Lakeland Wind Farm: Detailed Project Description

Contents

A. APPENDIX A: DETAILED PLANS

This Appendix provides details of the main components of Lakeland Wind Farm. It includes details of turbine layout and dimensions, a detailed civil plan of access roads, temporary and permanent infrastructure.

A.1 SUMMARY OF CONSTRUCTION COMPONENTS

A wind farm is made up of a number of key components: wind turbine generators, roads, hard stands, a substation and others. A summary of the components to be constructed appears in the table below.

TABLE A-1: KEY CONSTRUCTION COMPONENTS FOR THE KIATA PROJECT

Component	Number/ Length	Temporary/ Permanent	Section in this Report
Wind Turbine Generators	35	Permanent	A.3
Access Roads	20 km	Permanent	A.5
Hard Stands	35	Permanent	A.6
Construction Laydown Areas	2	Temporary	A.8
Concrete Batching Plant	1	Temporary	A.8
Site Office	1	Permanent	A.11
Water Storage	1	Permanent	A.11
Car park	1	Permanent	A.11
Monitoring Mast	1	Permanent	A.12
Temporary Monitoring Masts	3	Temporary	A.12
Underground Reticulation	10 km	Permanent	A.13.1
Substation	1	Permanent	A.13.2
Overhead Transmission	11 km	Permanent	A.13.2

A.2 TURBINE DETAILS

A.2.1 TURBINE DESCRIPTION

Wind turbines are made up of various components; a tower, a nacelle, a hub, and blades as shown in Figure A-1.

The tower can be manufactured in three to seven sections depending upon turbine make and model. These are bolted together at various height intervals. Towers house a lift and/or ladder inside them to gain access to the nacelle located at the top of the tower.

The nacelle is manufactured largely with glass reinforced plastic. The front (hub end) is made with cast iron to support the hub and direct the load onto the tower. The central frame supports the gearbox and motors of the yaw system. The rear of the nacelle houses the generator, hydraulic master unit, converter and transformer.

The hub is made with cast iron. This is connected to the front of the nacelle and has three joint flanges for the pitch control bearings (for blades).

The blades are generally manufactured from fibreglass. The most common commercial design is to have three blades (which is universally the case for larger turbines).

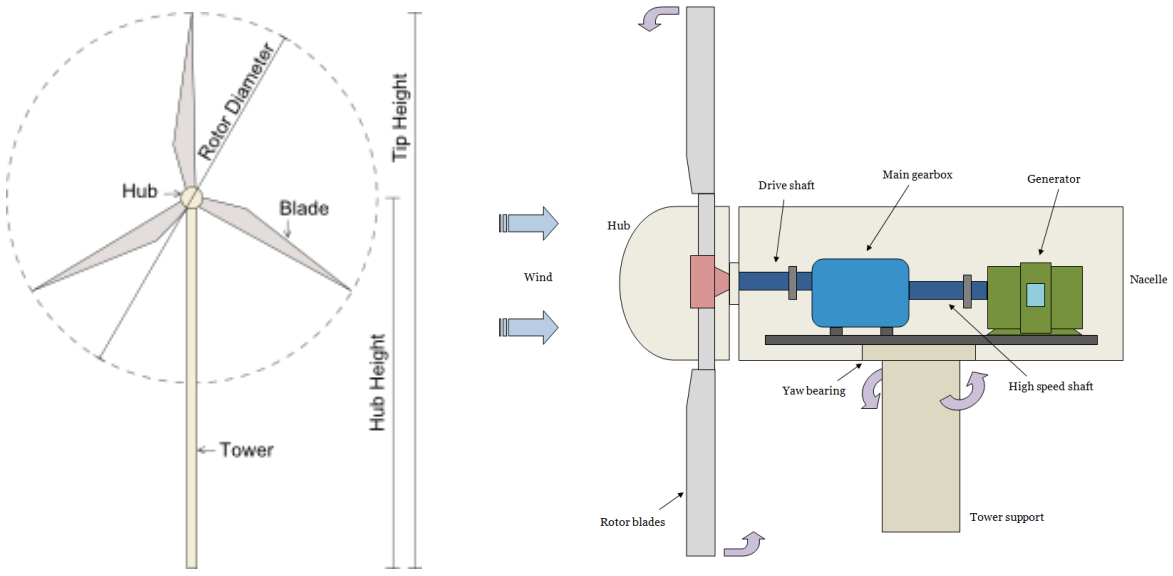


FIGURE A-1: GENERIC WIND TURBINE WITH COMPONENTS

A.2.2 MAXIMUM ENVELOPE

For Lakeland Wind Farm the turbines to be installed will have a maximum tip height of 240m, with a maximum hub-height of 160m and a maximum rotor diameter of 160m.

A.3 TURBINE LAYOUT

The proposed project comprises up to 35 wind turbines. The proposed turbine layout with associated on-site infrastructure, subject to micro-siting, is depicted in Figure A-2[1]. The proposed wind turbines will be erected within the participating landowners' land.

The turbine layout has been designed to minimise environmental impacts by utilising cleared land as far as practical, maintain a separation distance of 2000m between wind turbines and neighbouring dwellings, avoid communications and aviation alignments, take advantage of the local wind resource, and maintain separation between wind turbines along the direction of the prevailing winds.

Once the wind farm is commissioned, the land within the development envelope will remain working grazing land throughout the lifetime of the wind farm with little disturbance to stock operations (with the possible exception of protection of ecologically sensitive areas as native vegetation offsets). Existing wind farm sites are safely farmed with stock grazing right up to the turbine bases. The minimum separation distance between turbine locations is approximately 200m.

Preconstruction detailed geotechnical and environmental studies may merit slight alterations to the nominated positions and Lakeland Wind Farm requests that it be permitted to move turbines up to 100m from the nominated positions as part of this micro-siting.

[1] Note that the design in Figure A-2 was current in July 2017. Subsequent updates to the infrastructure footprint have been undertaken. The most up-to-date footprint has been provided with the referral as a .kml file.

TABLE A-2: PROPOSED TURBINE LOCATIONS FOR THE LAKELAND PROJECT

Turbine ID	Latitude	Longitude	Eastings (m)[2]	Northings (m)[1]
1	-15.7932	144.8063	265005	8252715
2	-15.7946	144.8045	264817	8252557
3	-15.7983	144.8049	264861	8252148
4	-15.8003	144.804	264766	8251921
5	-15.8019	144.8021	264565	8251746
6	-15.803	144.7993	264266	8251620
7	-15.8045	144.7977	264099	8251452
8	-15.8063	144.7968	264001	8251257
9	-15.8088	144.7965	263974	8250972
10	-15.8109	144.7963	263948	8250743
11	-15.8133	144.7958	263903	8250478
12	-15.8159	144.7957	263891	8250192
13	-15.8183	144.7961	263937	8249925
14	-15.8205	144.7962	263948	8249680
15	-15.822	144.7946	263784	8249512
16	-15.8231	144.7911	263405	8249388
17	-15.8248	144.7896	263249	8249196
18	-15.8049	144.8219	266684	8251435
19	-15.8064	144.8201	266496	8251266
20	-15.8083	144.8185	266326	8251052
21	-15.8097	144.8169	266153	8250895
22	-15.8113	144.8155	266013	8250726
23	-15.8133	144.815	265954	8250503
24	-15.815	144.8138	265833	8250306
25	-15.8171	144.8129	265738	8250078
26	-15.8191	144.8113	265570	8249859
27	-15.8207	144.8101	265443	8249672
28	-15.831	144.804	264806	8248532
29	-15.8325	144.8024	264629	8248355
30	-15.8342	144.8009	264476	8248174
31	-15.8367	144.8006	264441	8247898
32	-15.8385	144.7991	264285	8247698
33	-15.8403	144.7979	264162	8247491
34	-15.8413	144.796	263958	8247376
35	-15.8426	144.7945	263801	8247239

[2] *Projection is WGS84 UTM Zone 55(S)

A.4 MAP OF THE PROJECT

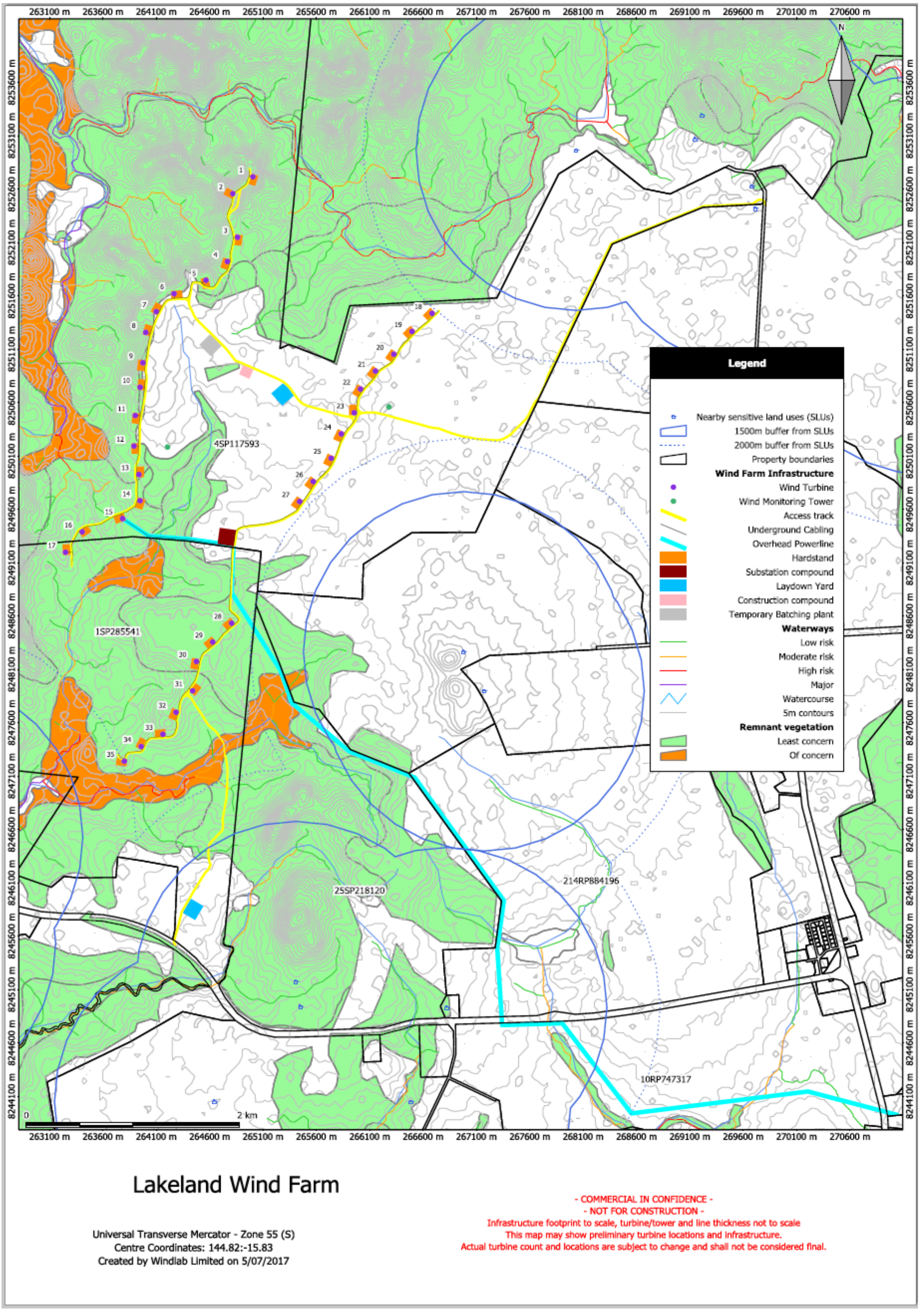


FIGURE A-2: MAP OF LAKELAND WIND FARM SHOWING ALL PERMANENT AND TEMPORARY SITE FACILITIES

A.5 ACCESS ROADS

Lakeland Wind Farm will be connected to the public road network via internal access track infrastructure. These access tracks, where possible, have been designed to avoid the removal of vegetation. Approximately 20 km of access tracks have been designed between the access points, turbines and compounds. These tracks will also provide improved access for the landowners. For maps of the access roads see Figure A-2. There is one proposed access point from the local road network; Hurse Road, and one from the state-controlled network, Peninsula Developmental Road.

A requirement for crane and truck access results in the roads being designed at 10m wide, having a load bearing capacity of approximately 25T/m^2. It is anticipated that the soil and rock that is removed will be stored on-site at convenient locations for re-use within the development area.

As much as possible materials will be sourced locally and processed to provide the necessary grade material for the access track construction. Subject to further design, there is a possibility that some steep sections that exceed 12-15% gradient may require to be sealed to increase the traction capability and allow for the safe delivery of equipment to the upper ridges.

Appropriate drainage infrastructure in the way of swales, culverts, and stormwater retention systems will be incorporated into the road network to mitigate any potential impact on local overground waterways. Incorporating a culvert crossing at the overflow intersection and a swale channel at the area of flooding will mitigate any adverse impact of the access road on overground waterways. See below.

Access road construction is likely to take approximately 2 months to complete and will occur in advance of turbine component delivery to site.

FIGURE A-3: IMAGES OF TYPICAL ACCESS ROAD DRAINAGE. LEFT: ROAD SIDE DITCH WITH SIMPLE DETENTION FACILITIES. RIGHT: CONCRETE CULVERT WITH SUPPORT STRUCTURE

A.5.1 CROSSINGS

The proposed access tracks will cross a small number of waterways. These crossings will be constructed at bed-level, and be carried out in accordance with the applicable Department of Agriculture, Fisheries and Forestry requirements, including the Code for self-assessable development - Minor waterway barrier works - Part 4: bed level crossings. This will ensure that fish are able to continue to move along the waterways.

A.6 CRANE HARDSTANDS

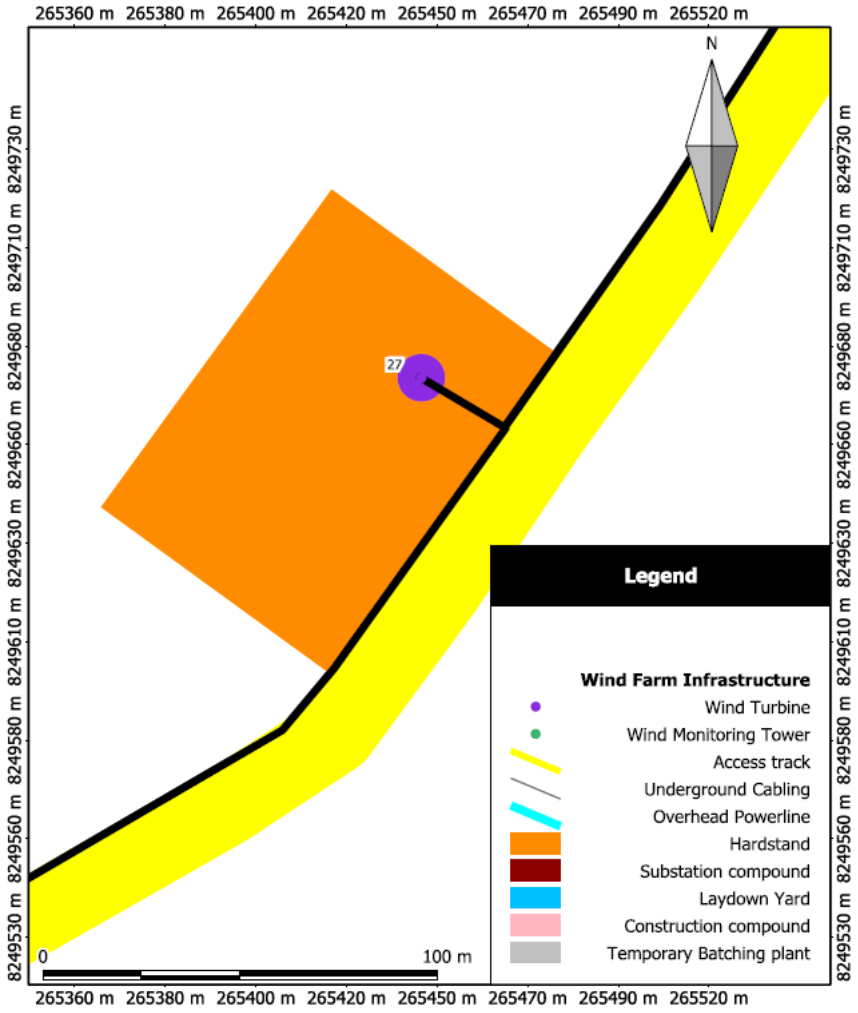
Each wind turbine location will require a crane hardstand. For the Lakeland Wind Farm, the footprints of the hardstands will be, at a maximum, 100m by 70m. This includes a temporary

storage area as well all required fire and safety buffers. See Figure A-4 for a scaled map of the hardstand at a typical turbine location.

The hardstand will be surfaced with appropriate material to meet the load bearing specifications of at least 25T/m².

All turbines require a temporary storage area near the hardstand. This is required to lay out the turbine components and must be flat and compacted to withstand the same loads as the hardstand.

Hardstands are generally retained throughout the operational life of the wind farm and used principally for the periodic maintenance of the wind turbines. These will have the footprint shown in Figure A-3.



Typical Hardstand

Universal Transverse Mercator - Zone 55 (S)
Centre Coordinates: 144.81:-15.82
Created by Windlab Limited on 13/07/2017

- NOT FOR CONSTRUCTION -
Infrastructure footprint to scale, turbine/tower and line thickness not to scale
This map may show preliminary turbine locations and infrastructure.

FIGURE A-4: LAYOUT OF A TYPICAL TURBINE AND HARDSTAND (WTG #27)

A.7 TURBINE ERECTION

Prior to erection, the turbine components will be delivered to the site on flat bed semi-trailers and stored in temporary storage area next to the turbine hardstand area, see Figure A-4.

Two cranes are used to install turbines; a small tailing crane and a larger crawler crane. The crawler crane is used to lift and position the turbine components and the tailing crane is used to stabilize the components. Once the tower base section is positioned and anchored, the subsequent tower sections are secured, followed by the nacelle. The blades can be erected in two ways: the hub is fastened to the nacelle and then one blade at a time is secured to the hub, or the blades and hub are assembled and secured on the ground and lifted as one complete rotor unit and then fixed to the nacelle.

Tower erection usually takes two to three days per turbine, however this is weather dependent.

A.8 ON-SITE LAY DOWN AND CONCRETE BATCHING

There are two designated lay down areas onsite, shown in Figure A-2, one near each of the proposed site entrances. These may be used for material stockpiles (concrete, sand and aggregate), temporary storage of turbine components, some onsite assembly and fabrication, vehicle parking as well as safe access for delivery trucks. The footprint of the lay down areas will be no greater than 150m by 150m.

During the construction a temporary concrete batching plant may be erected on the site compound to supply concrete primarily for the turbine foundations. If onsite batching is not used, then local batching may be used and the concrete transported to site.

Each turbine requires several hundred tonnes of concrete in the foundation. Any stockpiles of material will be appropriately managed including the construction of sedimentation basins, silt fences, dust suppression and appropriate siting to mitigate any risk of contamination of local waterways.

A.9 TURBINE FOUNDATIONS

There are several different types of turbine foundations and depending on detailed geotechnical studies the turbine manufacturer determines the most appropriate foundation for a particular site. Common foundation types are gravity based (slab foundations), and rock-anchor. Gravity foundations rely on the soil and concrete base to provide sufficient weight to stabilise the turbine (Figure A-5). This type is most common as it is applicable in a broad range of sub-grade strengths from soils to rock.

Rock anchor foundations are typically required at sites where strong bedrock is at shallow depth (see Figure A-6). The foundation applies the pressure to the bed rock and reinforcement steel through boreholes into the rock act as anchors. It is likely that rock-breaking will be required to achieve a solid bedrock surface.

It is expected that gravity based foundations will be used at Lakeland, which will be confirmed after detailed geotechnical testing.

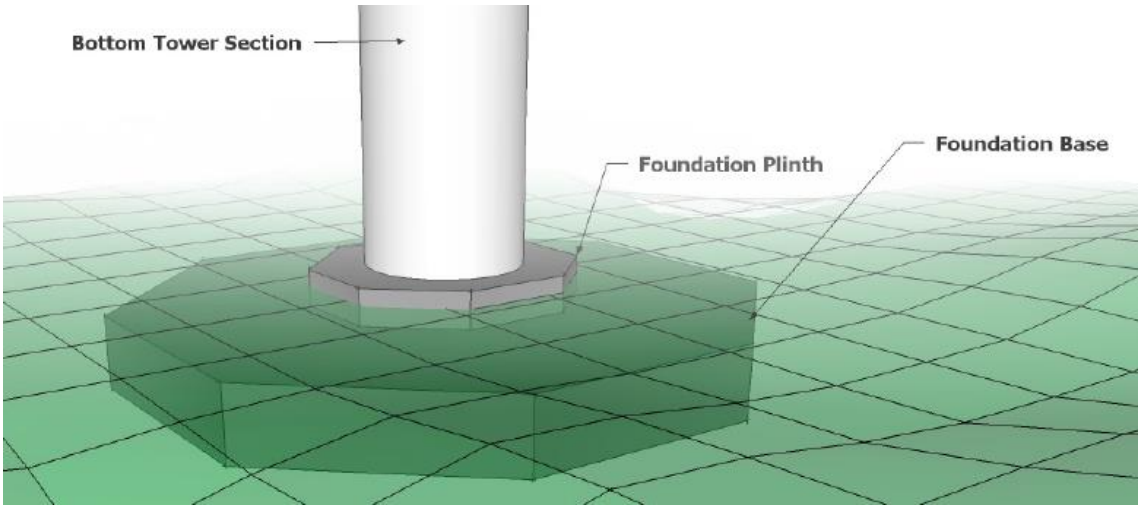


FIGURE A-5: TYPICAL GRAVITY FOUNDATION

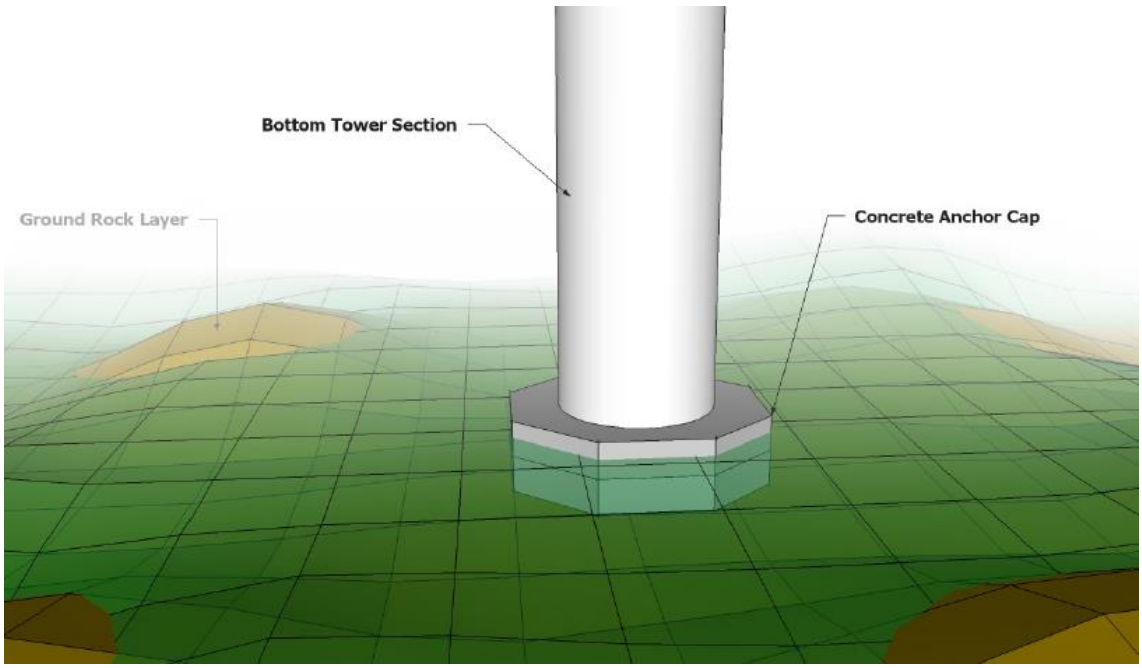


FIGURE A-6: TYPICAL ROCK AND ANCHOR FOUNDATION

A.10 TEMPORARY CONSTRUCTION COMPOUND

During construction there will be a number of demountable cabins with any required technical equipment as well as providing staff with refreshments and kitchenette facilities. There will also be a portable toilet and water facilities provided for the construction staff.

A.11 OTHER PERMANENT SITE FACILITIES

A maintenance facility will be commissioned on site, and remain for the duration of the project. This will be located on the substation compound footprint. The objective of this facility is to act as the central control with the following components:

- Car parking for staff vehicles;
- Site office and control room;
- Amenities, including bathroom and kitchen facilities;
- Substation;
- Warehouse to accommodate spare turbine parts and maintenance equipment; and
- Outside storage area.

The operation hours of the site will be during business hours, Monday to Friday. However, 24hr access will be available in case of emergency maintenance. The total floorspace of the buildings will be less than 1,000m^2. The footprint of the site compound will be, at a maximum, 150m by 150m, including any required fire and safety buffers and erosion and stormwater control works.

A.12MONITORING MASTS

Currently there is one 120m monitoring mast on site that has been monitoring the wind conditions since May 2017 after approval by the Cook Shire Council. It is also planned to seek approval for the Cook Shire Council for an additional 120m monitoring mast to improve the understanding of the onsite wind resource before construction of the wind farm goes ahead.

This development application for the wind farm includes up to 4 additional monitoring towers to allow verification of the performance of the wind turbines. These monitoring towers will have the same height as the wind turbine hubs, which is up to 160m. One of the monitoring towers will be placed at one of the locations in Figure A-2. In addition, a wind monitoring tower would be placed at one or more of turbine positions 11, 12 and 13. These will be erected up to 6 months before construction of the wind farm commences. The monitoring towers at the turbine positions will be dismantled shortly before installation of the wind turbines, with the other tower being kept permanently to enable ongoing monitoring of the wind farm performance. If the monitoring towers are over 150m in height, they will be lit until the wind turbines are erected to the same or greater height.

A.13 DETAILED ELECTRICAL PLAN

A.13.1 UNDERGROUND RETICULATION

The proposed reticulation network is shown in Figure A-2.

The wind turbines will be connected by strings of underground cabling. The collection strings will connect to the wind farm substation, through s step-up transformer and into the national electricity grid. The desired connection will be into the existing 132kV feeder bay at the existing Lakeland Substation, owned and operated by Ergon.

The underground cabling will be bedded in sand in a trench, which for the most part will run alongside the access tracks to minimise the amount of disturbed vegetation during construction, see Figure A-7**.**

When excavating the trenches, all top soils and sub soils will be reserved for back filling the trench after installation, ensuring the two stratifications are not mixed. The cables are installed by either hand or machines that carry the cable reels and slowly offer the cable which is directed into the trench. The total length of the underground collection is expected to be 10km. Some rock breaking may be required to form cable trenches.

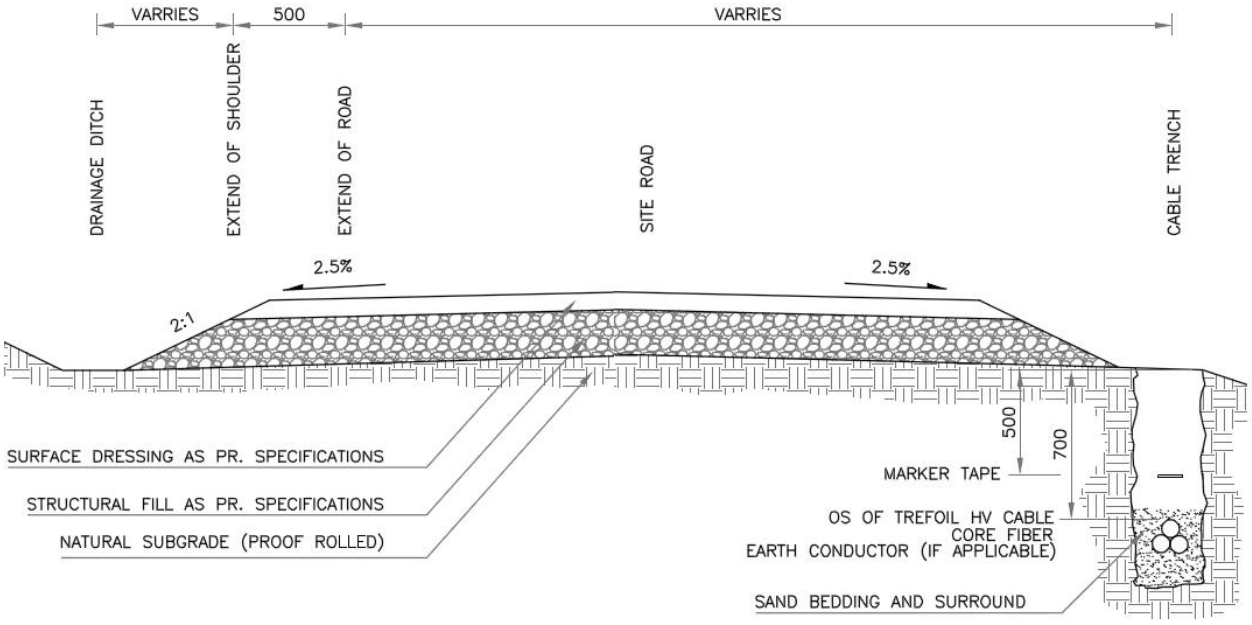


FIGURE A-7: ENGINEERING DRAWING OF A SITE ACCESS ROAD WITH CABLE TRENCH ALONGSIDE. THE RETICULATION FOR LAKELAND WIND FARM IS EXPECTED TO BE SIMILAR TO THIS CONFIGURATION

A.13.2 SITE SUBSTATION

The underground cabling will meet up at a substation located on the site compound. Although the final layout of this substation is not yet confirmed it is expected to consist of:

- 132/33kV Transformer,
- Control building,
- Circuit breakers,
- Voltage transformers,
- Current transformers,
- Isolators,
- Earthing systems including an earth grid,
- Communications equipment,
- Backup Generator,
- Auxillary transformer for Electricity Supply,
- Communications pole,
- Any other equipment reasonably required for the safe operation of a substation or agreed through discussion with the network operator, Ergon.

This proposed substation is shown in Figure A-9.

A.13.3 OVERHEAD RETICULATION

In order to connect the site substation to the proposed connection point at the existing Lakeland substation it will be necessary to install approximately 10km of 132kV overhead powerlines. These will be of monopole construction similar to the sub-transmission network owned and operated by Ergon throughout regional Queensland, including running south from the Lakeland substation, as pictured in Figure A-8. These powerpoles are typically 23m tall and spaced 200-300m apart, so the total number of poles is expected to be approximately 40-50. The powerline will cross over the top of existing Ergon distribution lines as well state-controlled road corridors, with the crossings to be designed according to the relevant standards as determined in consultation with Ergon and TMR. In addition a small section of the reticulation connecting the western row of wind turbines to the site substation may be placed overhead to minimise disturbance to the watercourse.

FIGURE A-8: ERGON 132KV POWERLINE SOUTH OF LAKELAND

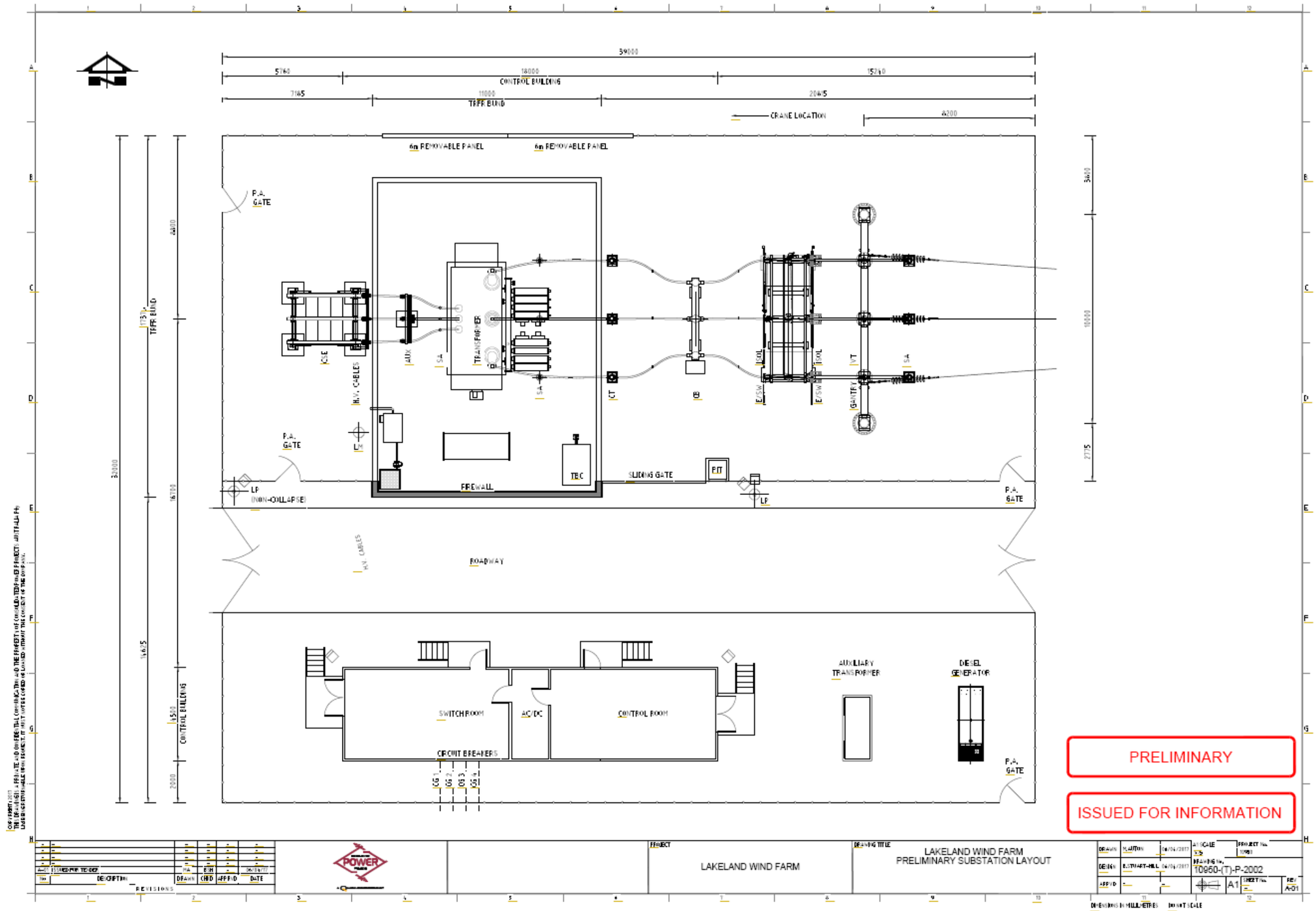


FIGURE A-9: LAKELAND WIND FARM SUBSTATION SCHEMATIC

A.14 CONSTRUCTION AND OPERATIONAL PHASES

Construction of the wind farm is expected to take place during 2018. Removal of temporary facilities including monitoring towers, batching plant and construction compound, as well rehabilitation of construction areas, will take place progressively during the construction period depending on when each facility/area is no longer required. Full operation of the wind farm is expected to commence in 2019 with an operational period of up to 30 years, or longer with refurbishment.

A.15 VEGETATION CLEARING (OPERATIONAL WORKS)

Construction and operation of the wind farm will require clearing of vegetation. The vegetation to be cleared is mapped as Category B areas, most of which are least concern regional ecosystems and a small minority of which contain of concern regional ecosystems. Clearing will occur within two watercourses.

A.15.1 DESCRIPTION OF THE CLEARING

A.15.1.1 Wind Turbines

Each wind turbine and associated hard-standing will require clearing of up to 70m x 100m. Up to 25 of these will be located within Category B areas that are least concern regional ecosystems. None of these will impact on areas that contain of concern regional ecosystems or watercourses. The area of 70m x 100m is a conservative estimate including required sediment, erosion and stormwater management works and fire safety buffers.

A.15.1.2 Access Tracks

Approximately 10km of access tracks will require clearing of from 10m up to 20m width. Approximately 200m of this will be within Category B areas that contain of concern regional ecosystems, including one watercourse, with the remainder of the clearing within Category B areas that are least concern regional ecosystems. The width of 20m is a conservative estimate including required sediment, erosion and stormwater management works and fire safety buffers, as well as allowance for underground cabling, which will generally be placed beside access tracks to minimise vegetation clearing.

A.15.1.3 Transmission

Approximately 3km of transmission will require clearing of a 40m corridor. Approximately 100m of this will be within Category B areas that contain of concern regional ecosystems, with the remainder of the clearing within Category B areas that are least concern regional ecosystems, including one watercourse. The width of 40m allows for 20m fire and safety buffers either side of the centreline of the transmission.

A.15.1.4 Overall

The total area of clearing within Category B areas is approximately 45ha, including approximately 0.4ha of areas of concern regional ecosystems, and two watercourses.

A.15.2 WHY THE CLEARING IS NECESSARY

The clearing is necessary to allow for the construction and safe construction of the wind farm and association infrastructure.

A.15.2.1 Wind Turbines

The placement of turbines within areas of remnant vegetation is necessary as the maximum number of wind turbines have been placed within Category X areas. Wind turbines have been placed within Category X areas where possible however in order to maintain necessary separation distances between wind turbines and neighbouring dwellings, aviation paths, microwave communication links between Lakeland and Cooktown, and other wind turbines along the direction of the prevailing winds, it is not possible to site additional turbines in Category X areas.

A.15.2.2 Access Tracks

It is necessary to build access tracks through remnant vegetation to access the wind turbines locations and to access the site from the Peninsula Development Road. Access to the site from Hurse Road may not be possible for over-dimensional loads such as wind turbine blades.

A.15.2.3 Transmission

It is necessary to build a transmission line to connect the generators to Ergon's existing Lakeland substation. This transmission line must traverse Lot 25 on Survey Plan 218120 and Lot 1 on Survey Plan 285541, neither of which is possible without traversing Category B areas, and connect to turbines in Category B areas on Lot 4 on Survey Plan 117593, which also requires traversing Category B areas. The 40m width is necessary to maintain the necessary fire and safety buffers when operating transmission at 132kV.

A.15.3 AVOIDANCE AND MINIMISATION

The wind farm has been designed to avoid and minimise the clearing of remnant vegetation, in particular areas containing of concern regional ecosystems and watercourses.

A.15.3.1 Wind Turbines

Up to 10 of the wind turbines and hard standings will be located within Category X areas, avoiding the need to clear approximately 7ha of remnant vegetation. All wind turbines will be located away from areas containing of concern regional ecosystems and watercourses, minimising the impact of vegetation clearing.

A.15.3.2 Access Tracks

Approximately 10km of access tracks will be located within Category X areas, avoiding the need to clear approximately 20ha of remnant vegetation. Access tracks will be aligned to minimise impacts on areas containing of concern regional ecosystems and watercourses, and to follow existing access tracks where practical, with upgrades to allow for the access of over-dimensional and heavy vehicles, minimising the impact of vegetation clearing. Underground cabling will generally be placed parallel to access tracks within the 20m width, avoiding the need for additional clearing.

Width of clearance corridors within the "of concern regional ecosystem" and within defined watercourses will be minimised to the extent practicable for road construction (nominally 10m).

A.15.3.3 Transmission

The transmission route will be aligned to avoid remnant vegetation where practical, with approximately 7km located within Category X areas, avoiding approximately 28ha of clearing. The transmission will be aligned to minimise impacts on areas containing of concern regional ecosystems and watercourses, and follow existing fence-lines where practical, minimising the impact of vegetation clearing. Areas containing of concern regional ecosystems and watercourses

will be spanned over where possible, restricting the vegetation requiring clearing to tall-growing species.

A.15.3.4 Other

Other infrastructure associated with the development, including the substation compound, control, office and storage buildings, laydown areas, temporary concrete batching plant and construction compound will all be located in category X areas. This will avoid the need to clear approximately 10 ha of remnant vegetation.