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Clarke Creek Wind Farm
Clarke Creek Energy Pty Ltd
22-Nov-2017

Construction Management Plan

Clarke Creek Wind Farm

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Clarke Creek Wind Farm

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1.0 Introduction

This Construction Management Plan has been developed for the Clarke Creek Wind Farm (the Project) in accordance with the *State Code 23: Wind farm development – Planning guideline*. The Construction Management Plan forms part of the supporting information to obtain planning approval for the construction of a 195 turbine wind farm at Clarke Creek, Queensland.

The purpose of the Construction Management Plan is to outline:

- What key activities are likely to occur during the construction of the Project
- What equipment is likely to be required
- The potential impacts that may occur as a result of these activities and how these impacts will be mitigated
- How to measure the performance of the Project during construction and operation.

2.0 Project description

2.1 Location

The Project is located approximately 150 km north-west of Rockhampton and is situated approximately:

- 150 km south-west of Mackay
- 74 km east of Middlemount
- 30 km west of Ogmore.

The Project is located within the LGAs of Isaac Regional Council and Livingstone Shire Council and is bounded to the east by the Bruce Highway (A1) and to the west by the Marlborough Sarina Road. The southern end of the Project is bisected by Marlborough-Sarina Road.

The closest townships to the Project are Ogmore and Marlborough approximately 30 km to the east and St Lawrence approximately 30 km north-east. Other small settlements are located throughout the region within the localities of Lotus Creek, Clarke Creek, Ogmore and Mount Gardiner which are intersected by the Project area.

The largest nearby towns include Rockhampton to the south-east and Mackay to the north-east. Dominant industries in both these areas include agriculture, tourism, resources and military, with members of the Australian Defence Force based at the Western Street Army Barracks located near the Rockhampton Airport.

Approximately 6 km east of the Project area is the Mount Buffalo State Forest. Other significant reserves in proximity to the Project include Glencoe State Forest, 16 km north-east and Junee State Forest 25 km to the west.

The Project construction footprint represents approximately 2.4 % of the total Project Area. The construction footprint will occupy an area of approximately 1,792 ha, and the operational footprint of the Project will occupy a much lesser area of only 828 ha. Land occupied by temporary infrastructure following the construction will continue to be used for rural and agricultural purposes.

2.2 Wind turbines

The power output from an operational wind farm largely depends on the strength of the wind blowing across the site at the time. During the operation of the Project, the turbines will automatically start, stop and alter their output as determined by wind speed and other environmental and electrical conditions.

Usually, wind turbines start to generate electricity at a wind speed of between 3 metres per second

(m/s) and 5 m/s, and the output increases up to their maximum rated power at a wind speed which varies significantly between the various turbine models. The wind turbines will also have a wind speed at which they automatically shut-down. This also varies amongst the different turbine models available.

The final selection of turbine technology will be determined as part of the detailed design following approval of the Project. However, the Project has been designed to accommodate the following turbine dimensions so any potential impacts of the Project on environmental values can be adequately considered.

The Project will accommodate turbines each with approximately 4.5 MW in capacity, however this may increase or decrease as further models are developed, between now and construction.

The turbines will be of the horizontal axis type, with a rotor consisting of three blades with a maximum blade length of up to 90 m and a maximum hub height of up to 150 m. The maximum height of the turbine to blade tip is up to 220 m. Blade length chosen and wind turbine hub height will be configured so that the tip height does not exceed 220 m. These maximum specifications are summarised in Table 1.

Table 1 Key generation and turbine specifications

Feature	Statistic
Number of turbines	Up to 195
Tip height**	Up to 220 m
Blade length**	Up to 90 m
Hub height	Up to 150 m

*The actual output of the wind farm will depend on the number, size and type of turbine chosen during the detailed design phase. Regardless of the size of the wind farm generation capacity, the Project will still need to comply with the Queensland Wind Farm State Code and supporting Planning Guidelines, particularly in relation to acoustic amenity and setback criteria. The maximum specifications listed in the table provide flexibility for any innovation in turbine design between now and the time of detailed design and construction.

**Dimensions and outputs are approximate to allow for innovation in turbine design prior to construction. Final dimensions will be confirmed during the detailed design phase of the Project.

Each turbine may have a transformer located in the base of the tower or in a kiosk adjacent to the turbine. Power and communication cables will be installed underground between the turbines and connect back to the substation, also connecting to medium voltage (33kV or 22kV) overhead powerlines and Site Offices. Wind turbines will be linked together in strings of around eight turbines connected to the same power cable and medium voltage line.

The turbines will be coloured light grey or white with a semi-matt finish to reduce their contrast with the background sky and minimise reflections. The turbines will be uniform in colour and will not contain any prominent company logos.

The maximum turbine tip height and blade length, listed in Table 1 above, is based on estimated wind turbine dimensions to allow for future flexibility and innovation in wind turbine design and development. Generally, larger turbine models on higher towers will more efficiently harness the available wind resource. Furthermore, larger wind turbines are generally installed in lower numbers, thereby reducing the on-ground impacts for a given level of energy generation.

Different areas of the Project site may have different wind speeds and turbulence intensity, which means different turbine models are more suitable in different locations. If this is the case, wind turbines installed may not be uniform in final dimensions, although they would all be the same colour meet the dimensions outlined in Table 6. In addition if the Project is built in stages over several years, turbine model availability may change, which may mean wind turbines installed may not be uniform in final dimensions, although they would all be the same colour meet the dimensions outlined in Table 6.

The final choice of turbine will be based on an assessment of the most suitable turbine available at the time of procurement taking the following criteria into account:

- Ability of the turbine to maximise power output based on the wind resource at the Project
- Availability of the turbine will also affect the final choice of turbines
- Turbine which provides the optimal financial outcome for the Project.

One of the key selection criteria for final turbine choice will be the ability to satisfy the environmental constraints and approval conditions. For example, the chosen turbine must achieve the noise criteria outlined in the State Code 23 and not exceed any of the maximum design specifications.

Each turbine foundation is located adjacent to a Hardstanding and will comprise a buried reinforced concrete footing of approximately 600 m^3. Turbine foundations may vary in size depending on imposed loadings, ground conditions, construction methodology and the drainage design. Each turbine manufacturer has individual foundation requirements which will need to be adhered to.

The detailed design of the foundations will be undertaken following approval of the Project and following the final selection of turbine model to be installed at the Project. The final design will also take account of the geotechnical conditions identified through detailed, micro-siting site investigation.

Any of the excavated material to locate the foundation will be stockpiled and reused to cover the foundation. It is envisaged that any surplus material will be reused on site.

2.3 Hardstandings

A hardstanding is a widening of the road to create trafficable access for construction vehicles, plant and machinery. Turbine locations will require an area of gravel capped hardstand adjacent to each turbine foundation, (approximately 100 m by 50 m, depending on turbine type). These hardstand areas are intended to provide a stable base on which to place turbine components ready for assembly and erection, and to locate the crane necessary to lift the turbine components into place. In addition to this some hardstanding area will be used for rock crushing purposes, stockpiling of material and temporary laydown areas.

Due to the undulating topography requiring batters from the hardstand to the natural ground level and space required to layout the blades, further vegetation than 100m by 50m is required to be removed. At various hardstand locations, the hardstand area will also be used for temporary rock crushing purposes, stockpiling of material and temporary laydown area.

The total clearing per turbine hardstanding will vary across the 195 turbines but be on average 1 Hectare, depending on the extent of vegetation at each location and the topography. If the three blades are joined on the ground to form the rotor, Clearing an area to accommodate each blade lengths will be done to allow construction.

These areas will be left in place following construction to allow for the use of similar plant should major components need replacing during the life of the Project, and for use during decommissioning at the end of the operational period.

2.4 Electrical connections, substations and grid connection

The electricity generated by harnessing the wind's energy must go through a transformer kiosk adjacent to each turbine (or a transfer located in the base of the turbine) in order increase its voltage and efficiently transfer it to the substations. The wind turbines will be connected in 'strings' of approximately eight turbines via a combination of medium voltage (22kV or 33kV) underground cable and overhead lines and in turn, to the main transformers located in the substations.

Power and communication cables are installed underground or overhead between the turbines and connect back to the Substation and Site Offices.

The underground power and communication cables will be laid in cable trenches of approximately 0.5 m to 1.5 m in width and a minimum fill of 500 mm to allow for continued agricultural activities. The route of the underground cables is typically adjacent to the roads, with no additional clearing of Regulated Vegetation required beyond that proposed for the road corridor, In cleared land the cables may be located away from the road.

All of the cable trenches will be located. The total length of cable trenches required will be dependent on the final layout of the substations, turbines, medium voltage overhead powerlines and site offices. Once the trenched areas have been backfilled, the disturbed area will be reinstated to promote the establishment of vegetation.

In addition to the underground cabling, there is approximately 120 km of medium voltage (33kV or 22 kV) overhead powerlines. Medium Voltage powerlines would be attached to structures up to 15 m high. The majority of these will be located in proximity to the proposed roads to avoid additional clearing requirements; however 23 km will be located outside of the proposed road corridors and 21 km of these are in regulated vegetation. Up to 20 m of clearing is required to install and maintain the line, a 4 m wide track is required to access each structure, and proposed tracks may travel underneath the powerline where required.. This access track would typically be unsealed and have no gravel cap. 19 km of high voltage (275 kV) overhead powerlines are also proposed. These are required for transferring electricity between substations or to Powerlink infrastructure. The line is proposed to have a 4 m wide track to access each structure. This access track would typically be unsealed and have no gravel cap.

All high voltage powerlines will be of sufficient height, approximately 63 m, to safely carry the designed voltage and allow for site vehicles to pass beneath.

Four substation options are being considered for the Project, two options for the north of the Project and two for the south. The final size and design of the Project, as well as electrical network considerations, will determine which substations will be built. It is anticipated that one substation will be built in the north and one built in the south, however there could be up to four areas developed.

The electrical configurations that are being considered for the substations in the northern section of the project are:

1. Option 1: all wind turbine strings in the northern section linking via cable and medium voltage overhead line to the wind farm substation in the centre, which is then connected with a high voltage (275kV) overhead transmission line linking this substation back to the existing 275kV line at one of the locations shown; or
2. Option 2: all wind turbine strings in the northern section linking via cable and medium voltage overhead line back to the wind farm substation located on the high voltage (275kV) transmission line at the location shown.

The electrical configurations that are being considered for the substations in the southern section of the project are:

1. Option 3: all wind turbine strings in the southern section linking via cable and medium voltage overhead line back to the wind farm substation on the 275kV transmission line; or
2. Option 4: all the wind turbine strings in the southern section linking via cable and medium voltage overhead line back to the wind farm substation adjacent to the existing Broadsound Substation.

Each proposed substation area is approximately 4.5 ha, and may contain offices, workshops, switchyard and switch-room, a step up transformer, high voltage equipment and an energy storage facility.

2.5 Site Offices and Workshop

Permanent Site Offices, Workshops and Warehouse are to be located at two locations on the Project site. These areas typically contain vehicle parking spaces, septic ablutions and wash down areas as appropriate. The footprint of the Site Offices Workshops is around 5 hectares at each location.

In addition there is provision for a small office, lunch room and amenities and ablutions elsewhere on the project area each around 50m by 50m . These could be established on a small portion of a construction compound, towards the end of construction period. One area would be in the North and the other would be in the south.

The Project site does not currently have access to the Isaac Regional Council reticulated water and sewerage network. Once operational, the Project is expected to utilise water tanks and an on-site septic system will be installed to comply with the Building Code of Australia and will be positioned adjacent to the operations and maintenance compound.

The footprint of the substation has been designed to accommodate the addition of energy storage. Substation Options 1,3 and 4 have areas suitable for around 100MW of storage each based on current technology. Option 2, which is located in cleared land and has been enlarged has capacity for over 300MW of storage.

2.6 Wind monitoring towers

2.6.1 Permanent wind monitoring tower

Locations for up to 13 permanent wind monitoring towers at the Project have been assessed primarily in order to establish measurement of the free stream wind from all directions, and where possible to meet the criteria in the International Electrotechnical Commission (IEC) 61400-12-1 for power performance testing.

These towers will be powered and contain measurement instruments and telecommunication equipment. These requirements include restrictions on the distance between mast and turbine, complexity of the terrain around the test site and the influence of obstacles and other turbines on the wind. The towers will be either free standing or guyed lattice structures with total concrete footings (30 m^2) at mast base and anchor points. The tower will reach up to the hub height of the wind turbines which is up to 150m.

Full engineering design and certification will be carried out during detailed design once the turbine type and layout of the wind farm has been confirmed. The Material Change of Use Proposal Plans provides an indicative position for meteorological masts for the Project. However, the final number and position of the wind monitoring towers will be determined during the detailed design phase of the Project. The total disturbance required is up to 1 ha for each guyed wind monitoring tower.

2.6.2 Temporary wind monitoring tower

Locations for up to 13 temporary wind monitoring towers on the sites of future wind turbines are proposed. These locations will be in close proximity to the site of the permanent wind monitoring towers. These towers will be powered and contain measurement instruments and telecommunication equipment. After a period of concurrent wind speed and direction monitoring during the construction period, the temporary wind monitoring towers are removed and the permanent wind turbine constructed. The weather data from both the temporary and the permanent wind monitoring towers will
then have a record of the wind before and after the wind turbine is installed to allow effective measurement of the performance of the turbines.

The temporary wind monitoring towers will be either free standing or guyed lattice structures reaching the hub height of the wind turbines of up to 150 m. The Material Change of Use Proposal Plans provides an indicative position for meteorological masts for the Project. However, the final number and position of the meteorological masts will be determined during the detailed design phase of the Project. No additional disturbance or clearing is required for this infrastructure as the infrastructure will be wholly located within the disturbance area of the wind turbine hardstanding areas.

2.7 Transport Routes

The four principal elements to be transported via the road network are the workforce, construction materials, construction equipment and wind turbine components.

A full assessment of the traffic and transport routes and potential impacts is provided in the Transport Assessment and Route Analysis attached in Appendix I.

2.7.1 Public access

The Project is intersected by several registered public access roads, including Marlborough Sarina Road and Tartrus Road, and private dwelling access roads. All public access roads will remain open during construction; however public access to construction areas will not be permitted.

Appropriate signage will be provided during the construction period for health and safety reasons.

2.7.2 Site Access

Based on the assumed transport corridors outlined in in the Traffic Assessment and Route Analysis (refer to Appendix I), access to the Project will be provided along Marlborough-Sarina Road and Tartrus Road. Four permanent site entrances are planned for Project access, one on Tartrus Road

and three on Marlborough-Sarina Road. These will be used during construction and operation of the Project and will be where the majority of all loads would access.

Moreover, in view of the spread of the Project, it is anticipated that some temporary access roads will be required. Up to six temporary site entrances are proposed that would be used to access the temporary accommodation site camp and to transport oversized loads, such as turbines components, crane and 275kV transformers off the State Highway onto specific areas of the Project site.

Access via these temporary site entrances, where there are not 300m sight lines, would be using traffic management such as signals or Stop-Slow signs. At all other times post construction these entrances would be gated and locked.

New fencing alignments, together with grids and gates will also be installed on site. The clearing requirements for this infrastructure are accounted for in the areas proposed to be cleared as part of the road and access areas, no additional clearing is required.

2.7.3 Access Roads

The onsite access road layout will be designed to utilise the existing topography of the land, avoiding steep areas where possible and minimising the amount of land required. It is likely that approximately 257 km of gravel capped roads will be required.

The following design criteria and mitigation measures will be applied to the access road layout to mitigate potential impacts:

- The access roads running width will typically be about 6 m wide, and would be expanded on bends to accommodate crane and delivery vehicle requirements
- Regular passing bays and turning areas
- Roads will be not sealed and constructed from locally sourced aggregate
- The number of water course crossings will be minimised
- Drainage channels 1 m in width (and/or appropriate drainage controls) will be located either side of the roads
- Road margins will be vegetated to reduce potential sediment-laden run-off.

The construction of access roads will vary depending on localised ground conditions. Conditions impacting construction include the existing vegetation, nature of the topsoil, level of moisture in the ground, geotechnical base and localised topography.

The clearing required to build roads comes from the need to cut and fill on gradients, create 2:1 batters and the road construction front requiring vehicles to access and egress in a circular motion to build the road. On flat and low gradient terrain, the clearing required to build the road would be around 20 m in width and in contrast in the steepest most complicated area of the Project area, the batters may be extended such that the total width is up to 200 m. Any material excavated on-site would be reused in the design as much as possible (e.g. balance of cut and fill). Material of suitable quality that is excavated to be crushed on site for gravel.

Post construction, the areas cleared to create batters and corners will be rehabilitated. Roads will be maintained and need to remain passable for oversize overmass (OSOM) loads in the event of a blade replacement during operation. Therefore, no trees that could grow to become future obstructions will be planted where large oversailing blades could be transported in.

The number of water course crossings will be minimised. The exact requirement and design of the water course crossings will be agreed during the detailed design and will be based on the detailed geotechnical site investigation and through discussions with the relevant State authorities.

2.8 Laydown Areas and Stockpiles

As illustrated in the Material Change of Use Proposal Plans (Appendix C), there are nine potential locations for temporary construction laydown areas and stockpiles, detailed in Table 2 below.

Table 2 Laydown and Stockpile Disturbance Area

Shown on Figure C1 and C2 in Appendix C as:	Area of disturbance (ha)	Regulated Vegetation
A	5.9	No
B	4.0	Yes
C	23	No
D	8.7	No
E	4.0	No
F	3.6	No
G	1.9	Yes
H	7.9	No
J	2.9	Yes
Total (ha)	**61.9**	

The total footprint proposed for the temporary construction compounds during the construction period is 61.9 ha, with approximately 8.8 ha falling with regulated vegetation.

These areas will accommodate temporary storage of construction plant equipment, wind farm components and construction materials prior to moving to their ultimate destination. Concrete batching plants may be established and disassembled at several of these laydown areas as the project progresses through the construction period. The areas may also be used for rock crushing and stockpiles.

The temporary laydown and stockpile areas will be formed into hardstand. Prior to forming the hardstand area, the topsoil will be removed and stockpiled adjacent to the hardstand area. Following the completion of the construction phase, the temporary construction laydown areas may be fully reinstated depending on the landowner requirements.

2.9 Temporary Construction Compounds

Six temporary construction compounds are proposed for the Project. These areas will be used to manage construction, with three areas proposed in the northern section of the Project site, and three in the Southern section. These compounds will include; portacabins (site offices, first aid facilities, canteen facilities, waste disposal and toilets); storage containers for tools and equipment; storage areas for plant, fuel storage, material and components; wash down facilities; and sufficient parking for the workforce, deliveries and visitors. However, it is likely that temporary office / lunch rooms and ablutions may also be established on turbine hardstandings during the construction period.

Concrete batching plants will be established and disassembled at several of these compound areas as the Project progresses through the construction period.

The total footprint proposed for the temporary construction compounds during the construction period is around 29 ha.

The temporary construction compound areas will be formed into hardstand. Prior to forming the hardstand area, the topsoil will be removed and stockpiled adjacent to the hardstand area. Following the completion of the construction phase, the temporary construction compound areas may be reinstated using the stockpiled topsoil depending on the landowner requirements.

The exact locations and nature of the temporary construction laydown will be established in consultation with the relevant landowners when a full construction methodology is determined.

2.10 Worker's Accommodation

A temporary accommodation is proposed to be provided for the construction of the Project. It is estimated that the workforce required to construct the Project will peak at approximately 350 persons. The proposed camp will be able to house around 300 people and be approximately 12 ha and situated in the southern area of the Project in cleared land. The camp will be rehabilitated once the construction period is complete.

The workforce will be combination of local and regional workers, with specialists coming in from a wider area as required. It is anticipated that some of the workforce may live locally and will not require additional accommodation and that some short term worker specialists will be located in nearby hotels and other accommodation.

3.0 Sensitive Uses

The Project is located within a rural landscape with no cities or towns in close proximity. Sensitive uses of the land during construction are limited to individual properties that are considered either participating or non-participating landowners. These properties are sensitive to noise, vibration, air quality, traffic and traffic impacts during construction.

There are 21 residential dwellings within approximately 5 km of the Project.

4.0 Construction methodology

The chosen Engineering, Procurement and Construction (EPC) contractor will be responsible for the detailed construction methodology for the Project.

The following sections describe a typical construction methodology that is likely to be similar to that used for the Project.

4.1 Timing and sequencing

The Project is likely to be developed in stages and the detailed design of each stage of the Project will be completed and informed by future work on wind energy output, geotechnical investigations, ecological constraints, network capacity connection constraints, and the market for renewable energy.

The construction period for the Project will be agreed between the EPC contractor and Lacour and will be subject to change depending on the weather conditions, availability of materials and construction speeds. Subject to Project approvals, construction is anticipated to commence in 2019 and the Project will be built "Generally in Accordance" with the approved plans.

During the construction phase, works could potentially occur for six days during each week, 12 hours per day (06:30 to 18:30). Under such a scenario, materials would be transported to the Project Site for up to 24 days per month (assuming a four week month). It may be necessary for certain construction activities to take place on a Sunday or during the night time (e.g. turbine installations during favourable weather conditions). In such instances, appropriate mitigation and management measures will be incorporated into the CEMP which will contain an Out of Hours Work (OOHW) Protocol will be developed for the assessment, management and approval of works outside of the approved hours for construction.

These assumptions will be revisited and modified as necessary during detailed design.

Some early enabling works will be required between approval of the Project and commencement of construction. This will include:

- Detailed site investigations, including the establishment of roads, and clearing for the purposes of micro-siting the turbines
- Obtaining all necessary consents for construction.
- Establishing water supply, through dams and bores
- Possible offsite road works
- Installation of wind monitoring towers and establishment of roads and clearing for their installation.

For the construction of the Project, the following activities are expected to occur:

- Site establishment (temporary site facilities, lay down areas, equipment and materials)
- Earthworks, paving (with gravel cap) and drainage for access roads and wind turbine hardstands
- Excavation for the foundations
- Construction of wind turbine foundations (bolt cage, reinforcement and concrete)
- Installation of electrical and communications cabling and equipment (including overhead lines and underground cables to the substation)
- Installation of wind turbine transformers, in parallel with electrical reticulation works
- Installation of towers for the wind turbines, delivery of the wind turbine components to the Project Site
- Installation of wind turbines, using large mobile cranes
- Commissioning and reliability testing of wind turbines
- Progressive rehabilitation and restoration of the Project Site where possible.

The activities listed above will predominately occur in the order listed, however some of these activities will be carried out concurrently to minimise the overall length of the construction programme.

4.2 Construction Activities and equipment

It is anticipated that the construction work may include excavation, rock hammering, drilling, bulldozing, crushing and screening, concrete batching and, subject to geotechnical conditions, possible blasting.

Noise will be generated by mobile plant such as excavators, bulldozers, mobile cranes and the movement of heavy vehicles. It is expected that the following typical equipment will be used: • Site mobilisation – road loaders, graders, backhoes, trucks, small crane and generators

- Access roads and hardstands – road loaders, bulldozers, excavators, graders, scrapers, rollers, articulated dump trucks, belly dumper trucks rock crushing plant, semi-trailers, tractors water carts and hydroseed trucks
- Wind turbines – excavators, concrete trucks. rock breaker, concrete trucks, flat-bed trucks, vacuum trucks, large crawler/all-terrain heavy lift cranes, medium crawler cranes, small crawler cranes, generators, tele-handlers, elevated work platforms
- Electrical reticulation works – trenchers, backhoes, excavators, graders, tractors, cable laying machines, and small terrain cranes
- Concrete batching plants -

Noise emissions from construction plant can be reduced by fitting exhaust mufflers, using reversing alarms that emit a broadband noise (e.g. white noise) rather than a beep, maintaining plant in good working order and following industry standard construction methodologies.

Other equipment and machinery may be required, depending on the nominated construction techniques.

4.3 Construction workforce

It is estimated that the workforce required to construct the Project will peak at approximately 350 assuming the project is built in one construction period or 24 months. A staged project may take 36 months but would have a lower workforce requirement. The estimated workforce profile is considered to be:

- 20-30 people in the first two months
- 100-150 people the following three months
- 350 people the following 14 months
- 100-150 people the following three months
- 20-30 people the final two months.

Typically these workers will be accommodated in an on-site accommodation camp if considered appropriate by the Contractor . However, local rental houses, hotels and motels in the surrounding localities and towns may also be used as required.

4.4 Construction water supply

The provision of water is essential for the construction of the Project. The construction activities likely to require water are:

- Bulk earthworks and material conditioning
- Dust suppression
- Concrete batching
- Drinking water for personnel and water for ablution facilities.

Water demands for the Project will require different water quality standards. Potable water fit for human consumption will be required at the site offices, while both medium (suitable for use in the concrete batching) and low quality raw water (for earthworks and dust suppression) may be used for construction purposes. Water will be tested from various supply options and allocated to the most appropriate use.

A water sourcing strategy will be developed so that water used during the construction phase does not cause issues to adjacent landowners or other stakeholders. Where possible, potable water will be obtained from the local government water reticulation network or otherwise trucked to the site. The proposed source of medium quality water for concrete production is proposed to be trucked to site. Lower quality water (for earthworks and dust suppression) is likely to be locally sourced from either:

- Groundwater – to include artesian and sub-artesian
- Surface water – to include watercourses, springs and overland flow.

Construction water supply options will be determined during the detailed design of the Project and confirmed with the Department of Natural Resources and Mines prior to construction.

5.0 Environmental impacts and mitigation measures

There are several potential environmental impacts which may arise during site mobilisation and construction activities. These potential environmental impacts are listed in the following tables along

with preventative measures to avoid or minimise these impacts throughout design, construction and operation.

5.1 Noise and vibration

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation
Noise and vibration	Noise and vibration impacts at residential dwellings	Compliance with Queensland Wind Farm State Code and Planning Guideline	**Prevention**	Ensure that the wind turbine layout within the Project Site is compliant with the applicable noise criteria. Select appropriate wind turbines to meet noise criteria	To minimise the impacts of construction noise, a Construction Noise and Vibration Management Plan will be prepared which outlines the proposed methodology and monitoring procedures to be put in place for the duration of the works. Scheduling of construction activities Maintenance of construction equipment Appropriate consultation with surrounding community about scheduling of construction activities Regular community consultation regarding noise created by the Project Management of construction hours to avoid or minimise noise impacts to nearby residents. Limitation of construction hours for noisy activities to Monday to Saturday where practicable. Construction work out of hours to be assessed on a case by case basis and the work program assessed against the noise impact on nearest residencies. An Out of Hours Work (OOHW) Protocol will be developed for the assessment, management and approval of works outside of the approved hours for construction. A key feature of this Protocol is considering the need and justification for any OOHW.	N/A

		Target	Management Objective

Environmental Factor	Potential Impact			Design	Construction	Operation
					This is the first step of the OOHW Protocol and will occur prior to any impacts being assessed. Where possible, OOHW will be avoided and scheduled to occur during the approved hours for construction. Where out of hours work are needed for the safe and efficient implementation of the project, or due to exceptional circumstances such as need to align with favourable weather, the level of impacts of OOHW will be considered.	
			Contingency Measures	N/A	Prepare a noise complaints procedure and register, and investigate any construction noise complaints appropriately. Vibration complaints are not expected, but will be appropriately investigated.	Investigate any operational noise complaints appropriately
			Monitoring	N/A	Where potential sensitive receivers may experience excessive noise, Noise monitoring requirements in accordance with the CEMP will be undertaken.	A Noise Monitoring Plan (NMP) will be developed to assist with determining compliance during the operational phase of the Project. Compliance measurements will be undertaken at a number of sensitive land uses adjacent to the Project site in order to demonstrate that compliance with the relevant criteria has been achieved. Undertake compliance noise measurements at sensitive receivers located in proximity to the Project to ensure compliance with the Queensland Wind Farm State Code

		Target	**Management Objective**

Environmental Factor	Potential Impact			Design	Construction	Operation
						and supporting Planning Guidelines

5.2 Landscape and visual

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation
Visual Amenity	Reduced visual amenity	Compliance with the visual impact mitigation commitments.	**Prevention**	Minimise vegetation removal, where possible Design of facilities to minimise visual impact on surrounds, such as semi-matt finishes on turbines to reduce glint and select colour finishes on operations offices and workshops that are sympathetic to surrounding environment	Limit works compounds and restrict to areas of lower visual sensitivity and/or lesser visibility where possible to avoid unnecessary visual impact Control after-dark construction lighting to minimise effects on sensitive visual receptors Re use of spoil from excavation sites for incorporation into bunding for buffer planting/seeding zones Rehabilitation / revegetation of areas disturbed by construction activities that are no longer required for operation	Maintain project in a tidy manner
			Contingency Measures	N/A	CEMP to manage construction waste generated to ensure waste is minimised and reduces impacts to landscape character	N/A
			Monitoring	N/A	N/A	N/A

5.3 Shadow flicker

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation

Shadow Flicker	Shadow flicker experienced at dwellings and causing nuisance	No exceedance of guideline limits for shadow flicker at sensitive receptors.	**Prevention**	Detailed design to be informed by shadow flicker modelling if turbine layout is altered If modelling demonstrates shadow flicker occurrence, a site visit will be arranged to investigate the dwellings expected to experience some shadow flicker to determine site-specific conditions. This will enable further modelling of the detailed design layout to incorporate site conditions at these locations, and will identify the need for mitigation measures at these locations	N/A	N/A
			Contingency Measures	N/A	N/A	Enable landowners with concerns about shadow flicker to contact the wind farm operator. Any complaints to be investigated appropriately. Install screening structures or plant trees to block shadows cast by turbines during operation, where required.
			Monitoring	N/A	N/A	N/A

5.4 Electromagnetic interference

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation
Electromagnetic Interference	Disruption to telecommunications operations in proximity to the wind farm	No EMI impacts or disruption	**Prevention**	Undertake EMI impact assessment and resolve potential issues prior to construction commencing	N/A	N/A

			Contingency Measures	Undertake EMI impact assessment and resolve potential issues prior to construction commencing	N/A	Establish a feedback process whereby stakeholders can raise concerns about EMI impacts with the wind farm operator. Investigate these complaints appropriately.
			Monitoring	Undertake EMI impact assessment and resolve potential issues prior to construction commencing	N/A	N/A
	Disruption to CB radio and mobile phone signals	Minimal temporary disruption to signals	**Prevention**	Educate host land users about small possibility of potential interference to CB radio and mobile phone signals	N/A	N/A
			Contingency Measures	N/A	Encourage CB radio and mobile phone users to move a short distance if experiencing signal interference.	Encourage CB radio and mobile phone users to move a short distance if experiencing signal interference.
			Monitoring	N/A	N/A	N/A

Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**
	Disruption to satellite and digital TV reception	No satellite or digital TV reception interference	**Prevention**	Ensure that any changes during detailed design to the wind farm layout are investigated for potential disruption to satellite or digital television		Educate residents experiencing interference issues on how to tune household antennas to alternative sources.

			Contingency Measures	N/A	Establish a feedback process whereby stakeholders can raise concerns about EMI impacts with the wind farm operator. Investigate complaints accordingly and where mitigation measures are necessary, consider undertaking one or more of the following: Tune the householder's antenna into alternative sources of the same or suitable TV signal Establish an alternative solution to restore reception (e.g. install a more directional and/or higher gain antenna; relocate the antenna; install satellite TV; or a TV relay station)	Establish a feedback process whereby stakeholders can raise concerns about EMI impacts with the wind farm operator. Investigate these complaints appropriately and employ the appropriate mitigation measures as necessary. Tune the householder's antenna into alternative sources of the same or suitable TV signal Establish an alternative solution to restore reception (e.g. install a more directional and/or higher gain antenna; relocate the antenna; install satellite TV; or a TV relay station)
			Monitoring	N/A	N/A	N/A

5.5 Aviation

Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**

Airspace	Increased risk of collisions by aircraft with wind turbines or meteorological masts	No significant increase to risk profile	**Prevention**	Consultation with appropriate authorities, including Civil Aviation Safety Authority (CASA), Airservices Australia, Department of Defence and any relevant the district aerodrome supervisor regarding the Project.	Notify Airservices Australia, CASA and RAAF when construction commences. Notify Air Information Services to have the Project included on aeronautical charts.	Wind farm operator to provide avenues for consultation with aviation stakeholders if any issues arise during the operation of the Project with respect to aviationrelated factors.
			Contingency Measures	Consider inclusion of obstacle lighting on wind turbines if Aviation Risk Assessment recommends or directed by development approval condition.	Operate obstacle lighting if required.	Operate obstacle lighting if required.
			Monitoring	N/A	N/A	N/A

5.6 Hazard and risk

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation

Bushfire	Increase in prevalence and severity of bushfires	Reduced bushfire risk in the Project area	**Prevention**	Preparation of a Bushfire Management Plan in consultation with Queensland Fire and Rescue Equipment and machinery (including the turbines) to provide high safety standards Develop emergency provisions for property owners neighbouring and those hosting wind turbines The Project detailed design will be in accordance with relevant industry standards, including requirements for emergency vehicle access and asset protection areas.	Maintain fire breaks around construction site Undertake risk assessment for construction activities Visual inspection of construction areas for presence of dry fuel Incorporate Bushfire Risk Plan into the CEMP Avoid higher risk areas when siting buildings or other infrastructure Ensure buildings meet specifications and requirements of AS 3959 Install lightning protection devices in wind turbines Observe fire warnings and notices Fit buildings with fire detection systems in accordance with AS1670 Maintain fire extinguishers at site offices and construction vehicles	Observe fire warnings and notices Maintain fire breaks and asset protection areas

Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**

			Contingency Measures	Provide suitable ingress and egress to the Project Site and escape routes Roads should be designed to carry fullyloaded fire fighting vehicles Ensure appropriate water supply	Prepare and implement an Emergency Response Plan for construction Investigate the cause of any fire, and update facilities or procedures to prevent further incidents Fire Danger Index (FDI) will be monitored daily.	Prepare and implement an Emergency Response Plan for operation Investigate the cause of any fire, and update facilities or procedures to prevent further incidents
			Monitoring	N/A	N/A	Maintenance of relevant vegetation to reduce risk of fire Regular maintenance and servicing of equipment and turbines
Mosquitos	Potential creation of artificial breeding sites	Compliance with the *Public Health Act 2005*	**Prevention**	Provide a mosquito management component in the Weed and Pest Management Measures	A Pest Management Technician, licensed under the *Pest Management Act 2001*, will be engaged when pest control activities are required to be undertaken during construction	A Pest Management Technician, licensed under the *Pest Management Act 2001*, will be engaged when pest control activities are required to be undertaken during operation
			Contingency Measures	N/A	Maintain activities as set out in the Weed and Pest Management Measures	Maintain activities as set out in the Weed and Pest Management Measures

Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**

			Monitoring	N/A	Visual inspections in accordance with the requirements set out in the Weed and Pest Management Measures	Visual inspections in accordance with the requirements set out in the Weed and Pest Management Measures

5.7 Socio-economic

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	**Construction**	**Operation**
	Missed opportunities in relation to local employment and use of local contractors	Maximise local employment and contractor opportunities	**Prevention**	Develop workforce management arrangements promoting local procurement Implement Stakeholder Consultation and Engagement Plan. Project already has a website which has attracted local suppliers to register their interest.	Implement workforce management arrangements that promote local procurement Implement and revise where necessary the Stakeholder Consultation and Engagement Plan Use of local contractors wherever feasible for all associated construction work Maximise local employment during construction phase	Maximise local employment during operational phase Implement and revise where necessary the Stakeholder Consultation and Engagement Plan
			Contingency Measures	N/A	N/A	N/A
			Monitoring	N/A	N/A	N/A

5.8 Land use

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation
Land Use and Planning	Loss of Good Quality Agricultural Land Disruption to agricultural practices	Minimal reduction in rural production or output caused by construction or operation of the wind farm	**Prevention**	Consult with landowners to determine methods to prevent disruption to current agricultural practices Avoided areas of Class A and B Agricultural Land Classification (ALC) where possible	Minimise disruption of agricultural practices during construction, based on discussions with landowners during the design phase	Operate the wind farm in accordance with measures identified during the design phase
			Contingency Measures	Where some disruption cannot be avoided, consult with landowners to identify ways to minimise impacts to agricultural practices	Where disruption cannot be avoided, liaise with landowners to reduce potential impacts Investigate the cause of complaints of disrupted activities and address the issue appropriately	Investigate the cause of complaints of disrupted activities and address the issue appropriately Implement a complaint recording, investigation and reporting system for construction and operation
			Monitoring	No monitoring required	No monitoring required	No monitoring required

5.9 Flora and fauna

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation

Flora Conservation	Direct loss of 'Of Concern' Regional Ecosystem	Compliance with the EPBC Act, NC Act, VM Act, and EP Act	**Prevention**	Avoid areas Of Concern and Endanged RE unless there is no suitable alternative Detailed design of the Project to promote the retention of remnant vegetation within the Study Area Maximise colocation of infrastructure to reduce area of vegetation clearing required	Minimise construction activities within remnant vegetation Maximise siting of construction sites, such as site office, soil stockpiles, machinery/ equipment storage within existing cleared areas or disturbed area Impose strict no-go zones for construction workers and machinery within remnant vegetation that has not been approved as part of the project footprint	N/A

Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**

			Contingency Measures	Option relevant permits and approvals under the VM Act and NC Act Provision of applicable offsets Develop a management and rehabilitation plan	All vegetation to be removed is clearly marked/delineated and clearing contractors briefed on clearing requirements Educate all relevant contractors on the importance of the vegetation, mitigation/management measures and ensure no encroachment occurs on surrounding vegetation Implement the management and rehabilitation plan	N/A
			Monitoring	N/A	Daily visual inspection of vegetation clearing boundaries	N/A

Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**

Flora Conservation	Direct loss of regrowth vegetation	Compliance with the EPBC Act, NC Act, VM Act, and EP Act Maintain the current extent of regrowth vegetation	**Prevention**	Avoid regrowth vegetation unless there is no suitable alternative Detailed design of the Project to promote the retention of regrowth vegetation within the Study Area Maximise colocation of infrastructure to reduce area of vegetation clearing required	Minimise construction activities within regrowth vegetation Maximise siting of construction sites, such as site office, soil stockpiles, machinery/ equipment storage within existing cleared areas or disturbed area Impose strict no-go zones for construction workers and machinery within regrowth vegetation that has not been approved as part of the project footprint	N/A
			Contingency Measures	Research viability of compensatory planting or /seeding Develop a management and rehabilitation plan	All vegetation to be removed is clearly marked/delineated and clearing contractors briefed on clearing requirements Educate all contractors on the importance of the vegetation and ensure no encroachment on surrounding vegetation Implement the management and rehabilitation plan	N/A
			Monitoring	N/A	Daily visual inspection of vegetation clearing boundaries	N/A

Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**

Flora Conservation	Degradation of vegetation communities and habitats through indirect impacts, including edge effects, spread of weeds, introduced pests, modified surface water drainage, light and noise intrusion	Compliance with the EPBC Act, NC Act, VM Act, and EP Act No new infestations of weeds or pests attributable to the Project	**Prevention**	Avoid fragmentation of existing small patches (<5 ha) where feasible Maintain, as far as practicable, existing surface drainage paths	Minimise construction activities within remnant vegetation Install washdown facilities at main site entry/exit points to remove soil and weeds Develop and implement Weed Management Measures that includes specific controls for environmental and noxious weeds	Progressively revegetate disturbed areas as soon as practicable after works with appropriate native species suitable for existing cattle grazing t
			Contingency Measures	N/A	Maintain activities as set out in the Weed Management Measures	Maintain activities as set out in the Weed Management Measures
			Monitoring	N/A	Imported materials to be weed-free prior to arriving onsite Visual inspections in accordance with the requirements set out in the Weed Management Measures	Visual inspections in accordance with the requirements set out in the Weed Management Measures
Flora Conservation	Removal of prescribed environmental matters that are regulated vegetation communities	Compliance with SP Act, VM Act and Environmental Offsets Act 2014	**Contingency Measures**	Determination of offsets (if required) Confirmation on delivery of offsets Delivery of financial offset (as applicable)	N/A	N/A

Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**

Fauna Conservation	Mortality of native fauna	No significant impact on a native fauna population directly attributable to the Project	**Prevention**	Minimise the removal of large hollow-bearing trees or dead trees wherever possible	Speed limits will be clearly signed on access roads and roads during construction and known fauna crossing points highlighted with signage Removal of hollow bearing trees to follow Tree Felling Protocol All site personnel shall be made aware of sensitive fauna/habitat areas and the requirements for the protection of these areas	Maintenance of fauna exclusion systems where required and structures designed for safe fauna passage to enable these systems to function effectively
			Contingency Measures	N/A	Investigate the cause of any fauna injury or death Information gained through investigations to be applied in adaptive management to prevent or minimise further losses or injuries where possible and practical and/or implement compensatory actions	N/A

Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**

			Monitoring	Develop a Vegetation and Fauna Management Plan and Bird and Bat Management Plan	Prepare a Vegetation and Fauna Management Plan that includes assessment of mortality of native fauna and adaptive management processes to prevent or minimise further losses or injuries and/or identifies measures to be implemented as compensatory actions Visual inspections in accordance with the Vegetation and Fauna Management Plan	Continued visual inspection of Project Site for fauna mortality in conjunction with scheduled maintenance works and according to the requirements established in the Vegetation and Fauna Management Plan Vegetation and Fauna Management Plan to include targeted monitoring of birds and bats including mortalities
Fauna Conservation	Impediment to movement of at risk wildlife (birds and bats) through natural wildlife corridors	Compliance with the EPBC Act, NC Act, VM Act, and EP Act	**Prevention**	Any turbine lighting is to be minimised, and red lights used to prevent the attraction of insects	All construction activities, e.g. site offices, stockpiles etc to remain within approved site layout areas. In accordance with Vegetation and Fauna Management Plan , spotter/catchers will be present where required to ensure minimal disturbance to onsite fauna and recover and rescue any injured or orphaned fauna during vegetation clearing activities	N/A
			Contingency Measures	N/A		N/A

Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**

			Monitoring	N/A	Visual inspections in accordance with the Vegetation and Fauna Management Plan	Continued visual inspection of wind farm for fauna mortality in conjunction with scheduled maintenance works and according to the requirements established in the Flora and Fauna Monitoring Program

5.10 Traffic

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation
Traffic Impact	Delays to traffic on State Controlled Roads (SCRs) and local roads	Manage increased traffic volumes appropriately	**Prevention**	Preparation of a Traffic Management Plan in consultation with the Department of Transport and Main Roads (TMR) and local councils Investigate opportunities to use alternative routes for deliveries avoiding or minimise school bus routes and populated areas	Implementation of the Traffic Management Plan for construction traffic	Implementation of the Traffic Management Plan for operational traffic
			Contingency Measures	Specific traffic planning elements to be considered will include road diversions, construction route options and scheduling of deliveries, services and shift patterns	Any necessary road closures will be described within the Traffic Management Plan and necessary approval obtained from TMR and local councils Access points to be located with adequate sight lines and advance warning signs provided	N/A
			Monitoring	N/A	N/A	N/A
Stock Routes	Disruptions to stock movement along a stock route	No stock movement disruptions along stock routes	**Prevention**	Investigate detailed design solutions to minimise impact on existing roads and stock routes.	Ensure all stock routes remain open during construction phase, and any works or improvements to the road infrastructure must consider potential stock movement	Ensure all stock routes remain open throughout the operational period where possible
			Contingency Measures	N/A	N/A	N/A
			Monitoring	N/A	N/A	N/A

5.11 Surface water, riparian areas and groundwater

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation
Water Quality	Sediment from disturbed areas may enter nearby waterways	Compliance with current State and Commonwealth legislation, guidelines, strategies and standards No visible evidence of sediment leaving the site No visible increase in turbidity in waterways attributable to construction or operation of the wind farm	**Prevention**	Develop Conceptual Erosion and Sediment Control Plan	Develop and implement a Erosion and Sediment Control Plan in accordance with Engineers Australia's *Soil Erosion and Sediment Guidelines for Queensland Construction Sites*, to manage rainfall, water used in road formation and dust suppression, Stormwater and Dewatering activities. Progressively rehabilitate areas disturbed by construction works that do not need to be retained for operations or by the landowner	Maintain revegetated / rehabilitated areas Maintain roads, hardstands and other infrastructure ensuring drainage controls are operational and effective
			Contingency Measures	N/A	Maintain, repair or reinstate damaged erosion and sediment control infrastructure Investigate cause of increased turbidity or released sediment and address accordingly	Implement erosion and sediment control measures if areas are causing high sediment loads or turbidity in nearby waterways
			Monitoring	No background monitoring required	Daily visual inspections of sediment control infrastructure Weekly visual inspections of discharge water and receiving water bodies (or after rainfall) Turbidity monitoring in the event of turbid plumes from construction activities	N/A

		Target	Management Objective

Environmental Factor	Potential Impact			Design	Construction	Operation
Riparian Zone	Physical damage or alteration to riparian areas	No net degradation of riparian areas attributable to construction or operation	**Prevention**	Design to avoid structures within riparian areas where practicable Design to include rehabilitation of riparian areas Design to minimise scour and erosion of riparian areas Clarify guidelines on construction activities around riparian areas in the project construction zone.	Minimise vegetation removal and construction activities within waterways Progressively rehabilitate riparian areas as soon as practicable after construction.	N/A
			Contingency Measures	N/A	N/A	Maintain rehabilitation areas
			Monitoring	No background monitoring required	Daily visual inspection of construction site for clearing or construction activities beyond designated areas Weekly visual inspection of rehabilitated areas until appropriate	N/A

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation

Riparian Zone	Interference with stream flow	Compliance with *Water Act 2000, Environmental Protection Act 1994* and *Fisheries Act 1994*	**Prevention**	Design to minimise construction within riparian areas where practicable Assess construction water supply requirements as part of design Department of Agriculture and Fisheries accepted development requirements for low-impact development activities will be used to design waterway barrier developments within the Project Site during construction.	Obtain construction water in accordance with the rights under the Water Act 2000 and any other approval. Obtain water for irrigation of revegetated areas during establishment of vegetation from an approved source.	Obtain construction water in accordance with the rights under the Water Act and any other approval . Obtain water for irrigation of revegetated areas during establishment of vegetation from an approved source
			Contingency Measures	N/A	N/A	N/A
			Monitoring	N/A	N/A	N/A
Riparian Zones	Introduction of weeds and pests	No introduction of weeds or pests into riparian areas	**Prevention**	Design to minimise construction within riparian areas where practicable Design to include rehabilitation of riparian areas to prevent establishment of new weed and pest species	Develop and implement a Weed and PestManagement Measures, detailing procedures for cleaning and checking construction vehicles entering the construction site Minimise vegetation removal and construction activities within waterways Rehabilitate riparian areas as soon as practicable after construction	Maintain vegetation within the Project Site to prevent the establishment of weed species

Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**

			Contingency Measures	N/A	Manually remove weed species within and adjacent construction areas in riparian areas Remove overabundant or notifiable pest species in accordance with advice from the Department of Agriculture and Fisheries	Manually remove weed species within and adjacent to wind farm infrastructure in riparian areas
			Monitoring	Establish a baseline of Weeds present on site prior to disturbance/clearing	Weekly visual inspection of construction areas for new infestations of weeds or pests Weekly inspections of weed or pest treatment areas to determine efficacy of measures	Inspection of Project Site during maintenance activities for weed infestation
Groundwater	Degradation of groundwater resource	Compliance with Water Act 2000 and *Environmental Protection Act 1994* No contamination of local groundwater system	**Prevention**	Determine water requirements for construction and identify suitable water sources Identify surface water bodies sensitive to groundwater movement (i.e. dams)	Comply with Emergency Spill Containment Plan in the event of a spillage/leak of potentially hazardous substances Contain poor quality discharge water and treat prior to disposal, subject to achieving water quality guidelines Manage any groundwater abstraction in accordance with approved permit conditions	No specific mitigation measures are considered necessary due to low potential risk
			Contingency Measures	N/A	Investigate the nature of any spilled/leaked potentially hazardous/contaminating substances Investigate the extent of any spillage/leakage of potentially	N/A

Environmental Factor	**Potential Impact**	**Target**	**Ma ıagement Objective**			
				Design	**Construction**	**Operation**
					hazardous/contaminating substances	

			Monitoring	N/A		

5.12 Topography, geology and soils

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation
Topography, Geology & Soils	Erosion	Effective erosion and sediment control measures implemented and maintained	**Prevention**	Incorporation of stable embankments and cuts, with catch drains and flow controls to minimise longer term erosion	Prepare and maintain a project-specific Erosion and Sediment Control Plan Keep land clearance to a minimum Avoid wherever possible clearing areas of highly erodible soils which are prone to water and wind erosion The interval between clearing and rehabilitation should be kept to an absolute minimum Coordinate work program to minimise extent of time disturbed land is exposed prior to stabilisation Attempt to program construction activities so that the area of exposed soil is minimised during times of the year when the potential for erosion is high, for example during Summer when intense rainstorms are common Stabilise the site and install and maintain erosion controls in accordance with the projectspecific Erosion and Sediment	Maintain project infrastructure such as roads and hardstandings, ensuring drainage controls are effective.

	Potential Impact	Target	Management Objective

Environmental Factor				Design	Construction	Operation
					Control Plan Keep vehicles to well-defined access roads	
			Contingency Measures	N/A	Identify and investigate the site of erosion and address in accordance with the projectspecific Erosion and Sediment Control Plan Maintenance of road surfaces and cleared footprints will be conducted following rainfall events during the construction phase and throughout the life of the Project, reducing the potential of mass movement of sediment.	Identify and investigate the site of erosion and provide suitable erosion controls, in accordance with the Erosion and Sediment Control Plan Investigate areas showing signs of excessive erosion and implement appropriate solution.
			Monitoring	No background sampling required	Erosion and sediment control measures documented Daily visual inspection and check sheets maintained In-situ turbidity (NTU) monitoring of local receiving surface waters, in accordance with the requirements of the project-specific Erosion and Sediment Control Plan	N/A
Topography, Geology & Soils	Mass Wasting	No mass wasting/landslip	**Prevention**	Geological and geotechnical investigations in	Construction activities undertaken in accordance with relevant work method	Visual inspection of susceptible areas following heavy

	Potential Impact	Target	Management Objective

Environmental Factor				Design	Construction	Operation
		events.		areas requiring cuts – areas for turbine foundations and hardstand, and access roads. Geological profile of slopes, with slope stability reports issued prior to undertaking earthworks	statements and detailed design	rainfall/landslip inducing event
			Contingency Measures	N/A	Identify and investigate the site of mass wasting and provide suitable remediation	Identify and investigate the site of mass wasting and provide suitable remediation
			Monitoring	No background sampling required	Mass wasting and landslip control measures documented Daily visual inspection and check sheets maintained	No background sampling required
Topography, Geology & Soils	Generation of Acidic Material	No generation of significant amounts of acidic waste water No generation of acidic material	**Prevention**	Inspection of intrusive igneous rock bodies for disseminated sulphides will be conducted as part of the geotechnical investigation	Any exposed acid producing material will need to be managed, according to the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines*	No specific mitigation measures are considered necessary due to low potential risk
			Contingency	N/A	Divert potentially acidic	N/A

	Potential Impact	Target	Management Objective

Environmental Factor				Design	Construction	Operation
			Measures		surface run-off away from local waterways, into established sedimentation basins Neutralise the contained surface run-off by chemical/biological means, in accordance with the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines*	
			Monitoring	No background sampling required	Submission of samples of suspected acidic material to a NATA accredited laboratory for characterisation pH monitoring of surface runoff generated from operational construction sites, at times and in locations where generation of acidic runoff is likely pH monitoring of local surface waters receiving surface runoff from construction sites, at times and in locations where generation of acidic runoff is likely	No background sampling required
Contaminated Land	Land contamination by on-site construction activities	No contamination of land	**Prevention**	Investigate the presence of any Notifiable Activities	Nature, quantity and location of all hazardous materials onsite recorded in a manifest	In accordance with legislated requirements and Australian Standards of the storage and

	Potential Impact	Target	Management Objective

Environmental Factor				Design	Construction	Operation
	or by export of contaminated material from site or importation of contaminated material			as listed in the *Environmental Protection Act 1994* on properties within the Study Area An Emergency Spill Containment Plan to be produced	Chemical/Fuel storage areas to consist of a compacted base, bunding to contain spillages and roofing to prevent contamination and infiltration of stormwater (as per AS1940 and AS3780) Residual hazardous materials will be removed from the construction site and returned to an appropriate storage area or a suitable waste facility Spillages of all dangerous goods and contaminated materials will be rendered harmless through investigation, collection and disposal at a suitable disposal facility Material imported from off-site to be procured from a licensed quarrying facility and accompanied by relevant documentation to verify it is contaminant/ASS free Contaminated fill material exported from site will be disposed at a facility licensed for disposal of such material	handling of dangerous and hazardous goods will provide appropriate practical responses to manage impacts on occupational health and safety and minimise the risk of a spill occurring
			Contingency	N/A	If potentially contaminated	Preliminary site investigation of

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation

			Measures		soils are encountered, a preliminary site investigation should be undertaken Visual and olfactory observation of all in-situ material excavated during construction	land exposed to leaked or spilled potentially hazardous substances/material
			Monitoring	No background sampling required	Submission of samples of suspected contaminated material to a NATA accredited laboratory for characterisation	Submission of samples of suspected contaminated material, generated from operational activities, to a NATA accredited laboratory for characterisation

5.13 Waste management

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation
Waste	Excessive waste generation	Minimal waste generation	Prevention	Detailed design for infrastructure to carefully specify material needs to avoid over estimating requirements.	Use a hierarchical approach to waste management, from the most preferable (reduce, reuse or recycle wastes) to the least preferable (disposal), and prioritise waste management strategies to avoid waste generation.	The waste stream generated from a wind farm during operation is minimal. A hierarchical approach to waste management during operation will be used.
			Contingency Measures	N/A	Where waste cannot be avoided, waste materials will be segregated by type for collection and removal (for processing or disposal) by licensed contractors.	Where waste cannot be avoided, waste materials will be segregated by type for collection and removal (for processing or disposal) by licensed contractors.

5.14 Air quality

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation

Air quality	Exhaust emissions: • Mono-nitrogen oxides (NO_x) • Particulate matter (PM_{10} and $PM_{2.5}$) • Volatile organic compounds (VOC) • Carbon monoxide (CO).	Minimise exhaust emissions	Prevention	Assess traffic and haulage routes	Vehicle/machinery engines to be switched off when not in use. Avoid idling vehicles where possible	The vehicle emissions generated from a wind farm during operation is minimal.
			Contingency Measures	N/A	N/A	N/A
	Fugitive dust: • particle size greater than the 10 micrometre (PM_{10}) fraction	Minimise fugitive dust emissions	Prevention	Preliminary site investigation prior to construction would be undertaken to reveal the quality of the sub-grade material	Plan construction by locating dust activities away from sensitive receptors where possible Access roads are to be dampened on a regular basis with water, especially during prolonged dry periods Washing facilities to prevent mud from construction operations being transported onto adjacent public roads Ensure that dusty materials are stored and handled appropriately (wind shielding or complete enclosure, storage is away from site boundaries, drop heights of materials are restricted, water sprays are used where practicable to reduce dust emissions) Minimise dust generating activities on windy and dry days Restricting vehicle access and speed limits on haul	Fugitive dust emissions will be minimal during operation
Environmental Factor	**Potential Impact**	**Target**	**Management Objective**			
				Design	**Construction**	**Operation**
					roads and other unsurfaced areas of the Project Site No fires on Project Site	

			Contingency Measures	N/A	If dust is generated, ensure that a water truck is used to dampen down all access roads and public access roads.	N/A
			Monitoring	N/A	Visually monitor work areas for dust emissions. Conduct air quality monitoring where there are complaints and/or excessive dust generation in the vicinity of sensitive receptors	N/A

5.15 Cultural heritage

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation
Cultural Heritage	Disturbance of items of cultural heritage	Minimal reduction of cultural heritage values	**Prevention**	Establish a dialogue with the Traditional Owners Development of a Cultural Heritage Management Agreement/Plan	Include construction phase within the Cultural Heritage Management Agreement/Plan	Include operation phase within the Cultural Heritage Management Agreement/Plan
			Contingency Measures	N/A	If items of potential cultural heritage significance are discovered during construction, work is to cease immediately in the vicinity of the construction works and the Cultural Heritage Management Agreement/Plan methodology is to	Investigate any heritagerelated complaints and address accordingly Implement a complaint recording, investigation

Environmental Factor	Potential Impact	Target	Management Objective			
				Design	Construction	Operation
					be followed prior to the resumption of works	and reporting system for construction and operation

			Monitoring	N/A	N/A	Visual inspection of items of cultural heritage value in the event of a complaint

6.0 Recommendations

This construction management plan has been developed for the Clarke Creek Wind Farm (the Project) in accordance with the *State Code 23: Wind farm development – Planning guideline.*

As the Clarke Creek Wind Farm continues through its design and development stages, construction management requirements will be reviewed and a Construction Environment Management Plan (CEMP) will be prepared by the EPC contractor prior to the commencement of any construction activities. The CEMP will include details of the construction programme, construction techniques to be employed, environmental mitigation measures to control construction impacts, monitoring and audit regime, and contact details for queries and reporting incidents.

The CEMP will consider the measures put forward in this construction management plan and any conditions of approval applied to the Project.

22-Nov-2017
Prepared for – Clarke Creek Energy Pty Ltd – ABN: 24 614 169 069