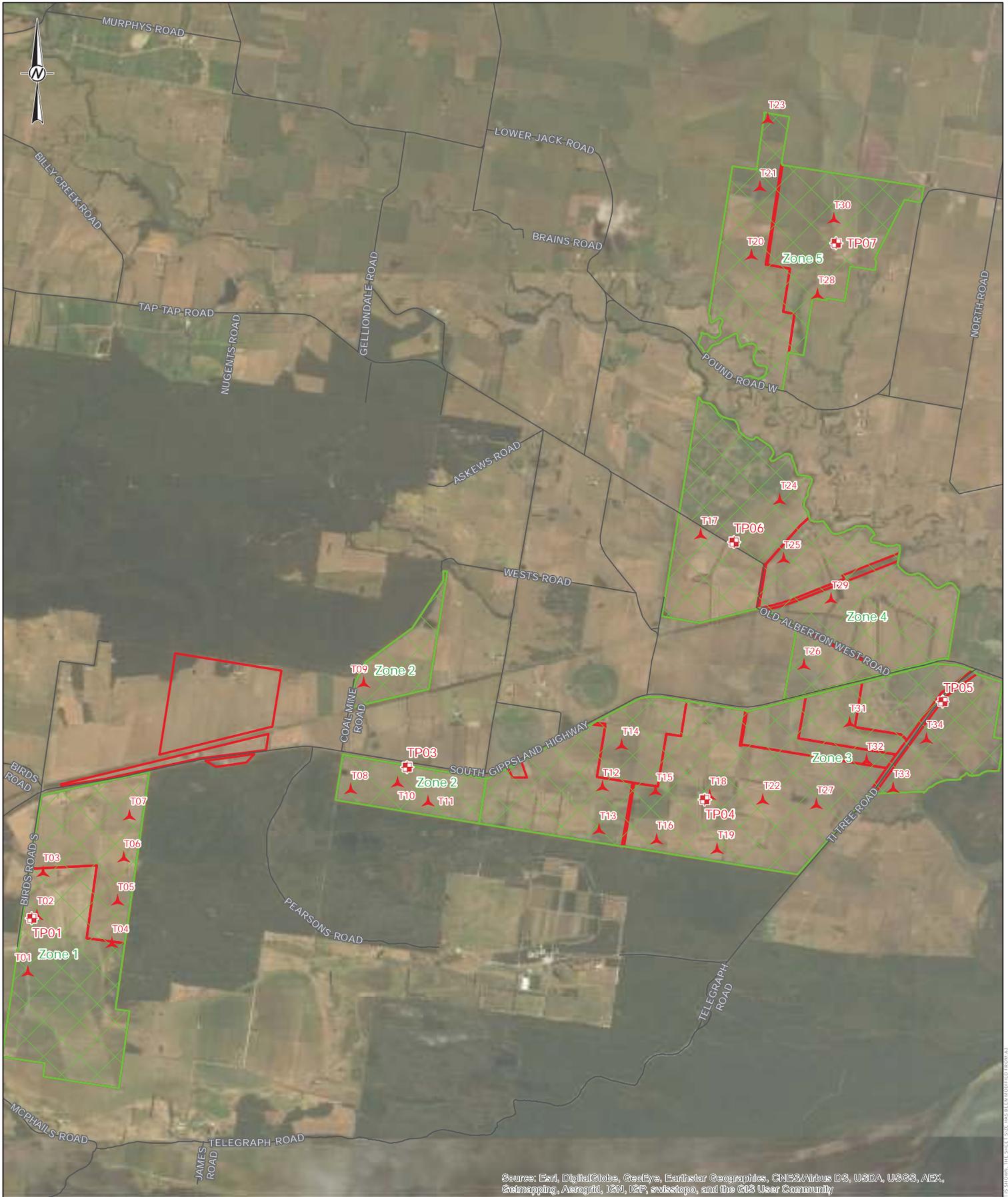


REFERENCE SCALE: 1:40,000 (at A3)
 PROJECTION: GDA 1994 MGA Zone 55

CLIENT		SYNERGY WIND PTY LTD	
PROJECT		HGA WIND FARM, SOUTH GIPPSLAND - PRELIMINARY GEOTECHNICAL INVESTIGATION	
TITLE		SITE LOCATION AND LAYOUT	
CONSULTANT	YYYY-MM-DD	2/12/2016	
PREPARED	AFK		
DESIGN	-		
REVIEW	ASR		
APPROVED	ASR		
PROJECT No.	CONTROL	REVIEW	FIGURE
1666035	001-R	0	1



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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aergrid, IGN, IGP, swisstopo, and the GIS User Community

- LEGEND**
- Approximate Test Pit Location
 - Proposed Wind Turbine
 - Wind Farm Zone
 - Site Property Boundary

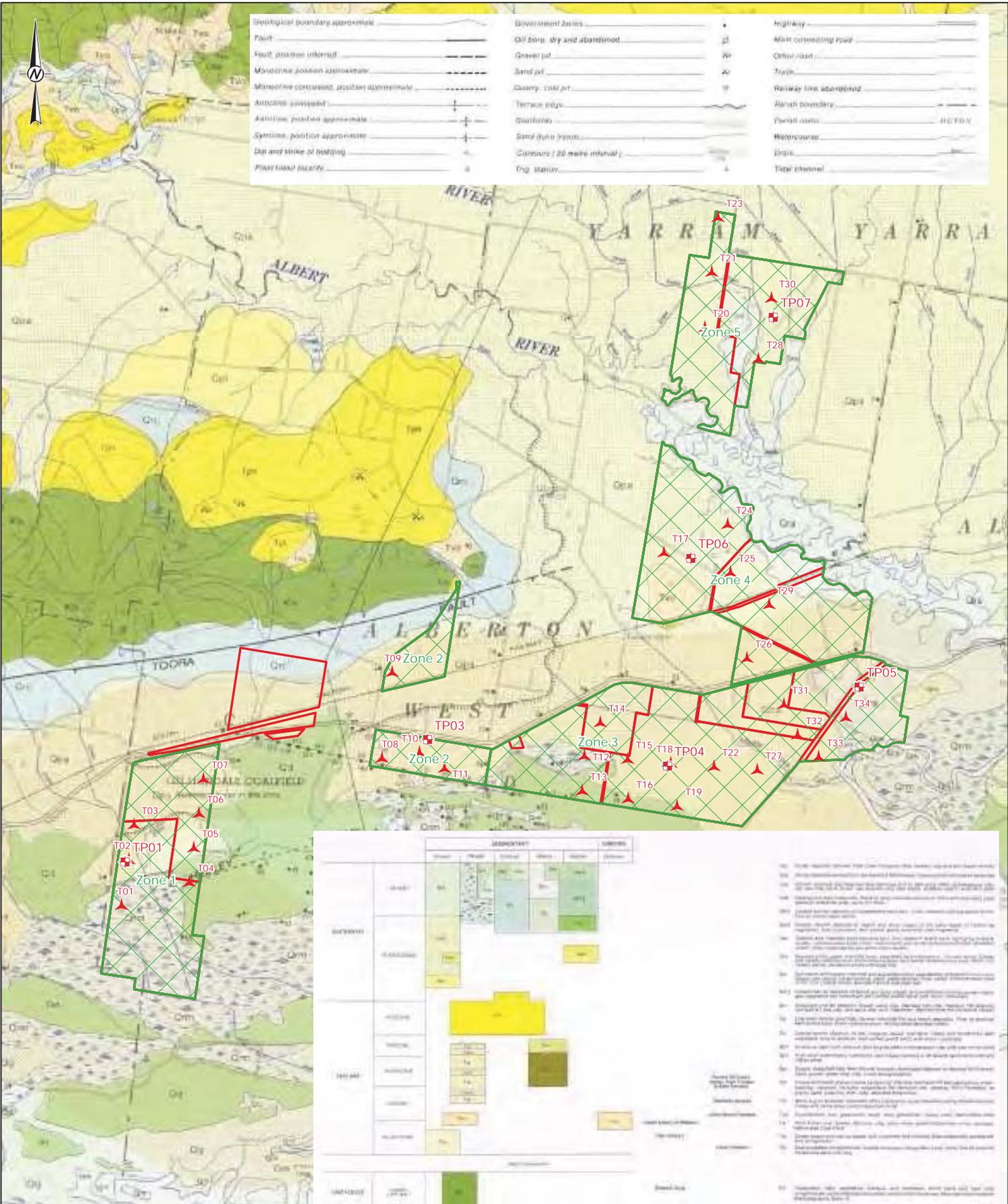


REFERENCE SCALE: 1:40,000 (at A3)
 PROJECTION: GDA 1994 MGA Zone 55

CLIENT	SYNERGY WIND PTY LTD	
PROJECT	HGA WIND FARM, SOUTH GIPPSLAND - PRELIMINARY GEOTECHNICAL INVESTIGATION	
TITLE	TEST PIT PLAN	
CONSULTANT	YYYY-MM-DD	2/12/2016
	PREPARED	AFE
	DESIGN	-
	REVIEW	ASR
	APPROVED	ASR

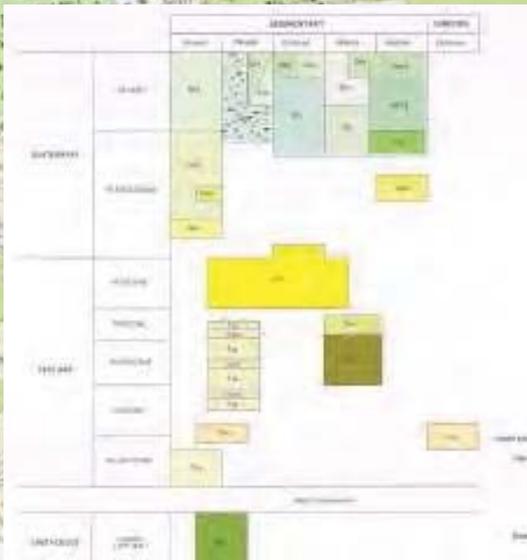


PROJECT No. 1666035 CONTROL 001-R REVIEW 0 FIGURE 2



LEGEND

- Approximate Test Pit Location
- ▲ Proposed Wind Turbine
- Wind Farm Zone
- Site Location



CLIENT
SYNERGY WIND PTY LTD

PROJECT
HGA WIND FARM, SOUTH GIPPSLAND -
PRELIMINARY GEOTECHNICAL INVESTIGATION

TITLE
WIND TURBINE LOCATION AND REGIONAL GEOLOGY

CONSULTANT	YYYY-MM-DD	2/12/2016
PREPARED	AFE	
DESIGN	-	
REVIEW	ASR	
APPROVED	ASR	

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1:50,000 Series - Map 001 'Alberton'

REFERENCE SCALE: 1:50,000 (at A3)
PROJECTION: GDA 1994 MGA Zone 55





APPENDIX A

Reports of Test Pits TP1 and TP3 to TP7

Photographs of Test Pits TP1 and TP3 to TP7

**Explanation of notes, abbreviations and terms used on
borehole and test pit reports**

**Method of soil description used on borehole and test pit
reports**



REPORT OF TEST PIT: TP1

CLIENT: Synergy Wind Pty Ltd
 PROJECT: HGA Wind Farm
 LOCATION: Birds Road South
 JOB NO: 1666035

POSITION: Birds Road South
 COORDS: 458631 m E 5722033 m N MGA94 56 (hhGPS)
 SURFACE RL: DATUM: AHD
 LENGTH: 3.00 m WIDTH: 0.45 m
 PIT DEPTH: 2.70 m
 BUCKET TYPE: 450 mm

SHEET: 1 OF 1
 MACHINE: Takeuchi TB180 FR
 CONTRACTOR: Latrobe Excavation
 LOGGED: TCD DATE: 17/11/16
 CHECKED: ASR DATE: 25/11/16

Excavation			Sampling		Field Material Description													
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm					
													0	5	10	15	20	25
			0.0					CH	Sandy Silty CLAY high plasticity, dark grey, fine sand	M (c PL)		rootlets and organics near surface						
			0.20					CH	CLAY high plasticity, dark grey	M (>PL)	F - St							
			0.50		0.50 m PP = 150 kPa													
			0.80						pale grey and orange									
			1.00		1.00 m PP = 150 kPa													
			1.50							M								
			2.00		2.00 m PP = 100 kPa						St							
			2.40						trace fine sand									
			2.50		2.50 m PP = 100 kPa					W								
			3.00						TEST PIT DISCONTINUED @ 2.70 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.40 m DEPTH BACKFILLED									

GAP 8_13.0.LIB.GLB Log GAP NON-CORED FULL PAGE 1666035-TEST PIT LOGS.GPJ <<DrawingFile>> 01/12/2016 14:24 8:30:003 Datgel Tools

This report of test pit must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

REPORT OF TEST PIT PHOTOGRAPHS: TP1

CLIENT: Synergy Wind Pty Ltd
 PROJECT: HGA Wind Farm
 LOCATION: Birds Road South
 JOB NO: 1666035

POSITION: Birds Road South
 COORDS: 458631 m E 5722033 m N MGA94 56 (hhGPS)
 SURFACE RL: DATUM: AHD
 LENGTH: 3.00 m WIDTH: 0.45 m
 PIT DEPTH: 2.70 m
 BUCKET TYPE: 450 mm

SHEET: 1 OF 1
 MACHINE: Takeuchi TB180 FR
 CONTRACTOR: Latrobe Excavation
 LOGGED: TCD DATE: 17/11/16
 CHECKED: ASR DATE: 25/11/16



1.



2.

This report of test pit photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.



REPORT OF TEST PIT: TP3

CLIENT: Synergy Wind Pty Ltd
 PROJECT: HGA Wind Farm
 LOCATION: South Gippsland Hwy
 JOB NO: 1666035

POSITION: South Gippsland Hwy
 COORDS: 462825 m E 5723740 m N MGA94 56 (hhGPS)
 SURFACE RL: DATUM: AHD
 LENGTH: 3.00 m WIDTH: 0.50 m
 PIT DEPTH: 2.60 m
 BUCKET TYPE: 450 mm

SHEET: 1 OF 1
 MACHINE: Takeuchi TB180 FR
 CONTRACTOR: Latrobe Excavation
 LOGGED: TCD DATE: 17/11/16
 CHECKED: ASR DATE: 25/11/16

Excavation			Sampling			Field Material Description													
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm						
													0	5	10	15	20	25	
EX	M		0.0					CH	Sandy Silty CLAY high plasticity, dark grey, fine sand	M (c PL)		rootlets and organics near surface							
			0.20				CH	CLAY high plasticity, dark grey	F - St										
			0.50	0.50 m PP = 100 kPa															
			1.00	1.00	1.00 m PP = 100 kPa				grey and orange	M (>PL)									
			1.50							F									
			2.00		2.00 m PP = 50 kPa					W									
			2.50																
			3.00						TEST PIT DISCONTINUED @ 2.60 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 1.90 m DEPTH BACKFILLED										

This report of test pit must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

REPORT OF TEST PIT PHOTOGRAPHS: TP3

CLIENT: Synergy Wind Pty Ltd
PROJECT: HGA Wind Farm
LOCATION: South Gippsland Hwy
JOB NO: 1666035

POSITION: South Gippsland Hwy
COORDS: 462825 m E 5723740 m N MGA94 56 (hhGPS)
SURFACE RL: DATUM: AHD
LENGTH: 3.00 m WIDTH: 0.50 m
PIT DEPTH: 2.60 m
BUCKET TYPE: 450 mm

SHEET: 1 OF 1
MACHINE: Takeuchi TB180 FR
CONTRACTOR: Latrobe Excavation
LOGGED: TCD DATE: 17/11/16
CHECKED: ASR DATE: 25/11/16



1.



2.

This report of test pit photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.



REPORT OF TEST PIT: TP4

CLIENT: Synergy Wind Pty Ltd
 PROJECT: HGA Wind Farm
 LOCATION: South Gippsland Hwy
 JOB NO: 1666035

POSITION: South Gippsland Hwy
 COORDS: 466154 m E 5723370 m N MGA94 56 (hhGPS)
 SURFACE RL: DATUM: AHD
 LENGTH: 3.00 m WIDTH: 0.50 m
 PIT DEPTH: 2.50 m
 BUCKET TYPE: 450 mm

SHEET: 1 OF 1
 MACHINE: Takeuchi TB180 FR
 CONTRACTOR: Latrobe Excavation
 LOGGED: TCD DATE: 17/11/16
 CHECKED: ASR DATE: 25/11/16

Excavation			Sampling		Field Material Description												
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm					
												0	5	10	15	20	25
EX	L		0.0				SW-SM	Silty SAND fine to medium grained, dark grey			rootlets and organics near surface						
			0.20				SW	SAND fine to medium grained, yellow grey, trace silt	M	MD-D							
	M		0.50				CH	Sandy CLAY high plasticity, orange grey, fine sand									
			1.40					SW	SAND fine to medium grained, yellow pale grey, with some silt	M (>PL)	St						
	L		2.40					Clayey SAND fine to medium grained, yellow pale grey, high plasticity clay	M	VD							
			2.5					TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT OBSERVED BACKFILLED									

This report of test pit must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

REPORT OF TEST PIT PHOTOGRAPHS: TP4

CLIENT: Synergy Wind Pty Ltd
PROJECT: HGA Wind Farm
LOCATION: South Gippsland Hwy
JOB NO: 1666035

POSITION: South Gippsland Hwy
COORDS: 466154 m E 5723370 m N MGA94 56 (hhGPS)
SURFACE RL: DATUM: AHD
LENGTH: 3.00 m WIDTH: 0.50 m
PIT DEPTH: 2.50 m
BUCKET TYPE: 450 mm

SHEET: 1 OF 1
MACHINE: Takeuchi TB180 FR
CONTRACTOR: Latrobe Excavation
LOGGED: TCD DATE: 17/11/16
CHECKED: ASR DATE: 25/11/16



1.



2.

This report of test pit photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

REPORT OF TEST PIT PHOTOGRAPHS: TP5

CLIENT: Synergy Wind Pty Ltd
PROJECT: HGA Wind Farm
LOCATION: Ti Tree Road
JOB NO: 1666035

POSITION: Ti Tree Road
COORDS: 468816 m E 5724475 m N MGA94 56 (hhGPS)
SURFACE RL: DATUM: AHD
LENGTH: 3.00 m WIDTH: 0.50 m
PIT DEPTH: 2.60 m
BUCKET TYPE: 450 mm

SHEET: 1 OF 1
MACHINE: Takeuchi TB180 FR
CONTRACTOR: Latrobe Excavation
LOGGED: TCD DATE: 17/11/16
CHECKED: ASR DATE: 25/11/16



1.



2.

This report of test pit photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.



REPORT OF TEST PIT: TP6

CLIENT: Synergy Wind Pty Ltd
 PROJECT: HGA Wind Farm
 LOCATION: Old Alberton West Road
 JOB NO: 1666035

POSITION: Old Alberton West Road
 COORDS: 466479 m E 5726274 m N MGA94 56 (hhGPS)
 SURFACE RL: DATUM: AHD
 LENGTH: 3.00 m WIDTH: 0.50 m
 PIT DEPTH: 2.50 m
 BUCKET TYPE: 450 mm

SHEET: 1 OF 1
 MACHINE: Takeuchi TB180 FR
 CONTRACTOR: Latrobe Excavation
 LOGGED: TCD DATE: 17/11/16
 CHECKED: ASR DATE: 25/11/16

Excavation			Sampling		Field Material Description													
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm					
													0	5	10	15	20	25
			0.0					CH	Sandy Silty CLAY high plasticity, dark grey, fine sand	M (c PL)		rootlets and organics near surface						
			0.30					CH	CLAY high plasticity, dark grey	M (c PL)								
			0.40 m		PP = 250 kPa													
			0.60						pale grey and orange									
			0.80 m		PP = 150 kPa													
			1.0															
			1.50 m		PP = 200 kPa					M (>PL)								
			2.00 m		PP = 150 kPa													
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT OBSERVED BACKFILLED									
			3.0															

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This report of test pit must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

REPORT OF TEST PIT PHOTOGRAPHS: TP6

CLIENT: Synergy Wind Pty Ltd
PROJECT: HGA Wind Farm
LOCATION: Old Alberton West Road
JOB NO: 1666035

POSITION: Old Alberton West Road
COORDS: 466479 m E 5726274 m N MGA94 56 (hhGPS)
SURFACE RL: DATUM: AHD
LENGTH: 3.00 m WIDTH: 0.50 m
PIT DEPTH: 2.50 m
BUCKET TYPE: 450 mm

SHEET: 1 OF 1
MACHINE: Takeuchi TB180 FR
CONTRACTOR: Latrobe Excavation
LOGGED: TCD DATE: 17/11/16
CHECKED: ASR DATE: 25/11/16



1.



2.

This report of test pit photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

Excavation		Sampling		Field Material Description					
EX	M	PP (m)	PP (kPa)	Soil Type	Color	Notes	Soil Type	Notes	
L		0.20		CH	Sandy Silty CLAY high plasticity, dark grey		M	rootlets and organics near surface	
		0.50		CH	CLAY high plasticity, dark grey		F		
EX	M	0.60	150			orange and pale grey			
		1.80	200				St		
		2.50	250				M (>PL)		
							VSt		
						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT OBSERVED BACKFILLED			

REPORT OF TEST PIT PHOTOGRAPHS: TP7

CLIENT: Synergy Wind Pty Ltd
PROJECT: HGA Wind Farm
LOCATION: Pond Road West
JOB NO: 1666035

POSITION: Pond Road West
COORDS: 467624 m E 5729643 m N MGA94 56 (hhGPS)
SURFACE RL: DATUM: AHD
LENGTH: 3.00 m WIDTH: 0.50 m
PIT DEPTH: 2.50 m
BUCKET TYPE: 450 mm

SHEET: 1 OF 1
MACHINE: Takeuchi TB180 FR
CONTRACTOR: Latrobe Excavation
LOGGED: TCD DATE: 17/11/16
CHECKED: ASR DATE: 25/11/16



1.



2.

This report of test pit photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

DRILLING/EXCAVATION METHOD

AS*	Auger Screwing	RD	Rotary blade or drag bit	NQ	Diamond Core - 47 mm
AD*	Auger Drilling	RT	Rotary Tricone bit	NMLC	Diamond Core - 52 mm
*V	V-Bit	RAB	Rotary Air Blast	HQ	Diamond Core - 63 mm
*T	TC-Bit, e.g. ADT	RC	Reverse Circulation	HMLC	Diamond Core - 63mm
HA	Hand Auger	PT	Push Tube	BH	Tractor Mounted Backhoe
ADH	Hollow Auger	CT	Cable Tool Rig	EX	Tracked Hydraulic Excavator
DTC	Diatube Coring	JET	Jetting	EE	Existing Excavation
WB	Washbore or Bailer	NDD	Non-destructive digging	HAND	Excavated by Hand Methods

PENETRATION/EXCAVATION RESISTANCE

- L Low resistance.** Rapid penetration possible with little effort from the equipment used.
- M Medium resistance.** Excavation/possible at an acceptable rate with moderate effort from the equipment used.
- H High resistance** to penetration/excavation. Further penetration is possible at a slow rate and requires significant effort from the equipment.
- R Refusal or Practical Refusal.** No further progress possible without the risk of damage or unacceptable wear to the digging implement or machine.

These assessments are subjective and are dependent on many factors including the equipment power, weight, condition of excavation or drilling tools, and the experience of the operator.

WATER


Water level at date shown



Partial water loss



Water inflow



Complete water loss

GROUNDWATER NOT OBSERVED The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.

GROUNDWATER NOT ENCOUNTERED The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18 30/80mm	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed sample
BDS	Bulk disturbed sample
G	Gas Sample
W	Water Sample
FP	Field permeability test over section noted
FV	Field vane shear test expressed as uncorrected shear strength (s_v = peak value, s_r = residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket penetrometer test expressed as instrument reading in kPa
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
WPT	Water pressure tests
DCP	Dynamic cone penetration test
CPT	Static cone penetration test
CPT _u	Static cone penetration test with pore pressure (u) measurement

Ranking of Visually Observable Contamination and Odour (for specific soil contamination assessment projects)

R = 0	No visible evidence of contamination	R = A	No non-natural odours identified
R = 1	Slight evidence of visible contamination	R = B	Slight non-natural odours identified
R = 2	Visible contamination	R = C	Moderate non-natural odours identified
R = 3	Significant visible contamination	R = D	Strong non-natural odours identified

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)

SCR = Solid Core Recovery (%)

RQD = Rock Quality Designation (%)

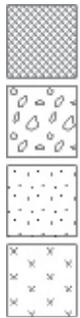
$$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$$

$$= \frac{\sum \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100$$

$$= \frac{\sum \text{Axial lengths of core} > 100 \text{ mm}}{\text{Length of core run}} \times 100$$



METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT REPORTS



FILL
GRAVEL (GP or GW)
SAND (SP or SW)
SILT (ML or MH)



CLAY (CL, CI or CH)
ORGANIC SOILS (OL or OH or Pt)
COBBLES or BOULDERS

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay.

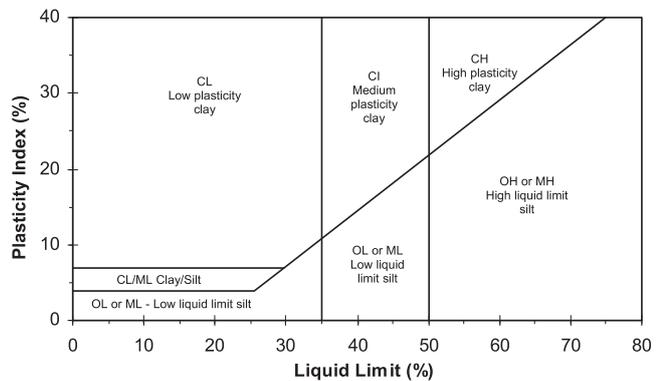
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and Rock is classified and described in Reports of Boreholes and Test Pits using the preferred method given in AS1726 – 1993, (Amdt1 – 1994 and Amdt2 – 1994), Appendix A. The material properties are assessed in the field by visual/tactile methods.

Particle Size

Major Division	Sub Division	Particle Size
BOULDERS		> 200 mm
COBBLES		63 to 200 mm
GRAVEL	Coarse	20 to 63 mm
	Medium	6.0 to 20 mm
	Fine	2.0 to 6.0 mm
SAND	Coarse	0.6 to 2.0 mm
	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

Plasticity Properties



MOISTURE CONDITION

AS1726 - 1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays & Silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition & may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726 - 1993

Symbol	Term	Undrained Shear Strength	Symbol	Term	Density Index %	SPT "N" #
VS	Very Soft	0 to 12 kPa	VL	Very Loose	Less than 15	0 to 4
S	Soft	12 to 25 kPa	L	Loose	15 to 35	4 to 10
F	Firm	25 to 50 kPa	MD	Medium Dense	35 to 65	10 to 30
St	Stiff	50 to 100 kPa	D	Dense	65 to 85	30 to 50
VSt	Very Stiff	100 to 200 kPa	VD	Very Dense	Above 85	Above 50
H	Hard	Above 200 kPa				

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

SPT correlations are not stated in AS1726 – 1993, and may be subject to corrections for overburden pressure and equipment type.



APPENDIX B

Important information



IMPORTANT INFORMATION RELATING TO THIS REPORT

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At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification.

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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