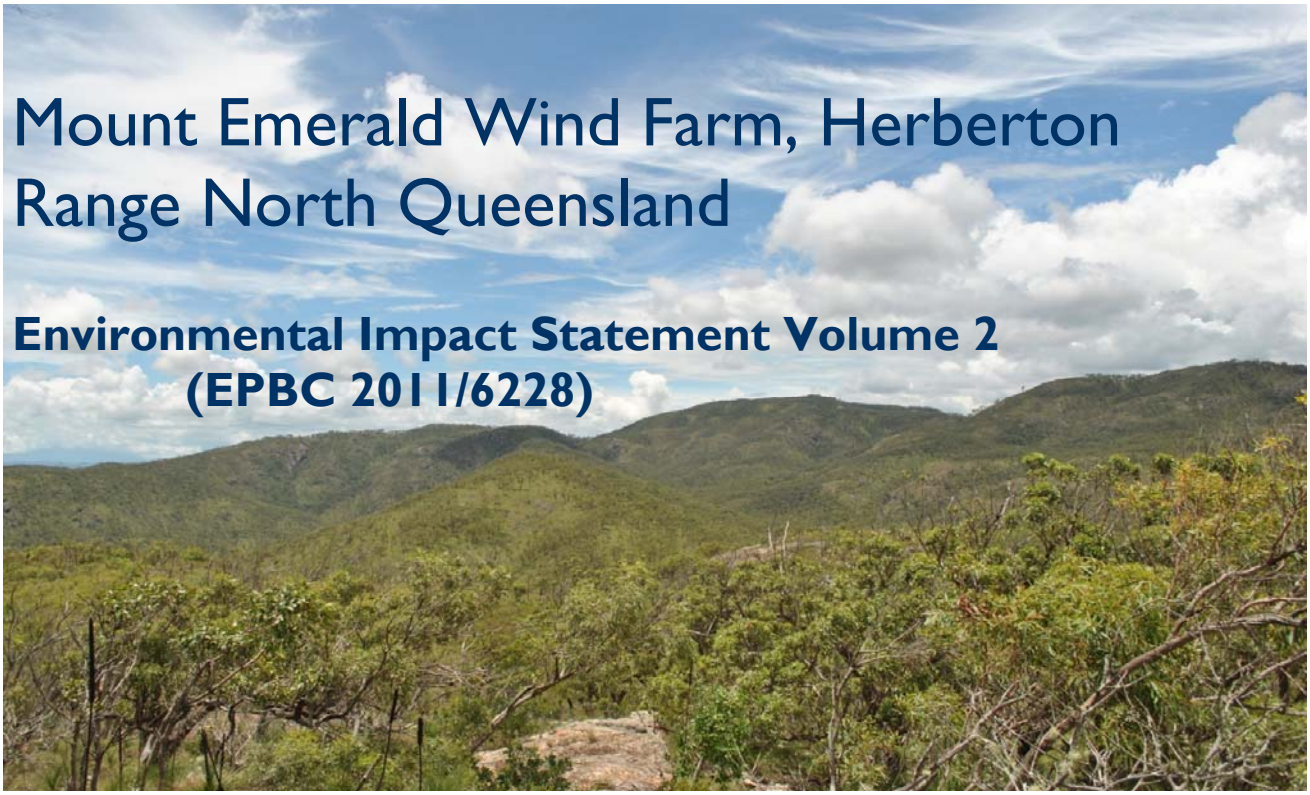
Mount Emerald Wind Farm, Herberton Range North Queensland

Environmental Impact Statement Volume 2 (EPBC 2011/6228)



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Contents

Tables

Figures

Plates

Glossary

Term	Description / Definition
AADT	Annual Average Daily Traffic
Access Roads	Roads connecting public roads to the Site and the Site Roads
ACH Act	*Aboriginal Cultural Heritage Act 2003*
Aquifer	A water-saturated geologic unit that is capable of transmitting significant or usable quantities of groundwater under ordinary hydraulic gradients.
Arboreal	Living in trees.
ASL	Above Sea Level (referring to altitude).
Assembly Area	Areas on site where rotor blades are attached to the hubs prior to the installation of the complete rotor to the nacelle. The area is only relevant for the rotor assembly installation method.
ATSIHPA	*Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
Bagasse	A by-product of sugar cane
Batching plant	Operational area where concrete and other aggregated materials are prepared.
Biodiversity	Totality of genes, species, and ecosystems of a region. A contraction of biological diversity.
Biological diversity	The totality of genes, species, and ecosystems of a region.
Bioregion	An area of land that comprises broad landscape patterns that reflect major structural geologies and climate, as well as major floristic and faunal assemblages (from Sattler and Williams 1999).
Biota	All the plant and animal life of a particular region.
Buffer	Area of vegetation providing protection from disturbance.
Catchment	The term used to describe the area which is drained by a river. It is sometimes called the river basin or watershed. The catchment is the most significant factor determining the amount or likelihood of flooding.
CHMP	Cultural Heritage Management Plan
Climate Change	Any long-term significant change in the 'average weather' that a given region experiences. Average weather may include average temperature, precipitation and wind patterns. It involves changes in the variability or average state of the atmosphere over durations ranging from decades to millions of years.
Community	A number of definitions depending on the context: a) Used to describe that stakeholder group which is comprised of both individual community members and community groups. Community groups are regarded as members of the public or a group of citizens that have united to form an identifiable group, due to a common interest (as defined in the Social Impact Assessment chapters). b) Group of populations of plants and animals in a given place (as defined in the terrestrial ecology chapters).
Compound for substation and control building	The base area for the site management and technicians. The area consists of restroom facilities, parking, site offices, tools and spare parts containers

Term	Description / Definition
Consequence	Outcome or impacts of an event. There can be more than one consequence from one event. Consequences can range from positive to negative. Consequences can be expressed qualitatively or quantitatively. Consequences are considered in relation to the achievement of objectives (*AS/NZS ISO 3100:2009 Risk management - Principles and guidelines*).
Conservation significance	Species or community listed as endangered, vulnerable, rare, near threatened or migratory under either the EPBC Act or the NC Act
Controlled action	A term used under the *Environment Protection and Biodiversity Conservation Act 1999* to determine whether an action is likely to have an impact on matters of national environmental significance. If a project is declared a 'controlled action', development approval is required from the Minister for the Environment, Heritage and the Arts.
Construction Area	The part of the Installation Area located at each WTG foundation position which is required for assembling the cranes and area for operating cranes, containers for lifting equipment, generator unit, working area with tools and containers etc.
Corridor	A continuous link of suitable habitat between vegetation patches allowing movement by fauna.
Connectivity	The connectedness between patches of suitable habitat for an individual species or group of species
Crane Hard Stand	An improved / stabilized area with a prepared surface where plant and cranes can operate, vehicles can be parked and material can be stored.
Cultural heritage	The legacy of physical artifacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations.
Culverts	Reinforced structures (usually concrete) to provide sealed access over watercourses.
DEHP	Department of Environment and Heritage Protection (Queensland)
Development envelope	The area of the project site in which the wind farm infrastructure (turbines, hardstands, access roads, electrical cables and substation) could potentially be sited, comprising an area of approximately 57 ha.
Development footprint	The final locations of the wind farm infrastructure. This includes the infrastructure footprint - the area occupied by turbines, access tracks, substation etc. during the operational phase - and other areas that will be affected by construction (for example, cable trench easements, construction phase access track width, construction compound, crane pads) which can be rehabilitated post-construction.
DNRM	Department of Natural Resources and Mines (Queensland)
DotE	Department of the Environment (Federal)
Ecologically sustainable development	The environmental component of sustainable development. It can be achieved partially through the use of the 'precautionary principle', namely that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
Ecology	The scientific study of the distribution and abundance of life and the interactions between organisms and their environment. The environment of an organism includes physical properties, which can be described as the sum of local abiotic factors such as insolation (sunlight), climate, and geology and biotic factors, which are other organisms that share its habitat.

Term	Description / Definition
Economic Impact Assessment	Assessment of the measured effect on the economy of a region of an impacting agent.
Ecosystem	A natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the non-living physical (abiotic) factors of the environment.
Ecosystem function	Processes including soil formation and stabilisation, nutrient cycling, water infiltration, pollination and seed production.
Endemic	A species restricted to a particular place or region.
Environmental values	An aspect of the environment that is to be protected.
EIS	Environmental Impact Assessment -An environmental impact assessment is an assessment of the possible impacts that a proposed project may have on the environment, consisting of the environmental, social and economic aspects.
EMI	Electromagnetic Interference -is disturbance that affects an electrical circuit due to either electromagnetic induction or electromagnetic radiation emitted from an external source
EMF	An electromagnetic field is a physical field produced by electrically charged objects. It affects the behaviour of charged objects in the vicinity of the field.
EMP	Environmental Management Plan
Environmental Impacts	Impacts that could be caused to the environment when a development project is constructed; in operation or when decommissioned.
EP Act	Environmental Protection Act 1994
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
ESCP	Erosion and Sediment Control Plan
ESD	Ecologically Sustainable Development
Fauna	Animal life
Flora	Plant life
Geotechnical	Technologies and sciences relating to geology.
GQAL	Good Quality Agricultural Land
Gravity Foundations	A standarad type of reinforced concrete slab which support the wind turbine tower by gravitational mass. Excavation is required to a depth of approximately 2.5 m.
Greenfield developments	Developments that occur on land that primarily holds natural values (e.g. remnant vegetation, forested, undeveloped with human infrastructure).
LA90	The A-weighted statistical noise level exceeded for 90% over the measurement period (normally 10min), measured in dBA.
LAeq	The A-weighted constant noise level over the time period, equivalent to the actual fluctuating noise level, measure in dBA.
Landscape	Natural and manmade features of the urban, rural or natural environment, such as vegetation, topography and land use elements.
Landscape Character Area	A distinct, recognisable and consistent pattern of elements, be it natural (soil, landform) and/or human (for example settlement and development) in the landscape that makes one landscape different from another, rather than better or worse.

Term	Description / Definition
Least Concern	A remnant vegetation conservation status under Queensland's *Vegetation Management Act 1999.*
Likelihood	Used as a general description of probability or frequency. Can be expressed qualitatively or quantitatively (AS/NZS ISO 3100:2009 Risk management – Principles and guidelines).
LVIA	Landscape and Visual Impact Assessment which is to assess the nature and extent of visual impacts and qualities relating to locations and proposals
MEWF	Mount Emerald Wind Farm
MNES	Matters of National Environmental Significance, as defined under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).
Microhabitat	A small localized habitat within a larger ecosystem.
Micro-siting	Accurately positioning infrastructure in order to take advantage of least environmental impact areas and positions in otherwise constrained areas.
Moisture Conditioning	Adding water to a soil or construction medium to improve its working/forming capability.
Montane heath	A rare plant community hosting numerous important species and restricted to exposed ridges above 900 m ASL.
MSC	Mareeba Shire Council
MW	Megawatts
Nacelle	The housing for the generating components of the wind turbine. This includes the generator, gear box, drive train and brake assembly.
Narrow endemic	A species with very limited and restricted distribution, and often confined to a unique or poorly represented habitat (e.g. *Melaleuca uxorum* and montane heath on the site).
NC Act	*Nature Conservation Act 1992* (Queensland)
NC Plan	Nature Conservation (Protected Plants) Conservation Plan 2006
NTA	*Native Title Act 1993*
Offsetting	Anything that balances, counteracts, or compensates for something else; providing compensation. For example carbon offsetting is the process of reducing greenhouse gas emissions by purchasing credits from others through emissions reductions projects, or carbon trading schemes.
Of Concern	A remnant vegetation conservation status under Queensland's *Vegetation Management Act 1999.*
Potable water	Water deemed safe for human consumption/drinking.
Project site	The land within the cadastral boundaries of all properties involved with the Proposal, comprising an area of 2,422 ha.
Proponent (the)	RATCH Australia Corporation Limited (RACL)
QH Act	Queensland Heritage Act 1992
RACL	RATCH Australia Corporation Limited
RCA	Radio Communications Act 1992
Regional ecosystem	Vegetation communities that are consistently associated with a particular combination of geology, land form and soil in a bioregion.

Term	Description / Definition
Regrowth	A native vegetation community that has regrown after clearing, in which native species that would have naturally occurred within this vegetation community dominate but have not reached the height and canopy cover necessary to be regarded as remnant as defined in the Queensland *Vegetation Management Act 1999.*
Rehabilitation	Relating to mitigating the impacts caused to the environment following disturbance (e.g. removal of vegetation cover, soil profiles, natural land features)
Remnant vegetation	Vegetation which is mapped by the Queensland Department of Environment and Resource Management as being within a remnant endangered regional ecosystem, a remnant of concern regional ecosystem, or a remnant not of concern regional ecosystem map. Vegetation remaining after an area has been cleared or modified.
Revegetation	The practice of direct-seeding or planting tubestock into the ground as part of the landscape rehabilitation process.
Riparian	Any land which adjoins or directly influences or is influenced by a body of water.
Sensitivity	The relative susceptibility to adverse impacts to environments.
Soil profiles	The 'layers' of soil as they are viewed in a vertical projection.
SPA	Sustainable Planning Act 2009 (Queensland)
SPP	State Planning Policy (Queensland)
Sustainable Development	Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Table drains	An erosion and sediment control measure - a flat-bottomed drain constructed adjacent to a road or track to slow down water velocity and reduce the rate of soil erosion, as well as capture transported soil.
Topographical	Relating to the various types of landform and features (e.g. mountains, ridges, watercourses).
TRC	Tablelands Regional Council
Turbine Footing	The stable horizontal platform for the towers sections and elements to be mounted. Foundations will be of either a gravity or rock-anchor type, depending on the geotechnical conditions at each wind turbine site.
Visual impact	Measure of a joint consideration of both visual sensitivity and visual effect that considered together determines the visual impact of a development.
VMA	*Vegetation Management Act 1999* (Queensland)
vpd	Vehicles per day
Weeds	Plant species that invade native ecosystems and can adversely affect the survival of indigenous flora and fauna. . A species not native to Australia. Sometimes referred to as naturalised species.
WTG	Wind Turbine Generator(s) - A wind turbine is a device that converts kinetic energy from the wind into electrical power.
WTWHA	Wet Tropics World Heritage Area - The Wet Tropics of Queensland World Heritage Site consists of approximately 8,940 km² of Australian wet tropical forests growing along the north-east Queensland portion of the Great Dividing Range.

12.0 Environmental Assessment

12.1 Climate

The dominant rainfall pattern of the local area is monsoonal, with alternating wet and dry seasons that typically last for four and eight months respectively although this can vary considerably depending on the severity of the El Nino/Southern Oscillation (Weatherzone, 2011). The Walkamin Research Station (station number 031108, elevation 594m) has been selected to represent the site as it is situated 6 km from the wind farm site and provides long term climate records of the area. A summary of the weather data from this station is presented in **Table 12.1.**

Average annual rainfall in the area is 1032.4 mm with the wettest month being February (248.9 mm), and the driest month being September (8.4 mm). The majority of rain (80%) falls within the months of December to March.

Seasonally temperatures are hottest from late November. The average maximum daily temperatures in summer are 30.7°C in December, with winter minimum's of 13.0°C in July.

The highest aspects of the site are 1089m ASL which are 550m higher in altitude than the Walkamin Monitoring Station. The change in temperature as a function of elevation is typically between 0.6^{o}C and 1^{o}C (BOM, 2013) but this can vary significantly by factors such as wind speed, moisture, daily temperatures etc.

Observations during seasonal ecological surveys indicate the temperature on site can vary by several degrees from the exposed ridgelines to the valleys or the few, well shaded riparian areas running through the centre of the site. Windward south-east to east facing slopes often receive more rainfall than leeward slopes due to the orographic effect.

Table 12.1 Summary of Weather Data for Walkamin Research Station (BoM, 1965 - 2013)

Weather Conditions	Measurements
Mean Annual Rainfall	1032.4mm
Highest Annual Rainfall	1750.5mm (1974)
Lowest Annual Rainfall	470.2mm (2002)
Highest Monthly Rainfall	894.1mm (Feb 2000)
Highest Daily Rainfall	284.8mm (28 Feb 2000)
Lowest Monthly Rainfall	0.0mm (May 2001)
Mean Annual Minimum/Maximum Temperature	17.1°C/27.3°C
Mean Monthly Minimum / maximum Temperature	13.0°C (Jul) / 30.7°C (Dec)
Highest Temperature	39.8°C (19 Nov 1990)
Lowest Temperature	2.6°C (4 July 1984)

Bureau of Meteorology (2013).

Monitoring equipment on site was installed in May 2010, with instruments recording wind speed and direction, barometric pressure and temperature. While limited to just over 3 years of data, temperature records collected from on-site monitoring shows:

- highest temperature of 36.7°C (12 Oct 2011)
- lowest temperature of 9.0°C (4 July 2011)

The extremes of climate in the existing environment and future climate change predictions are considered further in **Chapter 19.4.**

12.2 Air Quality

Air quality in the study area is consistent with a rural environment. Most air quality impacts experienced in the region are seasonal and generated by fire and agricultural activities such as sugarcane harvesting, tilling of soils, pesticide/herbicide spraying, and vehicles travelling on unsealed roads roads. These activities may result in elevated levels of smoke and dust, or odours associated with agricultural chemicals. There are however, no routine air quality measures undertaken in the region therefore there is no ability to reference any records.

12.2.1 Impact Assessment

There is potential for air quality to be impacted during construction of the wind farm. Traffic movements, bulk earthworks and vegetation clearing associated with construction phase activities have some potential to cause dust nuisance (airborne particulate matter). Dust may also be generated from unsealed access tracks and exposed tower site pads during visits by maintenance vehicles.

12.2.2 Mitigation Measures

The principles of dust mitigation are similar to management of soil erosion. Dust nuisance may be minimised by avoiding disturbing soils prone to erosion such as sodic soils and steep slopes. In areas where erosion prone soils cannot be avoided, there are techniques that can be employed to reduce erosion and dust emissions during both the construction and operational phases. These mitigation measures may include:

For access tracks

- Minimisation of the daily vehicle movements on access tracks;
- Provision of armouring on access tracks (gravel);
- Employment of a water truck during construction; and
- Dust suppression additives.

For tower sites

- Use of wind breaks (natural tree-line, erosion fences);
- Seeding with fast growing non-invasive sterile annual grass species and low growing shrubs;
- Armouring (hydromulching, gravel); and
- Watering.

12.3 Soils and Landforms

12.3.1 Overview of Landscape

The proposed Mount Emerald Wind Farm project site is situated over mountainous terrain coinciding with the northern extent of the Herberton Range. The site is characterised by acid igneous rhyolite geology forming windswept ridges and rock outcrops interspersed with rock pavements, which support skeletal soils. Between these prominent features are undulating valleys with sheltered aspects and with deeper, more structured soils.

Thin veneers of soil with low fertility, wind-shearing and exposure to extremes of temperature and solar radiation prevent the growth of tall vegetation on ridges and rock pavements. Soils developed from rhyolite parent rock are naturally low in important plant nutrients such as nitrogen and phosphorus. Exposure, depth, drainage, water availability and the nutrient status of soil are factors affecting the physiognomy of the vegetation (Groves, 1981). This is notably relevant to the heath-like vegetation which occurs as a mosaic along ridges and upper slopes generally above 900 m ASL. Several turbines and connecting tracks are proposed to be established in this landscape position.

Specialist habitats for plants are afforded by the fireproof nature of rock outcrops and rock pavements. These habitats support heath, low woodland and shrublands, which are also the preferred habitats for plants of interest to conservation. The montane heath vegetation of the Herberton Range is known for its special qualities and important habitats for a range of conservation significant plants and narrow endemic species (Craven and Ford, 2004).

Generally within the site, taller woodlands found on lower slopes and in valleys with areas of deeper soil support fewer conservation significant plants; although poorly known terrestrial orchids exist in the grassy ground layer of these communities and include *Habenaria elongata* and possibly *Diuris oporina*.

The site is broadly divided in terms of degree of surface relief. This has bearing on landforms, vegetation types and ultimately, the constructability of the project. To the south of the Chalumbin to Woree 275 kV transmission line the land is conspicuously dissected, rugged and characterised by narrow, high ridges and in some instances, precipitous slopes. The land to the north of the transmission line exhibits less surface relief, dissected ridges and steep slopes become far less frequent, and the landform generally becomes more undulating. Consequently, different vegetation types are hosted; where woodlands are generally taller, more widely represented on a regional basis, and conspicuously fewer conservation significant plants are present. From a constructability viewpoint, the Einasleigh Uplands section north of the existing transmission line, is least constrained and offers the most opportunities with the potential for notably reduced environmental impacts on important plant habitats and conservation significant plant species.

12.3.2 Geology

The primary geological unit described for the entire site is the Walsh Bluff Volcanics. The Walsh Bluff Volcanics (Pb) are included in the Early Permian, Koolmoon Volcanic Group and described as "Buff, greenish-grey or dark grey, welded rhyolitic ignimbrite; minor rhyolite lava, quartzose sandstone, volcanic breccia, tuff." (Donchack & Bultitude, 1998).

Regionally, the Walsh Bluff Volcanics (Pb) unit is not represented elsewhere on the ATHERTON 1:250 000 geological series map sheet (Donchak, *et al*., 1997). The unit's northern limit is the landmark of Walsh Bluff. It extends southwards to incorporate Hoot Hill and Mount Emerald, east to Bones Knob, and includes parts of the ranges west of Atherton, and Rocky Bluff north of the Walsh River. The distribution of the unit is shown in **Figure 12.1**.

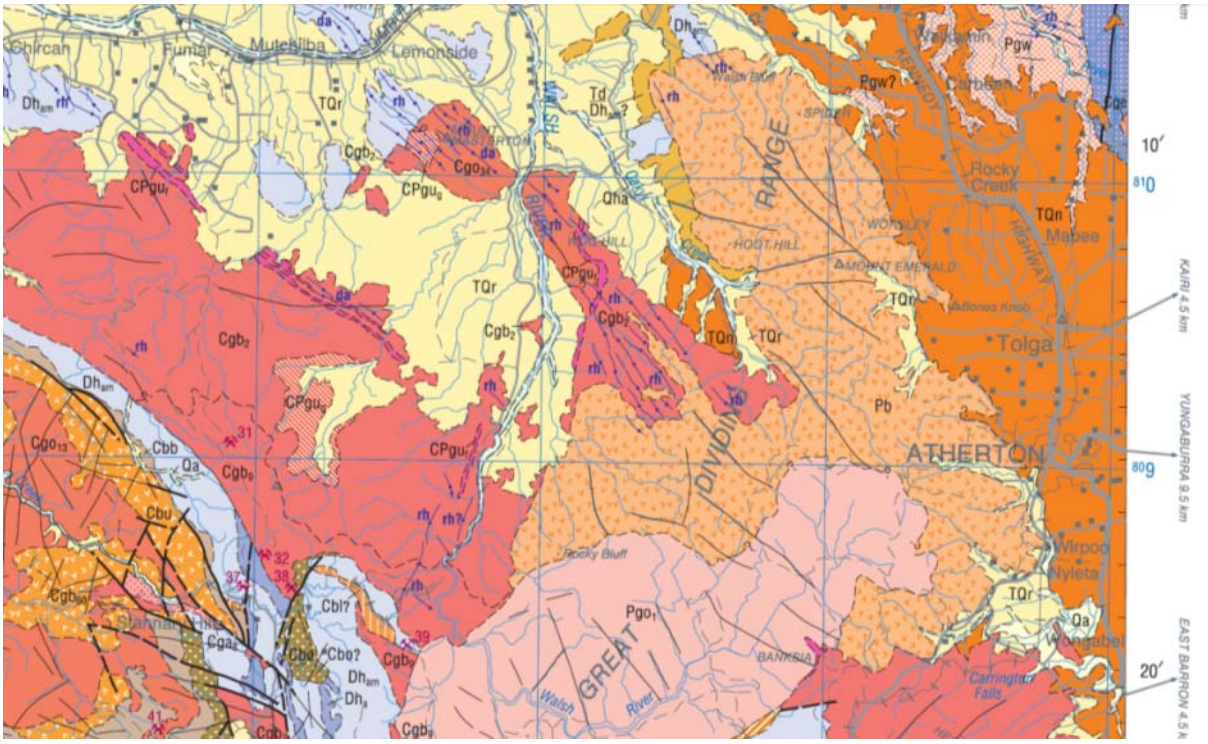

Figure 12.1 Extract from the ATHERTON 1:250 000 geological map sheet (Donchak, *et al*., 1997) showing the limit of the Walsh Bluff Volcanics (Pb)

12.3.3 Queensland Land Zone Concept

Land zones are central to the concept and categorisation of Queensland's remnant vegetation communities and the regional ecosystem classification (RE) after Sattler and Williams (1999). Wilson and Taylor (2012) define land zones as major geologies and associated landforms. Queensland is classified into 12 land zones.

The site is mapped as Land Zone 12, which is broadly defined as older Mesozoic to Proterozoic igneous rocks. Another wide definition is given as "Metamorphosed Cretaceous and older igneous rocks" (Wilson and Taylor, 2012).

The detailed description of Land Zone 12 (Wilson and Taylor, 2012) is "*Mesozoic to Proterozoic igneous rocks, forming ranges, hills and lowlands. Acid, intermediate and basic intrusive and volcanic rocks such as granites, granodiorites, gabbros, dolerites, andesites and rhyolites, as well as minor areas of associated interbedded sediments. Excludes serpentinites (Land Zone 11) and younger igneous rocks (Land Zone 8). Soils are mainly Tenosols on steeper slopes with Chromosols and Sodosols on lower slopes and gently undulating areas. Soils are typically of low to moderate fertility*."

12.3.4 Geotechnical Investigations

An initial Geotechnical assessment was carried out by ETS Geotechnical in July 2013 with the aim of providing a preliminary understanding of general site geology, water table depths, engineering design parameters for the soil and rock types encountered and preliminary advice in relation to footing design and bearing options (**Appendix 11**).

Key findings of the investigation include:

- A shallow soil profile existed at borehole locations, generally less than 1m thick. Soils consisted of Sandy Silt (ML) with low plasticity with fine to coarse sand of stiff consistency. Soils were underlain by slightly

weathered to fresh rhyolitic ignimbrite with minor moderately and highly weathered zones. Initial assessment of rock strength, later confirmed by laboratory analysis, was of high to very high strength.

- Excavation of the slightly weathered rock can be carried out by bull dozers (D8/D9) in bulk excavations and excavators with ripping tynes in confined excavations. Excavation of the fresh rock will need to be carried out with a large bull dozer (D11) or with a combination of hydraulic fracturing plus ripping with a D9 dozer.
- Given the limited investigation and high strength of the rock it is suggested that an allowance should be budgeted for rock breaking works in addition to minor blasting. Consideration could be given to lightly blasting of the rock mass to loosen it and to facilitate excavation.
- Excavation through the sandy silty soils is expected to be readily undertaken using conventional earthmoving equipment (i.e. backhoe or excavator).
- Subsurface conditions are suitable for use of a raft turbine foundation system; however rock anchors or rock socketed piers would also be suitable, subject to detailed investigations at each turbine site.
- Shallow foundations will likely require rock excavation or blasting at most locations to achieve planned foundation depth or placing the foundations at the bedrock surface and raising the site grade to provide the required soil cover over the foundations to provide stability.
- Further detailed geotechnical investigations will be required during the detailed design phase to guide specific foundation design for each turbine

Table 12.2 presents short and long-term recommended maximum batter angles for excavations through the soil profile.

Table 12.2 Batter Angles

Material	Short Term	Long Term
Controlled Fill	1H:1V	2H:1V
Sandy SILT	1.5H:1V	2H:1V

These values apply to dry and batter heights of up to 3.5 metres in soil above the water table.

Flatter batter slopes would be required where seepage is encountered and further geotechnical advice should be requested if this occurs. It is essential that batters be suitably protected from erosion and scour by the establishment of ground cover and shrubs, installation of surface drains, etc. Runoff should not be allowed to discharge directly across the batters.

Groundwater was not encountered during the investigations but if required, sump and pump dewatering methods are expected to be suitable only when catering for minor seepages through the less permeable silty/clay soils.

12.3.5 Erosion Potential Impact

The rate and severity of erosion depends upon slope angle, slope length, aspect, elevation, prevailing weather direction, flood susceptibility and the erodibility of each particular soil type. K factor is the soil erodibility value which represents both the susceptibility of soil to erosion and the rate of runoff. Essentially deeper soils are less susceptible to erosion than shallow soils because more rainfall can be stored in the soil profile before it runs off potentially causing erosion, whereas lighter textured soils are less susceptible because of higher infiltration rates that minimise volume and rate of potentially erosive stormwater.

Although there is only considered to be a low to moderate erosion risk across the study area, during construction and maintenance there is an increased potential for erosion in steep terrain where soil,

particularly finer subsoil is exposed and/or excavated for new access tracks and tower locations. Gully erosion is most likely to occur on hilly and steep terrain, while areas of lower relief are potentially more susceptible to sheet erosion and rill erosion.

Fine sediments displaced as a result of erosion may be carried downstream and potentially adversely affect the water quality of Granite Creek and its tributaries and hence dependent aquatic ecosystems.

12.3.6 Erosion Mitigation Measures

In general, best practice erosion and sedimentation control involves the principles of (in order of preference):

- Avoidance;
- Minimisation; and
- Treatment.

A primary objective for erosion control is avoidance by limiting the amount of exposed soil subject to erosion. In order to achieve this, the existing access tracks will be utilised wherever practicable. However due to the larger vehicles to be used during the construction phase, exposure of soils due to additional clearing will be unavoidable. Civil works in rock pavement areas with little soil and weathered rock substrate will undergo a certain amount of self armouring; cut and fill batters in areas with soil development will however, be very susceptible to erosion and require careful attention to erosion and sediment control.

All areas to be disturbed must be assessed individually according to site-specific conditions. Further detailed geotechnical and environmental soil investigations will be carried out during the detailed design phase to assist in determining any 'high risk' erosion areas. 'High risk' erosion areas include:

- Sites in close proximity to watercourses;
- High k factor values (erosion);
- Areas considered environmentally significant (i.e. riparian areas, montane heath environments);
- Steep slopes; and
- Dispersive saline and/or sodic soils.

Each construction site must be assessed with regard to the factors outlined above before works commence. If erosion is considered likely, an erosion strategy (Erosion and Sediment Control Plans (ESCP)) will be formulated for the construction and operation phases of the proposed works and identified clearly in both the CEMP and subordinate Environmental Work Plans (EWPs). The ESCP should meet the requirements set out in *Best Practice Erosion & Sediment Control* (International Erosion Control Association, Australasia, 2008) which outlines best practice sediment and erosion control measures in Queensland.

Erosion mitigation measures, as identified in the Draft EMP (**Appendix 33**), include:

- Implementation of the requirements of the ESCPs for each stage of construction. Installation of devices prior to soil disturbance from construction activities where possible;
- Maintain access tracks in good condition. Adequate erosion and sediment controls will be installed to reduce the likelihood of track deterioration and soil tracking;
- Develop specific benching or work plans for high erosion areas and steep benching sites prior to soil disturbance. These benching or work plans will detail the construction and controls/methods to be deployed to reduce the potential for pad failure, erosion and downstream sedimentation. Permanent engineering structures such as gabion walls and rock rip-rapping or groundcover vegetative controls will be used, where necessary, to ensure the long term stability of work areas;

- Provide on sites where there is potential for downstream sedimentation, sediment fences, mulch berms, maintenance of vegetative buffers or other sediment controls down slope of the work area. Maintain and install the controls in accordance with the *Best Practice Erosion and Sediment Control Guidelines (International Erosion Control Association, Australasia, 2008);*
- Install clean water diversions upslope of sloping WTG sites to direct clean stormwater away from work/bare areas. Where possible, runoff from access tracks will also be directed away from WTG sites;
- Direct all uncontaminated (clean) stormwater to stable land, ensuring that water is dispersed / diffused to prevent erosion;
- Strip topsoil (~200mm depth) separately and retained for rehabilitation/stabilisation activities;
- Respread/cover tower and permanent pad batters with topsoil and rehabilitate as soon as practicable on completion of pads;
- Stabilise pad surfaces using methods such as topsoiling and revegetation or gravelling, where there is a risk of erosion of the pad;
- Do not carry out clearing activities within 50 metres of a watercourse; where required, improve or develop appropriately designed watercourse crossings that prevent erosion;
- Maintain vegetation cover along hardstands and access tracks where possible. Reduce damage to grass cover and sensitive heath vegetation types by limiting vehicle movements to work areas and approved access tracks;
- Prepare and implement a dewatering plan or work procedure;
- Keep off site adjacent sealed public roadways clean and free of sediment. Tracking of soil onto local roads will be prevented by:
- Limiting off road vehicle movements after rainfall events to that essential for efficient and safe construction activities;
- Installing in areas with problematic soil types, a rock rumble pad or similar device in accordance with the *Erosion and Sediment Control Best Practice Guidelines* near the intersection of the access track and the sealed road;
- Providing brush/wash down equipment to remove loose soil from wheels, wheel arches, tracks, augers and under bodies; and
- Limiting access during and immediately after wet weather, when access tracks may be severely damaged by vehicle movements and there is a high possibility of the transport of soil materials onto sealed public roads.
- Retain sediment fences and other temporary erosion and sediment controls in place and maintained until the site has been successfully stabilised. On successful stabilisation, the temporary controls will be removed; and
- If wind erosion occurs, water trucks or sediment fences should be installed to minimise soil loss and soil movement away from the construction site.

Monitoring

- Before erosion control devices are removed, residual erodibility of the construction area should be assessed; and
- All remaining erosion control measures will be monitored for their effectiveness for at least 12 months. Remedial measures will be put in place should any controls fail.

12.3.7 Contamination Potential Impact

The site is not included on the Environmental Management Register nor the Contaminated Land Register (DERM, 2011) however, as per **Section 19.6**, an Unexploded Ordinance Investigation was required.

Soil contamination can occur as a result of spills, vehicle and machinery wash downs, or the intentional use of soil ameliorants or additives. Excessive use of herbicides has the potential to contaminate soil, as well as the organic layer, which may in some situations comprise a veneer of leaf litter and support a diverse range of soil invertebrates. Other soil contaminants include faecal waste, domestic rubbish as well as weed seed or weed matter.

The potential contamination of soil with weed matter is particularly important given the sensitivity of any riparian and montane heath environments through which interconnecting tracks and turbine construction pads are proposed. These environments are also particularly susceptible to weed invasion with weeds able to colonise natural areas in the wet tropics bioregion at a rapid rate. "New" weeds in an otherwise well-managed farm area also raise significant issues, such as economic loss and degradation of farming land.

12.3.8 Contamination Mitigation Measures

Mitigation measures to reduce the risk of soil contamination include:

- Chemical and petroleum products will be brought onto site as required, thereby minimising the quantities of these products stored on construction sites and reducing the risk of spillage. Storage of these products shall be within a designated bunded area that has the capacity to hold 120% of the largest volume container. Fuel storage areas will be designed in accordance with AS1940;
- Temporary storage and containment of spills and leaks of chemical and petroleum products shall be in accordance with Material Safety Data Sheets, the Australian Standard for the Storage and Handling of Flammable and Combustible Liquids (AS1940) and the *Workplace Health and Safety Act 1995*;
- Only minor servicing of equipment shall be allowed on site. Other routine and major servicing of vehicles will not be undertaken within the easement;
- All refuelling will be confined to designated areas, however heavy machinery which cannot be cost effectively refuelled at designated sites, must be refuelled using best practice techniques;
- No refuelling is to be undertaken within 50m of waterways and spillage of any kind will be treated as a non-conformance and remedial action taken;
- All refuelling will be undertaken to adequately control potential fuel spills (e.g. bunds, truck absorbent beams);
- Waste collection bins will be provided by the contractor at the contractors' camps/offices and laydown areas. Collection bins will enable the sorting of waste into general refuse, recyclables and regulated wastes. Bins will be collected and contents disposed of in accordance with local and State government regulations.

12.4 Waste minimisation and management

This section considers waste generated during the construction and decommissioning of the WTG's, oils and lubricants, solid waste and vegetative waste. It may also contain soil and other materials contaminated by fuel and oil or contaminated with the seeds or parts of listed or environmental weed species.

12.4.1 Waste – Potential Impacts

The risks associated with the construction and maintenance of the proposed MEWF project are low as they will mainly consist of inert substances, with only small amounts of fuel and hazardous chemicals stored on site.

12.4.2 Waste – Mitigation Measures

Detailed mitigation measures for the control of waste are contained within the EMP (**Appendix 33**). Some of these mitigation measures include:

- Materials from the decommissioned line will be recycled where possible;
- Oil and lubricants and other regulated waste will be removed from site and disposed of using a licensed specialist contractor;
- Solid waste will be removed from site and disposed of in collection bins at the contractor's camps. The collection bins will enable the sorting of this waste into recyclable and non-recyclable bins. These bins will then be collected by contractors; and

12.5 Water

12.5.1 Existing Environment

12.5.1.1 Watercourses

Watercourses occurring in the study area were mapped using the Department of Environment and Resource Management's (DERM) Regrowth Watercourses data (version 2.0, 2010). These features are shown on the mapping given in **Figure 12.2**. The mapping shows that a number of lower order watercourses will be crossed by the main site access track and turbine access tracks (mostly first order stream features). All these features flow intermittently during the wet season, and their integrity is expected to remain in near natural condition with expected limited levels of disturbance. Where these features are intersected, the proposed tracks will use existing stream crossings on the existing main track currently used as maintenance access for the powerline infrastructure.

A comprehensive survey of watercourses was not undertaken in the field, although detailed floristic investigations were undertaken of a reach of Granite Creek approximately situated in the centre of the study area. This section of watercourse is in sound ecological condition. Vegetation lining this feature is limited to a narrow band of *Lophostemon grandiflorus* trees, which form the only differentiation between stream bank dependent vegetation and the surrounding woodland. This limited floristic diversity is an indicator of seasonal flows and relatively dry bank conditions.

Depending on the intensity and duration of the wet season, small pools may persist through the dry season along the central watercourse which is a second order tributary of Granite Creek. The main access track crosses this watercourse once.

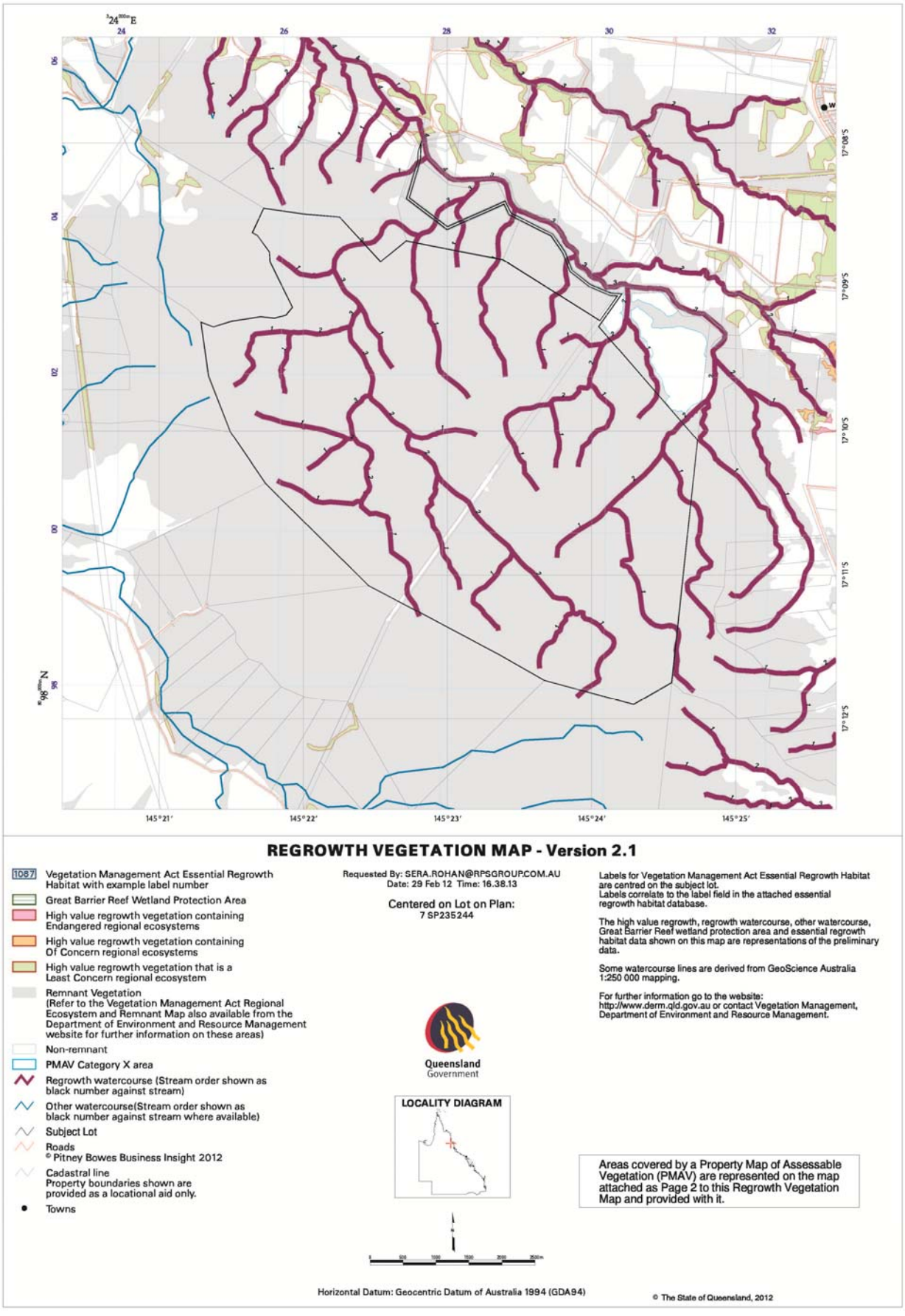

Figure 12.2 Regrowth Watercourses on the proposed MEWF project site.

12.5.2 Wetlands

Granite Creek at the base of the wind farm project area is mapped as a Wetland by DEHP. A reach of this watercourse adjacent to the main entry point and lower access road into the site has a 100 m buffer shown as a Wetland Management Area trigger zone. (**Figure 12.3**) Approximately 1 km of the lower access road passes through this trigger area due to the proximity of the existing track to Granite Creek. However, in August 2012, this management zone requirement was removed by *the Sustainable Planning Amendment Regulation (No. 5) 2012*.

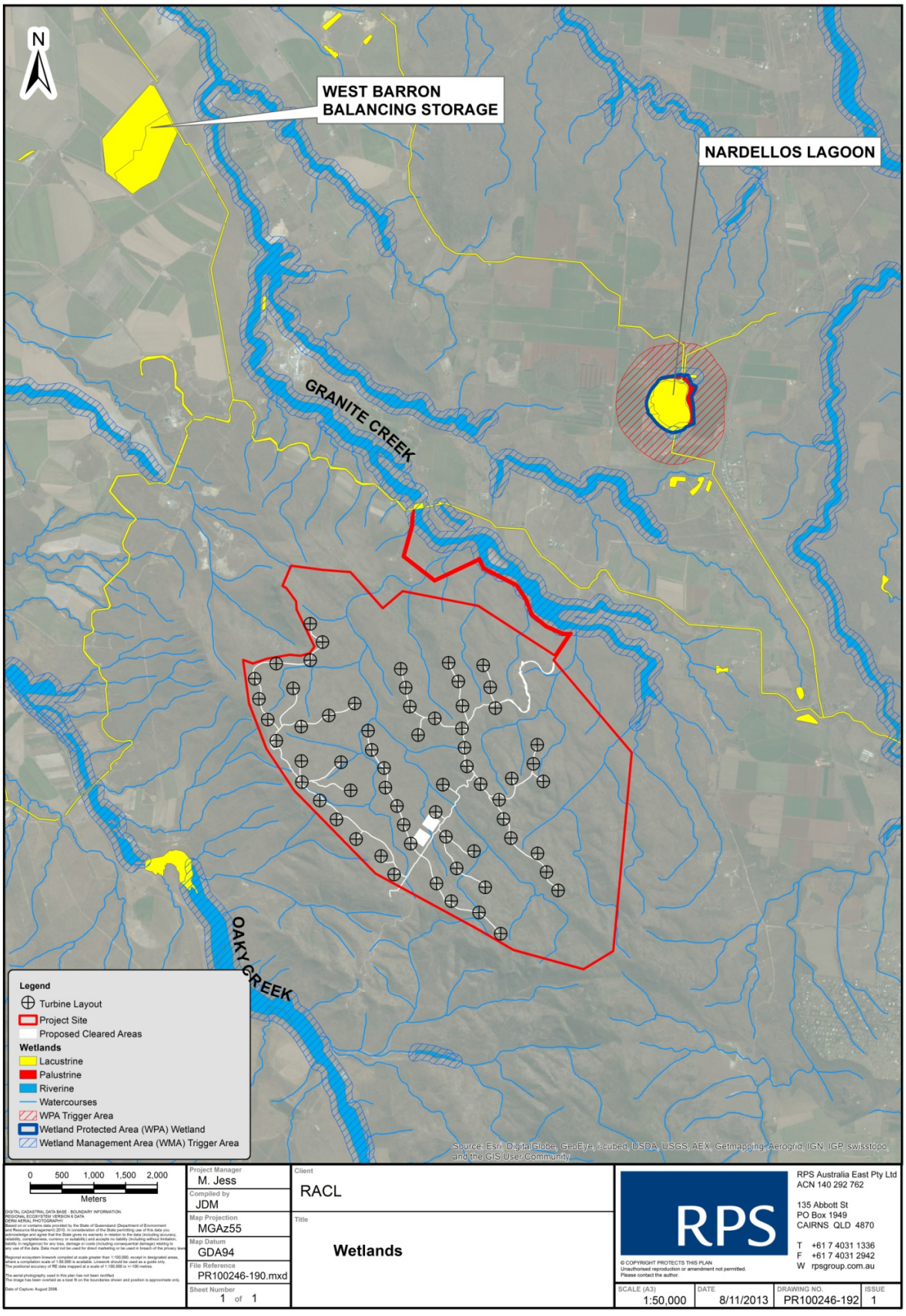

Figure 12.3 Wetlands in the vicinity of the project site

12.5.3 Existing Water Quality

Granite Creek along Kippen Drive and some tributaries are considered to be slightly to moderately disturbed ecosystems under ANZECC (2000) guidelines. At higher elevation within the wind farm footprint, the upper reaches of Granite Creek and its tributaries are undisturbed and show no significant signs of modification other than culvert crossings and some weedy grasses at these crossings. A quantitative baseline water quality assessment was not undertaken, however the site is subjected to only slight disturbance from clearing associated with the Chalumbin to Woree Transmission line and maintenance tracks and as such, site watercourses are expected to exhibit high water quality. It is noted that areas of high erosivity occur on site and anecdotal observations identified event based turbidity spikes, considered to result from natural sediment loads and varying contributions from existing track drainage.

12.5.4 Impact Assessment – Construction and Decommissioning

Civil construction activities such as track and turbine construction pads have potential to impact on site water quality as a result of stormwater runoff from earthworks disturbance to moderate to highly erodible soils, particularly in the southern parts of the site. Approximately 57 hectares of clearing (tracks; turbine construction pads) will be required, the majority of which will be along ridgelines. Detailed civil design plans will be prepared following approval; however it is likely that a significant amount of cutting and filling will be required to enable heavy and long vehicle access to the ridgelines and turbine sites. In these areas, topsoil depth is minimal and underlain by weathered rock which is far less erodible. Fill batters will be subject to more erosive forces, whereas track bases and cut batters will most likely be constructed in weathered rock which is less erodible and self armouring to varying extents.

Management of sewerage for an estimated maximum construction workforce of 250 could potentially impact on site water quality. If on-site effluent disposal is proposed, an Environmental Authority (ERA 63) will be required. Soils in the elevated parts of the site are generally shallow and not suitable for effluent disposal, however soils in the central “bowl” area are deeper and may be suitable. Detailed soil suitability assessments would be required by DEHP as part of the EA approval process. The selected construction contractor may choose to store and truck effluent off-site for treatment.

12.5.5 Impact Assessment – Operation

Water quality impact considerations during the operational phase relate primarily to erosion and sediment control and sewerage management. The key issue will be adequate maintenance of erosion and sediment control structures, particularly during the wet season including desilting of sediment basins and repair of track and batter stabilisation failures. Details of ESCP maintenance systems will be provided in the CEMP.

12.5.6 Management and Mitigation

Water quality management will be a key focus of the Construction Environmental Management Plan (CEMP) involving careful consideration of erosion and sediment control, water quality monitoring and adaptive management.

Detailed design of tracks and turbine construction pads will need to be cognisant of the high erosion risk at the site and should include detailed certified construction and operational phase erosion and sediment control plans including consideration of the following elements:

- Temporary and permanent drainage control through the sites;
- Upstream clean water diversions;
- Dirty water treatment strategies;

- Temporary pavement/batter erosion prevention (surface stabilisation) ;
- Final pavement sealing (gravel seal minimum); and
- Final fill batter stabilisation treatments.

Consideration of erosion and sediment control measures is provided in the EMP framework, **Appendix 33.** In accordance with ANZECC (2000) principles site water management should include a program of baseline and impacted area water monitoring during construction; it is recommended that baseline water monitoring commences prior to construction and/or during construction in undisturbed parts of the site. The CEMP should also identify a range of impact monitoring sites monitoring frequencies and water quality objectives and adaptive management protocols.

12.5.7 Water Demand

The construction phase of the project will require water for the following uses:

- Moisture conditioning of earth fill;
- Equipment washdown;
- Dust suppression;
- Potable water for site personnel; and
- Fire fighting.

The potential sources of water would depend on the water quality requirement for each application. Water for moisture conditioning of fill and for dust suppression can be sourced from sedimentation basins which may be built to settle silted run-off from construction areas, or from external sources. It is estimated about 20 kilolitres (kL) per day (or two 10kL water cart loads) would be sufficient for moisture conditioning and dust suppression.

Potable water will be required for the consumption of the construction workforce and site visitors. The estimated potable water requirement during construction is estimated to reach a maximum of 17kL per day, based on a peak number of approximately 250 personnel, if the average daily consumption is conservatively assumed to be 70L per person. (On average, per capita household water consumption in Australia is 285L per day, according to the Australian Water Association http://www.environment.gov.au/node/22261. Assume ¼ of this for site requirements).

As there is no supply at the project site, potable water will be delivered by tankers. Potable water requirements during the operational phase will drop dramatically as the number of permanent staff on site is not expected to exceed 15.

Water storage tanks will be provided within the construction compound (during construction) and control building compound (during operation) for bulk potable water storage. Provisions will also be made to allow collection and storage of rainwater from the roof of site buildings. Water will be made available in site storages for fire emergency response.

12.6 References

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13.0 Matters of National Environmental Significance

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), actions that have, or are likely to have, a significant impact on a Matter of National Environmental Significance (MNES) require approval from the Australian Government Minister for the Environment (the Minister). The proposed MEWF project was referred to DotE in December 2012, and as identified in **Chapter 1 (Volume 1)**, a delegate of the Minister determined that the proposed MEWF project was a controlled action under the provision of the *EPBC Act* as the action has the potential to have a significant impact on a number of MNES and therefore required an EIS before approval could be considered.

The controlling provisions for the proposed MEWF project under the *EPBC Act* are:

(a) Listed threatened species and ecological communities (sections 18 and 18A);

(b) Listed migratory species (sections 20 and 20A);

(c) World Heritage Properties (sections 12 and 15A); and

(d) National Heritage Places (sections 15B and 15C).

This chapter considers the potential impacts on MNES, associated with the proposed MEWF project. The primary focus is on **Section 5.6** of the EIS Guidelines (**Volume 1; Appendix 2**), to assist DotE with their assessment. Specifically, this assessment demonstrated the likelihood of occurrence of listed threatened and migratory species on the MEWF site and the potential impacts to the Wet Tropics World Heritage Area (WTWHA), listed as both a World Heritage Property and a National Heritage Place.

13.1 Methodology

13.1.1 Desktop Surveys

A review of databases and information relating primarily to threatened species was undertaken as an exercise to determine the likelihood of a particular species occurring at or in the vicinity of the project site. The results of these searches and reviews of information assisted with planning targeted field surveys for conservation significant species. Concurrent with this review was an examination of vegetation mapping for the region.

The following databases and sources of information were reviewed:

- Regional Ecosystem mapping. The most recent version of the Department of Environment and Resource Management's (DERM) regional ecosystem (RE) vegetation mapping (version 6.0, November 2009 and updates) was used to provide an indication of the status and position of remnant vegetation in relation to landforms of the project site. This mapping was overlaid on a digital colour aerial photograph base sourced from Google Earth™;
- Regional Ecosystem Description Database (REDD). Detailed descriptions of remnant vegetation communities (regional ecosystems) in Queensland. Version 6.0b, January 2011 and updates;
- Essential Habitat mapping. In association with the RE mapping for the study area, essential habitat mapping has been prepared by DERM for conservation significant species. A review of this mapping in relation to the vegetation types and respective habitats was made to establish its relevance;
- Wildlife Online database of flora and fauna. This database is managed by the Queensland Department of Heritage and Environmental Protection (DEHP) and holds records of plants and animals that have either been sighted or collected within a given radius of the site (a search parameter was prescribed limiting the search area to a 10 km radius around an approximate central point of the study area). The records held

in this database are jointly maintained by Queensland's Environmental Protection Agency and the Queensland Parks and Wildlife Service - now incorporated into DERM;

- Protected Matters database of MNES. This database applies a range of bio-models to predict the presence of species of flora and fauna and other MNES within a given radius of the site (a search parameter was prescribed limiting the search area to a 10 km radius around an approximate central point of the study area), as cited under the Commonwealth's *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- Atlas of Living Australia (ALA) contains a range of biodiversity data covering various aspects of the lives and nature of Australian species. Data in the Atlas of Living Australia (Atlas) is provided by a wide range of organisations, websites, individuals, community groups, government departments and information systems.
- HERBRECS database of plant records. This database provides confirmed records of plant collections made within a specified area, of which voucher specimens are held by the Environmental Protection Agency's (EPA) Queensland Herbarium. Data from this source provides useful information on the location of rare and threatened species and expedites targeted surveys for such plants in the field;
- Queensland Museum Biodiversity database. This database provides confirmed records of fauna species recorded within a specified area. Data from this source provides additional information on the known location of rare and threatened fauna species;
- Regional Vegetation Management Code – Coastal and Western Bioregions. The 'Performance Requirements' of these codes (as issued under the *Vegetation Management Act 1999*) were addressed and interpreted for their relevance to the project; and
- Literature review. A range of scientific papers and other literature were reviewed for a number of related matters.

13.1.2 Data Availability and Accuracy

The collated threatened and migratory fauna species records (**Appendix 12**) for the area are known to vary in locational accuracy and reliability (especially QLD DEHP Wildlife Online database records). During the review of threatened species records sourced from the Wildlife Online Database, consideration has been given to the reliability of each threatened species record in addition to an assessment of habitat suitability within the site. Similarly the EPBC Protected Matters Search Tool is a predictive model, which identifies species that have previously been recorded, or for which suitable habitat exists or could potentially occur within the area. This database is subject to the same inherent inaccuracy issues as the Wildlife Online database. In order to address these limitations in respect to data accuracy, threatened species records have been used to provide a guide only to the types of species which occur within the locality of the site. As a consequence, habitat assessment and the results of surveys conducted within the site have been used to assess the likelihood of occurrence of threatened species within the site (**Table 13.1**).

13.1.3 Ecological Surveys

Section 5.6 of the EIS Guidelines (**Volume 1**; **Appendix 2**) explicitly requests details of the full suite of surveys undertaken on the project site. Ecological surveys have been conducted on site since May 2010. The emphasis of the original ecological surveys was to assess the general ecology of the site and to assess the presence/absence of MNES species for the referral process. Further surveys (from 2012), involved targeted surveys, specific to an individual species considered at risk (i.e. Northern Quoll, Sarus Crane, Bare-rumped Sheathtail Bat and Spectacled Flying-fox). Many of these surveys focussed on fauna; flora surveys were undertaken at lower frequency and with less spatial coverage.Survey events occurred over a three year period, however the methodologies chosen to satisfy the requirements of the EIS Guidelines were to survey from August 2012 to September 2013 (i.e. to provide a seasonal spread of survey effort).

Appendix 13 describes these surveys and the location of supporting documentation is discussed in this Chapter and throughout the document. Over three years a considerable number of surveys were taken across the site. **Figure 13.1** shows the vegetation surveys while **Figures 13.2 - 13.4** below; identify the locations of fauna surveys on site, over three years. Proposed turbine locations (up to 75 original) and other site characteristics were surveyed during this time.

13.1.4 Flora Survey Techniques

Representative sites were selected across the project area in order to sample the vegetation types likely to be impacted by the establishment of the wind farm, and to understand the diversity of vegetation types and probable locations of particular flora species restricted to special habitats or limited by environmental conditions.

All vascular plant species were recorded including trees, shrubs, grasses, forbs and graminoids. A cumulative inventory of species was compiled over three years. For species that could not be identified in the field, a voucher specimen was collected and used for later identification. A large number of specimens were lodged with the Queensland Herbarium (BRI) for formal identification; however none of these species was a rare or threatened species that has not been considered in this EIS.

Ground searches were made for threatened plant species. In many cases, these searches extended beyond the bounds of representative vegetation survey plots, and typically included the proposed turbine access tracks. This land is mostly associated with ridge topography.

13.1.5 Fauna Survey Techniques

A variety of survey techniques were used to provide a comprehensive assessment of fauna species occurring on the site. The trapping and fauna detection methods used were based on the standard biological survey methodology developed by the NSW Department of Primary Industries and Animal Research Review Panel, and approved by the Queensland Department of Environment and Resource Management (DERM) and the Queensland Department of Employment, Economic Development and Innovation (DEEDI) Animal Ethics Committee. Specifically, the survey methodology was developed and undertaken in accordance with the following guidelines:

- Wildlife Survey Guidelines, NSW Department of Agriculture and NSW National Parks and Wildlife Service (recognised and recommended wildlife survey guidelines for Queensland use) including:
- Guideline 3 – General ethical considerations and wildlife surveys;
- Guideline 4 – Surveys of terrestrial and arboreal mammals;
- Guideline 5 - Surveys of bats;
- Guideline 7 – Surveys of birds;
- Guideline 8 – Surveys of reptiles and amphibians;
- ANZCCART Guidelines for the Euthanasia of Animals Used for Scientific Purposes; and
- Hygiene protocol for the control of disease in frogs (NSW National Parks and Wildlife Service).

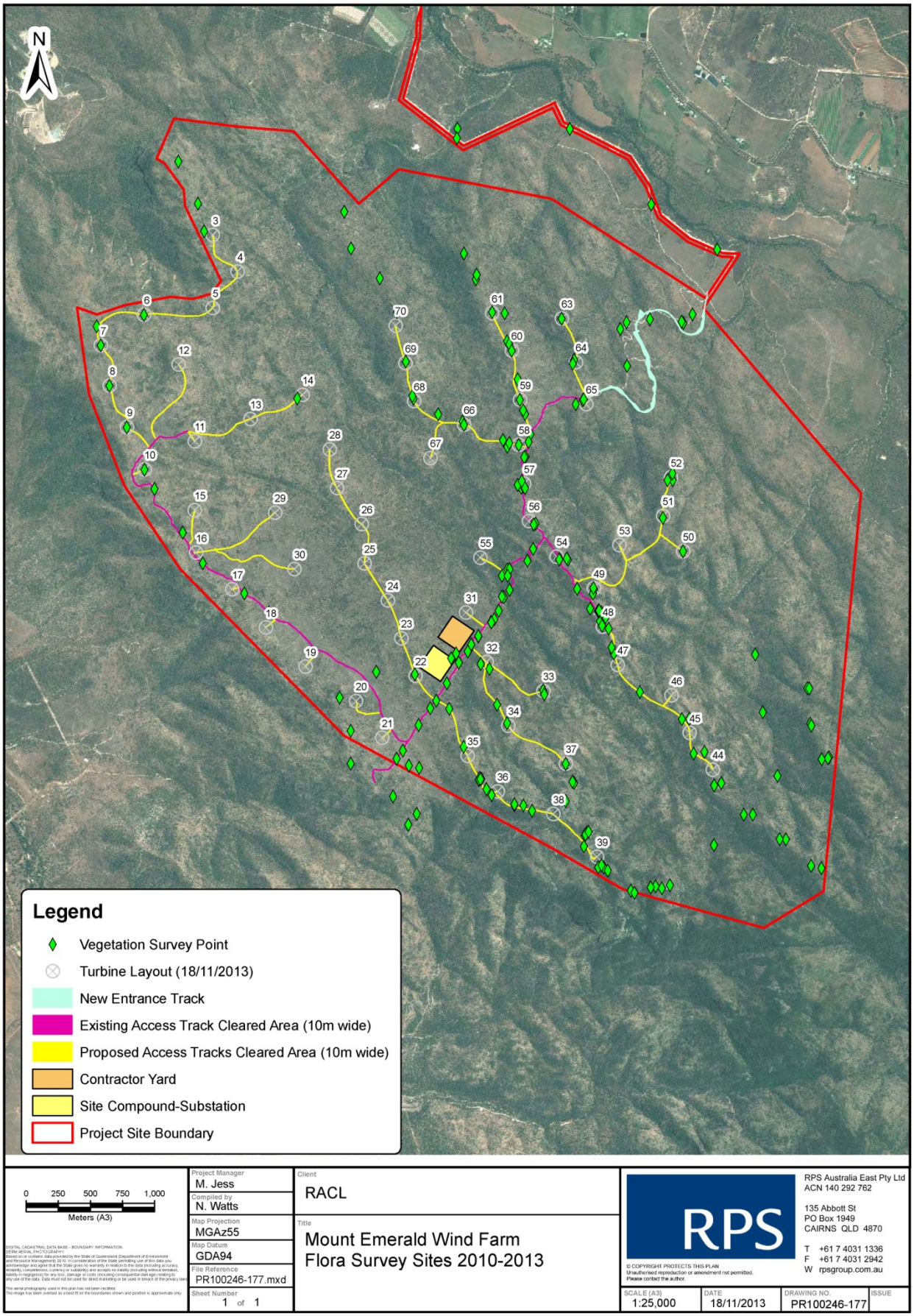

Figure 13.1 Vegetations Surveys on the proposed MEWF site between 2010 and 2013.

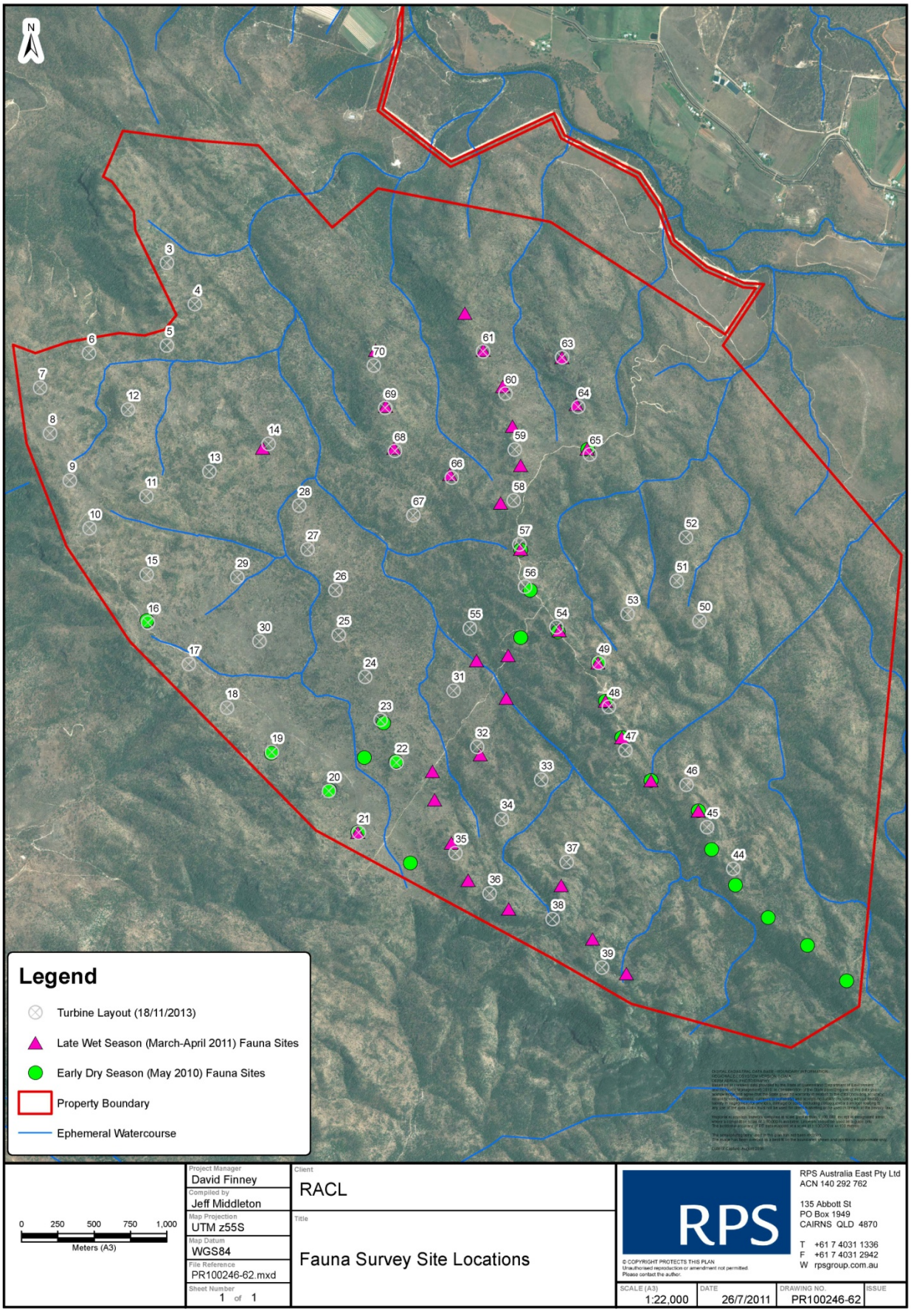

Figure 13.2 Fauna Survey Site Locations from 2010-2011.

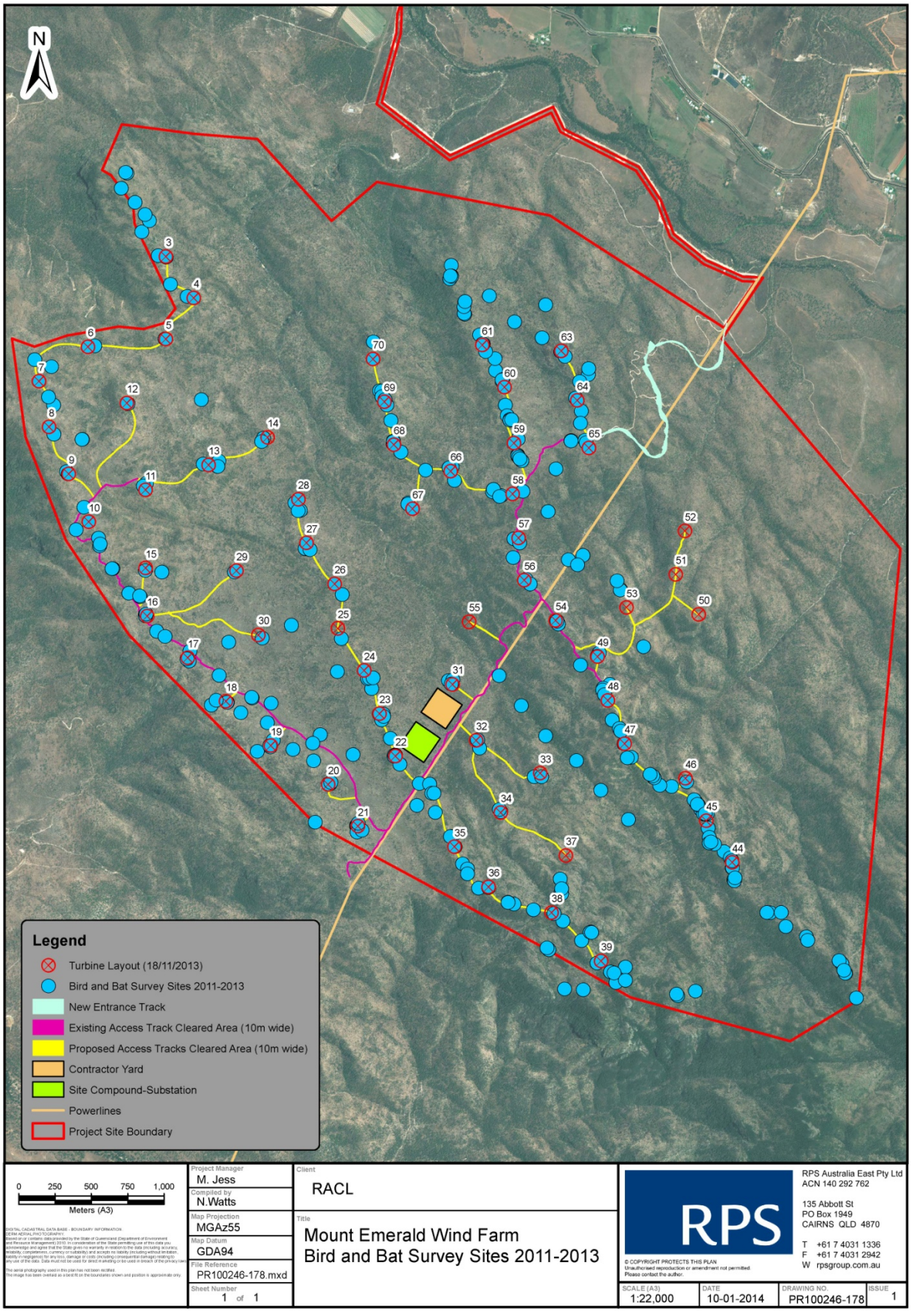

Figure 13.3 Bat and Bird Survey Site Locations from 2011-2013.

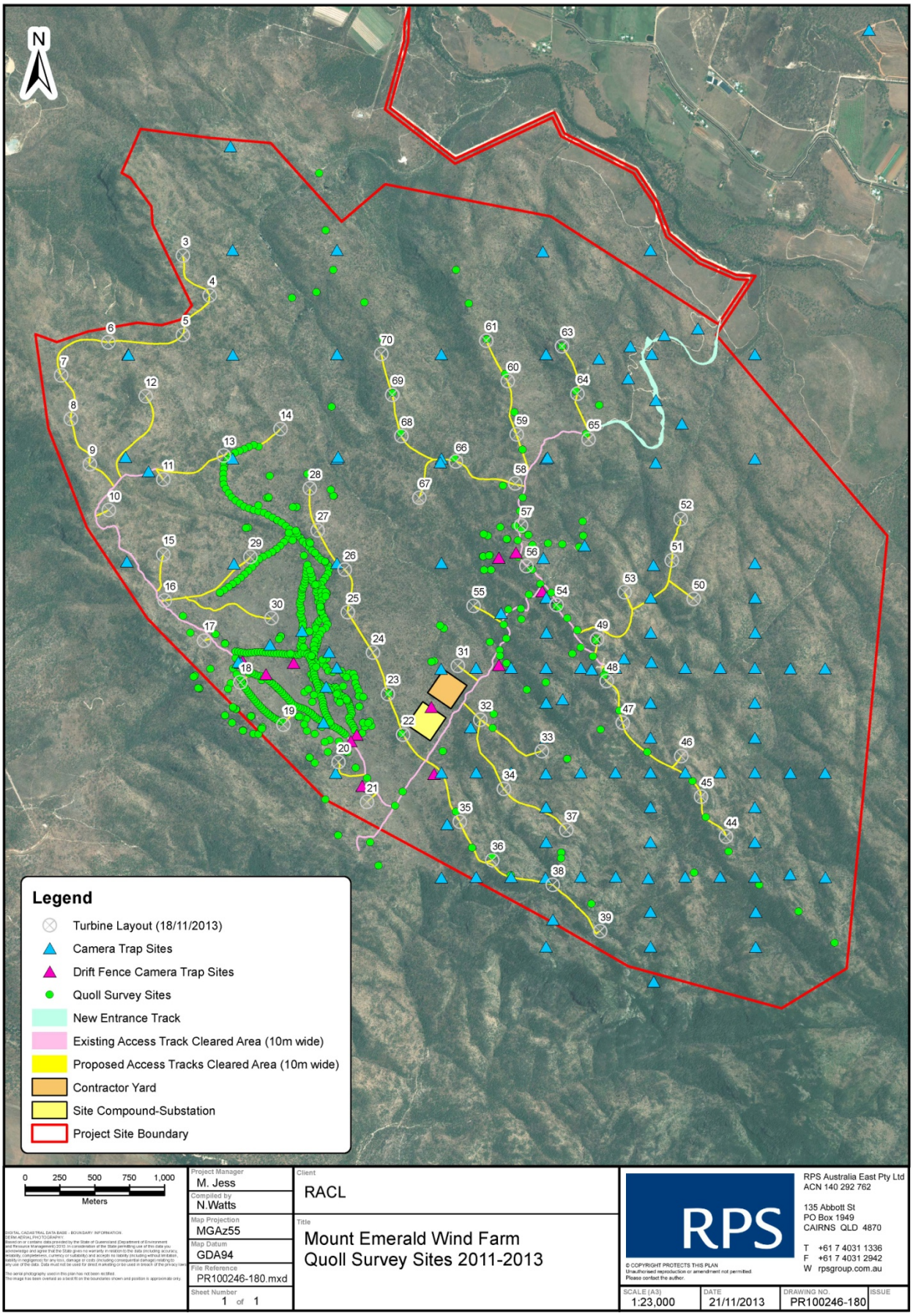

Figure 13.4 Quoll Survey Site Locations from 2011-2013.

13.2 Listed Threatened Ecological Communities

The EPBC Protected Matters search tool lists two threatened ecological communities as potentially occurring on the wind farm site. The relevance of these communities in relation to the wind farm site are discussed below.

13.2.1 Broad leaf tea-tree (*Melaleuca viridiflora*) woodlands in high rainfall coastal north Queensland (endangered)

This community was not observed within the wind farm site. Although the diagnostic tree *Melaleuca viridiflora* does occur across a range of habitats within the site, the species does not form characteristic woodlands. Where it occurs on the site, *M. viridiflora* is primarily a sub-component of woodlands dominated by trees such as *Corymbia leichhardtii* and *Eucalyptus lockyeri* subsp. *exuta*. This association occurs within the flatter, central parts of the site, where *Callitris intratropica* is also present around rocky areas and zones of exposed rock pavement.

Queensland's regional ecosystem mapping does not indicate that the following associated remnant communities occur on the site: 7.3.8a, 7.3.8b, 7.3.8c, 7.3.8d, 7.5.4g.

**Explanatory Note – community numbering protocol:

- the first number relates to the bioregion (i.e. Wet Tropics);
- the second number relates to the land zone (i.e. 3 – alluvial river and creek flats, and 5 - old loamy and sandy plains);
- the third number relates to the vegetation community floristic composition and description.

Land Zone 3 is associated with watercourses and the alluvium deposited from these features. Land Zone 5 refers to more extensive plains. Land Zone 5 is not present within the wind farm site. None of the probable candidates for supporting the endangered Broad-leaf Tea Tree woodland are present on the wind farm site. The predominant land zone of the wind farm site is Land Zone 12: hills and lowlands on granitic rocks.

13.2.2 Mabi Forest (Complex Notophyll Vine Forest 5b) (critically endangered)

Mabi forest was once widespread on the Atherton Tableland. It is a rainforest type (vine forest) and occurs on basalt soil. Being floristically rich and typically hosting a high percentage of valuable timber species, it was extensively cleared during the early days of settlement and development of agricultural land. Two Queensland regional ecosystems correspond with Mabi Forest: RE 7.8.2 and 7.8.4 – both occur on Land Zone 8 (basalt plains and hills), which is not present on the wind farm site. The predominant land zone of the wind farm site is Land Zone 12: hills and lowlands on granitic rocks.

13.3 Listed Threatened Species

13.3.1 Flora and Fauna

The EPBC Protected Matters Search Tool and Queensland's Department of Environment and Heritage (DEHP) Protection Wildlife Online database (DEHP, 2013a) returned a total of 28 threatened fauna species and 22 threatened flora species as being known to occur or having the potential to occur within a 10 km radius of the approximate centre of the project area (-17.166736^{O} lat, 145.386955^{O} long).

The EPBC Protected Matters database is a predictive model that identifies all species that could potentially occur or have suitable habitat within a given radius of the site. It applies a range of bio-models to predict the presence of those species and does not necessarily mean the species has been previously recorded in the area. This tool only lists species cited under the EPBC Act, and does not list species cited under state

legislation (i.e. Queensland's *Nature Conservation Act 1992*). The information used to produce the Wildlife Online data is based on collated wildlife records acquired by DEHP through a range of sources including;

- Specimen collections (e.g. herbarium vouchers, museum records);
- Research and monitoring programs;
- Inventory programs including extension activities;
- Literature records;
- Wildlife permit returns (issued under Queensland legislation); and
- Community wildlife recording programs.

Of the 22 flora species assessed for likelihood of occurrence (**Table 13.1**), 14 species are not considered likely to occur on the site due to the absence of suitable habitat. Six species have a moderate to high chance of being present on the site although surveys did not locate any specimens. Two species were confirmed on site, *Grevillea glossadenia* and *Homoranthus porteri.*

One fauna species was added to this assessment that was not predicted to occur by either fauna database. The Buff-breasted Buttonquail was not included in the EPBC Protected Matters Search Tool, but is considered as potentially occurring within the site, based on professional knowledge, the presence of suitable habitat in open *Eucalyptus* woodland and known records from nearby Mareeba and Mt Molloy. A report considering the Nature Conservation Act and EPBC listed fauna of conservation concern is located in **Appendix 14**. Only species listed as MNES are considered further here.

To assist in assessing the likelihood of occurrence, locations of fauna sightings and museum records were obtained from the Atlas of Living Australia, Qld Museum fauna record databases and previous studies undertaken on the site (RPS 2012). Likelihood of occurrence was determined for the species utilising the site for any purpose, including overflying. The site has a number of small wetlands in proximity, and several wetland species (e.g. Little Pied Cormorant, Darter, Australian Pelican, Ducks, Little Black Cormorants, Sarus Cranes) have been observed overflying, but not actually utilising any habitats within the subject site.

Of the 28 fauna species assessed for likelihood of occurrence under the EPBC Act in **Table 13.1** below, 12 species are not considered likely to occur on the site due to the absence of suitable habitats: principally closed rainforest, wet sclerophyll forest, permanent wetlands or streams. An additional five species, the Squatter Pigeon, Eastern Bristlebird, Star Finch (eastern), Northern Bettong, and Brush-tailed Rabbit Rat are also considered unlikely to occur on the site given knowledge of their known current distributions. Nine species are considered to have a 'moderate' likelihood of occurrence either due to the presence of suitable habitat or likelihood of overflying, but no positive sightings during field investigations. Of the EPBC-listed fauna, three threatened species, the Northern Quoll, Spectacled Flying-fox and the Bare-rumped Sheathtail Bat were positively confirmed during the field surveys.

Table 13.1 Threatened Fauna and Flora Known to Occur or Having the Potential to Occur on the Site

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
FLORA					
A low shrub	*Acacia purpureopetala*	V	A low-growing, semi-prostrate shrub found on rocky soil in the Irvinebank-Watsonville region.	**MODERATE:** this wattle has been found on the western slopes outside the site. Population centres are around Irvinebank, Stannary Hills and near Silver Valley. A significant population occurs at Toy Creek near Watsonville.	
Red Silky Oak, Queensland Waratah, Tree Waratah	*Alloxylon flammeum*	V	A tree found in well-developed rainforest.	**LOW:** Absence of suitable habitat.	
Hairy-joint Grass	*Arthraxon hispidus*	V	A grass associated with wetter soils usually around rainforest	**LOW:** Unsuitable habitat and absence of rainforest and mesic vegetation.	
A creeper	*Cajanus mareebensis*	E	A trailing creeper found on sandy soil - often by roadsides.	**MODERATE:** Potential habitat along lower road access points and possibly gravelly terraces of upper reaches of Granite Creek.	
A forb	*Chamaesyce carissoides*	V	A forb of rock outcrops usually with "clean" faces. Found in the Newcastle Range to the west. Recorded from Stannary Hills and Newcastle Range.	**MODERATE:** Potential suitable habitat across many rock areas, and possibly more so in the Einasleigh Uplands section, where the rock surfaces are more akin to those found where the species occurs in the Newcastle Range.	
A cycad	*Cycas platyphylla*	V	A woodland cycad with bluish-green foliage. Found on slopes in the Stannary Hills region.	**MODERATE:** Not sighted and quite easily distinguished from close relative: *Cycas media* (which is on the site). Higher potential for this species to be in the SW of the site.	
Cooktown orchid	*Dendrobium bigibbum*	V	An orchid preferring semi-moist habitats that are protected from fire. Generally found in more northern aspects of Cape York Peninsula.	**LOW:** Absence of suitable habitat. Exposure and infrequent fires could preclude this species from occurring along ridges.	
An orchid	*Dendrobium johannis*	V	An orchid of humid environments often found near swamps.	**LOW:** Unlikely to occur in proposed development footprint because of dry conditions and absence of favourable habitat.	
A shrub	*Grevillea glossadenia*	V	A shrub of rocky ground, often found along road edges in the Irvinebank-Stannary Hills - Watsonville region.	**CONFIRMED:** A relatively common Grevillea on the site with main populations focussed in the Wet Tropics bioregion section. Occurs along track edges, on ridges, but rarely under woodland cover.	

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
A shrub	*Homoranthus porteri*	V	A shrub forming thickets on rocky soil and ridges and bare slopes.	**CONFIRMED:** significant populations along ridges in Wet Tropics bioregion section and mainly at elevation above 900 m ASL.	
Rat's Tail Tassel-fern	*Huperzia filiformis*	E	A rainforest epiphytic orchid of wet environments (along creeks).	**LOW:** Absence of suitable habitat.	
Water Tassel-fern	*Huperzia marsupiiformis*	V	A rainforest epiphytic orchid of wet environments (along creeks).	**LOW:** Absence of suitable habitat.	
Layered Tassel-fern	*Huperzia phlegmarioides*	V	A rainforest epiphytic orchid of wet environments (along creeks).	**LOW:** Absence of suitable habitat.	
Lesser swamp orchid	*Phaius australis*	E	A ground orchid of near-permanent wet soil, swamp margins.	**LOW:** Absence of suitable habitat.	
Swamp Lily, Greater Swamp-orchid	*Phaius tancarvilleae*	E	A ground orchid of near-permanent wet soil, swamp margins.	**LOW:** Absence of suitable habitat.	
An orchid	*Phalaenopsis rosenstromii*	E	An orchid of moist rainforests - often found near waterfalls.	**LOW:** Absence of suitable habitat.	
A shrub	*Prostanthera clotteniana*	CE	Rocky slopes and scree areas. A fabled sighting of this shrub was made in the Toy Creek area near Watsonville.	**MODERATE to HIGH:** The most probable habitats for this shrub are likely to be those found in the remote sections of the SW and closer to Mt Emerald (Ford & Conn, 2013).	
A shrub	*Sauropus macranthus*	V	A shrub found in moister environments such as rainforest.	**LOW:** A rainforest shrub - no suitable habitat on the site.	
Siah's Backbone, Sia's Backbone, Isaac Wood	*Streblus pendulinus*	E	A small tree of well-developed rainforest.	**LOW:** Absence of suitable habitat.	
Minute Orchid, Ribbon-root Orchid V	*Taeniophyllum muelleri*	V	A small orchid associated with moister environments such as rainforests and sheltered gullies	**LOW:** Absence of suitable habitat in proposed development zone.	
Thin Feather Orchid	*Tropilis callitrophilis*	V	An epiphytic orchid of rainforest environments.	**LOW:** Absence of suitable habitat.	
A vine	*Tylophora rupicola*	E	A vine of grassy eucalypt woodlands of the Herberton Range.	**MODERATE to HIGH:** Although not sighted this vine is found in habitats represented on the site.	

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
FISH					
Lake Eacham Rainbowfish	*Melanotaenia eachamensis*	E	This small freshwater fish prefers small streams and lakes, but has disappeared from much of its former range. It is now restricted to the headwaters of the Johnstone, Tully and Barron Rivers above an altitude of 500m (Curtis *et al.* 2012).	**LOW:** The site is in the Barron River catchment and is above 500m elevation but the site does not contain permanent streams or lakes.	Yes
Freshwater Sawfish	*Pristis microdon*	V	This large fish species inhabits sandy or muddy bottoms of shallow coastal waters, estuaries, river mouths, freshwater rivers and isolated water holes (Curtis *et al.* 2012).	**LOW:** The site does not contain the preferred habitat of this species. There are no permanent streams on the site and is a significant distance and elevation from suitable coastal environments.	No
FROGS					
Waterfall Frog	*Litoria nannotis*	E	This species is patchily distributed across the Wet Tropics of north-eastern Queensland across an altitudinal range of 100-1,300m. It inhabits fast flowing streams in rainforest and adjacent sclerophyll forest (Hoskin and Hero 2008).	**LOW:** The site does not contain the preferred habitat of this species. There are no permanent fast flowing streams, rainforest or wet sclerophyll vegetation communities on the site.	No
Mountain Mist Frog	*Litoria nyakalensis*	CE	This frog species has not been recorded since 1990; however, there is still insufficient data to list it as extinct. Suitable habitat is considered to be fast flowing streams in rainforest and wet sclerophyll, where they were found near riffles or cascade (Hoskin and Hero 2008).	**LOW:** The site does not contain the preferred habitat of this species. There are no permanent streams, rainforest or wet sclerophyll vegetation communities on the site.	No
Common Mist Frog	*Litoria rheocola*	E	The Common Mist Frog occurs from Broadwater Creek National Park (north of Ingham) to Amos Bay (south of Cooktown) in northern Queensland, at altitudes between 0 and 1,180m above sea level. The species is restricted to fast flowing rocky creeks and streams in rainforest or wet sclerophyll forest (SEWPaC 2012a).	**LOW:** The site does not contain the preferred habitat of this species. There are no permanent streams, rainforest or wet sclerophyll vegetation communities on the site	No

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
Australian Lacelid	*Nyctimystes dayi*	E	The Australian Lacelid occurs throughout the Wet Tropics Bioregion from Paluma to Cooktown, at altitudes between 0 and 1,200m. It is associated with rainforests and rainforest margins. At low elevations, the Australian Lacelid favours rock soaks, narrow ephemeral streams and rock outcrops in larger watercourses (SEWPaC 2012b).	**LOW:** The site does not contain the preferred habitat of this species. There are no permanent streams or rainforest communities on the site.	No
Magnificent Brood Frog	*Psuedophryne covacevichae*	V	Populations of this brightly coloured frog are known from a small area 27km by 9km near Millstream Falls, Ravenshoe (McDonald *et al*., 2000), in open eucalypt woodlands with grassy understoreys (Curtis *et al* 2012). Known locations are on acid volcanic and granitic hills above 800m. Adults have mostly been located in seepage areas however dry season habitat use, movement patterns, and habitat use by tadpoles and metamorphs is unknown (McDonald *et al*., 2000). Museum records are known from vegetation contiguous and within 50km of the Mt Emerald.	**LOW:** Although this species is not known from outside current distribution occuring entirely on the Gordon Volcanics geological unit, areas of habitats with *Xanthorrhoea/ Themeda triandra* understory that fit the broad habitat description are present within the project site.	No
BIRDS					
Southern Cassowary	*Casuarius casuarius johnsonii*	E	This large and conspicuous bird generally requires dense tropical rainforest (such as complex/non-complex notophyll/ mesophyll vine forest) and associated habitat (such as mangrove Melaleuca, eucalypt woodland, swamp and swamp forest), that provides a year-round supply of fleshy fruit (SEWPaC, 2012c).	**LOW:** The site does not contain the preferred habitat of this species. None of the Regional Ecosystem types listed as Essential Habitat factors for this species occur on site.	No

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
Red Goshawk	*Erythrotriorchis radiatus*	V	The Red Goshawk occurs in coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia (Marchant and Higgins 1993). It nests in large trees, frequently the tallest and most massive in a tall stand, and nest trees are invariably within 1km of permanent water. Habitat must be open enough for fast attack and manoeuvring in flight, but provide cover for ambushing of prey. Therefore, forests of intermediate density are favoured, or ecotones between habitats of differing densities, such as between rainforest and eucalypt forest, between gallery forest and woodland, or on edges of woodland and forest where they meet grassland, cleared land, roads or watercourses (SEWPAC, 2012d).	**MODERATE.** There is potential for this species to fly over and utilise the site for foraging from time to time. However, no nests or suitable nesting sites were identified during the field investigations, so breeding places are unlikely to exist.	Yes
Buff-breasted Buttonquail	*Turnix olivii*	E	This ground-dwelling bird is most often recorded from stony and/or grassy woodlands and forest with a mid-storey of *Melaleuca viridiflora* or *M. minutifolia*, but is known to use sparsely wooded, well-drained bases of hills during the breeding season (Curtis *et al.,* 2012). Rarely seen, however, there are a number of recorded observations from the Lake Mitchell/ Big Mitchell Creek area north of Mareeba.	**MODERATE**: Suitable habitat is potentially widespread on the subject site, however, based on limited habitat records for this species, open woodland areas with a grassy understorey and a mid storey on *Melaleuca monantha* and/or *M. viridiflora* may represent the most likely habitat.	No
Australian Painted Snipe	*Rostratula australis*	V	The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains (SEWPAC, 2012e). Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire. Although there are records from within 30km of the subject area centre, this species is only rarely observed and the region is not considered to be important for it.	**LOW**: The subject site does not contain the preferred habitat of this species, particularly vegetated wetland habitats. They are unlikely to utilise the small ephemeral water bodies present during the wet season. No breeding places are likely to exist and they are only rarely observed in the broader region.	No

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
Squatter Pigeon (southern)	*Geophaps scripta scripta*	V	The Squatter Pigeon (southern) occurs mainly in dry grassy eucalypt woodlands and open forests, mostly in sandy sites near permanent water (Curtis *et al.* 2012). It has also been recorded in highly modified grassland environments and remains common in heavily-grazed country (Curtis *et al.,* 2012). It is almost always found close to bodies of water (SEWPaC 2012f). The threatened southern subspecies occurs as far north as Townsville, where it is generally found in drier areas or where there are large expanses of thinly wooded grassland.	**LOW:** The subject site occurs well outside the recognised range of the threatened southern subspecies. One individual (northern race) was sighted in the vicinity of turbine #11 in Jan 2013. It is presumed that incursions for foraging are made during the wet season when there is standing water available since there are no suitable permanent water bodies to facilitate a dry season presence. Not present in 2011 EPBC Search.	Yes (northern)
Masked Owl (northern)	*Tyto novaehollandiae kimberli*	V	This owl species typically occurs in sclerophyll forest and woodland with a grassy understorey or with a mosaic of sparse and dense ground cover (Curtis *et al.* 2012). Preferred roosting sites are in tree hollows, caves or dense foliage 3-8 m above the ground (Curtis *et al.* 2012). A historic record from 1958 exists from within 10km of the subject site.	**MODERATE**. Historic records indicate that they have occurred in the area in the past and suitably wooded areas exist in sheltered valleys where it is presumed that fire intensity is less. Not present in 2011 EPBC Search.	No
Eastern Bristlebird	*Dasyornis brachypterus*	E	This small brown passerine bird is restricted to upland open forest and montane heath in Southern Queensland in the Conondale Range, Lamington National Park and Mt Barney National Park (Curtis *et al.,* 2012).	**LOW:** The subject site occurs well outside the recognised range of this species. Museum records and Eremaea Birds databases do not show any records for North Queensland. Communication received from Canberra EPBC mapping department that the record was incorrect (9:74am 27-9-2013).	No
Gouldian Finch	*Erythrura gouldiae*	E	This small brightly coloured granivorous bird prefers open tropical woodland with a grassy understorey, often in rocky hills or low escarpment country (Curtis *et al.* 2012). They have now undergone a significant contraction in their range, particularly in Queensland (Garnett & Crowley, 2000). The Atlas of Living Australia includes a Gouldian Finch record from approximately 7km north of Mt Emerald from October 1976. There were attempts to reintroduce this species to the Mareeba area but no birds have been recorded since 2007.	**LOW – MODERATE**: The open woodland with a grassy understorey on rocky hills that dominates the project site is considered suitable habitat but it is doubtful any populations persist in the region.	Yes

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
Star Finch (eastern)	*Neochmia ruficauda ruficauda*	E	The distribution of the Star Finch (eastern) is very poorly known. The Star Finch (eastern) occurs only in central Queensland. Based on the small number of accepted records, the distribution of the Star Finch (eastern) is believed to extend north to Bowen, west to beyond Winton and, based on recent records, south to near Wowan. Within this range it occurs mainly in grasslands and grassy woodlands that are located close to bodies of fresh water (SEWPaC, 2012g).	**LOW:** The subject site occurs well outside the recognised range of the Endangered eastern subspecies which is currently only known from a 20km^2 area in Central Queensland. A 2010 record from the Atherton Tablelands is not thought to be this subspecies.	No
Black-throated Finch (southern)	*Poephila cincta cincta*	E	The Black-throated Finch (southern) (BTF) occurs mainly in grassy, open woodlands and forests, typically dominated by *Eucalyptus* (especially *E. tetradonta* and *E. platyphylla*), *Corymbia* and *Melaleuca*, and occasionally in tussock grasslands or other habitats (for example freshwater wetlands), often along or near watercourses, or in the vicinity of water (SEWPaC, 2012h). It is likely that permanent sources of water provide refuge for this species during the dry season, especially during drought years.	**LOW:** Although the endangered subspecies occurs as far north as the Mareeba Wetlands, the subject site does not contain permanent water needed for this species to persist in an area. The species predominantly occurs on Land Zone 3 while the subject site is dominated by Land Zone 12. Not present in 2011 EPBC Search.	No
MAMMALS					
Northern Quoll	*Dasyurus hallucatus*	E	The Northern Quoll is known to occur as far south as Gracemere and Mt Morgan, south of Rockhampton, and as far north as Cooktown. It occupies a diversity of habitats including rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert. However, habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. Habitats usually have a high structural diversity containing large diameter trees, termite mounds or hollow logs for denning purposes (SEWPAC, 2012i).	**CONFIRMED**: A number of individuals of both sexes and different ages were detected across the subject site, predominantly in rocky areas in both ridges and valleys. Quolls were detected through cage trapping, camera traps and scat identification. It was concluded that Northern quolls are abundant and widespread across the site (RPS 2012).	Yes

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
Spotted-tailed Quoll	*Dasyurus maculatus gracilis*	E	The subspecies is mostly confined to the relatively cool, wet and climatically equable upland closed-forests (mostly above 900 m altitude) that occur in the upper catchments of rivers draining east and west of the Eastern Escarpment. It is also suggested that the species occurs in lower altitude notophyll, mesophyll and wet sclerophyll forests in lesser numbers. The subspecies utilises dens for resting and for raising young. Dens have been found in tree hollows, logs, rock crevasses and even among building materials (SEWPaC, 2012j).	**LOW**: The subject site does not contain the currently known preferred habitat of this species, rainforest habitat above 900m.	No
Koala	*Phascolarctos cinereus*	V	The range of this population extends from approximately the latitude of Port Douglas to the New South Wales-Victoria border (SEWPaC, 2012k). Koalas inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus Eucalyptus (Martin & Handasyde, 1999). The Koalas diet is restricted mainly to foliage of Eucalyptus species but may also consume foliage of related genera, including Corymbia, Angophora and Lophostemon and at times supplement its diet with other species, including species from the genera Leptospermum and Melaleuca (Martin and Handasyde, 1999; Moore and Foley, 2000). There are very few records for the area west of the Wet Tropics rainforest; however, a 2005 anecdotal record from Koah, between Kuranda and Mareeba probably represents the northern-most record for this species (http://www.foe.org.au/media-releases/2005-media-release/most-northerly-koalas-in-danger---beattie-must-intervene!).	**MODERATE**: According to the Save the Koala Foundation's Koala habitat mapping, the entire site represents potentially suitable habitat (SKF, 2014) and is continuous with known Koala habitat (e.g. wet sclerophyll forest) on the Atherton tablelands. The site contains known Koala feed trees including *Eucalyptus tereticornis* (Blue Gum), which occur mostly along creek lines.	No

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
Northern Bettong	*Bettongia tropica*	E	The preferred habitat of the Northern Bettong is tall or medium open eucalypt forest with grassy understorey along the western edge of rainforest (SEWPaC 2012l). Structure and floristic composition of forests vary within their range, but the limiting factor is the presence and abundance of truffle fungi (Curtis *et al.*, 2012). Historically, the Northern Bettong occurred in Queensland, from Rockhampton to the present northern distribution near Cairns. The species currently occurs in only three geographically isolated locations - the Lamb Range, Paluma and Mt Zero.	**LOW:** Habitat is not considered likely to support Northern bettongs, which are currently only confirmed to occur within the, Lamb Range although they were previously known from the Mt Carbine Tablelands, Mt Windsor Tablelands and the Seaview Ranges (Australian Wildlife Conservancy's Mt Zero-Taravale Sancturary and adjacent areas)	No
Fluffy Glider	*Petaurus australis un-named subspecies*	V	This glider species is restricted to tall eucalypt forest above 600m altitude that always includes *Eucalyptus grandis, E resinifera* and usually *Syncarpia glomulifera* and *Banksia*s (Curtis *et al.,* 2012).	**LOW**: The subject site does not contain the preferred habitat of this species, particularly wet sclerophyll forest containing essential feed and denning trees (*Eucalyptus resinifera* or *Eucalyptus grandis).*	No
Spectacled Flying-fox	*Pteropus conspicillatus*	V	The Spectacled Flying-fox occurs in north-eastern Queensland, between Ingham and Cooktown, and between the McIlwraith and Iron Ranges of Cape York (SEWPaC 2012m). The species is associated primarily with tropical rainforest but may also occur in mangroves, eucalypt forests, melaleuca swamps, littoral and coastal mixed forests, farmland and urban gardens (Curtis *et al.,* 2012). Bats may forage up to 50-100 km each night (Curtis *et al.,* 2012), but roosts are always found within 6 km of rainforest (SEWPaC, 2012m). The Atlas of Living Australia show records from Mareeba and Tolga, within 20km of the subject site.	**CONFIRMED PRESENT**: No suitable roosting habitat (rainforest) is present on the subject site; however, the species has been recorded foraging on the site and flying over site at rotor height.	Yes
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	This Flying-fox species occurs in a variety of forest and woodland communities along the east coast of Australia, from Melbourne to Mackay (Curtis *et al.,* 2012).	**MODERATE**: Recent records have indicated presence of the species at a camp near Ingham in the southern Wet Tropics (David Westcott pers com), therefore it is likely that the species occurs elsewhere throughout the Wet Tropics and nearby areas of the Einasleigh Uplands bioregion.	No

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
Semon's Leaf-nosed Bat	*Hipposideros semoni*	E	The known broad-scale distribution for Semon's Leaf-nosed Bat includes coastal Queensland from Cape York to just south of Cooktown. There is an outlier population at Kroombit Tops, near Gladstone (Churchill, 2008). Semon's Leaf-nosed Bat is found in tropical rainforest, monsoon forest, wet sclerophyll forest and open savannah woodland (Churchill 2008). This species does not have an obligatory requirement for cave roosts. Daytime roost sites include tree hollows, deserted buildings in rainforest, road culverts and shallow caves amongst granite boulders or in fissures (SEWPaC 2012n).	**MODERATE**. The subject site contains suitable potential foraging and roosting habitat for this species. No records could be located for any area in or west of the Wet Tropics rainforest between Cedar Bay National Park and Townsville.	No
Greater Large-eared Horseshoe Bat	*Rhinolophus philippinensis Waterhouse 1843 (large form) (=Rhinolophus robertsi, R. philippinensis maros)*	E	This species occurs only in northern Queensland, from the Iron Range southwards to Townsville and west to Chillagoe (Churchill 2008). The species is found in lowland rainforest, along gallery forest-lined creeks within open eucalypt forest, *Melaleuca* forest with rainforest understorey, open savanna woodland and tall riparian woodland of *Melaleuca*, Forest red gum (*E. tereticornis*) and Moreton Bay ash (*C. tesselaris*) (SEWPaC 2012o). It mainly roosts in caves and underground mines located in rainforest, and open eucalypt forest and woodland, however roosts have also been observed in road culverts, and it is suspected that the species also uses basal hollows of large trees, dense vegetation, rockpiles and areas beneath creek banks (SEWPaC 2012o).	**MODERATE**. The subject site contains suitable potential foraging and roosting habitat (i.e. thicker vegetation in gullies and along creeks in open eucalypt forest and woodland; and caves, road culverst and possibly basal hollows of large trees, dense vegetation and areas beneath creekbanks in open forest respectively). A total of 4 specimens were collected by CSIRO approximately 20 km to the north of the site in 1986 (ALA, 2014; catalogue number M13858).	No

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
Bare-rumped Sheathtail Bat	*Saccolaimus saccolaimus nudicluniatus*	CE	Occasional individuals have been collected from a narrow coastal region (less than 40 km inland) between Ayr and Cooktown, North Queensland, with one isolated specimen from north of Coen on Cape York Peninsula (SEWPaC 2012p). The species inhabits tropical woodland and tall open forests where it roosts in long, wide hollows in the trunks of various Eucalypts, especially *E. tetradonta* and *E. platyphylla* (Churchill 2008). It appears to prefer coastal Eucalypt forests with high annual rainfall (Curtis *et al*. 2012).	**CONFIRMED**: The entire site represents critical habitat for the species.	No
Brush-tailed Rabbit Rat	*Conilurus pencillatus*	V	This small rodent lives in mixed eucalypt open forest and woodland, or on *Casuarina*-dominated sand dunes, but occurs mostly in the Kimberley (Western Australia), and Cobourg Peninsula and Kakadu in the Northern Territory. The only known Queensland population is on Bentinck Island, Gulf of Carpentaria (Van Dyke and Strahan 2008).	**LOW**: The subject site is a significant distance outside the known geographic range for this species, and does not contain likely habitat.	No

[1] Likelihood of occurrence is based on the known distribution and ecological requirements of the species in the context of the site, where **Low**: No recent records or suitable habitat present on the site; **Moderate**: Recent records and/or suitable/preferred habitat present and/or species that they commonly associated with are present on the site, or likely to overfly the site, however, the species was not recorded during the field investigations; and **Confirmed**: Known to occur on the site through direct observation within or immediately adjacent to the site.

[2] Previous records exist within 10km of the site (Wildlife Online).

13.4 Wetlands

Wetlands of ecological significance have been identified using DERM's rigorous Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM). The method identifies relative wetland conservation values within a specified study area (usually a catchment). Wetlands have been classified as being of high ecological significance (HES) or general ecological significance (GES). DERM Wetlands mapping indicates the location of wetland protection areas (WPA) in Great Barrier Reef catchments. Environmental values for wetlands are defined in *Section 81A* of the *Environmental Protection Regulation 2008* as the qualities of a wetland that support and maintain:

- the health and biodiversity of the wetland's ecosystems;
- the wetland's natural state and biological integrity;
- the presence of distinct or unique features, plants or animals and their habitats, including threatened wildlife, near threatened wildlife and rare wildlife under the Nature Conservation Act 1992;
- the wetland's natural hydrological cycle; and
- the natural interaction of the wetland with other ecosystems, including other wetlands.

The QLD State development assessment provision, Module 11: Wetland Protection and Wild Rivers (SDAP Module 11) aims to protect and where possible enhance these environmental values, ensuring wetland ecosystem services continue to be provided. SDAP Module 11 regulates development in and near wetlands in a wetland protection area (WPA wetland) by providing direction for regional and local planning instruments and development assessment decisions to protect wetlands. The policy sets the requirement for protecting wetlands in wetland protection areas by ensuring land use and development decisions protect their environmental values. A WPA consists of two parts: a WPA wetland and the surrounding trigger area. The trigger areas include a local area of hydrologic influence surrounding the wetland. The trigger area is 100 metres (m) in urban areas and 500m outside urban areas.

Granite Creek at the base of the wind farm project area is mapped as a Wetland by the Department of Environment and Heritage Protection (DEHP). A reach of this watercourse adjacent to the main entry point and lower access road into the site has a 100 m buffer shown as a Wetland Management Area Trigger Zone (**Figure 12.5**). Approximately 1 km of the lower access road passes through this trigger area due to the proximity of the existing track to Granite Creek. However, in August 2012, this management zone requirement was removed by the Sustainable Planning Amendment Regulation (No. 5) 2012. In addition to Granite Creek, a number of wetlands are located in the area immediately surrounding the project site including the West Barron Storage Area, smaller farm dams and impoundments and riverine wetlands along Oaky Creek and Nardellos Lagoon, which is categorised as a Wetland Protection Area (WPA) with 500 m tigger area applied (**Figure 13.5**). These wetlands are known to provide habitat for a wide range of listed migratory birds including Sarus Cranes and White-bellied Sea Eagles.

13.5 Potential Impacts on Threatened Flora

Individual significant impacts assessments are provided in **Tables 13.2** to **13.9** below for the EPBC listed threatened flora confirmed to be on the site.

13.5.1 *Grevillea glossadenia* (a shrub)

Grevillea glossadenia was confirmed to be present on the proposed MEWF site at numerous locations, where virtually all sightings of the species were made in the Wet Tropics bioregion section or in close proximity to this boundary with the Einasleigh Uplands bioregion section to the north of the 275 kV transmission line.

The shrub is known from a region including Irvinebank, Stannary Hills, Watsonville, the Herberton Range and Silver Valley.

The shrub prefers open, rocky habitat on soils with poor fertility and off rhyolite or granite origin. It is frequently encountered as a regenerating species (from seed) along road verges towards Irvinebank and at the Stannary Hills turnoff. In some locations it is found regenerating in rock and soil spoil from road works. The species is less frequently found under good woodland cover, and prefers an exposed, fully-lit, free-draining habitat.

On the proposed MEWF site, the habitat for the species is along ridges and the edges of existing tracks. It has readily regenerated around the 80m wind monitoring tower following construction disturbance of the rocky ground.

Table 13.2 Significant Impact Assessment for *Grevillea glossadenia*

***Grevillea glossadenia* – Vulnerable**	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of an important population	Areas of suitable habitat for this species will be lost as a result of constructing tracks along ridges, where the species is most common. Given the capacity for *Grevillea glossadenia* to regenerate after disturbance, the size of local populations is unlikely to decline, and may even increase in some areas of new disturbance.
Reduce the area of occupancy of an important population?	*Grevillea glossadenia* is well-represented from Irvinebank through to the site and regional surrounds. The area of occupancy will not be significantly reduced.
Fragment an existing important population into two or more populations?	The population diversity extends beyond the site. Within the site, populations are relatively large; however, they are restricted to a particular landform along ridges. Linear clearing of ridges may affect local population dynamics, but not on a regional scale.
Adversely affect habitat critical to the survival of a species	Disturbance to rocky ground may trigger germination responses in the species if viable seed is available in the soil-seed bank. Habitat is unlikely to be adversely affected.
Disrupt the breeding cycle of an important population	The project is unlikely to have an impact on the breeding cycle of *Grevillea glossadenia* if viable populations of the species are conserved.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to be in decline?	The scale of the project is unlikely to result in significant reduction and decline in quality of habitat for *Grevillea glossadenia* if functional populations are conserved outside the development footprint.
Result in invasive species that are harmful to a vulnerable species being established in the vulnerable species habitat?	The introduction of weeds has the potential to displace native species and modify habitats. Strict weed control and monitoring will need to be applied in order to minimise this potential impact.
Introduce disease that may cause the species to decline	There is some potential for the root rot pathogen *Phytophthora cinnamomi* to be introduced into the site at cooler, moist and elevated ridges. This pathogen has been known to attack proteoid roots of the family Proteaceae, of which *Grevillea glossadenia* belongs. Strict hygiene will need to be practiced as part of a Pest and Weed Management Plan.
Interfere substantially with the recovery of the species?	*Grevillea glossadenia* is relatively widespread for a conservation significant species. It responds well to fire and to some extent, after ground disturbance, where it has the capacity to regenerate in large numbers. It is represented elsewhere in the bioregion - also in proportionately large populations. Therefore, it is not considered that modification of the wind farm site through construction and operation will interfere with the recovery of the species.

13.5.2 *Homoranthus porteri* (a shrub)

Homoranthus porteri was confirmed to be present on the proposed MEWF site at locations along ridges or rock pavements and skeletal soil. As with *Grevillea glossadenia*, virtually all sightings were made in the Wet tropics bioregion section of the site. Two outlier populations were observed in the Einasleigh Uplands section- one at turbine 66; however, the largest populations occur along the southwest ridge south of the 275 kV transmission line.

The shrub is known from a region including Irvinebank, Stannary Hills, Watsonville, the Herberton Range and Silver Valley.

The shrub prefers open, rocky habitat on soils with poor fertility and off rhyolite or granite origin in very exposed situations (i.e. high levels of solarisation). It tends to occupy a physically contracted niche, and is often encountered growing in association with other rare and threatened plants and species with narrow distributions. There is a strong correlation of the presence of this species with narrow endemic plants found in the south-west of the site at high elevation.

It forms mono-specific thickets associated with ridges and rock pavements. The amount of dead, woody stems would contribute to fuel loads and it is not known what the responses to fire are for this species. However, the dead wood remains persistent for many years (based on three years of observations) and the rock pavement habitat affords fire-proof habitat qualities, suggesting perhaps that the species may not tolerate hot and frequent fires.

On the MEWF site, the primary habitat for the species is along ridges above 900 m ASL. It was not observed as a regenerating species after disturbance. Similar observations were made of the shrub growing in protected rocky gullies during regional surveys outside of the site near Watsonville.

Table 13.3 Significant Impact Assessment for *Homoranthus porteri*

A Shrub (*Homoranthus porteri*) – Vulnerable	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of an important population	Areas of suitable habitat for this species will be lost as a result of constructing tracks along ridges above 900 m ASL. On a regional scale, the site is considered to hold important populations along the south-west ridges, and therefore clearing these ridges will result in a decrease of important populations.
Reduce the area of occupancy of an important population?	Clearing of narrow ridges in the south-west of the site will result in a significant reduction in the area of occupancy for the species given that it is confined to a very narrow niche.
Fragment an existing important population into two or more populations?	Clearing along ridges in the south-west is likely to result in population fragmentation and may result in the loss of whole populations because of the narrow representation of *Homoranthus porteri*.
Adversely affect habitat critical to the survival of a species	Linear clearing will result in loss of the primary habitat for *Homoranthus porteri* on the site. Significant populations of the shrub will need to be conserved on-site to offset these potential losses.
Disrupt the breeding cycle of an important population	Loss of populations could result in disruption to the availability of viable reproductive plant material and hence cause a decline of local populations.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to be in decline?	There is potential for local populations of *Homoranthus porteri* to decline as a result of clearing along narrow ridges in the south-west of the site. Habitats will be modified and if weeds such as Praxelis and introduced grasses establish, this could result in a decline in population size.

A Shrub (*Homoranthus porteri*) – Vulnerable	
Will the proposed works..	**Response**
Result in invasive species that are harmful to a vulnerable species being established in the vulnerable species habitat?	The introduction of weeds has the potential to displace native species and modify habitats. Strict weed control and monitoring will need to be applied in order to minimise this potential impact.
Introduce disease that may cause the species to decline	Soil-borne pathogens may cause the species to decline; however, insufficient information is known regarding this matter. Phytophthora and Myrtle Rust are potential threats that cannot be quantified.
Interfere substantially with the recovery of the species?	*Homoranthus porteri* forms mono-specific thickets on the site and elsewhere where it has been observed in the region. It is reliant on a narrowly represented habitat type found on exposed ridges. It is not known whether the species would adequately recover on the site if complete thickets are cleared along ridges. Sub-populations occuring on the edges of ridges and possibly on rock shelves would contribute to the recovery of the species if some populations decline through clearing.

13.5.3 *Acacia purpureopetala* (a shrub)

Acacia purpureopetala was not observed within the wind farm project area during any field survey event between 2010 and 2013.

Populations of this species have been recorded from the Irvinebank, Silver Valley, Watsonville, Toy Creek and Stannary Hills regions. Where it occurs (usually on gravelly soils derived from granite or rhyolite) it can form reasonable size populations with many individuals. However, in some areas it can be relatively uncommon with diffuse populations (S. Gleed; S. de Ridder pers. obs.; S. de Ridder pers. comm.).

A single collection of the shrub was made just outside the wind farm property boundary to the south-west. Anecdotal evidence suggests the species also occurs approximately 100 m south of the last 275 kV transmission tower near the western boundary of the property. These records possibly represent close to a northern distribution limit for the main populations. Therefore, it would not be surprising to find *A. purpureopetala* in what appears to be suitable habitat along the south-west ridges in the project site.

As with *Homoranthus porteri* and to some extent *Grevillea glossadenia*, *A purpureopetala* is likely to favour high elevation environments above 900 m ASL. This preference for altitude was observed in the Toy Creek region west of the site; and near Top Nettle Road near Mt Misery south of the wind farm site during regional surveys (S. Gleed, pers. obs.).

This wattle can be a cryptic species to observe. It can have similar superficial morphology to seedlings of *A. leptostachya*; nevertheless, its rosette growth habit and purple flowers are quite distinguishing. Many of the ridges with suitable habitat have a ground cover flora that could obscure *A. purpureopetala* from detection. Plants such as *Jacksonia thesioides*, *Acacia calyculata*, *A. whitei*, *Gompholobium nitidum* and the grass *Cleistochloa subjuncea* form a low heath-like cover, which camouflages plants lying below. Proposed detailed design phase intensive field surveys would allow for a higher chance of detection.

There is some anecdotal evidence to support the theory that the wattle does not recover fully after disturbance. A once well-known population on a relatively long-term undisturbed road cutting at Jumna Creek near Irvinebank was quite stable until poorly informed road works significantly cleared the population. Observations made of the "regenerating" population in 2013 only saw two or three individual plants at the site (S. Gleed, pers. obs.). Contrary to this though, HERBRECS data from the Queensland Herbarium has records of the species regenerating at old mine sites. Therefore, the species may recover in the long-term (after several years) but not appear in a newly modified/cleared landscape for some time.

Nursery culture of the species is said to be fickle. Although seeds germinate readily under controlled conditions, it is difficult to propagate the species beyond the early seedling stage, where damping off is a common problem (S. de Ridder, pers. comm.).

Table 13.4 Significant Impact Assessment for *Acacia purpureopetala*

A Shrub (*Acacia purpureopetala*) – Vulnerable	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of an important population	It is possible that sections habitat for this species will be lost as a result of constructing tracks along ridges above 900 m ASL. The species however, is well-represented in populations occurring on meta-sediments in the Toy Creek area near Watsonville and elsewhere in the region.
Reduce the area of occupancy of an important population?	Clearing of narrow ridges in the south-west of the site could result in a significant reduction in the area of occupancy for the species if it occurs, where it is possible that the site could represent a northern distribution limit for *Acacia purpureopetala.*
Fragment an existing important population into two or more populations?	The species has not been detected; therefore population sizes cannot be determined.
Adversely affect habitat critical to the survival of a species	Habitat for the species is found elsewhere in the region. It is unlikely that the survival of the species will decline due to habitat degradation.
Disrupt the breeding cycle of an important population	If a population is discovered on the wind farm site and in the construction zone, then there is a possibility that regeneration, flowering and seed production could be disrupted.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to be in decline?	If the species is found to occupy only ridges, there will be potential for local populations to decline as a result of clearing along narrowly defined ridges in the south-west of the site. Habitats will be modified and if weeds such as Praxelis and introduced grasses establish, this could result in a decline in population size.
Result in invasive species that are harmful to a vulnerable species being established in the vulnerable species habitat?	The introduction of weeds has the potential to displace native species and modify habitats. Strict weed control and monitoring will need to be applied in order to minimise this potential impact. Weed management will need to be actively practiced throughout construction, operation and decommissioning.
Introduce disease that may cause the species to decline	Soil-borne pathogens may cause the species to decline; however, insufficient information is known regarding this matter. Phytophthora and Myrtle Rust are potential threats that cannot be quantified.
Interfere substantially with the recovery of the species?	It is not known whether the species would adequately recover on the site if it were to be present.

13.5.4 *Cajanus mareebensis* (a creeper)

Cajanus mareebensis was not found on the wind farm site at elevation. Limited surveys along Kippen Drive at lower elevation, where habitat is potentially more likely to be present, did not find the species.

It is a creeping vine (Fabaceae) usually found low in the grass layer or prostrate over bare ground on gravelly, sandy soils. Although poorly known, many records of the species are from near Musgrave in Cape York Peninsula, where it has been collected adjacent to unsealed road verges.

The creeper sheds its trifoliate leaves during drier months, rendering its detection more difficult; therefore the searches for the species must be undertaken when at least vegetative material is available. Ideally, positive identification would rely on fertile material also being available (S. Gleed, pers. obs., B. Wannan, pers. comm.).

HERBRECS data shows three records of *C. mareebensis* from the region and all on sandy or gravelly soil. There are several habitat opportunities within the wind farm site and along Kippen Drive where the species could inhabit. Levees adjacent to the upper reaches of Granite Creek within the site are potential sites, as is the entire length of Kippen Drive, although the latter has suffered extensively from weed modification and attendant loss of floristic integrity. *C. mareebensis* is in the pea family Fabaceae, and seed could germinate without issues; however, nothing is known regarding this species' germination and propagation capacity, and it has to be assumed that given its conservation status of endangered, the species is not necessarily a rapid coloniser or free germinator; or it requires specialist vectors to promote germination.

Table 13.5 Significant Impact Assessment for *Cajanus mareebensis*

A Creeper (*Cajanus mareebensis*) – Endangered	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of an important population	It is unlikely that the habitat for this species will be lost as a result of constructing activities. The main construction areas (except the main entry track) are not in the principal habitat zone for this species.
Reduce the area of occupancy of an important population?	It is unlikely that the area of occupancy for the species will be reduced as clearing will mainly occur outside of potential habitat areas.
Fragment an existing important population into two or more populations?	The species has not been detected; therefore population sizes cannot be determined.
Adversely affect habitat critical to the survival of a species	Habitat for the species is found elsewhere in the region and in Cape York Peninsula. It is unlikely that the survival of the species will decline due to habitat degradation.
Disrupt the breeding cycle of an important population	If a population is discovered on the wind farm site and in the construction zone, there is a possibility that regeneration, flowering and seed production could be disrupted.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to be in decline?	It is unlikely that these factors will occur due to the low probability of preferential habitat being modified.
Result in invasive species that are harmful to a endangered species being established in the endangered species habitat?	The introduction of weeds has the potential to displace native species and modify habitats. There is some probability that the species could be found along Kippen Drive; however, this entry road into the site is already severely weed-degraded. Weed management will need to be actively practiced throughout construction, operation and decommissioning.
Introduce disease that may cause the species to decline	Soil-borne pathogens may cause the species to decline; however, insufficient information is known regarding this matter. Phytophthora and Myrtle Rust are potential threats that cannot be quantified.
Interfere substantially with the recovery of the species?	It is not known whether the species would adequately recover on the site if it were to be present.

13.5.5 *Chamaesyce carissoides* (a subshrub)

Chamaesyce carissoides is a short, succulent to semi-woody subshrub generally growing in very shallow, pockets of soil in fissures and cracks of rock faces in fully lit situations or under light woodland cover. It was not detected on the site.

The species has been collected in the Stannary Hills region to the west of the wind farm site and as far west as the Newcastle Range closer to Georgetown.

The presence of numerous habitat opportunities (exposed rock and light woodlands) within the wind farm site in both the Wet Tropics and Einasleigh Uplands bioregion sections renders *Chamaesyce carissoides* a

potential candidate to be on the site. It would take considerable field time to observe the species unless it was conspicuously growing on a relatively bare rock feature.

Nothing is known of its propagation or resilience to disturbance; however, given the scarcity of the plant and low number of records in the region near the wind farm, it is potentially an unstable species.

Table 13.6 Significant Impact Assessment for *Chamaesyce carissoides*

A subshrub (*Chamaesyce carissoides*) – Vulnerable	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of an important population	Given the poor representation of this species close to the wind farm, it is possible that if individuals are cleared, there is a risk of decrease in the size of the population.
Reduce the area of occupancy of an important population?	It is unlikely that the area of occupancy for the species will be reduced as there are numerous zones of rock pavement and outcrop within the site and in the region where the species could potentially occur.
Fragment an existing important population into two or more populations?	The species has not been detected; therefore population sizes cannot be determined.
Adversely affect habitat critical to the survival of a species	The rocky habitat for the species is widespread in the region and possibly in areas within the site where construction work is not proposed. It is unlikely that critical habitat for this species will be significantly modified.
Disrupt the breeding cycle of an important population	If a population is discovered on the wind farm site and in the construction zone, then there is a possibility that regeneration, flowering and seed production could be disrupted.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to be in decline?	If the species is detected, there is a possibility of reduction of overall habitat availability; however, it is considered that several habitat niches are available in the region to support *ex situ* populations to the extent where there is unlikely to be a decline.
Result in invasive species that are harmful to a vulnerable species being established in the vulnerable species habitat?	The introduction of weeds has the potential to displace native species and modify habitats. Praxelis (*Praxelis clematidea*) and red natal grass (*Melinis repens*) are two weed species that tend to colonise newly disturbed rocky surfaces on the site - both have the capacity to displace native plants, and therefore, potentially interfere with the habitat attributes for *Chamaesyce carissoides.* Weed management will need to be actively practiced throughout construction, operation and decommissioning.
Introduce disease that may cause the species to decline	Soil-borne pathogens may cause the species to decline; however, insufficient information is known regarding this matter. Phytophthora and Myrtle Rust are potential threats that cannot be quantified.
Interfere substantially with the recovery of the species?	It is not known whether the species would adequately recover on the site if it were to be present.

13.5.6 *Cycas platyphylla* (a cycad)

Cycas platyphylla was not found in the site. This species is found however, to the west near Stannary Hills and Irvinebank in woodlands.

The cycad is readily identified in the field by its conspicuous bluish-green foliage. The only observed cycad on the site was *C. media* subsp. *banksii*, which primarily occurs at the northern end towards Walsh Bluff and on east-facing slopes. *C. media* subsp. *banksii* has green foliage.

Woodlands on the site are suitable habitat for *C. platyphylla*. The layout of the wind farm necessitates tracks and turbines are predominantly located along ridges at high points in the landscape. This largely avoids disturbing the potential habitat for *C. platyphylla*, which is expected to be found on slopes faces and at the

base of slopes, but probably not along ridges. The substation is provisionally planned to be located on flat ground adjacent to low woodland characterised by *Eucalyptus shirleyi* and scattered *Callitris intratropica. C. platyphylla* was not observed in this area or in this woodland type. It would appear the soil conditions are not favourable for the cycad at the substation sites because of slow drainage.

C. platyphylla is thought to be slow growing and sets few seeds; therefore propagation of the species may pose problems. It is also actively sought after by plant collectors because of its interesting foliage.

Table 13.7 Significant Impact Assessment for *Cycas platyphylla*

A cycad (*Cycas platyphylla*) – Vulnerable	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of an important population	Given the poor representation of this species close to the wind farm, it is possible that if individuals are cleared, there is a risk of decrease in the size of the population.
Reduce the area of occupancy of an important population?	It is unlikely the area of occupancy for the species will be reduced as it is known to occupy grassy woodland habitats, which is not the main vegetation type likely to be cleared.
Fragment an existing important population into two or more populations?	The species has not been detected; therefore population sizes cannot be determined.
Adversely affect habitat critical to the survival of a species	Grassy woodland habitat for the species is widespread in the region, particularly towards the Irvinebank locality where *Cycas platyphylla*. Construction of the wind farm will require clearing actions along ridges and near rocky outcrops, where the habitat for *C. platyphylla* is not well-represented.
Disrupt the breeding cycle of an important population	If a population is discovered on the wind farm site and in the construction zone, there is a high probability that regeneration, flowering and seed production could be disrupted.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to be in decline?	If the species is detected, it is unlikely to require clearing due its preference for grassy woodlands where the major construction activities will not occur. In the event such habitat is required to be cleared, detailed field surveys would need to be undertaken and advice given as to an alternative clearing area.
Result in invasive species that are harmful to a vulnerable species being established in the vulnerable species habitat?	The introduction of weeds has the potential to displace native species and modify habitats. Tall introduced grasses such as *Setaria pumila*, *Themeda quadrivalvis* and *Hyparrhenia rufa* poses a significant threat to natural grassy woodland function. Weed management will need to be actively practiced throughout construction, operation and decommissioning.
Introduce disease that may cause the species to decline	Soil-borne pathogens may cause the species to decline; however, insufficient information is known regarding this matter. Phytophthora and Myrtle Rust are potential threats that cannot be quantified.
Interfere substantially with the recovery of the species?	It is not known whether the species would adequately recover on the site if it were to be present.

13.5.7 *Prostanthera clotteniana* (a shrub)

Prostanthera clotteniana was not found on the site. The shrub has been collected from rocky cliffs above Toy Creek to the west of the site. Information provided here is also applicable to the closely related *P. albohirta* which was recently rediscovered to the south near Mt Emerald (thought extinct) and has been recommended for a conservation listing also of critically endangered (Ford and Conn, 2013)

Habitat for both *P. clotteniana* and *P. albohirta* is present on the wind farm site, with the highest quality and most suitable probably found along the south-west ridge and adjacent rock outcrops, terraces and cliffs. *P. albohirta* possibly has an association with stunted *Syncarpia glomulifera* and the slightly wetter habitat found towards Mt Emerald. *P. clotteniana* may favour drier conditions. Detailed ground searches for both species,

and the NCA-listed endangered *P.* sp. (Dinden P.I.Forster+ PIF17342) will be needed to confirm the presence or otherwise of this exceptionally uncommon (in north Queensland) group of plants.

Details of the reproduction of *Prostanthera* are not fully known; however, cuttings from the *P. clotteniana* population on Toy Creek (described above) were successfully propagated back in the early 1990s when the shrub was found close to the Baal Gammon mining area and associated leases (pers. comm. S. de Ridder). Other populations of *P. clotteniana* have been discovered closer to the wind farm site (HERBRECS data).

Table 13.8 Significant Impact Assessment for Prostanthera clotteniana, P. albohirta

A shrub (*Prostanthera clotteniana, P. albohirta*) Critically Endangered	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of an important population	Given the very poor representation of these species close to the wind farm, it is likely that if individuals are cleared, there is a significant risk of long-term decrease in the size of the populations.
Reduce the area of occupancy of an important population?	If present, it is probable the area of occupancy for the species will be reduced given the very small niche habitat that they occupy.
Fragment an existing important population into two or more populations?	The two species have not been detected; therefore population sizes cannot be determined. However, any fragmentation of populations would pose a significant risk.
Adversely affect habitat critical to the survival of a species	Construction works would adversely affect the habitat critical for the survival of these species.
Disrupt the breeding cycle of an important population	If a population is discovered on the wind farm site and in the construction zone, then there is a high probability that regeneration, flowering and seed production would be significantly disrupted.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to be in decline?	If present, any modification or clearing of rocky outcrops, cliff edges and appropriate habitat for these species is likely to result in a decline for either species.
Result in invasive species that are harmful to a critically endangered species being established in the critically endangered species habitat?	Disturbance of rock cover invariably leads to the introduction of the weed *Praxelis clematidea* on the wind farm site. Where this species is observed, there is a notably decline in native species presence. Therefore, the introduction of weeds should be considered as harmful to either species.
Introduce disease that may cause the species to decline	Soil-borne pathogens may cause the species to decline; however, insufficient information is known regarding this matter. Phytophthora and Myrtle Rust are potential threats that cannot be quantified.
Interfere substantially with the recovery of the species?	It is not known whether the species would adequately recover on the site if it were to be present.

13.5.8 *Tylophora rupicola* (a vine)

Tylophora rupicola was not observed at the wind farm site. There are however, significant areas of suitable woodland habitat in which this vine could occupy. Another habitat attribute the wind farm site possesses is the rockiness under the woodland that *T. rupicola* seems to prefer.

Most collections of *T. rupicola* have been made near Herberton to the south of the wind farm site. It is a wiry vine with narrow leaves and therefore may be difficult to detect in the grass layer or around rocks.

Reproduction of *T. rupicola* would probably be successful from cuttings, and also from seed.

Table 13.9 Significant Impact Assessment for *Tylophora rupicola*

A vine (*Tylophora rupicola*) Endangered	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of an important population	Habitat for this species (based on the rocky woodland environment) is well-represented on the wind farm site and elsewhere in the Herberton Range. It is unlikely there will be a long term decrease in the size of an important population as it possible the population would reside outside the construction footprint.
Reduce the area of occupancy of an important population?	It is unlikely the construction footprint would reduce the potential area of occupancy for *Tylophora rupicola.*
Fragment an existing important population into two or more populations?	An existing population has yet to be observed on the site; however, it is unlikely that any newly discovered populations would be dissected, and could probably be avoided if that were the case.
Adversely affect habitat critical to the survival of a species	The rocky woodland habitat is well-represented in the region of the site in the Herberton Range and adjacent properties. It is unlikely this habitat and its qualities would be adversely affected to the detriment of the species.
Disrupt the breeding cycle of an important population	If a population is discovered on the wind farm site and in the construction zone, avoidance measures would be implemented so as not to affect the breeding cycle of the species.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to be in decline?	Given the widespread potential habitat for this species and the relatively narrow construction footprint, it is unlikely that modification of the environment would occur to such an extent that the species would decline.
Result in invasive species that are harmful to an endangered species being established in the endangered species habitat?	The introduction, promotion and proliferation of weeds on the site will cause native species to decline in numbers or alter floristic composition where the infestation occurs. Therefore, the introduction of weeds should be considered as harmful to the species.
Introduce disease that may cause the species to decline	Soil-borne pathogens may cause the species to decline; however, insufficient information is known regarding this matter. Phytophthora and Myrtle Rust are potential threats that cannot be quantified.
Interfere substantially with the recovery of the species?	It is not known whether the species would adequately recover on the site if it were to be present.

13.6 Potential Impacts on Threatened Terrestrial Fauna

Individual significant impacts assessments are provided in **Tables 13.10** to **13.21** below for each of the EPBC listed threatened fauna species that have been assessed as having a moderate to high, or confirmed presence on the proposed MEWF site. Those species that are confirmed present on site and have had specialist studies conducted are also considered in further detail in **Chapters 14** to **19**.

13.6.1 Magnificent Brood Frog (*Psuedophryne covacevichae*)

The Magnificent Brood Frog was not recorded during general fauna surveys within the project area. Populations of this brightly coloured frog are known from a small area 27 km by 9 km near Millstream Falls, Ravenshoe (McDonald *et al*., 2000), in open eucalypt woodlands with grassy understoreys (Curtis *et al.,* 2012). All known locations are on acid volcanic and granitic hills above 800m. Adults have mostly been located in seepage areas however dry season habitat use, movement patterns, and habitat use by tadpoles and metamorphs is unknown (McDonald *et al*., 2000). Museum records are known from vegetation contiguous and within 50 km of the Mt Emerald. The Magnificent Brood Frog is threatened by habitat destruction in logging, mining and grazing across its known distribution (McDonald *et al*., 2000).

The significant impact assessment for the Magnificent Brood Frog is provided in **Table 13.10** below.

Table 13.10 Significant Impact Assessment for the Magnificent Brood Frog

Magnificent Brood Frog (*Psuedophryne covacevichae*) – Vulnerable	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of an important population	Some potential habitat for this species could be lost along ridge line access tracks as the species has a preference for seepage areas along steeper slopes. The development footprint of the proposed MEWF site is not considered to contain high value habitat such that its modification, destruction, removal or isolation would lead to a long term decrease in the size of an important population of the species.
Reduce the area of occupancy of an important population?	The estimated area of occupancy for the species is less than 50 ha (McDonald *et al* 2000) with known populations located 50km from the MEWF project site. The key habitat for the species would be unaffected and the area of occupancy if present would not be reduced.
Fragment an existing important population into two or more populations?	If this species is to occur on the proposed MEWF site, the population is unlikely to be of sufficient size for fragmentation to occur. Known populations in Ravenshoe cover small areas at a maximum of 0.5 ha (McDonald *et al*. 2000).
Adversely affect habitat critical to the survival of a species	The development footprint of the proposed MEWF site is primarily along ridge tops and above potential habitat areas. The vast majority of potential habitat for this species on site would be unaffected by the development.
Disrupt the breeding cycle of an important population	The project is unlikely to have an impact on the breeding cycle of the species as the project area does not impact on habitat which leads to first order streams.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to be in decline?	The majority of potential habitat for this species remains undisturbed on the steep slopes across the proposed MEWF site and it is unlikely that the project will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to be in decline.
Result in invasive species that are harmful to a vulnerable species being established in the vulnerable species habitat?	The proposed MEWF site has been impacted by cane toads despite the lack of human influence. The project is unlikely to introduce any invasive fauna that will be harmful to the species. Application of Pest and Weed Management Plans during each stage of the development would effectively avoid introduction of invasive species to potential Magnificent Brood Frog habitat.
Introduce disease that may cause the species to decline	This project is not likely to increase the risk of disease to the species. Application of Pest Management Plans during each stage of the development would effectively avoid introduction of disease to potential Magnificent Brood Frog habitat.
Interfere substantially with the recovery of the species?	The proposed MEWF site is not considered to contain substantial breeding habitat for the species such that its modification, destruction, removal or isolation or a decrease in availability or quality would interfere with the recovery of the species.

13.6.2 Red Goshawk (*Erythrotriorchis radiates*)

The Red Goshawk was not recorded in the project area. The species is primarily found in sub coastal and coastal woodlands of a mosaic of vegetation types (Curtis *et al*., 2012). Each home range is consistent with access to permanent freshwater. The species has been recorded infrequently on the Atherton Tablelands and is known to visit the area from June to October (Bravery, 1970 in SEWPAC, 2011g). There is the potential for Red Goshawks to forage within the project site; however, it is unlikely that suitable nesting habitat is present within the site given the lack of suitable tall trees located within one km of permanent water. The closest potentially suitable nesting habitat is located along Granite Creek which runs parallel to the main access road (Kippen Drive).

The primary threat to the species is clearing of forests and woodlands, fragmentation and loss of connectivity between remaining habitats, egg collecting and declines in prey species (Garnett & Crawley, 2000).

The significant impact assessment for the Red Goshawk is provided in **Table 13.11** below.

Table 13.11 Significant Impact Assessment for Red Goshawk

Red Goshawk (*Erythrotriorchis radiatus*) - Vulnerable	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of an important population	There is potential for loss of habitat as a result of the proposed MEWF project. However, the project will clear 57 ha of the site (approx 2.1%), with extensive areas of similar habitat remaining intact across the site and the region. The site is also limited in suitable nesting habitat. There is the potential for individuals to suffer turbine collision mortality over the life of the project. A long term decrease in the size of an important population as a result of the proposed MEWF project is unlikely.
Reduce the area of occupancy of an important population?	There is no important population known on the proposed MEWF site and there are limited records of the species in the region. Key habitats will be largely unaffected and the area of occupancy of any population around the site would not be reduced.
Fragment an existing important population into two or more populations?	An existing population has yet to be observed on the site; however, any population utilising the site for foraging would be sufficiently mobile to avoid fragmentation.
Adversely affect habitat critical to the survival of a species	The proposed MEWF project site does not include any habitat areas considered critical to the survival of the Red Goshawk. Extensive areas of potential foraging habitat occur across the site and region.
Disrupt the breeding cycle of an important population	The proposed MEWF project site does not contain habitat that is critical to the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to be in decline?	The proposed MEWF project site is not considered to contain key habitat for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.
Result in invasive species that are harmful to a vulnerable species being established in the vulnerable species habitat?	The proposed MEWF project is not likely to result in the introduction of invasive species to potential Red Goshawk Habitat. Application of Pest and Weed Management Plans during each stage of the development will help minimise the possibility of weed invasion.
Introduce disease that may cause the species to decline	The proposed MEWF project is not likely to increase the risk of disease to the species. Application of Pest Management Plans during each stage of the development would effectively avoid introduction and spread of disease.
Interfere substantially with the recovery of the species?	The proposed MEWF project site is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in interference with the recovery of the species. The species is not expected to be impacted during operation of the MEWF due to foraging preferences keeping the activities of a population below rotor height.

13.6.3 Buff-breasted Buttonquail *(Turnix olivii)*

Buff-breasted Buttonquail was not recorded on the proposed MEWF project site.

The Buff-breasted Buttonquail is only known to occur in north-eastern Queensland and have been recorded to the north of the site at Mount Molloy and Mareeba (SEWPaC, 2011f). Recent extensive surveys for the species throughout their potential range only recorded a total of three pairs in close proximity to Mount Molloy (SEWPAC, 2011f). The species is known to occur in open Eucalyptus woodland in addition to grasslands, open glades amongst *Melaleuca, Acacia, Alphitonia* or *Tristaniopsis*, and in rainforest (SEWPAC, 2011f). Generally, the species is not well understood with limited information known of their habitat distribution or ecology.

Suitable habitat is potentially widespread on the subject site, however, based on limited habitat records for this species, open woodland areas with a grassy understorey and a mid storey on *Melaleuca monantha* and/or *M. viridiflora* may represent the most likely habitat.

Survey guidelines for Australia's threatened birds from the Australian Government Department of The Environment (DotE) outlines the plan for the Buff-breasted Button-quail through two methods:

- "Area searches of favoured habitat during the wet season. Detection primarily by direct observation of flushing birds and listening for booming call. Flushing in areas with relatively open understory may be effective.
- With several people, walk in lines perpendicular to direction of travel to flush birds along the base of the slope when flushed it can be difficult to identify and distinguish from other Buttonquails so having several observers to see a bird from different angles during flushing will help increase chance of a correct identification broadcasting surveys may also be useful if a female can be recorded." (SEWPaC, 2010a).

The recommended duration of the survey method above is for land based areas of less than 50ha spend total 25 hours over 5 days (SEWPaC, 2010a). It is expected even if the species is present on site it would be highly unlikely individuals could be located. The Recovery Plan for the species also makes this distinction (Mathieson *et al.,* 2009) and is explicit about the paucity of information being a major contributing factor to its endangered status.

Multiple surveys across turbine towers and proposed access tracks occurred over a 12 month period. Surveys included diurnal bird surveys, camera traps, and observational recordings while moving between survey points. The camera trap surveys (with Japanese millet baits) were placed in key habitat locations (Quail had been observed), over an 8 month period to attempt to obtain presence-absence of the species (**Appendix 14**). No confirmed sightings of the Buff-breasted Buttonquail were made over this period. The Painted Buttonquail (*Turnix varius*), and the Brown Quail (*Coturnix ypsilophora)* were identified on camera trap footage (at traps located in open woodland areas with grassy understorey, typically away from high ridge lines) and occasionally disturbed whilst traversing the site on foot. It is acknowledged that positive identification of flushed quails and button quails is difficult and misidentification may have occurred.

The greatest threats to this species are considered to be from habitat degradation, clearing and predation although there is such a paucity of information that it can only be inferred (Curtis *et al.,* 2012). Grazing, burning and weed invasion are thought to impact significantly on the species preferential habitat. The significant impact assessment for the Buff-breasted Buttonquail is provided in **Table 13.12** below.

Table 13.12 Significant Impact Assessment for the Buff-breasted Buttonquail

Buff-breasted Buttonquail (*Turnix olivii*) – Endangered	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of a population?	The species was not recorded in the project area. If a population of the Buff Breasted Buttonquail was present on the proposed MEWF site it would be regarded as an important population. However, key habitats for the species are outside the development footprint for the majority of the project and are not likely to lead to a long term decrease in the size of a population. Mitigation strategies to reduce impact to vegetation from the development may also reduce potential impacts.
Reduce the area of occupancy of the species?	There is no known population of Buff Breasted Buttonquail in the area and a paucity of regional data to make reference from.
Fragment an existing important population into two or more populations?	It is unlikely that any population in the project area is sufficiently large enough to be fragmented by the MEWF. The development footprint does not impact the vast majority of habitat available to the species, and access tracks would not prevent this mobile species from utilising other areas of the site. It is unlikely that a 10 m wide track will represent a barrier to the movement of the species given the presence of naturally bare ground throughout the site

Buff-breasted Buttonquail (*Turnix olivii*) – Endangered	
Will the proposed works..	**Response**
Adversely affect habitat critical to the survival of a species?	The project area does not include any habitat considered critical to the survival of the Buff Breasted Buttonquail as identified in the EPBC Act or the species Recovery Plan.
Disrupt the breeding cycle of a population?	Key habitats available to the species in the area will not be significantly impacted by the project and will therefore not disrupt the breeding cycle of the population. It is not expected that the operation of the proposed MEWF project will result in a significant impact on the species due to rotor strike given the low likelihood of their occurrence on the site and the fact that, like other *Turnix spp.,* they prefer to remain on the ground.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The project area is not considered to contain key habitat for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.
Result in invasive species that are harmful to an endangered species being established in the endangered species habitat?	The project has the potential to lead to the introduction of invasive fauna and weed species that may impact the Buff Breasted Buttonquail. Application of Pest and Weed Management Plans will avoid the introduction and spread of these species into potential habitat.
Introduce disease that may cause the species to decline?	There are no diseases that are known to be a threat to this species. The project is not considered to represent a threat to the species with respect to disease transmission.
Interfere with the recovery of the species?	The study area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in interference with the recovery of the species. The species is not expected to be impacted during operation of the MEWF due to foraging preferences keeping the activities of a population below rotor height.

13.6.4 Masked Owl (northern) (*Tyto novaehollandiae kimberli*)

The Northern Masked Owl was not recorded in the project area. This species typically occurs in sclerophyll forest and woodland with a grassy understorey or with a mosaic of sparse and dense ground cover (Curtis *et al.,* 2012). Preferred roosting sites are in tree hollows, caves or dense foliage 3-8 m above the ground (Curtis *et al.,* 2012). The species occurs across tropical Australia and west to the Kimberly with Townsville being the most southern range. An historic record from 1958 exists from within 10 km of the site; however, there have been no further records in the area. There is some potential habitat for the species on site within sheltered valleys which will not be impacted by the project.

The Northern Masked Owl is threatened by land clearing and fragmentation of habitat, loss of hollow trees and fire impacts on breeding habitat. Collisions and rat poisons have also impacted populations (Curtis *et al.,* 2012). The significant impact assessment for the Masked Owl is provided in **Table 13.13** below.

Table 13.13 Significant Impact Assessment for the Masked Owl

Masked Owl (northern) (*Tyto novaehollandiae kimberli*) – Vulnerable	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of a population?	The species was not recorded in the project area. If a population of the Northern Masked Owl was present on the proposed MEWF project site it would be regarded as an important population. However, potential key habitats for the species are outside the development footprint of the majority of the project and are not likely to lead to a long term decrease in the size of a population. Mitigation strategies to reduce impact to vegetation and Northern Quolls (a species that also utilises tree hollows) will also reduce potential impacts.
Reduce the area of occupancy of the species?	The key potential habitats for the species will mostly be unaltered by the project which avoids valleys and creeklines and therefore the area of occupancy is unlikely to be reduced.
Fragment an existing important population into two or more populations?	Key potential habitats for the species will not be fragmented by the project and as the species has high mobility it will also not fragment any population that may be present in the vicinity.
Adversely affect habitat critical to the survival of a species?	The proposed MEWF project area does not include any habitat considered critical to the survival of the Northern Masked Owl as identified in the EPBC Act or the species Recovery Plan.
Disrupt the breeding cycle of a population?	An increased risk of fire during construction has the potential to impact on key habitats for the Northern Masked Owl. A Fire Management Plan has been developed to mitigate against any unnatural fire occurrences on site. There is considered to be a very low potential mortality risk to the species from turbine rotor strike as they are most likely to hunt for prey below the rotor sweep area and are not likely to occur on the site in significant numbers. There are no records in the area since 1958, and no evidence on site that there is habitat critical to the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	No potential key habitat would be modified, destroyed, removed, isolated or decreased in availability or quality of habitat that would result in the decline of the species.
Result in invasive species that are harmful to an endangered species being established in the endangered species habitat?	This project is not likely to result in the introduction of invasive species to potential Northern Masked Owl habitat. Application of Pest and Weed Management Plans during each stage of the development would effectively avoid introduction.
Introduce disease that may cause the species to decline?	Disease is not a known threat to this species. Application of Pest Management Plans during each stage of the development would effectively avoid introduction and spread of disease.
Interfere with the recovery of the species?	The proposed MEWF project is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in interference with the recovery of the species. The species is not expected to be impacted during operation of the proposed MEWF project due to foraging preferences keeping the activities of a population below rotor height.

13.6.5 Gouldian Finch (*Erythrura gouldiae*)

The Gouldian Finch was not recorded during extensive bird utilisation surveys on the proposed MEWF project site. The species prefers open tropical woodland with a grassy understorey, often in rocky hills or low escarpment country (Curtis *et al*., 2012).

Historically, the species was widely distributed throughout the tropical savannahs of northern Australia. In recent decades, there have been sporadic and scattered records from North Queensland (Homes, 1995 in (SEWPAC, 2011e), however, the region no longer appears to support large populations of this species.

The Atlas of Living Australia includes a Gouldian Finch record from approximately 7 km north of Mt Emerald from October 1976. There were attempts to reintroduce this species to the Mareeba area but no birds have been recorded since 2007. The open woodlands with grassy understory would be considered potential habitat for the species but it is unlikely any populations persist in the region.

Current threats to this species are predominately improper fire management and grazing threats. Introduced weeds have also modified seed yields, reducing viable habitat (Cutis *et al*., 2012). Trapping for the pet trade led to the species decline until the 1980's and the species has not recovered. The significant impact assessment for the Gouldian Finch is provided in **Table 13.14** below.

Table 13.14 Significant Impact Assessment for Gouldian Finch

Gouldian Finch (*Erythrura gouldiae*) – Endangered	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of a population?	The species was not recorded in the project area. If a population of the Gouldian Finch was present on the proposed MEWF project site it would be regarded as an important population. Habitat modification through changes in the fire regime resulting from invasion of exotic grasses brought in on construction machinery is a potential risk, although this threat can be significantly reduced through the implementation of weed control and monitoring and an appropriate ecological burning regime. This project is not likely to lead to a long term decrease in the size of a population
Reduce the area of occupancy of the species?	Impacts to key habitats from the proposed MEWF project will be minor and the area of occupancy of the species, if it were to be present, would not be reduced.
Fragment an existing important population into two or more populations?	An existing population has yet to be observed on the site; however, any population utilising the site for foraging would be sufficiently mobile to avoid fragmentation.
Adversely affect habitat critical to the survival of a species?	The proposed MEWF project site does not include any habitat considered critical to the survival of the Gouldian Finch as identified in the EPBC Act or the species Recovery Plan.
Disrupt the breeding cycle of a population?	Key habitats available to the species in the area will not be significantly impacted by the project and will therefore not disrupt the breeding cycle of the population. There is expected to be a very low potential risk of mortality to Gouldian Finch due to rotor strike from operating turbines as they are most likely to forage below the rotor sweep area and are not likely to occur on the site in significant numbers.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The proposed MEWF project is not considered to contain key habitat for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.
Result in invasive species that are harmful to an endangered species being established in the endangered species habitat?	The proposed MEWF project has the potential to lead to the introduction of invasive fauna and weed species that may impact the Gouldian Finch. Application of Pest and Weed Management Strategies will avoid the introduction and spread of these species into potential habitat.
Introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the proposed MEWF project would result in an increased threat to the species of disease.
Interfere with the recovery of the species?	The proposed MEWF project site is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in interference with the recovery of the species. The species is not expected to be impacted during operation of the proposed MEWF project due to foraging preferences keeping the activities of a population below rotor height.

13.6.6 Northern Quoll (*Dasyurus hallucatus*)

A population of Northern Quolls inhabits the project site. The species is discussed in detail in **Chapter 15** with reference to the existing environment and the anticipated impacts of the project. Specialist reports detailing the species ecology and dynamics are located in **Appendices 16-21**. The significant impact assessment for the Northern Quoll is provided in **Table 13.15** below.

Table 13.15 Significant Impact Assessment for the Northern Quoll

Northern Quoll (*Dasyurus hallucatus*) - Endangered	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of a population?	Habitat modelling shows that >72% of predicted high and very highly suitable habitat in Far North Queensland is found within a 55km radius of Mt. Emerald, suggesting the region including Mt. Emerald local area is a significant reservoir of quolls for the region (**Appendix 18).** Preliminary Population Viability Analysis (PVA) modelling reveals the high susceptibility of the Mt Emerald Northern Quoll subpopulation to increased extinction risk with even modest increases in extrinsic mortality (**Appendix 17).** The PVA found thatt an increase in local annual mortality as low as 2.5% (=1.325 individuals) results in a greater risk of extinction of the population and a 10% increase in local mortality (=5.3 individuals) may lead to localized extinction of the Mt. Emerald population within 20 years (**Appendix 17**). It should be clear that these extinction probabilities may be over-estimated due to the lack of any data on dispersal rates. Studies on patterns of dispersal of Northern Quoll between the various sub-populations of the FNQ metapopulation are required to improve the prediction of the PVA model. The combination of high and very high quality quoll habitat on the project site and its location adjacent to an area of discontinuous habitat suggests that the project site may be critically important for maintaining connectivity and dispersal of Northern Quoll between the Walsh/Herbert River catchment areas and the Barron/Mitchell catchment areas (**Appendix 18**). This is supported by the findings of the population genetics study (**Appendix 21**). Unless wide-scale habitat degradation of the project site occurs as a result of invasion of exotic fire-promoting pasture grasses and the subsequent establishment of inappropriate fire regimes, it is likely that the project site will continue to help to maintain connectivity of the Northern Quoll population between the Walsh/Herbert River catchment areas and the Barron/Mitchell catchment areas. Therefore, it is unlikely the clearing of ~57 ha of known Northern Quoll habitat on the project site will lead to a long-term decline in the size of the Far North Queensland (FNQ) metapopulation due to reduced gene flow. However, the assessment of the long-term viability of the Far North Queensland (FNQ) metapopulation and the relative importance of the Mt Emerald population in maintaining this viability is highly dependent upon the mechanism of gene flow, which remains unknown. Gene flow between the populations to the north and south of the Mt Emerald project site may occur quickly (i.e. within one generation) via long-distance movements of individuals passing through Mt Emerald from one catchment to the other, or gene-flow may occur gradually over many generations with genes 'diffusing' from one catchment to another ('stepping stone' scenario). This has implications regarding the potential impact of the proposed development on the overall Northern Quoll FNQ metapopulation. If the former mechanism of gene flow between populations is the dominant mechanism, this places less importance on the retention of the Mt Emerald Northern Quoll population, compared to the latter diffusion model which requires a constant presence of quolls on Mt Emerald to facilitate that gene flow. In the latter case it is possible that the local extinction of this population (as indicated by the PVA modelling) could lead to a long-term decline in the overall FNQ metapopulation.
Reduce the area of occupancy of the species?	The proposed development is not likely to reduce the area of occupancy of the FNQ metapopulation of Northern Quoll given only ~57 ha of known habitat will be cleared, unless widespread habitat degradation occurs through weed invasion and establishment of inappropriate fire regimes that render the site unsuitable for maintaining a viable quoll population. Implementation of appropriate management actions should reduce this risk significantly.

Northern Quoll (*Dasyurus hallucatus*) - Endangered	
Will the proposed works..	**Response**
Fragment an existing important population into two or more populations?	Whether the proposed development could lead to the fragmentation of the FNQ Northern Quoll metapopulation into two or more sub-populations depends greatly upon the mechanism of gene flow between populations in the various areas of high quality habitat. If gene flow occurs predominately via the long-distance dispersal of individuals, then the FNQ metapopulation is unlikely to be fragmented as long as the overall habitat suitability of the project site is maintained for the species. If gene flow occurs slowly (stepping stone scenario) and the habitat suitability of the project site is compromised, then it is possible that the FNQ metapopulation may become fragmented into two subpopulations over time. Therefore, in the absence of detailed understanding on the patterns of gene flow and dispersal movements in the Far North Queensland (FNQ) metapopulation, it is critical to ensure the viability of the Mt Emerald Northern Quoll sub-population by avoiding any mortality of individuals or wide-spread habitat degradation.
Adversely affect habitat critical to the survival of a species?	Preliminary modelling has suggested that the local Mt Emerald population of Northern Quoll represents <1% of the estimated total Far North Queensland metapopulation and does not represent a distinct genetic sub-population (**Appendix 21**). Therefore even the total removal of all suitable habitats for the species on the site may not cause the species to decline. However further validation studies are required before the significance of the habitat loss, degradation, isolation etc associated with the project on the long-term viability of the Far North Queensland metapopulation on can be assessed with reasonable confidence.
Disrupt the breeding cycle of a population?	It is unlikely that the proposed development will disrupt the breeding cycle of the entire FNQ metapopulation. It is also unlikely that the breeding cycle of the important Mt Emerald sub- population of Northern Quoll would be disrupted with the implementation of the mitigation strategies outlined below
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The proposed development will result in the clearing of ~57 ha of potential foraging or denning habitat of an important population of Northern Quoll. There is a high risk of invasive fire promoting grasses spreading from existing loci on the site or become established on the site in areas where chemical and mechanical control would not be feasible. Associated changes in fire intensity and frequency could result in a decrease in the quality of existing habitat e.g. fewer potential den sites (hollow tress and fallen timber) and changes in prey availability. Preliminary modelling indicates that the local Mt Emerald population of Northern Quoll represents <1% of the estimated total Far North Queensland metapopulation (~10,000 individuals) and do not represent a distinct genetic sub-population (**Appendix 21).** Therefore even the total removal of all suitable habitats for the species on the site may not likely cause in the species to decline. However further validation studies are required before the significance of the habitat loss, degradation, isolation etc. Impacts associated with the project on the long-term viability of the Far North Queensland metapopulation on can be assessed with high confidence.
Result in invasive species that are harmful to an endangered species being established in the endangered species habitat?	Without strict weed hygiene, control and monitoring, there is a high risk of invasive fire promoting grasses spreading from existing loci on the site or become established on the site in areas where chemical and mechanical control would not be feasible. Associated changes in fire intensity and frequency could result in a decrease in the quality of existing habitat e.g. fewer potential roost trees and changes in prey availability and cause direct mortality to individuals on the project site. Cane Toads (*Rhinella marinus*) are the one of the most ubiquitous and abundant terrestrial vertebrates on the project site. The FNQ metapopulation of Northern Quoll has managed to persist despite the high abundance of Cane Toads throughout the entire region, including the site. It is highly likely that Cane Toads will be transported onto and within the project site on machinery and equipment. However, this will not have an adverse impact of the local Northern Quoll population.

Northern Quoll (*Dasyurus hallucatus*) - Endangered	
Will the proposed works..	**Response**
Introduce disease that may cause the species to decline?	There is some evidence to suggest that disease has been responsible for rapid declines in some dasyurid species (carnivorous marsupial family) across Australia last century (see Hill & Ward, 2010). However, there is no evidence of any diseases causing such population declines for Northern Quoll.
Interfere with the recovery of the species?	It is uncertain at present whether the proposed development could potentially interfere with the recovery of Northern Quoll. The long-term viability of the FNQ metapopulation of Northern Quolls is certainly crucial to the recovery of the species as a whole, given the apparent stability of the FNQ metapopulation in the face of Cane Toad invasion.

13.6.7 Koala (*Phascolarctos cinereus*)

The Koala was not recorded during surveys within the project area. The range of this population extends from approximately the latitude of Cairns to the New South Wales-Victoria border (SEWPaC, 2012k). Koalas inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus *Eucalyptus* (Martin & Handasyde, 1999). The koala's diet is restricted mainly to foliage of Eucalyptus species but may also consume foliage of related genera, including *Corymbia*, *Angophora* and *Lophostemon* and at times supplement its diet with other species, including species from the genera *Leptospermum* and *Melaleuca* (Martin & Handasyde, 1999; Moore & Foley, 2000). The species is limited in its range to altitudes below 800m, and is very selective to temperature and leaf moisture (Munks *et al*., 1996).

There are very few records for the area west of the Wet Tropics rainforest. Due to the paucity of records for the species in the northern part of its Australian distribution, what constitutes critical Koala habitat is not well understood. According to the potential habitat mapping (Save the Koala Foundation, 2014), the entire project site may provide suitable habitat for the species and is continuous with known Koala habitat to the south e.g. Herberton Ranges and Toumoulin area.

Threats to this species are clearing resulting in loss and fragmentation of habitat, although dog predation, vehicle strike and disease have a large impact on mortality rates. The significant impact assessment for the Koala is provided in **Table 13.16** below.

Table 13.16 Significant Impact Assessment for Koala

Koala (Phascolarctos cinereus) – Vulnerable	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of a population?	The species was not recorded in the project area. However, if a population of the Koala was present on the proposed MEWF project site it would be regarded as an important population as there are very few records from north Queensland and the species is likely to occur at low density relative to the south-eatsern QLD populations. The nearest records for the species are from Koah and the western tablelands (Wondecla area). Little is known of the detailed habitat preference of the species in the northern extent of its range. If the species was found to occur on site, targeted mitigation measures would be implemented to protect all individuals. This project is not likely to lead to a long term decrease in the size of a population given the large extent of potentially suitable habitat in the region.
Reduce the area of occupancy of the species?	There are no records from the MEWF project site however there are several records within a 30 km buffer of the site. Impacts to key habitats from the project are likely be minor and the area of occupancy of the species, if it were to be present, would not be reduced.

Koala (Phascolarctos cinereus) – Vulnerable	
Will the proposed works..	**Response**
Fragment an existing important population into two or more populations?	It is unlikely that any population in the project area would be fragmented by the MEWF project. Koalas are capable of traversing open ground, therefore the creation of a track network and turbine pads etc is not likely to fragment the population.
Adversely affect habitat critical to the survival of a species?	The proposed MEWF project site does not include any habitat considered critical to the survival of the Koala as identified in the EPBC Act or the species Recovery Plan.
Disrupt the breeding cycle of a population?	Key habitats for this species in FNQ are unknown. The habitat area will not be significantly impacted by the proposed MEWF project and will therefore not disrupt the breeding cycle of the population. There is considered to be no risk to a population from operation of wind turbines.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	With a development footprint of 57 ha within a total property area of 2422ha, it is not expected the reduction would result in a decline in the species. The project area is not considered to contain key habitat for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.
Result in invasive species that are harmful to an endangered species being established in the endangered species habitat?	The project has the potential to lead to the introduction of invasive fauna and weed species that may impact the Koala. Application of Pest and Weed Management Plans may minimise the introduction and spread of these species into potential habitat.
Introduce disease that may cause the species to decline?	The disease Chlamydia is a known threat to the Koala. Application of a Pest Management Plan may reduce the potential for vectors in other mammal introductions however it remains poorly known. Most populations of Koalas carry antibodies to the disease and it is expected that intra-species infection is the most common method of contraction. The proposed MEWF project is not expected to present a threat to Koalas through the introduction of disease.
Interfere with the recovery of the species?	There is limited information on what constitutes important Koala habitat in the region, however the whole proposed MEWF site is potential habitat to the species. The removal of 57ha (2.4%) of the site would not result in interference with the recovery of the species.

13.6.8 Spectacled Flying-fox (*Pteropus conspicillatus*)

The Spectacled Flying-fox (SFF) has been confirmed during targeted surveys on site. The species is discussed in detail in **Chapter 18** with reference to the existing environment and the anticipated impacts of the project. A specialist report detailing the species ecology and dynamics are located in **Appendix 25**. The significant impact assessment for the Spectacled Flying-fox is provided in **Table 13.17** below.

Table 13.17 Significant Impact Assessment for Spectacled Flying-fox

Spectacled Flying-fox (*Pteropus conspicillatus*) – Vulnerable	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of a population?	The Spectacled Flying-fox is known to utilise the proposed MEWF project site, however, to what extent remains unknown. Without mitigation, the proposed action has a possibility to lead to a long-term decrease in the size of the Wet Tropics population of Spectacled Flying-fox given that: ▪ large camps occur within the maximum foraging distance of the site; ▪ there are suitable foraging plants available sporadically; and ▪ the species is known to fly below 150 m. This is discussed further in **Chapter 18**. Appropriate mitigation strategies at construction and operation will serve to reduce the risk to the species of long term decrease in population size.

Spectacled Flying-fox (*Pteropus conspicillatus*) – Vulnerable	
Will the proposed works..	**Response**
Reduce the area of occupancy of the species?	The proposed MEWF project is unlikely to reduce the area of occupancy of the species given the high mobility and extensive range of colonies.
Fragment an existing important population into two or more populations?	The proposed MEWF project is unlikely to fragment an existing important population into two or more populations due to the high mobility of the species and the availability of areas of continuous similar habitat around and off site.
Adversely affect habitat critical to the survival of a species?	Key habitat is available to the Spectacled Flying-fox on the proposed MEWF project site, however, this habitat is not critical to the survival of the species and with a small portion approx. 2.4% of the site affected it is unlikely to have an impact.
Disrupt the breeding cycle of a population?	The proposed MEWF project could potentially disrupt the breeding cycle of an important population, if mass turbine collision fatalities occur at a sensitive time in the life cycle e.g. when females have dependent young left at the camp site while they forage, or if females are preferentially at a higher risk of collision due to some behavioural factor. Implementation of mitigation measures from a Spectacled Flying-fox Management Plan will reduce the likelihood of disruption to the breeding cycle of the SFF population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	There is no key habitat on the site that will be modified, destroyed, removed, isolated or decreased such that the availability or quality of habitat for the species is likely to decline. The majority of foraging habitat is also widely available to the species offsite and around the region.
Result in invasive species that are harmful to a vulnerable species being established in the vulnerable species habitat?	The project has little potential to lead to the introduction of invasive species that are harmful to the Spectacled Flying-fox. Implementation of Pest and Weed Management Plans will militate against any potential threats.
Introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the project would result in an increased threat to the species of disease.
Interfere with the recovery of the species?	If unsustainable turbine collisions were to occur the proposed MEWF project site would interfere with the recovery of the species. However with effective mitigation measures at the operational phase of the MEWF project it is expected that this risk would be minimised.

13.6.9 Grey-headed Flying-fox (*Pteropus poliocephalus*)

The Grey-headed Flying-fox was not recorded on the proposed MEWF project site. The site is outside the known geographic range for this species (Mackay). However, recent records have indicated presence of the species on the lower Atherton tablelands (David Westcott pers. com.).

This species is known to feed in a wide variety of forest and woodland habitats (Curtis *et al.,* 2012), including the sclerophyll wood lands that are available habitat on the proposed MEWF site. The species is highly mobile and relies on a diverse array of flowering and fruiting patterns which influence its distribution (DECCW, 2009).

Colonies are typically nomadic with few individuals remaining resident in camp (Curtis *et al.,* 2012), and are known to travel up to 1000 km for available food. However, contraction of their range is continuing to occur due to the known threat of loss of feeding habitat and availability due to clearing and degradation. The Grey-headed Flying-fox recovery plan identifies that for the species to survive it requires a continuous sequence of productive foraging habitat and migration corridors to link them, with suitable roosting habitat (Fleming & Eby, 2003 *in* DECCW, 2009), within close range of foraging habitat.

Other threats to the species include licensed killing around orchards, electrocution from powerlines and entanglement and the impacts of climate change on seasonality of flowering (Curtis *et al*., 2012). The significant impact assessment for the Grey-headed Flying-fox is provided in **Table 13.18** below.

Table 13.18 Significant Impact Assessment for the Grey-headed Flying-fox

Grey-headed Flying-fox (*Pteropus poliocephalus*) – Vulnerable	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of a population?	The Grey-headed Flying-fox is not known to utilise the proposed MEWF project site. If the species is confirmed then mitigation strategies appropriate to the Spectacled Flying-fox at construction and operation will be effective to reduce the potential risk to the species of long term decrease in population size.
Reduce the area of occupancy of the species?	The species known range has recently been extended to the Southern Atherton Tablelands (D. Westcott pers. com.), therefore there is the potential for the species to be utilising the proposed MEWF project site. The project is unlikely to reduce the area of occupancy of the species given the high mobility, extensive range of colonies and limited foraging potential on site.
Fragment an existing important population into two or more populations?	The proposed MEWF project is unlikely to fragment an existing important population into two or more populations due to the high mobility of the species and the availability of areas of continuous similar habitat around and off site.
Adversely affect habitat critical to the survival of a species?	Limited foraging and roosting habitat is available to the Grey-headed Flying-fox on the MEWF site and is not critical to the survival of the species and with a small portion (2.4%) of the sites overall affected it is unlikely to have an impact.
Disrupt the breeding cycle of a population?	The proposed action could potentially disrupt the breeding cycle of an important population, if mass turbine collision fatalities occur at a sensitive time in the life cycle e.g. when females have dependent young left at the camp site while they forage, or if females are preferentially at a higher risk of collision due to some behavioural factor. Implementation of mitigation measures from a Spectacled Flying-fox Management Plan will reduce the likelihood of disruption to the breeding cycle of the SFF population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	There is no key habitat on the site that will be modified, destroyed, removed, isolated or decreased such that the availability or quality of habitat for the species is likely to decline. The majority of foraging habitat is widely available to the species offsite and around the region.
Result in invasive species that are harmful to an endangered species being established in the endangered species habitat?	The project has little potential to lead to the introduction of invasive species that are harmful to the Grey-headed Flying-fox. Implementation of Pest and Weed Management Plans will mitigate against any potential threats.
Introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the proposed MEWF project would result in an increased threat to the species of disease.
Interfere with the recovery of the species?	There is potential for the species to occur on site, however, considering current distribution and location of colonies it is unlikely the proposed MEWF project would interfere with the recovery of the species. With effective mitigation measures for bat and birds at the operational phase of the project it is expected that any risk would be minimal.

13.6.10 Semon's Leaf-nosed Bat (*Hipposideros semoni*)

This species was not recorded during field surveys including ultrasonic call detection surveys. The site contains potential foraging and roosting habitat and is within its known distribution range. Semon's Leaf-nosed Bat occurs in tropical rainforest, monsoon forest, wet sclerophyll forest and open savannah woodland (SEWPAC, 2011b).

The species typically forages within the undergrowth within 1-2 m above the ground, and their flight is relatively slow and manoeuvrable (Churchill, 2009). The species is known to roost in tree hollows, caves, relatively shallow underground structures including overhangs and cracks, shallow caves or other unusual relatively open situations (SEWPAC, 2011b).

The majority of the records are known from Iron Range, Coen and Cooktown areas, with three specimens collected from the Townsville region which appears to represent the southernmost extent of its range.

Recent overseas research indicates wind farms have the potential to cause microchiropteran bat mortality, mostly amongst high-flying or migratory species (Arnett *et al.,* 2011). The major cause of bat deaths has been shown to be due to barotrauma, that is, damage to the lungs caused by changes in air pressure near the moving blades, rather than direct turbine collisions (Kunz *et al*., 2007). Ultrasonic echoes returned from moving turbine blades have features which may render them attractive to bats or which might make it difficult for bats to accurately detect and locate blades with sufficient time to avoid a collision (Long *et al.*, 2010a). In addition to direct mortality caused by barotrauma, bats may suffer lesser injuries, such as hearing impairment and other internal injuries that may allow bats to fly or otherwise move away from the vicinity of the turbine but would ultimately result in their death (Kunz *et al.*, 2007). Little definitive work on these potential impacts on Australian species has been carried out.

The construction of the proposed wind farm infrastructure has the potential to remove some foraging and roosting habitat for this species; however similar potentially suitable habitat is widespread over the site and in the surrounding region.

The operation of the proposed turbines has the potential to result in the mortality of *H. semoni* individuals due to rotor strike and/or barotrauma. Semon's Leaf-nosed Bat has been observed to typically forage below the potential rotor strike and barotrauma zone (Churchill, 2009) and as a result, it may be expected the risk of barotrauma and/or collision for this species is likely to be low. However, all Australian microchiropteran bats have the capacity to fly within the rotor sweep height and, while some may do so less than others, current knowledge is insufficient to suggest the exclusion of any key bat taxa from a preliminary assessment of the potential for turbine-related mortality such as has been conducted to date (EPHC, 2010).

Chapter 17 details the impacts and mitigation measures as applied to the confirmed present Bare-rumped Sheathtail Bat (**below**); however, these measures can apply to other microbats potentially occurring on site. The significant impact assessment for the Semon's Leaf-nosed Bat is provided in **Table 13.19** below.

Table 13.19 Significant Impact Assessment for Semon's Leaf-nosed Bat

Semon's Leaf-nosed Bat (*Hipposideros semoni*) – Endangered	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of a population?	This species is highly unlikely to occur on the proposed MEWF project site. Acoustic surveys on site over a three year period did not positively identify calls for this species (**Appendix 24**). Should this species be detected, the application of mitigation strategies for microbats under the Bare-rumped Sheathtail Bat Management Plan will reduce the risk of potential impact to the species.
Reduce the area of occupancy of the species?	The key potential habitats for the species will be mostly unaltered by the proposed MEWF project and therefore the area of occupancy is unlikely to be reduced.
Fragment an existing important population into two or more populations?	Key potential habitats for the species will not be fragmented by the proposed MEWF project and as the species has high mobility it will also not fragment any population that may be present in the vicinity.
Adversely affect habitat critical to the survival of a species?	The proposed MEWF project does not include any habitat considered critical to the survival of the Semon's Leaf-nosed Bat as identified in the EPBC Act or the species Recovery Plan. Additionally, similar habitats to that located on the project site are available to this species within the region.

Semon's Leaf-nosed Bat (*Hipposideros semoni*) – Endangered	
Will the proposed works..	**Response**
Disrupt the breeding cycle of a population?	Mitigation measures under the Bare-rumped Sheathtail Bat Management Plan would ensure the breeding cycle of a population is not disrupted by the construction or operational phases of the project.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	No potential key habitat would be modified, destroyed, removed, isolated or decreased in availability or quality of habitat to the extent that would result in the decline of the species.
Result in invasive species that are harmful to an endangered species being established in the endangered species habitat?	The proposed MEWF project is not likely to result in the introduction of invasive species to potential Semon's Leaf-nosed Bat habitat. Application of Pest and Weed Management Plans during each stage of the development would effectively avoid introduction.
Introduce disease that may cause the species to decline?	There are no infectious diseases of Australian microchiropteran bats that are currently known to result in high levels of mortality (ARWH, 2013). In is not likely the proposed MEWF project will facilitate the spread of any diseases that may cause the species to decline.
Interfere with the recovery of the species?	The proposed MEWF project is considered unlikely to interfere with the recovery of the species.

13.6.11 Greater Large-eared Horseshoe Bat (*Rhinolophus robertsi*)

No Greater Large-eared Horseshoe Bat individuals were recorded during the field surveys. However, the proposed MEWF project site contains potential foraging and roosting habitat and is within the species known distribution range. The species occurs in lowland and upland rainforest, along riparian gallery forest within open eucalypt forest, *Melaleuca* forest with rainforest understorey, open savannah woodland and tall riparian woodland of *Melaleuca* spp., *E. tereticornis* and *E. tessellaris* (Churchill, 2009). The species commonly roosts during the day in caves and underground mines but it is also suspected to utilise basal hollows of large trees, dense vegetation, rock piles and areas beneath creek banks (see references in SEWPAC, 2011c).

The Greater Large-eared Horseshoe Bat has been recorded in the nearby vicinity of the proposed MEWF project site from Danbulla State Forest (~18 km east), Curtain Fig Tree National Park (~23 km SE), Mt Baldy State Forest (~14 km SSE) and Mt Molloy (~53 km N) (Duncan *et al.* 1999 in SEPWAC, 2011c; Kutt, 2004 in SEPWAC, 2011c).

The loss of potential foraging and roosting habitat due to clearing is not likely to present a significant impact on this species due to the large extent of similar habitat occurring throughout the site and in the surrounding region.

Clearing of ~57 ha of sclerophyll woodland and open forest for the proposed infrastructure may result in the direct mortality of some individuals and the loss of some potential roost sites such as the basal hollows of trees and rock piles. It is not expected clearing will have significant direct and indirect impacts on the species given the majority of known roost sites have been recorded in caves, underground mines and road culverts.

The operation of the proposed turbines has the potential to result in the mortality of an unknown number of Greater Large-eared Horseshoe Bat individuals due to collisions and/or barotrauma caused by moving blades and wind wake turbulence. In addition to direct mortality from barotrauma, lesser injuries may result, such as hearing impairment or other internal injuries that may allow bats to fly or otherwise move away from the vicinity of the turbine but would ultimately result in their death (Kozuka *et al*. 1997).

Greater Large-eared Horseshoe Bats appear to prefer to forage amongst thicker vegetation in gullies and along creeks in open forest and woodlands (SEWPAC, 2011c), thereby lowering potential impact risk, however, all Australian microchiropteran bats have the capacity to fly within the rotor sweep height and, while some may do so less than others, current knowledge is insufficient to suggest the exclusion of any key bat taxa from a preliminary assessment of the potential risk turbine-related mortality such as has been conducted for this project to date (EPHC, 2010). The significant impact assessment for the Greater Large-eared Horseshoe Bat is provided in **Table 13.20** below.

Table 13.20 Significant Impact Assessment for Greater Large-eared Horseshoe Bat

Greater Large-eared Horseshoe Bat (*Rhinolophus robertsi*) – Endangered	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of a population?	This species is highly unlikely to occur on the proposed MEWF project site. Acoustic surveys on site over a three year period did not positively identify calls for this species (**Appendix 24**). Should this species be detected, the application of Mitigation Strategies for microbats under the Bare-rumped Sheathtail Bat Management Plan will reduce the risk of potential impact to the species.
Reduce the area of occupancy of the species?	The key potential habitats for the species will be mostly unaltered by the proposed MEWF project and therefore the area of occupancy is unlikely to be reduced.
Fragment an existing important population into two or more populations?	Key potential habitats for the species will not be fragmented by the proposed MEWF project and as the species has high mobility it will also not fragment any population that may be present in the vicinity.
Adversely affect habitat critical to the survival of a species?	The proposed MEWF project site does not include any habitat considered critical to the survival of the Greater Large-eared Horseshoe Bat as identified in the EPBC Act or the species Recovery Plan. Additionally, similar habitats to that located on the site are available to this species within the region.
Disrupt the breeding cycle of a population?	Mitigation measures under the Bare-rumped Sheathtail Bat Management Plan would ensure the breeding cycle of a population is not disrupted by the construction or operational phases of the proposed MEWF project.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	No potential key habitat would be modified, destroyed, removed, isolated or decreased in availability or quality of habitat to the extent that would result in the decline of the species.
Result in invasive species that are harmful to an endangered species being established in the endangered species habitat?	This project is not likely to result in the introduction of invasive species to potential Greater Large-eared Horseshoe Bat habitat. Application of Pest and Weed Management Plans during each stage of the development would effectively avoid introduction.
Introduce disease that may cause the species to decline?	There are no infectious diseases of Australian microchiropteran bats that are currently known to result in high levels of mortality (ARWH, 2013). It is not likely the proposed MEWF project will facilitate the spread of any diseases that may cause the species to decline.
Interfere with the recovery of the species?	The project is considered unlikely to interfere with the recovery of the species.

13.6.12 Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*)

The Bare-rumped Sheathtail Bat has been confirmed during targeted surveys on site. The species is discussed in detail in **Chapter 17** with reference to the existing environment and the anticipated impacts of the project. A specialist report detailing call identification on site is provided in **Appendix 24**. The significant impact assessment for the Bare-rumped Sheathtail is provided in **Table 13.21** below.

Table 13.21 Significant Impact Assessment for Bare-rumped Sheathtail Bat

Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*) – Critically Endangered	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of a population?	Any confirmed records of individual Bare-rumped Sheathtail Bat can be considered as belonging to an important population given the current lack of understanding of the population structure of the species throughout its currently known distribution range. It is not known whether the species occurs in discrete isolated populations (e.g. Jeroma, Townsville, Iron Range, Hartley's Creek) or is continuously distributed in suitable habitat between the isolated known locations. There is a possibility that an unknown number of Bare-rumped Sheathtail Bat individuals could be killed due to turbine collisions or barotrauma given their known flight behaviour (i.e. high, fast fliers that feed on aerial insects). It is not possible to assess the significance of potential mortalities due to turbine collision or barotrauma on the important population of the species because it is not feasible to obtain the necessary demographic parameters (e.g. population size, age at first reproduction, mortality rates etc) for *S. saccolaimus* (or any other closely related taxa) to conduct Population Viability Analysis or Population Biological Removal to examine the viability of the important population. Targeted mitigation measures will be used to avoid impacts on the species. (**Chapter 17**).
Reduce the area of occupancy of the species?	There is currently no information on whether operating wind turbines similar to those proposed act as a barrier to the movement of any species of microchiropteran bats. Miderman *et al.* (2012) showed that bat activity (as measured by the number of detected call passes per hour) declined significantly with increasing wind speed in close proximity to small wind turbines (up to 18 m hub and 13 m blade diameter). The decline in activity was present to a lesser extent at greater distances from the wind turbine (20-25 m). It is not known how this observed avoidance effect would scale up with larger wind turbines. Given the high numbers of bat deaths reported at some overseas wind farms using turbines similar to those proposed; it is unlikely that microchiropteran bats avoid the vicinity of operating wind turbines (due to noise, movement) to the extent that they act as a barrier to their movement or reduce the area of occupancy of the wind farm through displacement due to disturbance as has been frequently demonstrated for many bird species (e.g. Fielding et al., 2006; Fox *et al.*, 2006; Masden *et al.,* 2009). The construction of the proposed wind farm infrastructure will result in the loss of a maximum 57 ha of potential roosting habitat for the species. This represents 2.4% of the total area of the project site. The Bare-rumped Sheathtail Bat has been reported to be prone to disturbance with individuals readily abandoning their roost site when approached closely by people on foot. Little is known about what are the critical roost site requirements for the species, therefore it is not possible to assess the availability of suitable roost sites on the project site. The loss of approximately 57 ha of sclerophyll woodland and open forest could potentially be significant if it includes a large number of roost trees. Targeted mitigation measures will be used to avoid impacts on the species (refer **Chapter 17**).
Fragment an existing important population into two or more populations?	There is no information about the extent of any important population present on the project site. However, it is unlikely the important population is restricted to the project site given the occurrence of similar continuous dry sclerophyll woodland and open forest habitat to the south, and elsewhere in the region The turbine avoidance behaviour of the species and the likelihood of the wind farm acting as a barrier to the movement of the species or the degree of displacement that may occur are not currently understood. However, even if the species is displaced from large areas of the proposed MEWF project site, areas of continuous similar habitat exists around the periphery of the site outside any likely zone of disturbance due to turbine noise or movement, which could be utilised by the species. It is unlikely the movement of the species will be reduced by the project and therefore, any important population could be fragmented into two or more populations.

Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*) – Critically Endangered	
Will the proposed works..	**Response**
Adversely affect habitat critical to the survival of a species?	What constitutes critical habitat for the species is not currently well understood therefore it is not possible to make a reliable assessment of the significance of the loss of 57 ha of potential foraging (and potentially roosting) habitat due to clearing. However, the dominant regional ecosystems present on the project site are well represented (total area of ~267,000 ha) elsewhere in the Einasleigh Uplands and Wet Tropics bioregions. The BIOCLIM distribution model for the species only indicates a narrow coastal section of the Wet Tropics bioregion as potential habitat (Thomson *et al*., 2001); however, this is certainly an underestimate of their potential range as the modelling was based on a very small number of record locations.
Disrupt the breeding cycle of a population?	Reproduction in the Bare-rumped Sheathtail Bat species is known to vary between geographic regions, but in Queensland it is known that females give birth to a single young between late December and early January, and lactate during the wet season (Churchill, 2008). If potential mortalities preferentially affect a particular age or sex class e.g. females of reproductive age, as has been shown elsewhere (Reynolds, 2006), then this has the potential to disrupt the breeding cycle.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The proposed MEWF project will result in the clearing of 57ha of potential foraging or roosting habitat for Bare-rumped Sheathtail Bat. There is a moderate risk of invasive fire promoting grasses spreading from existing loci on the site or become established on the site in areas where chemical and mechanical control would not be feasible. Associated changes in fire intensity and frequency could result in a decrease in the quality of existing habitat e.g. fewer potential roost trees and changes in prey availability. Without an understanding of the viability of the existing important population it is not possible to assess the likelihood of the above potential impacts resulting in a decline in the population of the species. Weed control and vehicle hygiene management during and post-construction will reduce the risk of this impact.
Result in invasive species that are harmful to an endangered species being established in the endangered species habitat?	There is a moderate risk of invasive fire promoting grasses spreading from existing loci on the site or become established on the site in areas where chemical and mechanical control would not be feasible. Associated changes in fire intensity and frequency could result in a decrease in the quality of existing habitat e.g. fewer potential roost trees and changes in prey availability. Weed control and vehicle hygiene management during and post-construction will reduce the risk of this impact.
Introduce disease that may cause the species to decline?	There are no infectious diseases of Australian microchiropteran bats that are currently known to result in high levels of mortality (ARWH, 2013). It is not likely the proposed MEWF project will facilitate the spread of any diseases that may cause the species to decline.
Interfere with the recovery of the species?	The recovery plan for the Bare-rumped Sheathtail Bat does not identify any populations that are currently known to be under threat nor are any specific conservation measures aimed at the Bare-rumped Sheathtail Bat (Shulz and Thomson, 2007). While the loss of tree hollow availability due to land clearance has been listed as a primary threat to the species by Schulz and Thompson (2007), additional potential impacts on the Bare-rumped Sheathtail Bat include: ▪ timber collection and the targeted removal of hollow-bearing and dead trees along road reserves, in parks and other urban situations; ▪ competition for hollows by European/Asian honey bees and feral birds such as the Common Myna (*Acridotheres tristis*); ▪ disease such as Australian bat lyssavirus; ▪ the loss or degradation of habitat such as tropical forests due to anthropogenic climate change (Curtis *et al.* 2012). The project is considered unlikely to interfere with the recovery of the species.

13.7 Listed Migratory Species

Under the EPBC Act, an action will require approval from the Federal Environment Minister if the action has will have or is likely to have a significant impact on a listed migratory species. Significant impacts are defined as impacts which degrade areas of important habitat for listed migratory species, or which disrupt the lifecycle of ecologically significant populations of the listed migratory species.

DotE (SEWPaC 2013) notes that an action is likely to have a significant impact on a migratory species if there is a possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

Important habitat is defined in terms of:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
- Habitat that is of critical importance to the species at particular life-cycle stages; and/or
- Habitat utilised by a migratory species which is at the limit of the species range; and/or
- Habitat within an area where the species is declining (SEWPaC, 2013)

Criteria are not specified for determining the ecological significance of a population of a migratory species. Exactly what constitutes an 'ecologically significant proportion' of the population is different for each species, and may need to consider the species population status, genetic distinctiveness and species specific behavioural patterns (SEWPaC, 2013).

The EPBC Protected Matters Search Tool lists a total of 17 species (16 birds and the Estuarine Crocodile) as known or having the potential to occur up to 10km around the project site (refer **Table 13.22**). Of these, nine species were recorded in the DEHP Wildnet search as having been recorded within 10 km of the centre of the subject site.

Due to the lack of suitable habitat, principally permanent vegetated water bodies, it is not considered likely that six of these migratory listed species will utilise the site as roosting, nesting or foraging habitat (refer **Table 13.16**). Five species were assessed as having a moderate likelihood of occurrence, in that suitable habitat exists, but were not recorded during site surveys. Bird species that are unlikely to utilise the subject site, but possibly fly over the site, whilst moving between suitable surrounding habitats were also given a moderate likelihood of occurrence.

A total of six EPBC migratory listed species were recorded during the field surveys (**Table 13.22**)**.** Two of these species, the Rainbow Bee-eater and the Rufous Fantail have been recorded utilising the site, with habitat potentially available. Four migratory species were confirmed as fly-overs to the site. It is not however, considered that the subject site represents important habitat for any of the listed migratory species. It is also not considered that the construction phase of the proposed project is likely to have a significant impact; however, mortality to animals in transit through the site during the operational phase of the project is considered in **Chapter 16** Sarus Cranes.

Table 13.22 Migratory Species Potentially Occurring Within the Project Site

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
REPTILES					
Salt-water Crocodile, Estuarine Crocodile	*Crocodylus porosus*	MW	The Estuarine Crocodile inhabits coastal rivers and swamps and extends inland along major drainage systems. It is also occasionally observed in the open ocean (Wilson & Swan 2010).	**LOW:** The subject site does not contain the preferred habitat of this species. There are no permanent streams or deep waterholes necessary for this species.	No
BIRDS					
Australian Cotton Pygmy-goose	*Nettapus coromandelianus albipennis*	MW	Normally found on permanent water such as deeper freshwater swamps, lagoons, and dams with water lilies and other semi-emergent water plants (Pizzey & Knight, 2007). Although often seen in pairs or small groups, they congregate in larger flocks on permanent water-bodies during the dry season.	**MODERATE**: No suitable habitat (permanent water) is present on the subject site and unlikely to utilise small ephemeral water bodies. However, the species may fly over site at rotor height between suitable nearby water bodies.	Yes
Great Egret, White Egret	*Ardea alba*	MM, MW	Great Egrets are widespread and occur in all states/territories. They have been reported in a wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial) (SEWPAC, 2012q). These include swamps and marshes; margins of rivers and lakes; damp or flooded grasslands, pastures or agricultural lands; reservoirs; sewage treatment ponds; drainage channels; salt pans and salt lakes; salt marshes; estuarine mudflats, tidal streams; mangrove swamps; coastal lagoons; and offshore reefs (Marchant & Higgins, 1993).	**CONFIRMED FLY OVER:** The site does not contain the preferred habitat of this species and unlikely to utilise small ephemeral water bodies. However, the species is common in surrounding areas and may fly over site at rotor height between suitable nearby water bodies.	No
Cattle Egret	*Ardea ibis*	MM, MW	The Cattle Egret is widespread and common according to migration movements and breeding localities surveys (SEWPAC 2012r). The species occurs in tropical and temperate grasslands, woodlands and terrestrial wetlands. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures. It is commonly associated with the habitats of farm animals, particularly cattle, and is known to follow earth-moving machinery. It also uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora (Marchant & Higgins 1993).	**MODERATE**. The subject site contains potential seasonal habitat for this species.	No

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
White-bellied Sea Eagle	*Haliaeetus leucogaster*	MT	The White-bellied Sea Eagle is distributed along the coastline (including offshore islands) of mainland Australia and Tasmania. It also extends inland along some of the larger waterways, especially in eastern Australia (SEWPAC, 2012s). The habitats occupied by the White-bellied Sea Eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes, and the sea). Birds have been recorded at or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs, saltmarsh and sewage ponds, as well as in (or flying over) a variety of terrestrial habitats (Marchant & Higgins, 1993).	**CONFIRMED FLY OVER**: This species has been recorded during site surveys. There is potential for this species to fly over at rotor height. No nests or suitable nesting sites were identified during the field investigations.	Yes
Sarus Crane	*Grus antigone*	MW	This large crane prefers well-vegetated shallow freshwater wetlands, isolated swamps in eucalypt forest, grasslands, paddocks, ploughed fields, irrigated pastures, bore drains, claypans, crops, grain stubbles and sometimes tidal areas (Pizzey & Knight, 2007). Locally common on the Atherton Tablelands (Pizzey & Knight, 2007).	**CONFIRMED FLY OVER:** Several flocks and aggregations have been seen on or adjacent to the subject site (RPS 2012). No suitable foraging/roosting habitat present on site and unlikely to utilise small ephemeral water bodies. There is potential for this species to fly over at rotor height between suitable nearby habitat.	Yes
Latham's Snipe, Japanese Snipe	*Gallinago hardwickii*	MW	Latham's Snipe is a non-breeding visitor to south-eastern Australia, and is a passage migrant through northern Australia (i.e. it travels through northern Australia to reach non-breeding areas located further south) (Higgins & Davies, 1996). It occurs in permanent and ephemeral wetlands up to 2,000 m above sea-level and usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies) (SEWPAC, 2012t).	**LOW**: The site does not contain the preferred wetland habitat of this species and is unlikely to utilise small ephemeral water bodies.	No
Australian Painted Snipe	*Rostratula benghalensis s. lat.*	MW	The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains (SEWPAC, 2012e). Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire.	**LOW**: The subject site does not contain the preferred habitat of this species, particularly vegetated wetland habitats. They are unlikely to utilise the small ephemeral water bodies present during the wet season. No breeding places are likely to exist.	No

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
Fork-tailed Swift	*Apus pacificus*	MMB	The Fork-tailed Swift is a non-breeding visitor to all states and territories of Australia (Marchant & Higgins, 1999). In north-east Queensland there are many records east of the Great Divide from near Cooktown and south to Townsville. The species is almost exclusively aerial, and mostly occur over inland plains, over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They also occur over settled areas, including towns, urban areas and cities (SEWPAC, 2012u).	**MODERATE**. The subject site contains suitable habitat for this species. The Atlas of Living Australia has a 2010 record 10.2 km north of the Mt Emerald centroid. The species may fly over site at rotor height between suitable nearby water bodies.	No
White-throated Needletail	*Hirundapus caudacutus*	MT	The White-throated Needletail breeds in the Northern Hemisphere but is widespread in eastern and south-eastern Australia during summer months (Barrett *et al*., 2003; Higgins, 1999). In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains (SEWPAC, 2012v). The species is almost exclusively aerial, from heights of less than 1m up to more than 1,000m above the ground. Although they occur over most types of habitat, they are probably recorded most often above wooded areas, including open forest and rainforest (Higgins 1999).	**CONFIRMED FLYOVER:** - Several flocks (up to 50 individuals) have been recorded flying within the rotor sweep area in the vicinity of turbines #62, 65, 66 and 70 (RPS, 2012).	No
Rainbow Bee-eater	*Merops ornatus*	MT	The Rainbow Bee-eater is distributed across much of mainland Australia, where it is both a migratory and wintering resident species. The species occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (Higgins, 1999). It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water (SEWPAC, 2012w). It also occurs in inland and coastal sand dune systems, and has been recorded in various other habitat types including heathland, sedgeland, vine forest and vine thicket, and on beaches (Higgins 1999).	**CONFIRMED**: This species is regarded as being among the most common bird species on the site (RPS, 2012). No nest sites were observed on the subject site.	Yes
Black-faced Monarch	*Monarcha melanopsis*	MT	The Black-faced Monarch is found along the coast of eastern Australia, becoming less common further south. The species inhabits rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. It forages for insects among foliage, or catches flying insects on the wing (Marchant & Higgins, 1993).	**LOW:** The site does not contain the preferred rainforest habitat of this species. It is likely to utilise patches of rainforest and gallery forest to disperse, reducing likelihood of flying within rotor strike zone.	Yes

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
Spectacled Monarch	*Monarcha trivirgatus*	MT	The Spectacled Monarch is found throughout coastal north-eastern and eastern Australia and coastal islands, from Cape York (Qld) to the Watson River on the west coast and to Port Stephens (NSW) on the east coast. It inhabits the understorey of mountain and lowland rainforests, thickly wooded gullies, waterside vegetation including mangroves; mostly well below the canopy (Pizzey & Knight 2007).	**LOW:** The site does not contain the preferred rainforest habitat of this species. It is likely to utilise patches of rainforest and gallery forest to disperse, reducing likelihood of flying within rotor strike zone.	Yes
Satin Flycatcher	*Myiagra cyanoleuca*	MT	The Satin Flycatcher is widespread in eastern Australia. In Queensland, it is widespread but scattered in the east (SEWPAC, 2012x). Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands. They especially prefer wet sclerophyll forest with a tall shrubby understorey of tall acacias (Blakers *et al.,* 1984). They are mainly insectivorous, preying on mostly insects, although very occasionally they will also eat seeds. They are arboreal foragers, feeding high in the canopy and subcanopy of trees, usually sallying for prey in the air or picking prey from foliage and branches of trees (Pizzey & Knight, 2007).	**MODERATE**. The subject site contains suitable habitat for this species, particularly along heavier wooded valleys.	Yes
Rufous Fantail	*Rhipidura rufifrons*	MT	The Rufous Fantail is found throughout coastal eastern Australia and coastal islands (Pizzey & Knight 2007). It inhabits the understorey of rainforest, wetter eucalypt forest, thickly wooded gullies, monsoon forest, paperbarks, sub-inland and coastal scrubs, and vegetation along watercourses. They are mainly insectivorous, preying on arthropods, mostly insects which are gleaned from leaves, branches, the ground and logs (Pizzey & Knight, 2007).	**CONFIRMED**: This species has been sighted once on the subject site (RPS, 2012). The open woodland vegetation on the subject site is considered to represent potential habitat for this species, particularly along the ephemeral watercourses.	Yes
Gouldian Finch	*Erythrura gouldiae*	MT	This small brightly coloured granivorous bird was formerly common in tropical woodland with a grassy understorey (Garnett & Crowley, 2000), but has now undergone a significant contraction in their range, particularly in Queensland.	**LOW**: The open woodland with a grassy understorey on rocky hills that dominates the project site is considered suitable habitat but it is doubtful any populations persist in the region.	Yes

Common Name	Scientific Name	Status[1]	Habitat	Assessed Likelihood of Occurrence[2]	DEHP Record[3]
Barn Swallow	*Hirundo rustica*	MT	The Barn Swallow is a non-breeding migrant to Australia, usually occurs patchily along the north coast from the Pilbara region, Western Australia, to Fraser Island in Queensland (SEWPAC, 2012y). It is recorded in open country in coastal lowlands, often near water, towns and cities. Birds are often sighted perched on overhead wires (Blakers *et al*., 1984), and also in or over freshwater wetlands, paperbark Melaleuca woodland, mesophyll shrub thickets and tussock grassland (Schodde & Mason, 1999).	**MODERATE**. The subject site contains woodland areas suitable for this species. The Atlas of Living Australia has a 1976 record from the 10 minute grid square containing the Mt Emerald centroid and there are confirmed 2013 records from Kairi approximately 16 from the centroid. This is an uncommon bird unlikely to ever be present in significant numbers in the subject site. .	No

[1] Migratory status as listed under the EPBC, where MW – migratory wetland species, MT - migratory terrestrial species, MM – migratory marine species MMB - migratory marine birds, -: No listing.

[2] Likelihood of occurrence is based on the known distribution and ecological requirements of the species in the context of the site, where **Low**: No recent records or suitable habitat present on the site; **Moderate**: Recent records and/or suitable/preferred habitat present and/or species that they commonly associated with are present on the site, or likely to overfly the site, however, the species was not recorded during the field investigations; **Confirmed**: Known to occur on the site through direct observation within or immediately adjacent to the site. **Confirmed fly over**: Known to fly over the site through direct observation within or immediately adjacent to the site, however with limited habitat available to the species on site.

[3] Previous records exist within 10km of the site (Wildlife Online).

13.8 Migratory Species Significant Impact Assessments

Significant impact assessments provided in **Tables 13.23** to **13.28** below to consider the EPBC listed migratory fauna species that have been assessed as having a moderate to high or confirmed presence on the MEWF site. It is unlikely the clearing of ~57ha of remnant vegetation for the proposed infrastructure will have a significant impact on any of the migratory species. There are large tracts of similar vegetation immediately offsite and in the surrounding region in which the Rainbow Bee-eater and Rufous Fantail are known to utilise. For the further four species (Great Egret, White-bellied Sea Eagle, White-throated Needletail and Sarus Crane), no suitable foraging or roosting habitat, principally vegetated wetlands, will be removed or indirectly affected.

None of the surrounding wetlands or other suitable habitats are known to support significant populations of any migratory species, with the exception of the Sarus Crane. The Atherton Tablelands is known to be an important over-wintering site for the Sarus Crane and individuals have been recorded foraging in agricultural lands in all directions surrounding the project site (Elinor Scambler, pers. comm.). A significant proportion of the known Atherton Tablelands population of Sarus Cranes were observed foraging on freshly ploughed fields within 3-5 km of the site (>100 birds).

There is the potential for some individuals of migratory species to be killed by rotor strike whilst flying over the site between adjacent suitable areas of habitat. Little is known about the local or regional movements of migratory birds in North Queensland. However, preliminary observations suggested Sarus Cranes and other birds (raptors, White-throated Needletail, Australian Darter etc.) utilise the updraft on the eastern edge of the site to gain altitude.

It is thought a general avoidance rate for birds of up to 90% may be applicable, although this figure has not been confirmed by observational studies. It is unlikely rotor strike will have a significant impact on any of the above listed migratory species, with the possible exception of Sarus Cranes, given the majority of these species are relatively abundant and have extensive distributions throughout Northern Australia. The ability of these species to avoid rotor strike is unknown.

Avian utilisation surveys were conducted to model the risk of rotor strike for Sarus Cranes and other listed migratory bird species. **Chapter 16** is dedicated to this assessment and the impacts on the Sarus Crane. **Appendix 23** provides the collision risk modelling report as supporting documentation.

13.8.1 Rainbow Bee-eater *(Merops ornatus)*

The Rainbow Bee-Eater was commonly observed in sclerophyll woodlands across the site, typically in pairs. The species is a colourful bird with a slim body and extended beak with distinctive tail streamers. Its dashing flight, coloration and trill call make it easily identifiable from other species.

This species is a common site across the Atherton Tablelands and coastal regions and is widespread throughout the country (Higgins, 1999). The species utilises a variety of habitat from open woodlands and scrublands to urban areas. In northern Australia sub coastal and coastal populations are present year round however they migrate from breeding territories to more open habitats outside the breeding season. These populations migrate throughout their coastal range in small flocks (Higgins, 1999).

Table 13.23 presents the significant impact assessment for the Rainbow Bee-eater.

Table 13.23 Significant Impact Assessment of Rainbow Bee-eater

Rainbow Bee-eater (*Merops ornatus*)	
Will the proposed works..	**Response**
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	The Rainbow Bee-eater is one of the most commonly observed species across the site – particularly in sclerophyll woodlands in the central portion of the site. Habitat modification through changes in the fire regime resulting from invasion of exotic grasses brought in on construction machinery is a potential risk, although this threat can be significantly reduced through the implementation of weed control and monitoring and an appropriate ecological burning regime. The total area of impact of the site is 2.4% of the total site. The development does not prevent access to different areas of the site and does not prevent habitat utilisation.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The proposed MEWF project is unlikely to introduce any invasive species that are harmful to migratory species on site. The Rainbow Bee-eater commonly utilises urban areas where pests and weed species are prevalent. An Environmental Management Plan and Weed Management Plans will be implemented to prevent the spread of weeds on site.
Seriously disrupt the lifecycle (breeding feeding, migration or resting behaviour) of an ecologically significant proportion of a population of a migratory species.	The Rainbow Bee-eater is common across much of its range and is a highly mobile, dispersive species. The development footprint of the proposed MEWF project would impact less than 2.4% of the overall habitat available to this species on site and is unlikely to disrupt its lifecycle. The species was most frequently observed flying under canopy level on site (below 15 m) and was not observed in groups of typically more than 2-3 at any one time. There is potential for the operation of turbines to disrupt the lifecycle of the species however this is unlikely. Nonetheless, implementation of Bird and Bat Adaptive Management Plans will significantly reduce any risk to the species.

13.8.2 Rufous Fantail (*Rhipidura rufifrons*)

This species has been sighted on one occasion on the proposed MEWF project site. The open woodland vegetation on the subject site is considered to represent potential habitat for this species, particularly along the ephemeral watercourses.

The Rufous Fantail is found throughout coastal eastern Australia and coastal islands (Pizzey & Knight 2007). The species is readily identified from others due to its striking orange-rufous back, rump and base of tail and is typically seen singly or in pairs preferring to forage within dense habitat (Higgins & Davies 1996). It inhabits the understorey of rainforest, wetter eucalypt forest, thickly wooded gullies, monsoon forest, paperbarks, sub-inland and coastal scrubs, and vegetation along watercourses. They are mainly insectivorous, preying on arthropods, mostly insects which are gleaned from leaves, branches, the ground and logs (Pizzey & Knight 2007).

Threats to the species are particularly fragmentation and loss of core moist forest for breeding habitat through land clearing activities (Higgins & Davies 1996). **Table 13.24** presents the significant impact assessment for the species.

Table 13.24 Significant Impact Assessment of Rufous Fantail

Rufous Fantail (Rhipidura rufifrons)	
Will the proposed works..	**Response**
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	A single observation of the species was recorded in 2012. It is unlikely that the site has key habitat for this species. Habitat modification through changes in the fire regime resulting from invasion of exotic grasses brought in on construction machinery is a potential risk, although this threat can be significantly reduced through the implementation of weed control and monitoring and an appropriate ecological burning regime. The total area of impact of the site is 2.4% of the total site. The development does not prevent access to different areas of the site and does not prevent habitat utilisation
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The proposed MEWF project is unlikely to introduce any invasive species that are harmful to migratory species on site. An Environmental Management Plan and Weed Management Plans will be implemented to prevent the spread of weeds on site.
Seriously disrupt the lifecycle (breeding feeding, migration or resting behaviour) of an ecologically significant proportion of a population of a migratory species.	It is unlikely that that habitat critical to the Rufous Fantail is present on the proposed MEWF site. The development footprint of 2.4% of the proposed MEWF would impact little of the overall habitat available to this species on site and is unlikely to disrupt its lifecycle. There is limited potential for the operation of turbines to disrupt the lifecycle of the species however this is unlikely. Nonetheless implementation of Bird and Bat Adaptive Management Plans will significantly reduce any risk to the species.

13.8.3 Great Egret *(Ardea alba)*

The Great Egret was recorded flying over the site on one occasion during diurnal bird surveys in 2011.

Great egrets are widespread and occur in all states/territories. They have been reported in a wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial) (SEWPAC, 2012q). They breed in wetland with fringing or flooded trees (Marchant & Higgins, 1990), although few breeding colonies are known in Queensland.

The Great Egret is considered dispersive in its migratory patterns rather than seasonal and typically travels in small flocks (Marchant & Higgins, 1990). **Table 13.25** presents the significant impact assessment for the species.

Table 13.25 Significant Impact Assessment of Great Egret

Great Egret (*Ardea alba*)	
Will the proposed works..	**Response**
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	The total area of impact of the site is 2.4% of the total site. The development does not prevent access to different areas of the site and does not prevent habitat utilisation.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The proposed MEWF project is unlikely to introduce any invasive species that are harmful to Great Egrets on site. There are no identified suitable breeding places or large areas known to be utilised by this species. An Environmental Management Plan and Weed Management Plans will be implemented to prevent the spread of weeds on site.

Great Egret (*Ardea alba*)	
Will the proposed works..	**Response**
Seriously disrupt the lifecycle (breeding feeding, migration or resting behaviour) of an ecologically significant proportion of a population of a migratory species.	Due to the lack of suitable habitat available to these species for breeding, feeding and resting etc., it considered highly unlikely that the activities of construction and decommissioning will impact on the migratory species on site. Implementation of Bird and bat Adaptive Management Plans in which comprehensive mitigation measures are introduced will reduce the likelihood of impact on this species.

13.8.4 White-bellied Sea Eagle *(Haliaeetus leucogaster)*

The White–bellied Sea Eagle was observed soaring in the updrafts along the eastern edge of the site. The nearest known nest is Nardello's Lagoon which is approximately 4 km from the site (RPS, 2012).

The species is distributed along the coastline (including offshore islands) of mainland Australia and Tasmania. It also extends inland along some of the larger waterways, especially in eastern Australia (SEWPAC, 2012s). The habitats occupied by the sea-eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes, sea). Birds have been recorded at or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs, saltmarsh and sewage ponds, as well as in (or flying over) a variety of terrestrial habitats (Marchant & Higgins, 1993).

The species is generally seen singly or in pairs, however when resources are available there may be adults and sub adults soaring together (Marchant & Higgins, 1993). Breeding pairs are generally sedentary and have small breeding territories which are active around the nest; however their home range can extend up to 100km.

Threats to the species are loss of habitat due to coastal land development and disruption of nests from human activities (Bilney & Emison 1983; Clunie 1994). **Table 13.26** presents the significant impact assessment for the species.

Table 13.26 Significant Impact Assessment of White–bellied Sea Eagle

White-bellied Sea Eagle (Haliaeetus leucogaster)	
Will the proposed works..	**Response**
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	The total area of impact of the site is 2.4% of the total site. The development does not prevent access to different areas of the site and does not prevent habitat utilisation.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The proposed MEWF project is unlikely to introduce any invasive species that are harmful to the White-bellied Sea Eagle on site. There are no identified suitable breeding places or large areas known to be utilised by this species. An Environmental Management Plan and Weed Management Plans will be implemented to prevent the spread of weeds on site.
Seriously disrupt the lifecycle (breeding feeding, migration or resting behaviour) of an ecologically significant proportion of a population of a migratory species.	Due to the lack of suitable habitat available to these species for breeding, feeding and resting etc., it considered highly unlikely that the activities of construction and decommissioning will impact on this species. Implementation of Bird and Bat Adaptive Management Plans in which comprehensive mitigation measures are introduced will reduce the likelihood of impact on this species.

13.8.5 Sarus Crane (*Grus antigone*)

The Sarus Crane has been confirmed during diurnal bird surveys, to fly across the site in large flocks, and has also been recorded in smaller numbers during nocturnal surveys.

There is thought to be approximately 13,000-15,000 Sarus Cranes in Asia with an additional subpopulation in Australia of approximately 5000 birds. It is thought the introduction of cattle into Cape York has had a positive impact on these cranes such that their distribution has expanded to include the Atherton Tablelands where there is a dependable supply of winter food available on agricultural lands. The most significant threat to this species throughout its entire range is considered to be the modification and destruction of wetlands. The project will not directly impact any wetland areas (e.g. loss of habitat), however the aggregation behaviour of these cranes in the area during winter months (thought to be 750-1200 birds) may put them at risk of mortality due to rotor strike. Mortality due to collisions with high voltage powerlines is currently a significant source of mortality for Sarus Cranes on the Atherton Tablelands (Dr John Grant, pers. com., Elinor Scambler, pers. com.). The site occupies a relatively small area within the wider locality that could be traversed by Sarus Cranes, however little is known about the local scale movements of this species.

The species is discussed in detail in **Chapter 16** with reference to the existing environment and the anticipated impacts of the project. A specialist report detailing collision risk modelling of the species is provided in **Appendix 23**. **Table 13.27** presents the significant impact assessment for the species.

Table 13.27 Significant Impact Assessment of Sarus Crane

Sarus Crane (*Grus antigone*)	
Will the proposed works..	**Response**
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	The total area of impact of the site is 2.4% of the total site. The development does not prevent access to different areas of the site and does not prevent habitat utilisation.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The proposed MEWF project is unlikely to introduce any invasive species that are harmful to Sarus Crane on site. There are no identified suitable breeding places or large areas known to be utilised by this species. An Environmental Management Plan and Weed Management Plans will be implemented to prevent the spread of weeds on site.
Seriously disrupt the lifecycle (breeding feeding, migration or resting behaviour) of an ecologically significant proportion of a population of a migratory species.	Due to the lack of suitable habitat available to these species for breeding, feeding and resting etc., it considered highly unlikely that the activities of construction and decommissioning will impact on the migratory species on site. The operation of turbines has a high potential to disrupt the lifecycle of the Sarus Crane, due to the presence of the species in large flocks surrounding wetland areas and known fly overs. **Chapter 16** and the associated technical report considers this risk further and describes the assessment used to determine the level of risk attributed to wind turbines, for bird mortality. Implementation of a Bird and Bat Adaptive Management Plan in which comprehensive mitigation measures are introduced will reduce the likelihood of impact on this species.

13.8.6 White –throated Needletail (*Hirundapus caudacutus*)

The White-throated Needletail has been confirmed as flying over the proposed MEWF site. Early surveys confirmed several flocks between 12 and 50 individuals were seen passing over the site in November 2011.

The White-throated Needletail breeds in the Northern Hemisphere but is widespread in eastern and south-eastern Australia during summer months (Barrett *et al*., 2003; Higgins, 1999). In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains (SEWPAC, 2012v). The species is almost exclusively aerial, from heights of less than 1m up to more than 1,000m above the ground. Although they occur over most types of habitat, they are probably recorded most often above wooded areas, including open forest and rainforest (Higgins, 1999). **Table 13.28** presents the significant impact assessment for the species.

Table 13.28 Significant Impact Assessment of White-throated Needletail

White-throated Needletail (*Hirundapus caudacutus*)	
Will the proposed works..	**Response**
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	The total area of impact of the site is 2.4% of the total site. The development does not prevent access to different areas of the site and does not prevent habitat utilisation.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The MEWF project is unlikely to introduce any invasive species that are harmful to White-throated Needletail on site. There are no identified suitable breeding places or large areas known to be utilised by this species. An Environmental Management Plan and Weed Management Plans will be implemented to prevent the spread of weeds on site.
Seriously disrupt the lifecycle (breeding feeding, migration or resting behaviour) of an ecologically significant proportion of a population of a migratory species.	Due to the lack of suitable habitat available to these species for breeding, feeding and resting etc., it considered highly unlikely that the activities of construction and decommissioning will impact on the migratory species on site. Implementation of a Bird and Bat Adaptive Management Plans in which comprehensive mitigation measures are introduced will reduce the likelihood of impact on this species.

13.9 World Heritage Properties

The Wet Tropics of Queensland World Heritage Area (WTWHA) includes 900,000 ha of land between Townsville and Cooktown was placed on the World Heritage List in 1988 as the area is considered to meet all four of the natural criteria for listing as discussed below:

The Wet Tropics:

- is an outstanding example representing the major stages of the earth's evolutionary history;
- is an outstanding example representing significant ongoing ecological and biological processes;
- is an example of superlative natural phenomena; and
- contains important and significant habitats for *in situ* conservation of biological diversity.

The proposed MEWF project site is considered to potentially have an indirect impact on the WTWHA as it may have an impact on world heritage values, namely the Nothern Quoll and the Spectacled Flying-fox. The Northern Quoll is considered a World Heritage Value due to its contribution to the genetic diversity of the area, and the Spectacled Flying-fox is considered a world heritage value due to its contribution to the genetic diversity of the area and its importance in pollination and dispersal of rainforest flora (DEH, 2003).

The criterion under which the WTWHA is listed and potential project related impacts are specified in **Table 13.29.**

Table 13.29 Potential Project Impacts on World Heritage Values.

Project Impacts to the World Heritage Values on the WTWHA	
Criterion	**Response**
C7: Contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance	The WTWHA is approximately 14 km to the east of the site and therefore does not contain any direct values associated with a World Heritage property. Sections of the southern portion of the wind farm site in the Wet Tropics bioregion, listed under the Vegetation Management Framework Amendment Act 2013, do contain particularly good condition landscapes along the south-west ridges, and ridges closer to Mt Emerald. This area of the project site has very high natural integrity and supports poorly represented plant communities. It contains high value habitat for narrow distribution endemic flora and conservation significant fauna, however the development will not fragment or degrade the habitat such that it has an impact on the WTWHA. The WTWHA will not be directly impacted through clearing, fragmentation, edge effects or impact on habitat values of the area.
C8: Be an outstanding example representing the major stages of Earth's history, including the record of life, and significant ongoing geological processes in the development of landforms, or significant geomorphic or physiographic features.	Although the site is not within the WTWHA or does not have a contiguous landscape connection, it does support an interesting geological formation: the Walsh Bluff Volcanics, which are not represented elsewhere within the geological map sheet region. Because of the unique site geology, a range of unusual and narrowly represented plant communities and habitats are present south of the 275 kV electrical transmission line however are not contiguous with the WTWHA and will not impact the WTWHA values.
C9: Be an outstanding example representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.	Arguably as the site is located within the Queensland Wet Tropics bioregion it affords significant and important refuge for the unique montane heath vegetation community above 900 m ASL. This community is possibly not represented in any significant area within the WTWHA. The wind farm site does not meet the criteria for representing significant impact on ongoing ecological and biological processes in the evolution of fresh water and coastal environments because of the absence of these features within and adjacent to the site.
C10: Contain the most important significant habitats for in situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation	The site does contain important significant habitats for the montane heath community and conservation significant plants such *as Homoranthus porteri* and *Melaleuca uxorum*. At least two populations of the latter species are found within the wind farm site. The physical and topographic separation created at altitude in the dissected Wet Tropics bioregion section of the site is crucial for the survival of many narrow endemic and conservation significant plant species. These habitats are only represented elsewhere on the adjacent Mt Emerald and in isolated outliers to the site. These habitats are not representative of the WTWHA.

The proposed MEWF project site is considered to potentially have impact on the WTWHA as it may have an impact on World Heritage Values, namely the Nothern Quoll and the Spectacled Flying-fox. The Northern Quoll is considered a World Heritage Value due to its contribution to the genetic diversity of the area, and the Spectacled Flying-fox is considered a World Heritage Value due to its contribution to the genetic diversity of the area and its importance in pollination and dispersal of rainforest flora (DEH, 2003).

Significant impact assessments for the Northern Quoll and Spectacled Flying Fox as values of the WTWHA are provided in **Table 13.30** and **13.31** below.

Table 13.30 Significant Impact Assessment of the Project on Northern Quoll as a World Heritage Value of the WTWHA

World Heritage Values of the WTWHA	
Will the proposed works..	**Response**
Lead to one or more of the World Heritage values to be lost	It is unlikely the proposed MEWF project will have a significant impact on the World Heritage Area such that the Northern Quoll would become extinct. Preliminary modelling has suggested that the local Mt Emerald population of Northern Quoll represents <1% of the estimated total Far North Queensland metapopulation and does not represent a distinct genetic sub-population (**Table 13.15**). Therefore even the total removal of all suitable habitats for the species on the site may not cause the species to decline, however avoiding mortality and habitat degradation will assist persistence of the population. The proposed MEWF project is unlikely to have an impact on the remaining values of the WTWHA such that any of these values will be lost.
One or more of the World Heritage Values to be degraded or damaged altered, modified, obscured or diminished.	The project is unlikely to degrade or damage, alter, modify, obscure or diminish World Heritage values. Implementation of the Northern Quoll Management Plan will provide appropriate mitigation measures to protect populations of the Northern Quoll as a value of the WTWHA. The development footprint of the site is located 14.5 km to the north and approximately 12 km to the west of the WTWHA boundaries and will not present a direct impact to the WTWHA from construction, operation or decommissioning activities on values within the WTWHA. Unless wide-scale habitat degradation of the project site occurs as a result of invasion of exotic fire-promoting pasture grasses and the subsequent establishment of inappropriate fire regimes, it is likely the project site will continue to help to maintain connectivity of the Northern Quoll population between the Walsh/ Herbert River catchment areas and the Barron/Mitchell catchment areas. Therefore, it is unlikely the clearing of ~57 ha of known Northern Quoll habitat on the project site will lead to a long-term decline in the size of the Far North Queensland (FNQ) metapopulation and impact on the WTWHA.

Table 13.31 Significant Impact Assessment of the Project on Spectacled Flying Fox as a World Heritage Value of the WTWHA

World Heritage Values on the WTWHA	
Will the proposed works..	**Response**
Lead to one or more of the World Heritage values to be lost	It is unlikely the proposed MEWF project will have a significant impact on the World Heritage Area such that the Spectacled Flying-fox would be lost. There are potentially high risks from turbine collision mortality to large numbers of individuals during the Operational Phase of the proposed MEWF project. Further research combined with implementation of the Spectacled Flying-fox Management Plan will provide appropriate mitigation measures to protect populations of the Spectacled Flying-fox. Refer to **Chapter 18** for more details. The proposed MEWF project is unlikely to have an impact on the remaining values of the WTWHA such that any of these values will be lost.
One or more of the World Heritage Values to be degraded or damaged altered, modified, obscured or diminished.	The project is unlikely to degrade or damage, alter, modify, obscure or diminish National Heritage values. Implementation of the Spectacled Flying-fox Management Plan will provide appropriate mitigation measures to protect populations of the Spectacled Flying-fox as a value of the WTWHA. The development footprint of the site is located 14.5 km to the north and approximately 12 km to the west of the WTWHA boundaries and will not present any direct impact to the WTWHA values from construction, operation or decommissioning activities.

13.10 National Heritage Places

The National Heritage List contains places or groups of places with outstanding heritage value to Australia – whether natural, Indigenous or historic or a combination of these. As with the World Heritage properties listed in **Table 13.29** above, the Wet Tropics World Heritage Area is listed as a National Heritage Place due to its outstanding natural heritage values.

A significant impacts assessment is provided in **Table 13.30 and 13.31** above for the National Heritage Property – Wet Tropics World Heritage Area.

13.11 Conclusion

13.11.1 Flora

The most probable significant impact to flora species listed under the EPBC Act is the clearing of ridges in the south-west of the site, and above 900 m ASL. This altitudinal zone is the key habitat for *Homoranthus porteri* - a species which occupies a restricted habitat range characterised by exposed, wind-sheared ridges.

Significant populations of *H. porteri* are found in this area and must be considered important on a regional scale when compared with other populations outside the site (i.e. Irvinebank, Watsonville, and Toy Creek). The site's populations of the shrub by comparison with the regional populations are large, well-protected and represented by healthy thickets. Clearing of ridges where the shrub is found only on rock pavements is likely to have a significant impact (**Chapter 14**) and could disrupt the viability of the local population. Preconstruction surveys are proposed to inform micro-siting of turbines and tracks thereby minimising potential impacts on this species.

The shrub *Grevillea glossadenia* was found to be more resilient to landscape modification and has greater representation (in numbers and populations) than *H. porteri*. This species grows in association with *H. porteri*, but has a wider habitat niche. It was found to respond positively to surface disturbance (e.g. track grading) and is considered to be capable of active regeneration.

13.11.2 Fauna

Three threatened terrestrial MNES fauna species have been identified through field surveys to occur on the proposed MEWF project site:

- Bare-rumped Sheathtail Bat (critically endangered);
- Northern Quoll (endangered); and
- Spectacled Flying-fox (vulnerable).

While modelling indicates the local Mt Emerald population of Northern Quoll represents <1% of the estimated total Far North Queensland metapopulation (~10,000 individuals) and does not represent a distinct genetic sub-population, the population located on site is important to the genetic diversity of the regional population. The most probable significant impact to this species is directly through mortality/disturbance and loss of habitat during construction. While it remains unanswered whether ridge tops are the most favoured denning locations, it is known that the species utilise ridgetop habitats of the MEWF. Although the overall impact of the site from clearing for the development footprint is only 2.4%or ~57 ha, these are primarily on ridge tops therefore mitigation measures specifically targeting this impact have been devised (**Chapter 15**).

The most significant potential impact to the Spectacled Flying Fox is predicted to be turbine mortalities through operation of the proposed MEWF project. This is also the case for the Bare-rumped Sheathtail Bat,

however, preferred habitat for roosting and foraging is so poorly known that land clearing activities may also be a threat to the local population. Mitigation measures to reduce and potentially remove these impacts have been addressed in the individual **Chapter 17** and **Chapter 18**. It is unlikely the proposed MEWF project will impact any important habitat of these species or any of the other listed MNES species that occur in the region.

Of the six migratory bird species confirmed to occur on site two are known to utilise the habitat on site. Neither of these species preferentially utilise the site as key habitat. There are also large tracts of continuous habitat available to these species throughout the region and the project is unlikely to impact on their population.

Four migratory species were recorded to fly over the site:

- Sarus Crane;
- Whitethroated Needletail;
- Great Egret; and
- White-bellied Sea Eagle.

Of these species the Sarus Crane is the most vulnerable to impact from turbines during operation due to their large flocking and nocturnal flight behaviours. Mitigation measures that include detailed radar observations and implementation of turbine curtailment technology have been developed and are described in the relevant chapters to follow.

On the basis of mitigation measures, the project is not anticipated to have impacts on World Heritage or National Heritage values such that it will result in loss of or degradation to that value. To manage the potential impacts to MNES from the proposed MEWF project, RACL have committed to a range of mitigation measures. These are detailed in **Chapter 20** Environmental Risk Assessment. Further details and mitigation measures are outlined in individual threatened species chapters (**Chapters 14 - 18).**

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14.0 Flora

This chapter considers the impacts to threatened flora and vegetation on site. The specialist study is provided in full in **Appendix 16.**

14.1 Assessment Methodology

The study area focussed on the land (mostly ridges) where the wind farm is proposed to be sited. Supplementary investigations were made of vegetation between ridges and on adjacent slopes to gain a wider understanding of the overall project area. The most remote areas in the south-west of the site were unable to be accessed.

14.1.1 Preliminary Studies

Desktop and field studies were completed in 2011 and a *Preliminary Flora & Fauna Assessment* report was compiled (RPS, 2011). The preliminary assessment identified a number of Matters of National Environmental Significance listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Subsequently, the project was referred to the Department of The Environment (DotE). The department determined the project to be a "controlled action" and should be assessed through an Environmental Impact Statement (EIS), of which this chapter is part fulfilment.

14.1.2 Desktop Assessment

Over the course of the studies (RPS, 2011, EPBC referral, and this EIS) a range of literature, databases, mapping, digital data and imagery was reviewed, and included:

- Books and published scientific literature (journals, taxonomic revisions and descriptions);
- Wildlife Online, EPBC Protected Matters, HERBRECS databases;
- Regional ecosystems, soil, geology, topographic, watercourses mapping;
- LiDAR (Light Detection and Ranging) and elevation/contour data; and
- 8-band spectral imagery, aerial photography (hard copy and digital).

14.1.3 Field Assessment

Field assessments have been performed since May 2010 and over 140 sites have been inspected. The purpose of these surveys was to locate and characterise the species of flora across the site; the vegetation communities which host the flora; and identify species of plants known to be of interest to conservation, and particularly, those listed under the EPBC Act.

Surveys were undertaken in accordance to Mueller-Dombois and Ellenberg (1974), which samples an area of 10-25 m^2 for heath communities; and Neldner, *et al*. (2012) for surveying woodland communities in an area of 500 m^2. Larger areas of a certain vegetation type were often surveyed by examining the routes chosen for the interconnecting tracks between turbines.

Detailed CORVEG sites were recorded by the Queensland Herbarium within the project site. CORVEG sites are detailed vegetation survey sites, where the data collected is used by the Queensland Herbarium to formally described vegetation communities, which in turn informs the descriptions of Regional Ecosystems (RE's).

A voucher collection of plants was compiled since 2010 and has been formally identified by the Queensland Herbarium (**Appendix 16 – Addendum A**). The foral identification corresponded with records collected over the survey period with no additional rare and threatened species to consider.

A number of regional surveys (outside of the project site) were also completed to investigate the habitat characteristics and determinants of presence for several conservation significant species. The regional surveys were undertaken in the Irvinebank-Watsonville-Silver Valley-Herberton region.

14.2 Existing Environment

14.2.1 Vegetation Communities

Eight vegetation communities were identified across the site. These are summarised below in **Table 14.1** and profiles of each community provided in **Appendix 16**.

Table 14.1 Vegetation Communities of the MEWF Site

Community Description	
Rustyjacket Woodland Woodland to open woodland of *Corymbia leichhardtii*, *Callitris intratropica* with *Eucalyptus shirleyi* and *Eucalyptus granitica* to 8 - 12 m. Occurs mainly the centre of the site in the EU bioregion section.	
Silver-leaf Ironbark Woodland Woodland to low open woodland of *Eucalyptus shirleyi* to 4 m with emergent *Callitris intratropica* (12 m). Best representation is near the centre of the site close in the EU and WT bioregion sections.	

Community Description	
Yellow Stringybark Woodland Grassy woodland of *Eucalyptus portuensis* with *Corymbia citriodora* to 7-12 m. Occurs on slopes of WT and EU bioregion sections.	
White Stringybark Woodland Tall, grassy woodland of *Eucalyptus reducta* with *Eucalyptus portuensis* and occasional *Corymbia citriodora* and *Eucalyptus drepanophylla* (sens. lat.) to 12-18 m. Occurs mainly in the WT bioregion section on slopes.	
Range Bloodwood Woodland and Shrubland Low, windswept woodland to open woodland and shrubland of *Corymbia abergiana* to 4 m on exposed ridges. Mainly occurs in the WT bioregion section close to ridge tops and edges.	

Community Description	
Montane Heathland Low heathland with scattered shrubs or isolated, wind-sheared and stunted trees of *Corymbia abergiana* and *Eucalyptus lockyeri* subsp. *exuta*. Includes patches of rock pavements and outcropping rock. Occurs above 900 m in the WT bioregion section.	
Narrow-leaf Ironbark and Lemon-scented Gum Woodland Woodland of *Eucalyptus drepanophylla* (sens. lat.) and *Corymbia citriodora* to 15 m. Occurs in northern aspects of the site mainly in the EU bioregion section.	
Dead Finish Woodland Grassy woodland to 8-10 m of *Eucalyptus cloeziana*, *Corymbia citriodora* and *E. portuensis*. Occurs mainly around the boundary junction of the WT and EU bioregion sections.	
WT - Wet Tropics, EU - Einasleigh Uplands	

With the exception of the linear clearing associated with the existing 275 kV electrical transmission line that bisects the project area, the wind farm site is predominantly covered by remnant vegetation, much of which is in exceptionally good condition. Landscape disturbance and hence, modification, is minimal and virtually absent from the southern half of the project area in the Wet Tropics bioregion section as shown in **Figure 1.1.** Where disturbance is present adjacent to cleared tracks, wattle regrowth (*Acacia* spp.) is the main successional community. The most severe land modification and lowest ecological function is associated with Kippen Drive at the base of the project site, where weeds are the dominant vegetation.

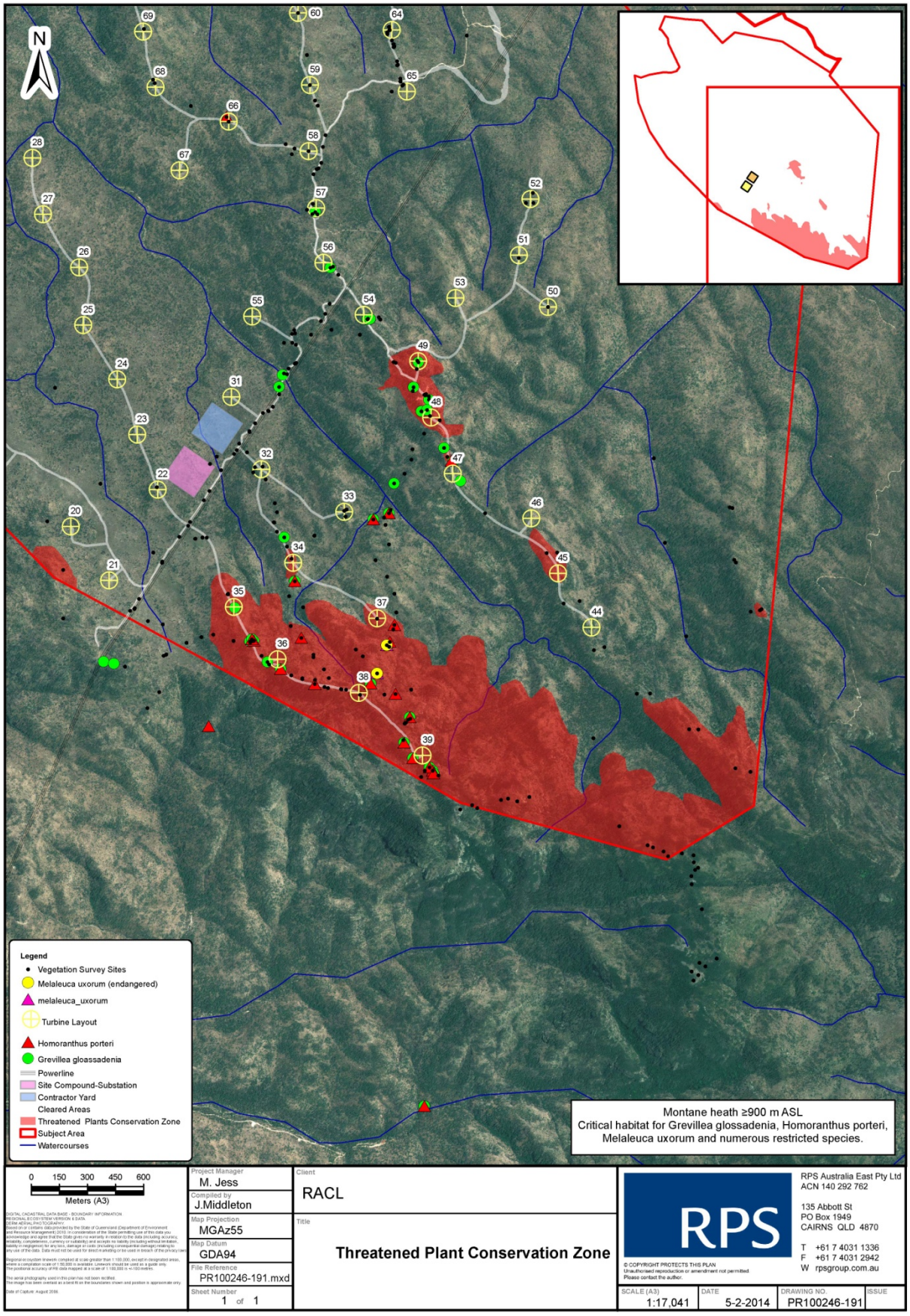

Figure 14.1 Wet Tropics Bioregion Section: Key Conservation Areas and Environmental Constraints – Vegetation and Flora

14.2.2 Mapped Regional Ecosystems

Several REs (regional ecosystems - remnant vegetation communities) are mapped over the project site. The transmission line which bisects the site coincides with the boundary between two bioregions:

- The Wet Tropics to the south of the transmission line; and
- The Einasleigh Uplands to the north.

The RE vegetation mapping for these bioregions is at a scale 1:50,000 and 1:100,000 respectively. A summary of the mapped RE's of the project area is given below.

The Wet Tropics Bioregion is not considered to contribute to the WTWHA. The Wet Tropics bioregion and the Wet Tropics World Heritage Area are unrelated biophysical mapping areas. Mapping of the boundaries of these entities (**Figure 14.2**) indicates the physical separation of the Wet Tropics bioregion section of the wind farm site (see inset), and the WTWHA boundary. The WTWHA boundary has two sections – to the south, and to the east - both separated from the site by farm land, roads and built infrastructure.

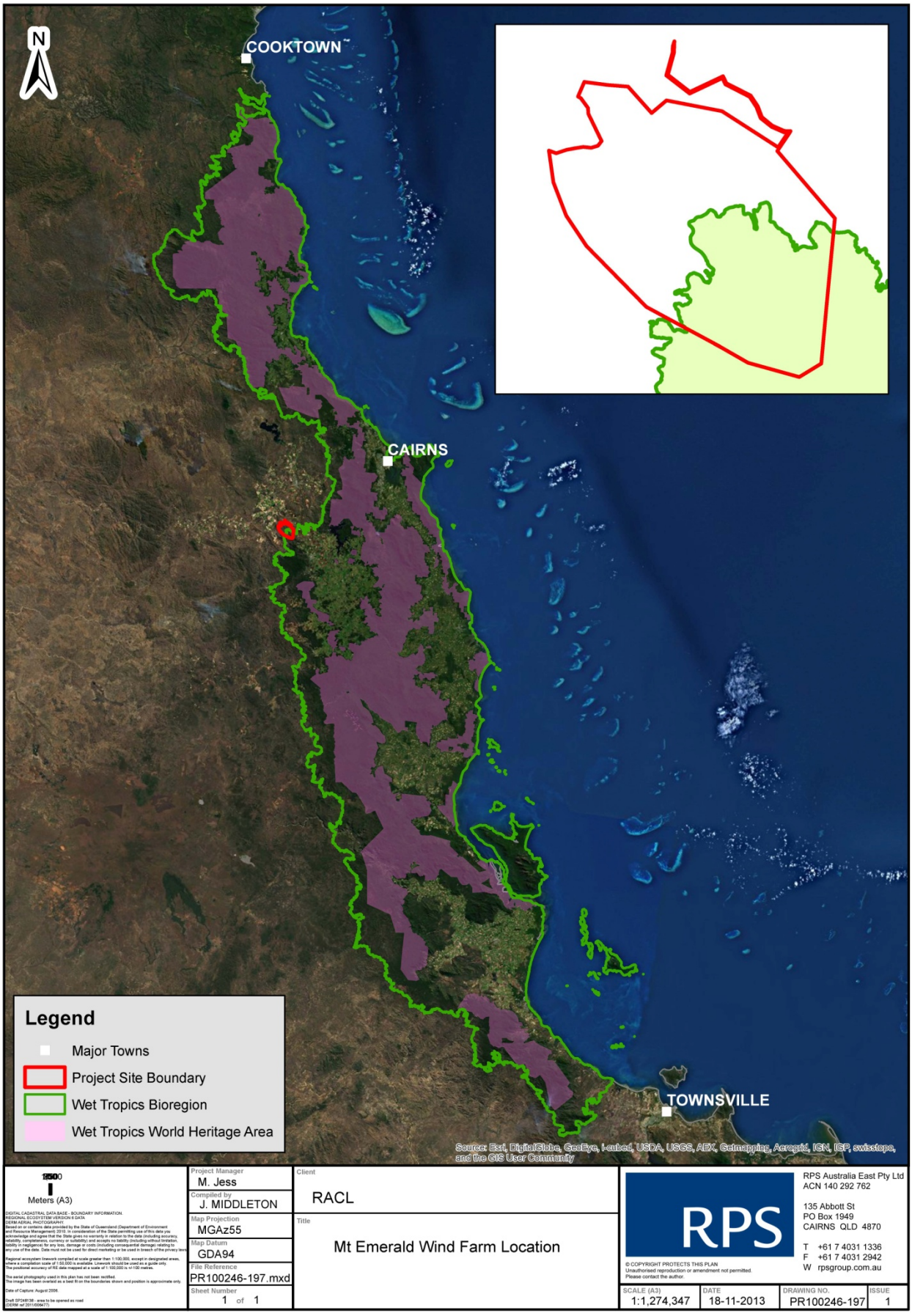

Figure 14.2 Boundaries of the Wet Tropics Bioregion and the Wet Tropics World Heritage Area

14.2.2.2 Wet Tropics Bioregion Section

7.12.30: Woodland to open forest mosaic with variable dominance, often including *Eucalyptus cloeziana, Corymbia abergiana, C. citriodora, E. portuensis, E. reducta, E. lockyeri, C. leichhardtii, E. atrata, E. pachycalyx* and *E. shirleyi*, on rhyolite and granite.

7.12.57: Shrubland and low woodland mosaic with *Syncarpia glomulifera*, *Corymbia abergiana*, *Eucalyptus portuensis*, *Allocasuarina littoralis*, and *Xanthorrhoea johnsonii*, on moist and dry uplands and highlands on granite and rhyolite. Shrubland/low woodland mosaic with variable dominance, often including *Eucalyptus cloeziana*, *Corymbia abergiana, E. portuensis*, *E. reducta*, *E. lockyeri*, *C. leichhardtii*, *E. atrata*, *E. pachycalyx*, *E. shirleyi* and *Homoranthus porteri*, on rhyolite and granite

7.12.58: *Eucalyptus reducta, E. granitica, Corymbia dimorpha, C. citriodora* and *Syncarpia glomulifera* woodland, on granite and rhyolite.

7.12.65: Rock pavements or areas of skeletal soil, on granite and rhyolite, mostly of dry western or southern areas, often with shrublands to closed forests of *Acacia* spp. and/or *Lophostemon suaveolens* and/or *Allocasuarina littoralis* and/or *Eucalyptus lockyeri* subsp. *exuta*.

14.2.2.3 Einasleigh Uplands Bioregion Section

9.12.4/9.12.2: (9.12.4) - *Eucalyptus shirleyi or E. melanophloia* with *Corymbia peltata* and/or *C. leichhardtii* low open woodland to low woodland on acid volcanic rocks. / (9.12.2) - Open forest commonly including *Eucalyptus portuensis*, *E. crebra* (sens. lat.), *Corymbia clarksoniana*, *C. citriodora* on steep hills and ranges on acid and intermediate volcanics close to Wet Tropics boundary.

9.12.30/9.12.20/9.12.4: (9.12.30) - *Corymbia leichhardtii +/- Callitris intratropica +/- Eucalyptus shirleyi* low woodland to low open woodland on rhyolite hills. /(9.12.20) - *Eucalyptus pachycalyx* and *E. cloeziana* woodland on acid volcanics. / (9.12.4) - *Eucalyptus shirleyi* or *E. melanophloia* with *Corymbia peltata* and/or *C. leichhardtii* low open woodland to low woodland on acid volcanic rocks.

14.2.3 Conservation Status

All RE's in the Einasleigh Uplands section of the project site (north of the transmission line) have a conservation status under Queensland's *Vegetation Management Act 1999* (VMA) of Least Concern. The Least Concern regional ecosystems are: 7.12.30, 7.12.65, 9.12.2, 9.12.4, 9.12.20 and 9.12.30.

The land in the project area south of the transmission line in the Wet Tropics bioregion is mainly categorised as remnant communities with a conservation status under the VMA listed as Of Concern. Some areas of the Wet Tropics section (a majority outside the construction footprint zone) are listed as Least Concern. The remnant communities listed as Of Concern correspond with the montane heathland and range bloodwood woodland described previously and occur on ridges and adjacent slopes. The Of Concern regional ecosystems are: 7.12.57 and 7.12.58.

14.2.4 Flora Composition

The Wet Tropics bioregion section of the project site is rendered interesting and noteworthy for the occurrence of numerous species of plants with restricted distribution and a concentration of narrow endemic species. The primary habitat for these plants is the montane heath community which occurs above 900 m ASL and is found in the Wet Tropics bioregion section of the site (RE's 7.12.57 and 7.12.65). The reasons for the concentration of these species in a specific habitat niche is largely due to determinants such as

elevation, cloud-stripping of moisture, and the limited ground area along ridges which host the montane heath community.

A cumulative checklist has recorded at least 250 species of vascular plants within the project site, which reinforces the floristic diversity of the high elevation zones.

14.2.5 Threatened Flora Species Assessment

The project site is located in a region known for its high floristic diversity and unique plant communities. Targeted surveys over the project site and in surrounding locations with similar landscape characteristics were completed to detect and estimate the population numbers and importance of plant species of conservation significance. A review of literature, databases and Queensland Herbarium data (HERBRECS) provided a background to the species targeted in ground searches.

14.3 Population Viability

Population viability refers to a species' capacity to retain a persistent and viable local population in the wild (i.e. within the location and habitat where each population occurs). A definition of *viable* in reference to population viability analysis and conservation planning is given by Akçakaya and Sjögren-Gulve (2000) as: "*Viability of a species in a given geographic region is often expressed as its risk of extinction or decline, expected time to extinction, or chance of recovery*."

The viability of a plant population relies on a number of factors, including but not limited to:

- population size (number of individuals);
- specificity of habitat (reliance on certain habitat attributes); and
- area and ordination of habitat (linear features are prone to change and external influence).

Negative consequences for the viability of a population of plants can occur as a result of habitat fragmentation and isolation (Klank, *et al*. 2010). These effects are obviously more profound for species of plants that grow in spatially constrained environments (e.g. ridges, rock pavements, fringes of wetlands).

Plant populations on the wind farm site of species such as *Homoranthus porteri* and *Melaleuca uxorum*, which both grow in specific, poorly represented habitats associated with ridges and rock pavements could be adversely threatened by clearing for tracks and the turbine footprint (assuming the respective species grows within the disturbance footprint). Falk (1991) suggests that these types of species could be considered as *edaphic specialists*: relying on a particular geology and soil environment and consequently may be prone to population demise at the micro-scale.

Grevillea glossadenia exhibits greater plasticity in its preference for habitat, and is found in a variety of environments ranging from ridges, to track edges and infrequently, in woodland adjoining ridges. Given this species' propensity for greater habitat tolerance, plus its capability of forming significantly larger and spatially diffuse populations, it is likely to be more resilient to the effects of habitat modification. This shrub is often encountered as seed-derived plants growing in rock spoil and even in stockpiled road base material. It is also one of the descendants of the horticultural Grevillea 'Orange Marmalade' - recognised by the nursery trade and growers alike to be an exceptionally hardy plant resilient to even errant encounters with lawnmowers.

The approximate population sizes for conservation significant plants are summarised in **Table 14.2**, and are based on observations made during walking traverses of ridges and the proposed routes of the access and cabling tracks linking each turbine.

Table 14.2 Approximate Population Size and Descriptions of Conservation Significant and Narrow Endemic Plants

Species	Status	Distribution - within site	Distribution - regional	Population estimate - overall site	Population estimate - impacted zone	Habitat	Notes
Grevillea glossadenia	V	Widespread in rocky habitat of the Wet Tropics bioregion section of site. Relatively common along ridges above 900 m, but rarely found under woodland cover.	Found in Herberton Range and south to Ravenshoe. Mt Garnet Road, Silver Valley, Irvinebank.	>500	300-400	Most common on exposed ridges, but also found on track edges and very well-lit woodlands close to ridges and almost exclusive to Wet Tropics bioregion section of site. Responds to ground disturbance of rocky sites and will regenerate in rock spoil.	With *Grevillea dryandri,* this species is the commonest Grevillea on the site in the southern portion.
Homoranthus porteri	V	More or less confined to SW ridges of the Wet Tropics bioregion section, with isolated populations (x2) in Einasleigh Uplands bioregion section.		>400	300-350	When mature, forms thickets on rock pavements or their edges, and along exposed rocky ridges. Not found in woodland on slopes.	Can be common in patches on exposed ridges and frequently on rock pavements or their edges.
Melaleuca uxorum	E	Very limited and narrow distribution on southern part of ridge in SW portion of site. Two separate populations confirmed.	Restricted to Mt Emerald, the site and an outlier population in the Silver Valley region.	~120+	<120	Very restricted on windswept east-facing rock pavement/ridge complex.	Highly restricted and exceptionally rare - only two populations found on site, although extreme SW corner not surveyed (design amended to remove turbines from this area).
Plectranthus amoenus	V	Recorded from near Turbine 66, but possibly found on rock pavements of SW portion of site. Species identification difficult and may intergrade with other species of *Plectranthus*.	?	?	<50	Confined to rock pavements with no tree cover on ridges or pavements at lower elevation interspersed in woodland with *Callitris intratropica* and *Corymbia leichhardtii*.	Difficult taxon to identify in field, but *Plectranthus* favours rock pavements and very rocky ground. Rarely found under woodland cover.

14.3.1 Biodiversity Values

Regionally, the site forms the northern extent of the Herberton Range. The Wet Tropics bioregion section is contiguous with the Mount Emerald mountain range. The Wet Tropics section and the western ridge of the Einesleigh Uplands section are in near pristine condition. They hold very high values in terms of floristic diversity, landscape connectivity and undisturbed ecological function. The site forms important refuge areas for numerous species of flora and fauna, many of which are restricted to montane environments.

14.4 Impact Assessment

14.4.1 Impact Characterisation

The presence of species of flora is linked to habitats and vegetation types. It follows, that rarely is a conservation significant plant species widespread across a wide range of habitats. Therefore, the main impacts associated with construction of the wind farm are associated with vegetation clearing and more precisely, direct loss of habitat along ridges where the greatest proportion of conservation significant plants occur.

Initial clearing for access tracks and cabling t between turbines is estimated to average 10 m wide however some areas of greater clearing will be required. Clearing for turbine pads is expected to be in the order of 40 m wide and 60 m long - aligned with the adjacent interconnecting tracks.

Vegetation clearing and ground preparation is likely to result in surface reshaping; loss or relocation of the topsoil and a proportion of the soil-seed bank; compaction (albeit minor due to the rocky ground); and altered surface hydrology.

Clearing will have lesser impact on plant habitats north of the transmission line in the Einasleigh Uplands bioregion section of the project site. The greatest impact of this type of land clearing and surface modification is expected to occur along ridges south of the transmission line in the Wet Tropics bioregion section. Here and generally above 900 m ASL, plant habitats for conservation significant species are at their best development and highest representation in terms of area. These habitats are also narrow and confined to ridge tops and the immediate slopes.

The total area of impact associated with new road and turbine construction pad clearing is estimated to be 57 ha (**Figure 14.1**).

14.4.2 Threatened Flora

Ridge tops are the proposed location for a majority of the interconnecting tracks and turbine construction pads. This type of habitat in the Wet Tropics section and the western ridge of the Eiesleigh Uplands section support the following conservation significant plant species; all were confirmed to occur on the site and within the construction footprint:

- *Grevillea glossadenia*: a shrub found on ridges and adjacent to tracks. Relatively common on site. Listed under EPBC Act and *Nature Conservation Act 1992* as vulnerable.
- *Homoranthus porteri*: a shrub found mainly on higher elevation ridges, where it forms thickets on rock pavements or their edges. Common in places where important populations exist. Uncommon elsewhere. Listed under EPBC Act and *Nature Conservation Act 1992* as vulnerable.
- *Melaleuca uxorum*: a shrub found (during the surveys) only in two locations on exposed ridges in the SW of the site. Exceptionally uncommon and rare. Listed under *Nature Conservation Act 1992* as endangered.

- *Plectranthus amoenus*: a succulent, low shrub found on rock pavements in the SW of the site and an isolated occurrence near proposed turbine 66. Relatively uncommon and restricted to rock pavement geology. Listed *Nature Conservation Act 1992* as vulnerable. Conservation plants are rarely if ever encountered in the Einasleigh Uplands section on rolling hills, flat zones, and wide ridges.

14.4.3 Conservation Significant Plant Communities

Regional ecosystems 7.12.57 and 7.12.58 are listed under the *Vegetation Management Act 1999* as Of Concern. These communities are also linked to the key habitats for the conservation significant plants listed above and only occur in the Wet Tropics section.

The montane heath community which occurs above 900 m ASL is a variant of regional ecosystem 7.12.57; and is narrowly represented along ridges to the south of the transmission line in an area of very high biodiversity value with a concentration of conservation significant and poorly distributed plants.

14.5 Cumulative Impacts

The Baal Gammon mining project which was recently operational between the towns of Herberton and Watsonville cleared large areas of key habitat for at least two species of conservation significant plants listed under the EPBC Act. Entire sections of woodland dominated by the EPBC-listed tree *Corymbia rhodops* were cleared (circa 2011) to make way for the mine expansion. At the same time, known populations of the EPBC-listed shrub *Acacia purpureopetala* were also cleared. The Baal Gammon mine, which is situated in the broader region approaching Stannary Hills and Irvinebank is well-regarded for its floristic importance and concentration of many narrow endemic plant species (Pollock, 2002). Given the loss of important sections of habitat in this location, additional losses of high altitude habitat on the wind farm site must be considered as potentially detrimental to the survival of local populations of conservation significant plants.

The high altitude ridges in the Wet Tropics bioregion section of the site are sensitive environments that serve as important habitats for plants and the poorly represented montane heath community above 900 m ASL where the cloud base is a determinant of the moisture regime at this elevation (Ford and Hardesty, 2012). It appears that the narrow rhyolite ridges could be slow to recover from gross surface disturbance and modification. The ridge topography is not conducive to generic methods of land rehabilitation and a probable scenario following track clearing is that the floristic composition and consequently the vegetation structure will change. This could have implications for the recovery of species such as *Homoranthus porteri*, which unlike *Grevillea glossadenia*, does not appear to respond favourably to disturbance.

Whilst the Wet Tropics bioregion section and the western ridge of the Einasleigh Uplands section are in near pristine condition and hold very high values in terms of floristic diversity, landscape connectivity and undisturbed ecological function, they are not considered to contribute to Wet Tropics World Heritage Area values in a flora sense. The presence however, of the narrowly represented montane heath above 900 m ASL is important and is probably represented elsewhere in the bioregion only in very small areas because of its natural occurrence above 900 m and in the vicinity of the sclerophyll ecotone. Therefore, it is unlikely that a montane heath community with a similar floristic composition and community structure would occur at other suitable elevations in rainforested country such as around Mt Bartle Frere and Bellenden Ker. Based on a review of the altitudinal transect (see **Figure 14.3**) from the Great Dividing Range to the east coast (intersecting Mount Emerald, the Atherton Tableland, Bellenden Ker and the Graham Range) at latitude 17° 15' 45"S, the montane heath habitat found at (≥900 m) is only likely to occur at the MEWF site and on Mount Emerald immediately to the south and other areas of the Great Dividing Range. The full extent of this vegetation community in the Great Dividing Range region is however not known. Floristic and structural affinities are unlikely to be found at similar altitude on Bellenden Ker because of the predominance of vine forest cover and a significant difference in moisture availability.

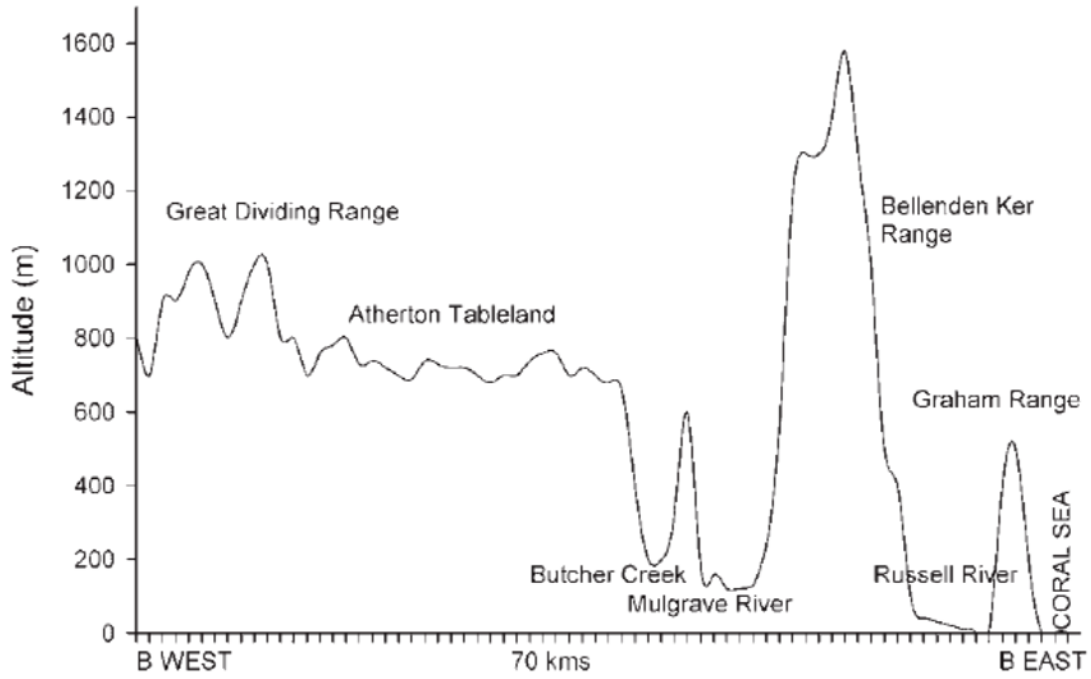

Figure 14.3 West to east altitudinal gradient. Source: Ramsey and Cairns (2004).

Mount Emerald and the MEWF site occur approximately where the Great Dividing Range is depicted. Impacts are expected to occur over time during the operational phase of the project, and as a result of creating linear disturbance and therefore removing important habitats for conservation significant plants - notably above 900 m ASL. The removal of habitat in this altitudinal zone could have implications in regard to the total area of similar habitat for these plants found in the region. For example, clearing ridges around and above the 900 m contour will effectively remove some key habitat for *Homoranthus porteri*. This species is more or less restricted to this type of particular habitat on the site, with only two outlying populations (relatively small) found in different habitat and below 900 m ASL in the Einasleigh Uplands section.

Similar impacts to those imparted during the construction phase could occur if the windfarm during decommissioning. Assuming some habitat for conservation significant plants has regenerated or been reinstated after ten or twenty years, decommissioning could require widening of tracks and removal of infrastructure. Works associated with the decommissioning phase would require habitat removal to a lesser scale, however post decommissioning rehabilitation should encourage recovery of such revegetation.

Linear clearing causes edge effects, pathways for weeds, pathogens and diseases to move; and creates barrier effects (potential to limit seed movement and genetic material across landscapes). On a smaller scale, surface hydrology can be altered and redirected, which in turn affects micro-habitat function in sensitive environments reliant on limited resources such as mosses, lichens ferns with contribute to pockets of soil and growing medium. This will be more applicable to narrow ridges where the actual habitat representation for certain species may only be in the order of 5-10 m wide in places.

Consequential impacts on the two EPBC Act listed species (*Grevillea glossadenia* and *Homoranthus porteri)* associated with operation of the MEWF are most likely to be the introduction of new weed species into the site and potential long-term establishment of such species.

Slow vegetation succession is also expected on ridges where soil development is minimal and of very low fertility. Plant species which occur along ridges are specialists and reliant on special habitat/soil characteristics that may not be able to be replaced or rehabilitated to their original status. Some plants of

ridges are obligate seeders, where their regeneration capacity is only through production and germination of seed. This regenerative strategy differs from other plants of ridges that may recover from resprouting (Bond & Midgley, 2001). Therefore, scalping of ridge top soils will remove seed from the seed bank and if undertaken at a depth below the root zone, could seriously affect the species composition of regenerating vegetation.

Altered fire regimes may occur as a result of increased fuel loads developing adjacent to newly cleared tracks. Changed fire ecology could result in species elimination and / or the promotion of different plant functional groups, and consequently changing the habitat micro-environment. Obligate seeder species are killed by fire and regenerate through germination of seed stored in the soil seed bank; whereas, resprouters recuperate after fire by reshooting from stems or rootstock. Fire ecology (intensity, timing, duration etc) is critical for the successful regeneration of plant communities. As many rock areas are considered refuges, inappropriate fire regimes that breach the natural level of protection afforded by rock pavements and outcrops are likely to have a deleterious effect at least in the short-term, but possibly in the longer-term if the fire event is unnaturally severe.

In regard to climate change, rocky landscapes are termed by some as litho-refugia (Shoo *et al*., 2011) and are thought to provide long-term, stable habitat for plants and fauna that is buffered from variation in temperature and moisture (Murphy, *et al.*, 2012). Therefore, the narrow ridges where cloud stripping (occult precipitation) occurs afford crucial zones of refugia in long-term. Modification of the physical characteristics and condition of these ridges may lead to a reduction in landscape integrity and the biodiversity status, and possibly the efficiency of high altitude sites in the wet tropics bioregion section to function as refugia for plants and fauna.

It is not fully understood what practices are best suited to rehabilitating the disturbed land of ridges. More is understood regarding flatter land, where for example, more generic methods of direct-seeding could have applicability. However, judging by the condition of mountainous tracks under the existing 275 kV powerline in the western part of the site, regeneration is slow, and it is expected that even human intervention will have slow rates of efficacy. The loss of fruticose and crustose lichens, mosses and ferns from cleared rock areas will affect the rate and status of soil generation on otherwise soilless landforms. This will have implications for the eventual species composition and success rates of rehabilitation. On dissected ridges, it is not expected that the original floristic composition and structure will be able to be reproduced through conventional rehabilitation treatment.

Impacts (loss of habitat and species) caused by the wind farm development will possibly exceed natural variability that would be experienced in the region, especially for sections of the project site above 900 m ASL. This is more applicable to *Homoranthus porteri* than *Grevillea glossadenia* - the latter species favours disturbance and regenerates actively on disturbed soil environments. *H. porteri* conversely, occurs in landscapes that are not conducive to anthropogenic activities and infrastructure other than mining, and in this situation, a small section of a wind farm proposed in remnant vegetation areas of high altitude, dissected hills.

14.6 Avoidance, Safeguards, Management and Mitigation Measures

14.6.1 Constraints and Opportunities

A constraints and opportunities overview was developed which identified the project site is more or less divided into two parts of contrasting environmental values.

The Einasleigh Uplands bioregion section north of the transmission line was determined to be the least environmentally constrained; supported considerably less important plant habitats; and consequently hosted

notably fewer conservation-dependent plant species. This portion of the site also affords the greatest constructability options in regard to the less incised and dissected topography and less remote aspect.

A majority of the specialist habitat for conservation significant plants is found in the elevated country south of the transmission line in the Wet Tropics bioregion section of the site. Impacts to these habitats and conservation significant species could be directly mitigated by avoiding or reducing construction in this area. Any new roads or tracks directly introduce linear impacts and landscape fragmentation. Therefore, limiting the number and length of new tracks is an important mitigation planning aspect.

Mapping showing the important habitat zones and a recommended conservation zone is given in **Figure 14.1.**

Given the remnant status and high levels of natural integrity of the site, mitigating impacts will need to consider a range of site-based strategies; and will call for specifically compiled management plans to be developed because of the special attributes of the site.

14.6.2 Mitigation Measures & Safeguards

Key impact mitigation measures will need to avoid impacts in the first place. Careful ground-based route selection and turbine placement will be required. As part of this EIS impact mitigation process RACL designers have removed four (three >900m elevation) turbines from the priority Wet Tropics bioregion. Turbines 36, 38 and 39 remain in the critical habitat zone. Accuracy of desktop mapping and location of turbines is limited; due to the fine scale of special habitats and the focus of conservation significant plants along narrow ridges. Detailed ground-truthing will be required prior to final turbine placement and track routes. Mitigation measures are summarised in **Table 14.3**.

Table 14.3 Summary of flora and habitat-related mitigation measures.

Project Phase	Mitigation and Management Measures
Layout and planning	A pre-clearance survey will be undertaken by a botanist conversant with the unique flora and habitats of the site. A RACL engineer or nominated representative will accompany the survey for logistical purposes. Alignment of new interconnecting tracks and turbine construction pads, as well as other construction zones requiring clearing will be "micro-sited" during this survey to avoid or minimise removal of conservation significant plants.
	Locating infrastructure (as above) is to avoid highest value habitats and concentrated zones of plant diversity.
	Key habitat areas and concentrations of conservation significant plants should be clearly demarcated by a botanist.
	An absolute minimum buffer of 20 m should be applied around the two populations of the endangered *Melaleuca uxorum*. There should be no construction or clearing activities in this buffer (**Figure 14.1**).
	Vegetation clearing, ground disturbance, scraping and modification is to be kept to the absolute minimum required to achieve an appropriately prepared work-construction site.
	In all situations, advantage should be taken of utilising pre-cleared tracks and land for access roads and construction pads.
	Wherever possible, clearing of the montane heath community above 900 m ASL is to be avoided; or the route of least impact is chosen where conservation significant plants do not occur. Site-based advice from a botanist is proposed to guide this process.
	Works should avoid niche plant habitats such as rock outcrops and ledges.
	Large-class trees should not be felled wherever practicable.
	A site-based Rehabilitation and Revegetation Plan will be prepared, which details priority areas, key conservation zones, suitable plants for revegetation and timelines for monitoring rehabilitation progress and efficacy.

Project Phase	Mitigation and Management Measures
	A Weed & Pest Management Plan will be prepared prior to construction.
	A vehicle/machinery washdown bay will be constructed and made functional at the primary entrance into the site. Prior to entry into the site all vehicles and machinery will be required to be washed at the washdown facility. Weed hygiene protocols will be adhered to at all times.
	A Rehabilitation Plan and an Environmental Monitoring Plan will be compiled prior to construction.
Construction	Topsoil is a rare commodity on the site and soil and rock spoil should be stockpiled separately and adjacent to where to where the material was taken, or the very nearest suitable storage area. Stockpiles of material (particularly soil) will not exceed a height of 1 (one) metre.
	All soil and rock material is to be stockpiled *in situ*. All imported construction material (road base, sand, rock-fill etc.) is to be free of weed seed and propagules, and be sourced from clean suppliers in the local region.
	Windrowed vegetation should not be burnt. It will be stored adjacent to the clearing area and respread over disturbed sites following construction.
	Felled and cleared vegetation should be retained and re-spread adjacent to the track edges to assist with rehabilitation.
	Any seed or plant propagules should be collected, stored and labelled by a botanist or qualified person to accumulate a seed bank for future rehabilitation.
	The use of chemical herbicides for clearing/controlling native vegetation is not permitted.
	All conservation significant plants that are to be cleared are to be recorded (numbers, description and species) prior to removal.
	All efforts to transplant reasonable-size plants are to be practised as a rehabilitation/conservation measure. Transplanting will occur when ground conditions are best suited to plant growth (i.e. some longer term moisture is available in the soil).
	To minimise weed incursion and the cumulative impact of edge effects in vegetation; consideration should be given to a more permanent road seal other than bare soil in some strategic locations. This will assist erosion control, improve year-long access and limit the potential for weeds to establish along track edges.
Post-construction	Road, track and construction zone edges are to be rehabilitated according to the rehabilitation plan.
	Natural regeneration of interconnecting tracks is to be promoted and monitored. Supplementary revegetation may be required is many areas.
	All rehabilitation is to be monitored and progress, failures and improvements recorded.
	No introduced plants will be used in rehabilitation. This includes naturally occurring species which are not found in the region on similar soil and geology. Specialist advice will be given by a qualified botanist. Specifically, but not limited to, the following species are <u>not</u> to be used in rehabilitation: Japanese millet, couch grass, siratro, centro, stylo, Japanese sunflower, Singapore daisy, Glycine, Wynn cassia, sicklepods and rattlepods, exotic grasses, introduced pasture legumes, ornamental trees and shrubs (unless advised suitable by botanist), bamboo, exotic garden plants, any daisy species not approved by botanist. All rehabilitation/revegetation species are to be approved by a botanist prior to application.
	On-going propagation of special plant species (conservation significant, narrow endemics) to be carried out progressively as propagating material becomes available. Records to be kept of seed collection, propagation trials and success/unsuccessful species.
	Weed monitoring and control to be recorded and applied weekly (control when necessary). Significant outbreaks of noxious, declared and problematic weeds to be reported to botanist immediately for further investigation and action. Some weed outbreaks will need to be reported to the Mareeba Shire Council.
	Weed control is to adopt the most environmentally sensitive techniques. Chemical control should be reserved as a last option in areas of high ecological integrity. Small weed outbreaks will be manually removed/controlled (grubbing). Grubbed out weed material is to be removed from the site and dumped in an approved location.
	Monitoring, recording and floristic and photographic records to be kept of vegetation succession and colonisation of cleared verges and edges.

Project Phase	Mitigation and Management Measures
	Suspicious incidences of poor plant health, dieback, disease to be reported immediately to botanist and then to DEHP if necessary.
	Any fire events, whether natural, accidental or otherwise are to be recorded.
	Controlled burns or deliberate fires are not to occur unless authorised in an approved Fire Management Plan. The existing RACL Fire Management Plan will require updating and revising to reflect the special vegetation and natural habitat characteristics of the MEWF site.

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Fauna

15.0 Northern Quoll Impact Assessment

15.1 Introduction

This Chapter provides the relevant information on Northern Quoll ecology, the potential impacts of the project and their likely significance on the MEWF project site population, and propose mitigation strategies to avoid or reduce these impacts. Specialist studies are provided in **Appendices 17 to 22.**

15.2 Species Ecology

15.2.1 Population Information

15.2.1.1 Population Viability

Population Viability Analysis (PVA) modelling was conducted for the Mt Emerald Northern Quoll sub-population using demographic variables obtained directly from camera-trapping and live-trapping studies (estimated population size) or from other published research (e.g. Oakwood, 1997 -fecundity, life-span, age-specific mortality etc.).

The PVA modelled four scenarios:

(1) Baseline scenario, which used only the baseline matrix to examine population viability with no additional mortality occurring from the proposed development throughout the duration of the simulation period (30 years, 2013 – 2043);

(2) A 2.5% increase in mortality over the same simulation period;

(3) A 5% increase in mortality over the same simulation period; and

(4) A 10% increase in mortality over the same simulation period.

The PVA modelling revealed the high susceptibility of Northern Quoll populations to increased extinction risk with even modest increases in extrinsic mortality, (the risk of death that is not conditional on an animals reproductive behaviour) although the absolute estimates of risk are likely to be subject to error due to lack of some key demographic data **(Appendix 17)** and likely to be an over estimate.

Without a detailed understanding of the nature and extent of impacts on quolls from the proposed MEWF project, which will require additional pre-construction studies to answer, it was not possible to quantify the level of impact on population viability. It is currently not understood what the minimum area is required for the Far North Queensland metapopulation to remain viable.

15.2.1.2 Population Status (Impact vs Non-impact Areas)

Estimates of Northern Quoll abundance were obtained from a wide-scale camera trapping survey conducted across Mt Emerald and in other 11 areas within a 55 km buffer of the project boundary in July 2012 (**Appendix 18**). Density estimates were obtained for each of the 11 districts based on the inter-trap distances moved by identifiable individuals. These density estimates were then used to estimate the total population of Northern Quoll in Far North Queensland based on extent of suitable habitat obtained from the habitat model (**Appendix 19**).

Applying the density/unit area potential habitat approach, the entire Far North Queensland (FNQ) Northern Quoll population is estimated at approximately 9466 individuals. Application of the density method to estimate the size of the Mt Emerald Northern Quoll population suggests 53 individual Quolls potentially inhabit the site. Closed capture-recapture modelling using data from a 750 m camera trap grid which covered

most of the site, also suggests a population size of 53 individuals (95%CI 34 – 109 individuals). This equates to between 0.35% and 1.2% of the entire estimated FNQ Northern Quoll population (**Appendix 18**). There are a number of sources of uncertainty, which suggest the total population size could be overestimated and further validation studies are required to validate and refine these estimates (**Appendix 18**).

15.2.2 Patterns of Movement and Dispersal

Intensive radio-tracking and live-trapping studies were undertaken on the project site to determine fine-scale movement patterns of Northern Quoll adult and juvenile males and females (**Appendix 19**). It was not possible to obtain spatially accurate locations of foraging individuals during the night due to technical issues with the automated radio-telemetry system (ARTS). Nor was it feasible to obtain manually triangulated locations due to the limited existing vehicle track access and the rugged nature of the site which precluded traversing long-distances at night off track.

Some information on the movement patterns of radio-collared Northern Quoll on the project site was able to be derived such as the mean Euclidian distance between day-time den sites on consecutive days. The mean Euclidian distance between den sites located on consecutive days for collared individuals (seven individuals; a total of 67 den sites) was ~241 m. It is possible to obtain some movement information on the distance between successive captures of individuals during the camera trapping surveys (both within the project site and other regional locations); however budget constraints have precluded this to date.

Individual quolls were able to be identified on images captured by baited camera traps (**Appendices 18 and 19**) and the mean distance moved between successive camera trap sites calculated. From the July 2012 camera trapping surveys on Mt Emerald, the mean inter-trap distance moved by all identified individuals (25 individuals and 39 movement events) excluding zero-distances was 648 m (standard deviation of 717 m) (Scott Burnett, pers. com.).

No data is available specific to the project site for pre-construction recruitment rates and dispersal patterns. Previous research indicates that rates of recruitment of juveniles into the population are typically low, with this age class experiencing high rates of mortality once they leave the pouch, mostly due to predation (Oakwood, 1997).

Understanding of the patterns of dispersal of juvenile Northern Quoll is limited. Oakwood (1997) found that of the 22 young that were born on her Kakadu National Park study site, only one female and one male were recaptured early the following year still within the general vicinity of their mother's denning home range area. The juvenile individuals that were radio-collared on the MEWF site for a period of 1-3 weeks in February-March 2013 did not appear to undertake large dispersal movements (**Appendix 19**); however, it is likely they may have already established territories as they would have become independent around November 2012 and may have already dispersed from the maternal home range area.

Adult male Northern Quoll are likely to undertake movements over large distances especially during the breeding season (Oakwood, 1997), although the maximum distances and frequency of such large-scale movements by individuals is not currently understood. The majority of adult males fitted with radio-collars on the project site were unable to be located on all occasions and many were only located 1-2 times, suggesting they may have moved outside of the radio-detection range. Oakwood (1997), also found that adult males were difficult to track for long-periods which may have been due to movements out of the study site.

15.2.3 Critical Habitat

Habitat modelling conducted by University of Sunshine Coast researchers for the project (**Appendix 18**) indicate that 72% of the predicted high and very highly suitable Northern Quoll habitat in FNQ is found within a 55 km buffer of the project site boundary.

The population genetic studies confirm the importance of the Mt. Emerald area for maintaining the genetic flow between northern and southern populations of FNQ Northern Quolls (**Appendix 21).**

Radio-telemetry studies on Mt Emerald suggest that non-breeding season den site habitat is likely to be widespread across the site. However, only limited information is available on the maternal den site habitat availability; with data obtained to date indicating that ridge habitat where turbines are proposed to be located may be critical (**Appendix 21**). Whilst the narrow ridgelines are dominated by rocky habitat, it is also prevalent along creek lines and as outcrops in mid slope areas, therefore it is considered likely that suitable maternal denning habitat may not be restricted to ridgelines only. The extent of potential foraging and denning habitat for Nothern Quoll on site is detailed in **Figure 15.1.** Rocky areas are thought to be important for the survival of Northern Quoll populations across their range. For example, modelling of the distribution of island populations of Northern Quoll in the Northern Territory showed their occurrence was strongly related to topographic ruggedness (Woinarski et al., 2007). Declines of Northern Quoll populations in Queensland have been found to have occurred predominately in flatter, lowland areas (Woinarski *et al.,* 2008). Rocky areas may provide refugia from fire and predation by feral cats and due to their water retaining attributes, they may support high floristic diversity and productivity and thus higher prey abundances than areas without rocky outcrops (Burnett, 1997; Hill & Ward, 2010).

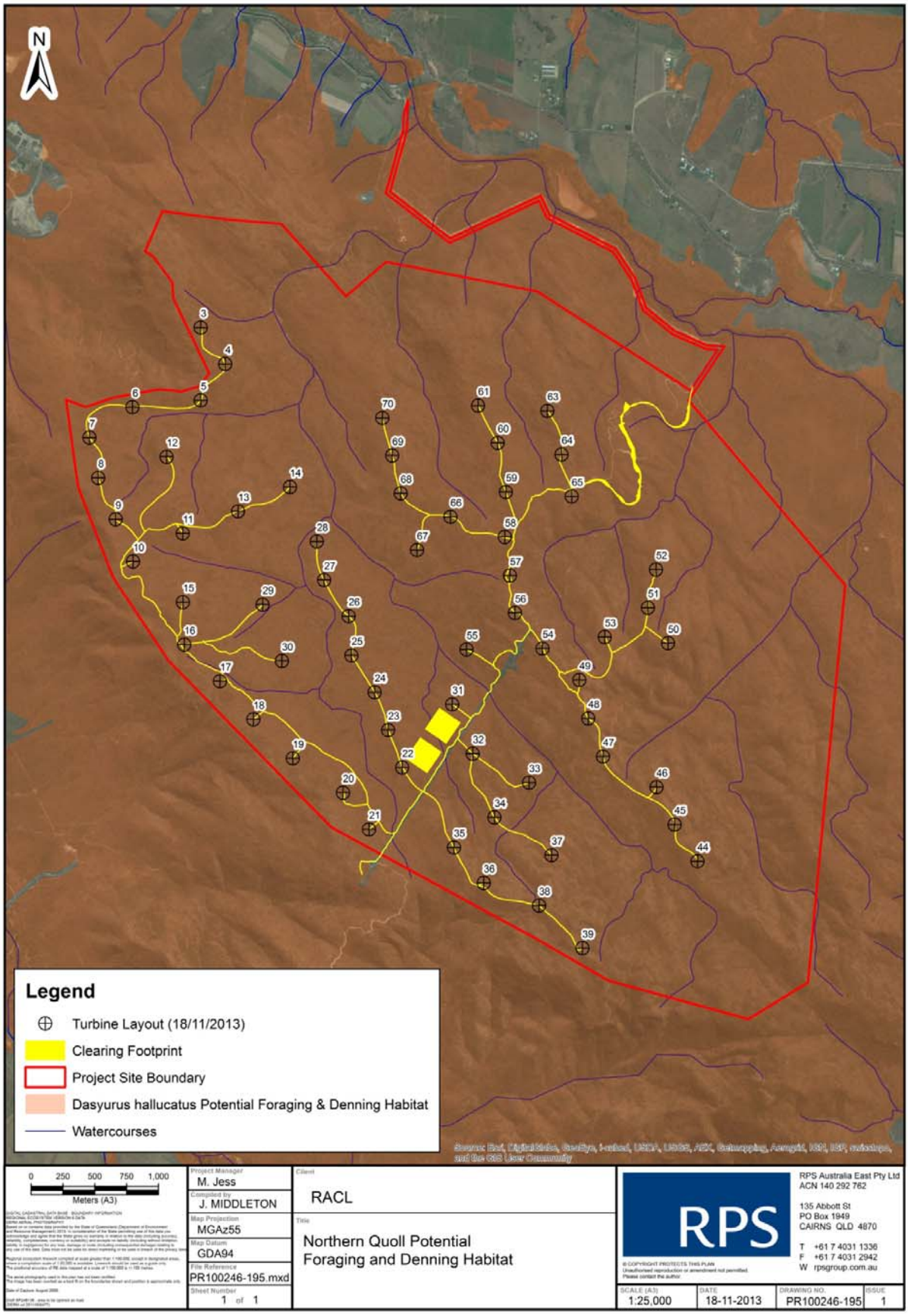

Figure 15.1 The potential denning and foraging areas for the Northern Quoll on the proposed MEWF site.

15.2.4 Genetic Diversity

The preliminary population genetic study indicated there is a high degree of similarity (>90%) amongst the Northern Quoll sub-populations in the four areas that were sampled within the Atherton Tablelands region (Tinaroo/Davies Creek/Biboora; Mt Emerald; Upper North Walsh River/Upper South Walsh River/Lion Mountain; and Mt Windsor Tablelands).

Estimates of observed and expected heterozygosity (having different alleles at one or more corresponding chromosomal loci) in the main population sampled in the population genetics study (Upper Walsh River North & South/Lion Mountain, Mt Emerald and Tinaroo/Davies Creek/Biboora) were almost identical and similar to those found in previous studies of Northern Quoll populations in Western Australia and the Northern Territory (**Appendix 21**).

15.2.5 Economic, Cultural and Social Values

Northern Quolls are predators of small mammals, and may assist in the control of domestic and agricultural rodent pests such as *Rattus rattus* and *Mus musculus* in some areas. Similarly the Northern Quoll is known to include significant amounts of invertebrates in their diet, some of which could potentially be agricultural pests.

Northern Quolls are an integral component of the biodiversity of the dry sclerophyll habitats of the Wet Tropics and Einasleigh Uplands bioregions in Far North Queensland, and as such help maintain ecosystem services which contribute to societal well-being and economic prosperity.

Northern Quolls and other quolls are the focus of community engagement groups such as the Quoll Seekers Network, which raises the profile of all Australian Quolls through education and assist with conducting regional camera trapping surveys.

15.3 Potential Impacts

15.3.1 Construction Phase

15.3.1.1 Direct Mortality during Clearing, Excavating and Blasting Operations

There is the potential for some individual Northern Quoll present within their day time den sites to be killed by crushing during the construction phase when habitat is being cleared or during blasting. This impact may be particularly significant if females are preferentially utilising ridge habitats for maternity denning.

15.3.1.2 Noise, Dust & Vibration Disturbance

Noise is an environmental stressor and can potentially affect wild animals in a number of ways including: alientaiton of noisy habitats, hearing loss, increased rates of predation or reduction in foraging success due to masking (i.e. interference with the perception of sounds of interest), physiological stress and associated adverse health effects, increases in energetic expenditure due to startling etc (see references in Kerlinger *et al*., 1995). However, it is not well understood how the Northern Quoll is likely to respond to disturbance associated with construction activities. Although the Northern Quoll displays some tolerance to human activities, being known to inhabit human dwellings in the vicinity of the site (Luke Jackson, *pers. com*.), they are not typically exposed to the levels of disturbance likely to be experienced during construction of the wind farm infrastructure. In addition, animals inhabiting human habitation are likely to habituate to human noises, whereas it is unknown whether this would apply to more intrusive elements of construction noise.

15.3.1.3 Habitat Loss

There is the potential for the loss of approximately 57 ha of foraging and denning habitat that occurs within the proposed infrastructure footprint. Given the abundance of potentially suitable fallen and standing (live or dead) hollow eucalypts and rocky outcrops as denning microhabitats across the site, it is not likely the loss of 57 ha of potential den habitat will significantly impact the local population. That is, unless maternal den sites are concentrated preferentially along ridge habitats (which is indicated by the limited data available from the project site).

Oakwood (1997) found that female Northern Quolls at Kakadu showed distinct seasonal variation in den site habitat preferences; between mid-late August and mid-November each year, they denned significantly more often in the forest, in contrast to the remainder of the year when they preferred rocky habitat.

15.3.1.4 Habitat Degradation

Invasion of Introduced Pasture Grasses

The introduction of exotic pasture grasses in the Northern Territory disadvantages Northern Quolls by inhibiting movement and hunting ability through high density stands of exotic pastures and also fosters more intense fire regimes (Hill & Ward 2010).

Unless stringent machinery weed hygiene protocols are enforced on site and frequent and comprehensive weed monitoring and control actions are conducted, there is a high likelihood of potentially highly invasive introduced grasses, particularly Grader Grass (*Themeda quadrivalvus*) and Thatch Grass (*Hyparrhenia rufa*), Pigeon grasses (*Setaria spp.)*, that are currently established on the site in small areas along access tracks and creek crossings, being spread across the site into new area.

Inappropriate fire regimes

The frequency, season and intensity of fires are all likely to be important factors affecting Northern Quoll populations (Hill & Ward, 2009). Hill & Ward (2009) suggest the decline of the Northern Quoll may be related to increased vulnerability of individuals to predation following the removal of ground cover vegetation by fire, particularly in areas without extensive rocky outcrops. Oakwood (1997) found that the main cause of Northern Quoll mortality in Kakadu National Park was due to predation by cats, dingos and raptors in the period following extensive fire. Frequent, intense fires may result in the destruction or degradation of important Northern Quoll habitat resources such as hollow trees or logs and termite mounds for denning (DotE, 2013a)

Unless strict weed hygiene, monitoring and control management actions are undertaken, there is a high likelihood of invasive pasture grasses becoming more widely established on the project site. If these grasses become well established across the site, they are likely to contribute to a more intense fire regime which could pose a serious threat to the viability of the local Northern Quoll population.

The construction of the MEWF may lead to an increased risk of accidental wild fire (e.g. hot exhaust manifolds from heavy machinery coming in contact with dry flammable vegetation), particularly during the late dry season. The rugged nature of the site and the consistent strong winds could result in wild fires spreading rapidly into areas where control would be difficult if not impossible.

The fact that a severe, intense late dry season wild fire burnt out the majority of the project site in October 2009 indicates that either the Northern Quoll population has made a rapid recovery or that the rocky, rugged nature of the site provides numerous, effective fire refugia.

15.3.2 Operation Phase

15.3.2.1 Disturbance resulting in exclusion and changes in utilisation patterns

There is the potential for individuals to be excluded from areas of their home range due to disturbance resulting from noise produced by the operating wind turbines, which will be approximately 55 dB at ground level at the base of the wind turbines (roughly equivalent to the loudness of a noisy office environment). It is not currently understood how the Northern Quoll is likely to respond to these expected levels of turbine noise. In addition to vision and olfaction, the Northern Quolls are likely to rely heavily on hearing to avoid predators and locate prey. Excessive noise levels have the potential to interfere with hunting and predator avoidance activities in the vicinity of the turbines.

The inadvertent provisioning of turbine-killed flying fauna carcasses may potentially modify foraging patterns of Northern Quoll individuals on the project site.

It is unlikely that shadow flicker and blade glint could potentially adversely impact Northern Quolls given their predominately nocturnal behaviour. Northern Quolls have been observed basking during the morning and late afternoon during cold weather (Oakwood, 2000) so there is some possibility of disruption of this behaviour due to shadow-flicker and blade glint. There has been no research investigating the impacts of shadow flicker and blade glint on non-human animals.

15.3.3 Vehicular Collision

A study by Oakwood (2000) of Northern Quolls in Kakadu National Park suggests road mortality is a frequent occurrence with this species and appears to be biased towards males with six times as many males as females hit by cars. Oakwood (2000) also concluded that increase frequency of road mortality in Northern Quolls corresponds highly with the breeding season (May-October).

There is the potential for some Northern Quoll individuals to be directly killed due to vehicular collisions during the night and day although a vehicle speed limit (60km/h) will be enforced throughout construction and operation.

Oakwood (1997) found that at Kakadu, both sexes of Northern Quoll are more conspicuous during the day prior to and around the mating season (May-early June), and that males are also often visible both outside and inside their dens during the die-off (June-July). Oakwood (1997) recorded numerous Northern Quoll individuals sheltering in grass or moving during the day. Similarly several observations of individuals moving around during the day were recorded during location of day-time den sites at the project site; however it is possible these movements were in direct response to disturbance to the animals whilst attempting to locate day time den sites

15.3.4 Habitat Degradation

15.3.4.1 Inappropriate fire regimes

See **Section 15.3.1.4** above.

15.3.4.2 Invasion of Introduced Pasture Grasses

See **Section 15.3.1.4** above.

15.4 Cumulative Impacts

Any source of additional mortality has the potential to adversely impact Northern Quoll populations relatively more than other species due to their life histories, which make them susceptible to population decline (e.g. synchronous die-off of adult males, high juvenile mortality), and relatively low abundance.

The following sources of unnatural mortality have the potential to act in concert with potential impacts of the proposed MEWF project to adversely affect the Far North Queensland Northern Quoll meta-population.

15.4.1 Mining Operations

There are a number of small proposed mining operations within the predicted distribution of the Far North Queensland Northern Quoll metapopulation (a set of discrete populations of the same species, in the same geographic area that exchange individuals through migration or dispersal) that are currently operating, under assessment or have obtained approval and have the potential to contribute to cumulative impacts on the important population of the species including:

- Watershed Project - Vital Metals (EPBC Referral 2010/5495).
- Vital Metals Limited is currently developing a tungsten resource under Mineral Development Licence (MDL) 127 at the Watershed deposit some 23 km north-west of Mt Carbine on the boundary between Cook and Mareeba Shires in North Queensland. Fauna surveys have confirmed the presence of *Northern Quoll* within the proposed project area.
- Baal Gammon Expansion – Consolidated Tin Mines Ltd (CTM) (Snow Peak majority shareholder).
- CTM is proposing to expand the current Baal Gammon mine (mining application MLA 20692), in the vicinity of the water catchments of Toy Creek and Bussy Creek which flow into the Walsh River, upstream from the site of a severe 2012 water contamination event. The headwaters of Toy Creek are known to support high densities of the endangered Northern Quoll (Scott Burnett, *pers. com.).*

15.4.2 Vehicular Collisions

Northern Quoll are frequently observed killed by vehicular collisions along the Mulligan Highway (generally 100km/h limit) between Speewah (~18 km W of Cairns) and Walkamin (~4 km WSW of the project site) (Jeff Middleton, *pers. obs*.). The significance of vehicular collision mortality on the long-term viability of the Wet Tropics Northern Quoll metapopulation is not currently understood.

15.4.3 Poison Baiting

The wild dog is a Class 2 declared animal under Queensland legislation. It is the responsibility of landholders to control wild dogs on their land. Baiting of wild dogs/dingos by land owners is a requirement under the Queensland Land Protection (Pest and Stock Management) Act (DAFF, 2013).

Although King and King (1989) and Morris *et al.* (2005) found no radio-collared Northern Quoll individuals died as a direct result of aerial 1080 baiting for dingos in the Western Australia, other research has highlighted the potential for sub-lethal effects of 1080 on native marsupials including sterility. Given the extensive movements of Northern Quolls, especially males (e.g. >2 km per night), the removal of multiple 1080 baits from more widely-spaced bait stations is a distinct possibility. The Queensland Government has recently relaxed the restrictions on the use of poison baiting to control wild dogs and dingos, which may increase the use of 1080 baiting throughout the Wet Tropics Northern Quoll population distribution.

Recent research indicates that unmolested dingo populations effectively control populations of feral predators, particularly cats (JCU, 2011) which are a recognised threatening process for Northern Quoll (Hill &

Ward, 2010). Wild dog control using 1080 baiting is widespread on cattle leases in the drier western section of the modelled distribution of the Wet Tropics Northern Quoll metapopulation (Jeff Middleton, *pers. com.*).

The use of strychnine is still also permitted in Queensland for the control of wild dogs and dingos and has been implicated in the decline in Spotted-tail Quolls (Burnett & Marsh, 2004). Strychnine baiting is less commonly practiced than 1080 baiting, however is highly toxic and lethal to the Tiger Quoll (*D. maculatus*) (Burnett & Holmes, 2008) and therefore is also likely to have a similar effect on the significantly smaller Northern Quoll.

Given the propensity of Northern Quoll to live within or in close proximity to human dwellings in some areas e.g. Mareeba, and Speewah areas (Scott Burnett, *pers. com*.), there is a high potential for animals to directly ingest lethal doses of domestic or commercial rodenticides containing Warfarin and Brodifacoum, or to prey upon rats and mice that have accumulated lethal doses of these toxins in their body tissues.

15.4.4 Deliberate Killing at Poultry Pens

Larger relatives of Northern Quoll, such as the Western Quoll (*D. geoffroi*) Spotted-tail or Tiger Quoll (*D. maculatus*) are known to attack poultry and historically they were frequently killed at backyard chicken pens (Scott Burnett, *pers. com*.). It is not known how frequently Northern Quoll attempts to prey upon captive chickens, however given that poultry keeping is no longer particularly common activity, it is unlikely to be a large source of mortality except at specific locations and is therefore not a significant threat to the species.

15.4.5 Urban Development and Agricultural Expansion

Legislation restricting land clearing in Queensland has been substantially amended this year. It is now permissible to clear remnant forest if it can be proven the land has high agricultural potential (e.g. cropping and horticulture) and the proposed development is economically viable. In addition many clearing activities are now self-assessable including logging and other extractive industries, thinning, maintaining fence lines, firebreaks, roads, and constructing and maintaining built infrastructure.

These legislation changes could result in an increase in the loss of dry sclerophyll forest and woodland habitats within the estimated distribution of the Wet Tropics metapopulation of the Northern Quoll, particularly on the relatively rich agriculturally suitable volcanic derived soils of the western Atherton Tablelands area e.g. Dimbulah, which could have the potential to adversely affect the species. The lack of sufficient irrigation water however is likely to limit further agricultural development in this area. The Mareeba Shire Planning Scheme has identified potential zones for future urban expansion that includes areas of remnant eucalyptus woodland and open forest that forms a potential movement corridor for Northern Quoll individuals between the Barron River and the large intact block of remnant dry eucalypt woodland to open woodland on sandy plains surrounding the Mareeba Wetlands.

15.4.6 Habitat Degradation

Inappropriate Fire Regimes

Large areas of the modelled distribution of the Far North Queensland metapopulation of Northern Quoll are subject to what are likely to be inappropriate fire regimes e.g. frequent late dry season intense wild fires.

Weed Invasion

Several invasive pasture grasses including significant environmental weeds such as Gamba Grass (*Andropgon gayanus*), Thatch Grass (*Hyparrhenia rufa*), *Pennisetum spp*. and Grader Grass (*Themeda quadrivalvus*) are well established within the modelled distribution range of the FNQ Northern Quoll

metapopulation. Ward & Hill (2009) suggest these exotic pasture grasses may disadvantage Northern Quoll because (a) they produce high fuel loads which are more likely promote more intense fire regimes and (b) their high density, biomass and rigidity may inhibit the animals ground movements.

15.5 Significance of Impacts

Under the EPBC Act, an action will require approval from Federal Environment Minister if the action has, will have, or is likely to have a significant impact on a listed species or ecological community. Each of the nine criteria for assessing the significance of impacts on an endangered species as outlined in the *Matters of Environmental Significance – Significant Impact Guidelines 1.1 EPBC 1999* (DotE, 2013b) are addressed below in **Table 15.1**.

A '***population of a species'*** is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to endangered threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations; or
- a population, or collection of local populations, that occurs within a particular bioregion.

Table 15.1 Significant Impact Assessment for the Northern Quoll.

Northern Quoll (*Dasyurus hallucatus*) - Endangered	
Will the proposed works..	**Response**
Lead to a long term decrease in the size of a population?	Habitat modelling shows >72% of predicted high and very highly suitable habitat in far north Queensland is found within a 55km radius of Mt. Emerald, suggesting the region including Mt. Emerald local area could be a significant reservoir of quolls for the region (**Appendix 17).** Preliminary Population Viability Analysis (PVA) modelling reveals the high susceptibility of the Mt Emerald Northern Quoll subpopulation to increased extinction risk with even modest increases in extrinsic mortality (**Appendix 16).** PVA reveals that an increase in local mortality as low as 2.5% (=1.325 individuals) results in a greater risk of extinction of the population and a 10% increase in local mortality (=5.3 individuals) may lead to localized extinction of the Mt. Emerald population within 20 years (**Appendix 16**). It should be clear that these extinction probabilities are likely to have been over-estimated due to the lack of any data on dispersal rates. Studies on patterns of dispersal of *Northern Quoll* between the various sub-populations of the FNQ metapopulation are required to improve the prediction of the PVA model. The combination of modelled high and very high quality quoll habitat on the project site and its location adjacent to an area of discontinuous habitat suggests that the project site may be critically important for maintaining connectivity and dispersal of *Northern Quoll* between the Walsh/ Herbert River catchment areas and the Barron/Mitchell catchment areas (**Appendix 17**). This is supported by the findings of the population genetics study (**Appendix 21**). Unless wide-scale habitat degradation of the project site occurs as a result of invasion of exotic fire-promoting pasture grasses and the subsequent establishment of inappropriate fire regimes, it is likely that the project site will continue to help to maintain connectivity of the *Northern Quoll* population between the Walsh/ Herbert River catchment areas and the Barron/Mitchell catchment areas. Therefore, it is unlikely that the clearing of ~57 haof known *Northern Quoll* habitat on the project site will lead to a long-term decline in the size of the Far North Queensland (FNQ) metapopulation due to reduced gene flow. However, the assessment of the long-term viability of the FNQ metapopulation and the relative importance of the Mt Emerald population in maintaining this viability is highly dependent upon the mechanism of gene flow, which remains unknown. Gene flow between the populations to the north and south of the Mt Emerald project site may occur quickly (i.e. within one generation) via long-distance movements of individuals passing through Mt Emerald from one catchment to the other, or gene-flow may occur gradually over many generations with genes 'diffusing' from one catchment to another ('stepping stone' scenario). This has implications regarding the potential impact of the proposed development on the overall *Northern Quoll* FNQ metapopulation. If the former mechanism of gene flow between populations is the dominant mechanism, this places less importance on the retention of the Mt Emerald *Northern Quoll* population, compared to the latter diffusion model which requires a constant presence of quolls on Mt Emerald to facilitate that gene flow. In the latter case it is possible that the local extinction of this population (as potentially indicated by the PVA modelling) could lead to a long-term decline in the overall FNQ metapopulation.
Reduce the area of occupancy of the species?	The proposed development is not likely to reduce the area of occupancy of the FNQ metapopulation of Northern Quoll given only ~57 ha of known habitat will be cleared, unless widespread habitat degradation occurs through weed invasion and establishment of inappropriate fire regimes that render the site unsuitable for maintaining a viable quoll population. Implementation of appropriate management actions should reduce this risk significantly.

Northern Quoll (*Dasyurus hallucatus*) - Endangered	
Will the proposed works..	**Response**
Fragment an existing important population into two or more populations?	As discussed above in 15.5.1.1, whether the proposed development could lead to the fragmentation of the FNQ Northern Quoll metapopulation into two or more sub-populations depends greatly upon the mechanism of gene flow between populations in the various areas of high quality habitat. If gene flow occurs predominately via the long-distance dispersal of individuals, then the FNQ metapopulation is unlikely to be fragmented as long as the overall habitat suitability of the project site is maintained for the species. If gene flow occurs slowly (stepping stone scenario) and the habitat suitability of the project site is compromised, then it is possible that the FNQ metapopulation may become fragmented into two subpopulations over time. Therefore, in the absence of detailed understanding on the patterns of gene flow and dispersal movements in the FNQ metapopulation, it is critical to ensure the viability of the Mt Emerald Northern Quoll sub-population by avoiding any mortality of individuals or wide-spread habitat degradation.
Adversely affect habitat critical to the survival of a species?	Preliminary studies have found that the local Mt Emerald population of Northern Quoll represents <1% of the estimated total Far North Queensland metapopulation and does not represent a distinct genetic sub-population (**Appendix 21**). Therefore even the total removal of all suitable habitats for the species on the site is not likely to cause species decline. However, further validation studies are required before the significance of the habitat loss, degradation, isolation etc associated with the project on the long-term viability of the FNQ metapopulation can be assessed with high confidence.
Disrupt the breeding cycle of a population?	It is unlikely that the proposed development will disrupt the breeding cycle of the entire FNQ metapopulation. It is also unlikely that the breeding cycle of the Mt Emerald sub- population of Northern Quoll will be disrupted with the implementation of the mitigation strategies outlined below.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The proposed development will result in the clearing of ~57 ha of potential foraging or denning habitat of an important population of *Northern Quoll.* There is a high risk of invasive fire promoting grasses spreading from existing loci on the site or become established on the site in areas where chemical and mechanical control would not be feasible. Associated changes in fire intensity and frequency could result in a decrease in the quality of existing habitat e.g. fewer potential den sites (hollow tress and fallen timber) and changes in prey availability. Preliminary studies have found that the local Mt Emerald population of *Northern Quoll* represents <1% of the estimated total Far North Queensland metapopulation (~10,000 individuals) and does not represent a distinct genetic sub-population (**Appendix 21).** Therefore even the total removal of all suitable habitats for the species on the site is not likely to cause the species to decline. However further validation studies are required before the significance of the habitat loss, degradation, isolation etc. Impacts associated with the project on the long-term viability of the FNQ metapopulation can be assessed with high confidence.
Result in invasive species that are harmful to an endangered species being established in the endangered species habitat?	Without strict weed hygiene, control and monitoring, there is a high risk of invasive fire promoting grasses spreading from existing loci on the site or become established on the site in areas where chemical and mechanical control would not be feasible. Associated changes in fire intensity and frequency could result in a decrease in the quality of existing habitat e.g. fewer potential roost trees and changes in prey availability and cause direct mortality to individuals on the project site. Cane Toads (*Rhinella marinus*) are the one of the most ubiquitous and abundant terrestrial vertebrates on the project site. The FNQ metapopulation of Northern Quoll has managed to persist despite the high abundance of Cane Toads throughout the entire region, including the site. It is highly likely that Cane Toads will be transported onto and within the project site on machinery and equipment. However, this will not have an adverse impact of the local *Northern Quoll* population.

Northern Quoll (*Dasyurus hallucatus*) - Endangered	
Will the proposed works..	**Response**
Introduce disease that may cause the species to decline?	There is some evidence to suggest that disease has been responsible for rapid declines in some dasyurid species (carnivorous marsupial family) across Australia last century (see Hill & Ward, 2010). However, there is no evidence of any diseases causing such population declines for Northern Quoll
Interfere with the recovery of the species?	It is uncertain at present whether the proposed development could potentially interfere with the recovery of Northern Quoll. The long-term viability of the FNQ metapopulation of Northern Quolls is certainly crucial to the recovery of the species as a whole, given the apparent stability of the FNQ metapopulation in the face of Cane Toad invasion.

15.6 Proposed Mitigation Strategies

The proposed strategy to minimise impact on the Northern Quoll is based on a hierarchical approach of further risk assessment, avoidance of areas and times of high risk and lastly implementation of specific Northern Quoll management procedures during the construction phase. Details of the strategy are provided in **Sections 15.6.1** and **15.6.2** and summarised below.

Further risk assessment:

- RACL propose to undertake additional utilisation studies during the 2014 breeding season (May – November) aimed at identifying the potential preferential use of ridgeline areas for maternal denning.
- Minimise risk through scheduling bulk earthworks (works involving blasting) outside of breeding season where feasible. Where these activities must be undertaken during the breeding season, implement the following risk avoidance and management procedures:
- Risk Avoidance
- It is proposed to initially push through as many of the ridge top access tracks (involving clearing and bulk earthworks) as possible during the lower risk April to July and December period, weather depending. The timing of these works will be informed by regular assessment of breeding progression. Completion of tracks to a trafficable standard can then take place in these cleared areas with minimal risk.
- Avoidance of areas identified as higher risk (including known denning sites) through adaptive scheduling of earthworks, that is, rescheduling of turbine pad and footings construction works in areas known to contain maternal dens to outside of critical denning phase (nom, September – November). Higher risk areas could be reprioritised where monitoring indicates dens are not being utilised.

  NB If research determines that maternal denning is not preferential to ridgelines the risks will be reassessed.
- Construction Phase Management Procedures:
- Intensive preconstruction trapping and radio collaring of animals in areas of proposed bulk earthworks;
- Daily trapping and relocation of trapped males and non lactating females;
- Identification of maternal dens through release and tracking of trapped lactating females;
- Implementation of spotter catcher methodologies during clearing.

15.6.1 Preconstruction Phase

15.6.1.1 Utilisation Studies/Validation of PVA/Species Distribution Model

Further studies are proposed to be conducted on the project site to gather information on seasonal variation in fine-scale habitat utilisation, particularly concentrating on female maternal denning and foraging utilisation patterns using recently available light-weight combined GPS-VHF radio-telemetry collars and live-trapping.

Validation of the population viability analysis (PVA), regional habitat suitability model and population estimates based on camera trapping is required before it is possible to have a high degree of confidence in the assessment of the importance of the local Northern Quoll population on the project site. The following additional research as outlined in **Appendix 17** would be required to validate the PVA, distribution models and density/population estimates:

- Quoll population and metapopulation boundaries are poorly known, and represent estimates at best. There has been insufficient recent or historical survey for Northern Quolls to have high confidence that the species only occurs in mapped metapopulation areas;
- It was not possible to ground-truth the MaxEnt habitat distribution model output during this project. This leads to uncertainty in the accuracy of habitat model output. An assessment of the accuracy of this output entails stratified sampling of Northern Quolls within the modelled extent in far north Queensland;
- The applicability to the rest of the far northern metapopulation area of the quoll density estimates derived for the Mt Emerald and surrounds is untested. This requires an extensive program of camera trapping stratified by habitat-type and covering the entire far northern region in order to validate the density data; and
- There are no data concerning the density or area of extent of Northern Quolls in any other metapopulation area so no conclusions can be drawn as to the relative abundance of Northern Quolls between the far north Queensland metapopulation and other metapopulations or populations. This requires a program of Northern Quoll population survey and enumeration, using the same methods as those used in this study, in other metapopulation areas.

15.6.1.2 Redesign of Infrastructure Layout

The Draft National Wind Farm Development Guidelines (EPHC, 2010), which outlines current best practice for wind farm risk assessment and mitigation strategies, states the most effective mitigation strategies to avoid impacts on fauna is to re-design the wind farm infrastructure layout to avoid areas of high conservation significance.

The Northern Quoll Referral Guidelines (DotE, 2011) recommend the following mitigation actions to avoid direct mortality and displacement due to habitat clearing:

- Design the project to avoid and protect habitat critical to the survival of the species; and
- Reconfigure the project to remove threatening processes

If pre-construction fine-scale utilisation indicates maternal den sites are preferentially located within proposed impact ridge areas, then it would be appropriate to reduce the number of turbines and the amount of associated access tracks within this habitat or to relocate them to less critical areas. The scope for relocating turbines away from ridge habitats is likely to be limited if the project is to remain economically viable because of the requirement to locate turbines in these areas where wind speeds are highest and not subject to turbulence.

15.6.2 Construction Phase

15.6.2.1 Direct Mortality from Construction Activities and Loss of Critical Maternal Den Sites

The proposed mitigation strategy to reduce the risk of construction associated mortality is as follows:

- Conduct intensive pre construction live-trapping surveys in the vicinity of the planned infrastructure areas beginning when Northern Quoll are likely to be large enough to be fitted with permanent GPS-VHF collars with a battery life of at least 9-12 months. This will allow for the location of denning sites, including maternal sites which can be checked for occupation immediately prior to ground disturbance.
- Two to three days prior to the commencement of primary bulk earthworks (including initial ground breaking and trenching using dozers, rock breakers etc) in discrete clearly marked areas, establish live-trapping line traps immediately outside of the infrastructure area. The night before construction starts, traps to be checked at dawn and all captured animals (with the exception of females with young deposited in maternity den sites – see below) to be relocated to suitable refugial areas (e.g. rocky outcrops) at least 1000 m away from the construction area. Trapping and relocation will be continued for the duration of construction. All trapped Northern Quoll individuals will be fitted with light-weight GPS-VHF radio- telemetry collars.
- In addition to live-trapping, the proposed footprint clearing will be searched methodically for denning radio-collared individuals each morning prior to starting construction activities. If any actively occupied dens are located within the construction area, then all bulk earthworks will be halted until such time as the individual shifts den sites.
- When dependent young are deposited by the female Northern Quoll in a maternity den, as opposed to being carried around in the pouch, they will be impossible to capture in live traps. Oakwood (1997) found that young were deposited in maternal dens in mid to late-August and were not trappable until at least November each year. It is not known whether the timing of this will vary significantly each year; therefore, ongoing live-trapping to monitor female reproductive status will need to be undertaken to determine when young are deposited in maternal dens and when they are independent and relocatable.
- Primary bulk earthworks will need to be conducted in discrete, clearly marked sections on a sequential basis. The size of each discrete construction area would be limited to that able to be trapped and searched for collared animals in the 1-2 hours around dawn each day. Best practice mitigation options as described in the *Referral Guidelines for the Northern Quoll* (DotE, 2011) strongly recommend that all construction activities involving the use of heavy machinery or blasting should be avoided during the breeding season (typically May-November but the exact timing of breeding varies across the range of the species). If this recommendation is followed, it would only leave 5 months of the year available for primary earthworks. Limiting the use of heavy machinery to the non-breeding season months is not considered to be an economically feasible option and therefore trapping and relocation of individuals, and exclusion from breeding dens is the client's preferred strategy.
- If adult females are captured during the preconstruction live-trapping and inspection indicates that they have dependent young not in the pouch (i.e. lactating nipples), then the female will be released immediately at the point of capture rather than being relocated, and then tracked to the day-time maternity den and construction will be halted within a buffer distance (to be determined) until live-trapping monitoring indicates that young are trappable, the female vacates the den with the dependant young or fibre optic camera monitoring of maternal behaviour indicates that disturbance is at tolerable levels.
- Preliminary investigation of the use of two specially trained Quoll detection dogs and handlers in October 2013 was successful in identifying areas of the site utilised by Northern Quoll (**Appendix 21**). At the time of the detection dog trial, no Northern Quolls were fitted with radio-collars. This survey was only the second actual field trial of the dogs and at the time, it was not possible to differentiate between Northern Quoll scent and actual inhabited den sites. However, ongoing field testing of the sniffer dogs throughout the Australia distribution of the species indicates that the trained Quoll

sniffer dogs are capable of discriminating between scats/scent and live animals within daytime dens. On the basis of their level of excitement and behaviour i.e. repeated indicating (Amanda and Lloyd Hancock, Sadler Springs Education Centre, pers. com.). Further investigation of the potential for using detection dogs to identify inhabited den sites is warranted as it may enable construction activities to be continued into the period when dependent young are deposited in maternity dens and when they are independent (mid-late August to November). The use of Quoll detection dogs together with radio-telemetry would increases the likelihood that all animals denning in each construction area is free of Northern Quoll in den sites.

- In addition to the above specific live-trapping, radiotracking and detection dog mitigation strategies, the following general standard mitigation action will be implemented during all construction activities involving potential habitat destruction. A licensed and experienced spotter catcher(s) will be onsite during all clearing activities and will ensure any injured animals are given to an appropriate wildlife carer group or vet, Australian Department of the Environment and Queensland Department of Environment and Heritage Protection will be notified within 24 hours of any native animal injuries or deaths.
- The construction of deep, wide trenches for the laying of underground electricity cabling is generally not considered likely to entrap individuals or act as a barrier to movement as the species is highly scansorial (adapted to or specialized for climbing) and the majority of trenches will be constructed in rocky ground, which will typically result in fractured sides that are likely to be readily climbable for Northern Quolls. However, the following management actions will be implemented to avoid any possible mortality associated with open trenches:

    (a) Surveillance of the open trench in all areas and the removal of wildlife from the trench by appropriately trained personnel (the whole trench length will be checked at least twice a day (early morning/late afternoon);

    (b) Minimising the period of time the trench is open, particularly in any identified important habitat areas,

    (c) Backfilling of trenching to be preceded by visual inspection to identify and remove trapped wildlife.

    (d) Formed slopes or plugs, branches, hessian sacks, ramped gangplanks or similar to be used to create ‘ladders’ to enable fauna to exit the trench, where trenches are to be left open for prolonged periods (overnight or longer) . These structures will be placed every 50 to 100 m, depending on the surrounding landscapes.

Effectiveness of Construction Associated Direct Mortality Mitigation Strategy

The effectiveness of attempting to ensure that bulk earthworks areas are free of denning Northern Quolls immediately prior to the commencement of the use of heavy machinery or blasting activities, is likely to be relatively effective prior to the young being deposited in maternity dens by their mother. The live-trapping effort will have to be sufficient to ensure the capture of a high proportion of all individuals whose home ranges include the proposed construction areas. Once clearing and bulk earthworks (including rock breaking) in the disturbance footprint have been undertaken (higher risk period) pad construction, remedial (secondary) earthworks and turbine assembly should be able to take place as required without significant risk.

The effectiveness of the use of Northern Quoll detection dogs to assist with identifying locations of denning Quolls is not certain at present, however, recent trials in the Kimberley at the Australian Wildlife Conservancy’s Mornington Sanctuary showed that handlers are able to discriminate when the dogs detected radio-tracked Quolls in their day time den sites as opposed to scats and scent (Amanda Hancock, pers. com.). There have been no studies in Australia or elsewhere examining the effectiveness of the use of spotter catchers to minimise mortality of native wildlife during construction/clearing activities despite it being

adopted as standard practice. It is likely only a small proportion of all individuals of terrestrial fauna species inhabiting tree hollows, fallen timber, rock piles and burrows are able to be located and removed prior to being killed. However, spotter-catchers may be effective at identifying Northern Quolls fleeing den sites and halting subsequent clearing activities.

The frequent inspection of open cabling trenches and removal of entrapped Northern Quolls is likely to be effective in the rare event that individuals are unable to climb out on their own.

15.6.2.2 Direct Mortality Due to Vehicle Collision

The following best practice mitigation actions to minimise mortality caused by vehicular collision will be implemented:

- "Control and manage traffic levels to minimise fragmentation and mortality";
- "Educate project staff";
- "Ensure no entry into conservation areas with signage (except for necessary environmental management and monitoring)";
- "Avoid and enforce unauthorised off track driving with signage and penalties";
- "Reduce and enforce speed limits in the vicinity of quoll habitat with signage and penalties";
- "Fence underpasses where appropriate to funnel movement to safer areas"; and
- "Report and record road kills" (as per DotE, 2011).

Additional mitigation strategies to avoid mortality of Northern Quoll due to vehicular collisions will be to restrict the operation of vehicles to day light hours, except for essential emergency and environmental management and monitoring (e.g. live-trapping, radio-tracking, ecological night survey work).

Assessment of the Effectiveness of Vehicle Mortality Mitigation Strategy

The above proposed mitigation strategies to avoid mortality of Northern Quolls caused by vehicular collisions are likely to be highly effective. However, there is no published research examining the effectiveness of the proposed strategies.

15.6.2.3 Habitat Degradation

Inappropriate Fire Regimes

The following best practice mitigation actions will be implemented to reduce the risk of habitat degradation resulting from inappropriate fire regimes:

- "Manage fires to reduce incidence, extent and severity to levels appropriate to retain or restore optimal Northern Quoll habitat. In QLD, storm-burning (lighting fires after the first wet season rains) is the suggested burning regime for Northern Quoll. Such a regime aims to reduce the risk of high fuel accumulation and homogeneity. Storm burning significantly reduces the risk of extensive dry season wildfire which can result in local population extinctions of Northern Quoll"; and
- "Educate and train staff about equipment and procedures to act on unexpected fire events" (as per DotE, 2011).

Assessment of the Effectiveness of Inappropriate Fire Regime Mitigation Strategy

- There is still some uncertainty as to what constitutes the most appropriate burning regime to ensure the viability of Northern Quoll populations in different habitats so it is difficult to make an informed

assessment of the effectiveness of implementation of this strategy. However, reducing the frequency and intensity of late-dry season wild fires by creating a mosaic of patches that differ in their time since last burnt is likely to be beneficial.

Weed Invasion

The following best practice mitigation actions will be implemented to reduce the risk of habitat degradation resulting from weed invasion:

- "Implement quarantine protocols";
- "Install a wash down facility. The wash down facility should comprise high pressure water and steam devices";
- "Develop and facilitate educational programs for staff and contractors about quarantine protocols and associated risks involved with invasive weed species";
- "Implement a no fill policy for the life of the project e.g. no introduction of material from off-site such as soil or vegetation".
- "Control (and where possible) eradicate weeds with a high priority for habitat-modifying weeds";
- "Remove and spray high priority weeds"; and
- "Manage fuel loads of weeds to reduce risk of high fire intensity"(as per DotE, 2011).

Assessment of the Effectiveness of Inappropriate Weed Invasion Mitigation Strategy

The effectiveness of this proposed mitigation strategy is likely to be dependent on the vigilance of the staff and operators conducting the vehicle wash down in particular.

It will be important to conduct weed monitoring frequently enough to detect fire-promoting weed incursions before they have an opportunity to become established in areas that would make their control extremely costly and/or impossible.

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16.0 Sarus Crane Impact Assessment

16.1 Introduction

Several species of migratory bird have been confirmed to fly over the proposed MEWF site, namely the Sarus Crane, White Throated Needle tail, White-bellied Sea Eagle and the Great Egret. Of those species only the Sarus Crane (*Grus antigone*) has been observed in significant numbers flying adjacent to or over the site, or has been observed foraging in the local area surrounding the site.

Under the EPBC Act, an action will require approval from the Federal Environment Minister if the *action has will have or is likely to have a significant impact on a listed migratory species*. Significant impacts are defined as impacts which degrade areas of important habitat for listed migratory species, or which disrupt the lifecycle of ecologically significant populations of the listed migratory species. **Chapter 13** on Matters of National Environmental Significance (MNES) details the significant impact assessments conducted on each of the above species. The Sarus Crane was the only species found to potentially have a high risk of impact from the proposed MEWF project and required specialist studies (**Appendix 23**) and adaptive mitigation and management strategies. Nonetheless appropriate mitigation measures outlined below will be beneficial to other bird species accessing the MEWF site.

The purpose of this chapter is to assess the potential impacts to the Sarus Crane from the proposed MEWF project. Sections 5.9 to 5.11 of the EIS Guidelines (**Appendix 2**) are considered here.

16.2 Species Ecology

16.2.1 Global Distribution

Three subspecies of *Grus antigone* are currently recognised: *G. a. antigone*, *G. a. sharpie* and *G. a. gilliae* (IUCN, 2013).

The nominate sub-species, G*. a.antigone*, occurs in northern and Central Indian and Nepal is thought to number approximately 8,000 to 10,000 individuals (IUCN, 2013). *G. a. sharpie* is confined to Cambodia, southern-most Laos, south Vietnam and Myanmar (1300 -1800 individuals) (IUCN, 2013). *G. a. gillae* is restricted to Australia (described below).

16.2.2 National Distribution

The Australian subspecies of Sarus Crane, *G. a.gillae,* occurs predominately in the Cape York Peninsula and the Gulf regions of Queensland, from approximately Townsville west to Burketown and south to Julia Creek; and in a line north to Weipa and east to the coast. The species also occurs in the Northern Territory, mostly in the vicinity of the Roper and McArthur Rivers floodplains. Scattered reports have also been recorded in Western Australia in the Kimberley region (Lake Argyle, Parry floodplain, Windjana Gorge and Karratha) (Marchant & Higgins, 1993).

16.2.3 Local Distribution

The Sarus Crane occurs in large numbers on the Atherton Tablelands in the dry season months. The majority of animals leave the Atherton Tablelands in late November to return to the Gulf Region to breed over the wet season; however, small numbers of animals often remain in the area until January/February.

16.2.4 Australian Sub-species Population

The total Australian population was estimated at fewer than 10,000 breeding adults in 2000 (Garnett & Crowley, 2000), but has been estimated as low as 5000 individuals (Archibald *et al*., 2003).

The Atherton Tablelands supports the only significant non-breeding aggregation known to occur of Sarus Crane in Australia. Annual Crane counts have been undertaken by volunteers since 1997 on the Atherton Tablelands, co-ordinated initially by the OzCrane Network (Elinor Scambler and John Grant) and more recently by Birdlife Australia (Virginia Simmons). Unfortunately the methodology and the number of roost sites surveyed were not consistent between years, making direct comparisons difficult. Between 1997 and 2013, the number of Sarus Crane individuals recorded within the Central Atherton Tablelands area varied between approximately 400 and 1200, with a 17-year average of 858 individuals (Graham Harrington, pers. com.).

A total 839 Sarus Cranes were observed during the 506 x 20-minute duration bird utilisation point counts conducted on the MEWF project site between 6/8/2012 and the 24/7/2013; however some of these records were likely to have been double-counted individuals. The average estimated horizontal distance of birds from the observers was ~864 m (0 m to 3000 m) and the average estimated distance above the ground was ~367 m (30 m to 2000 m). Of those individuals recorded flying over the site, 132 flights were within rotor-swept height (Biosis, 2013). The potential fly over habitat for the Sarus Crane and other migratory species on site is detailed in **Figure 16.1.**

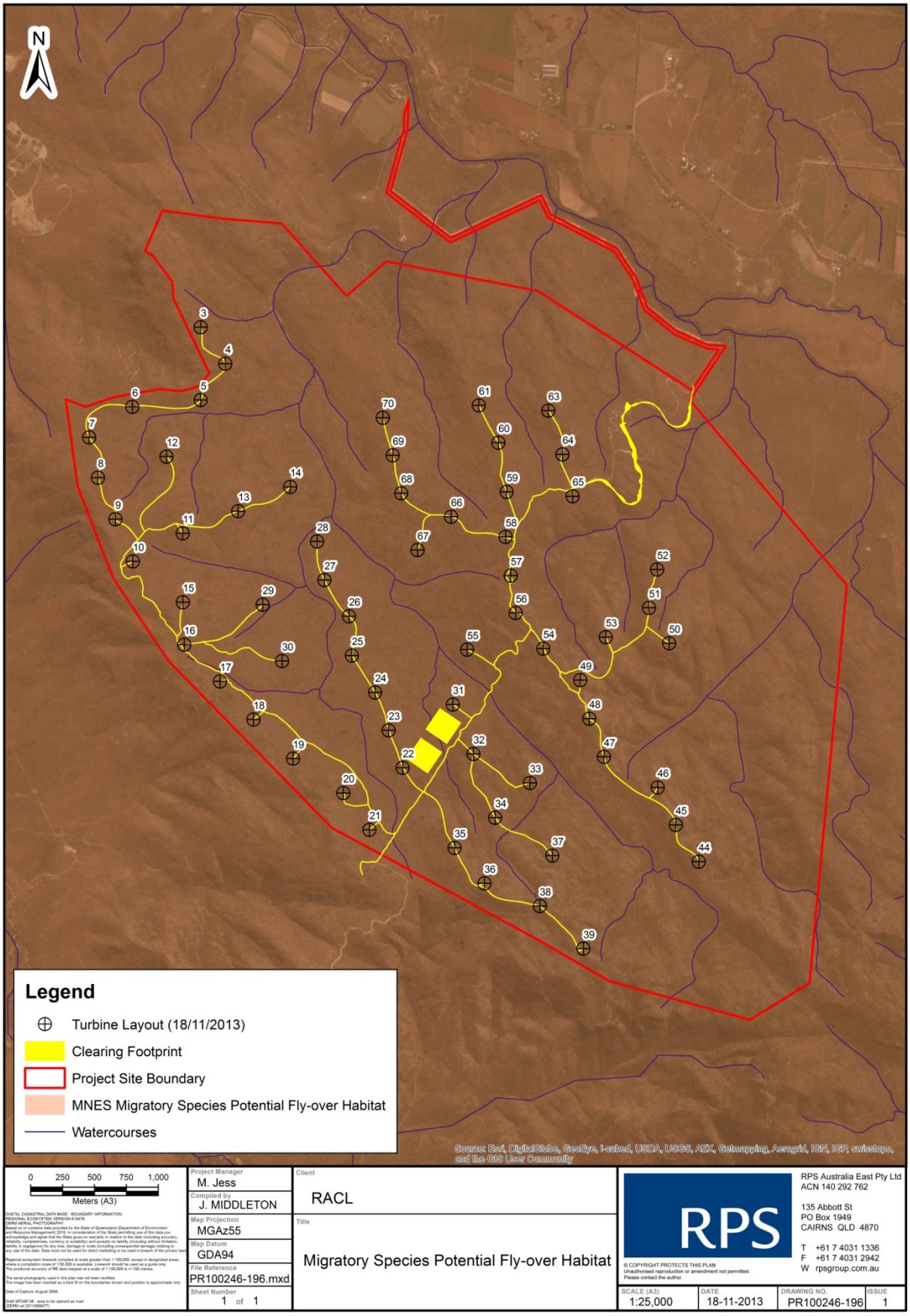

Figure 16.1 Migratory Species Potential Fly Over Habitat at the Proposed MEWF Site.

The highest number of Sarus Crane individuals recorded at any one time in the vicinity of the project site during the entire period of field surveys (2010-2013), was 600 individuals at c. 55K 333992 E 8100152 S, observed foraging in a newly harvested maize field just to the north of Rocky Creek, approximately 3 km from the south-eastern most section of the property boundary (**Figure 16.1**).

16.2.5 Population Viability

There is no information on the viability of the Australian population of Sarus Crane. The Action Plan for Australian Birds, 2010 states that the population is stable (Garnett *et al*., 2010).

16.2.6 Critical Habitat

16.2.6.1 Breeding Roosting and Foraging Habitat

The Sarus Crane breeds in the Gulf of Carpentaria region (Marchant and Higgins, 1993) and nests in the following habitats:

- Narrow wetlands (30- 100 m wide), usually with scattered trees and between slightly elevated, often forested ridges;
- Shallow open wetlands with scattered trees, where wetlands abut ridges;
- Open wetlands; and
- Next to small ponds in dry upland habitat (Machant & Higgins, 1993).

16.2.6.2 Non-breeding Roosting Habitat

On the Atherton Tablelands, Sarus Cranes roost in marshes, or on long narrow peninsulas jutting into lakes (Lake Tinaroo) (Archibald & Swengel, 1985 in Marchant & Higgins, 1993).

There are several roosting sites currently known to occur on the Atherton Tablelands and adjacent areas including:

- Bromfield Swamp;
- Mareeba Wetlands;
- West Barron Storage;
- Nyleta Wetlands (Hastie's Swamp National Park);
- Lake Tinaroo (numerous locations –);
- Woodleigh Station (between Mt Garnet and the Herbert River) (Graham Harrington, pers. com.; Elinor Scambler, pers. com.);
- Quincin Swamp;
- Kaban (Elick's Dam);
- Tumoulin (Bullock Swamp, Sinapius 1); and
- Hardwick's Dam.

The nearest known roost to the project site is located in the West Barron Storage irrigation impoundment roughly 7 km to the NNW of the project site. A single dusk fly-in count conducted in November 2011 by RPS Group at the West Barron Storage recorded greater than 100 Sarus Crane individuals.

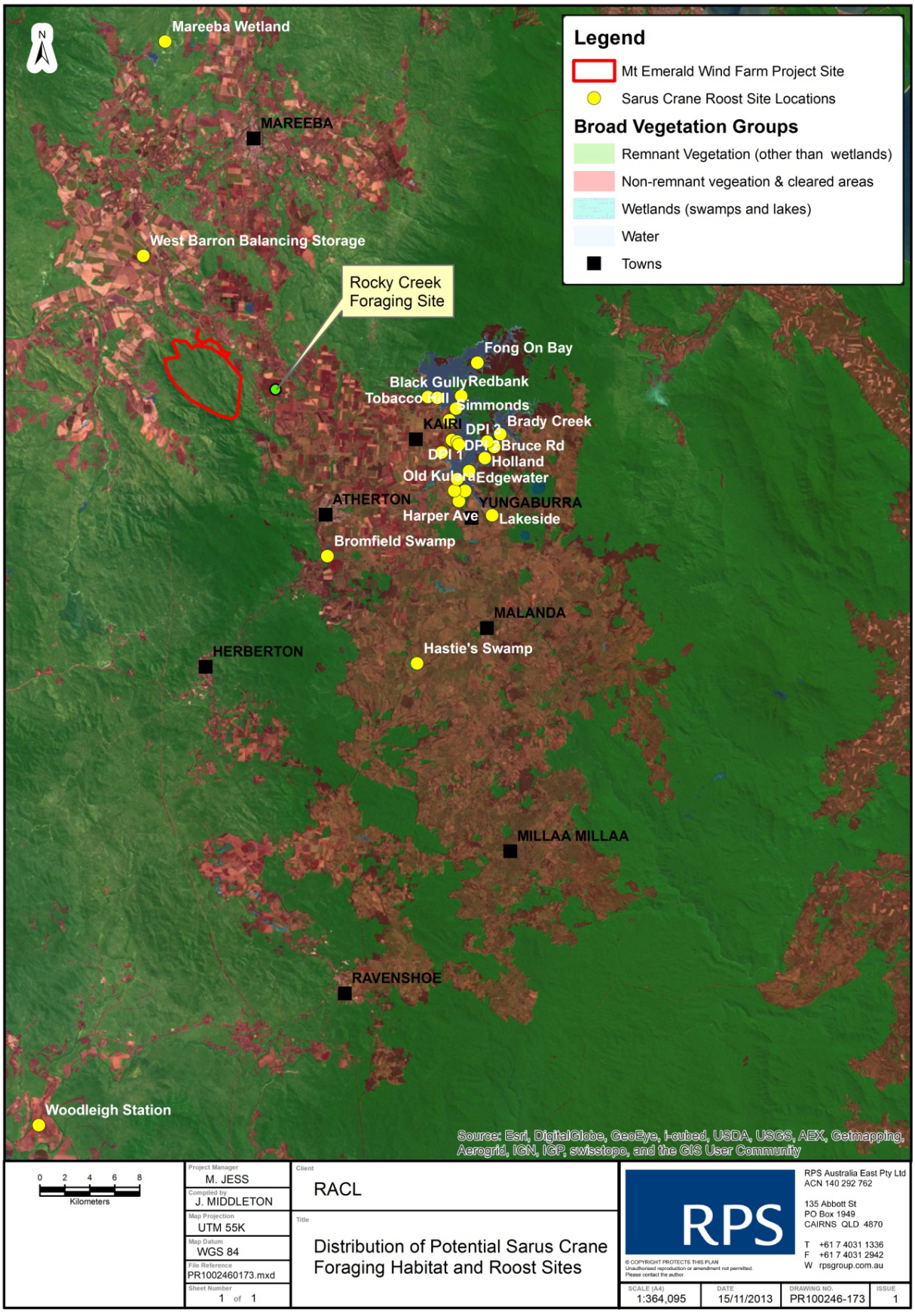

Figure 16.2 Sarus Crane Roost Sites & Potential Foraging Areas

16.2.6.3 Non-breeding Foraging Habitat

Sarus Cranes depend upon the cultivation of maize and peanuts and grazing pasture, with other crops of much less value for foraging habitat (Graham Harrington, pers. com.).

No cleared agricultural habitat which constitutes critical non-breeding foraging habitat for the species on the Atherton Tablelands occurs on the project site; however extensive areas of suitable cleared (non-remnant) farm land surround the site on all sides except to the south (**Figure 16.2**).

Large aggregations (up to 600 individuals) were recorded at times foraging on newly ploughed fields near between Mt Aunt (55K 328451 E 8109810 S) and Rocky Creek (55K 333992 E 8100152 S).

16.2.7 Movements

16.2.7.1 Broad-scale Movements

The Sarus Crane is partly migratory, with some of the total Australian population moving between the Gulf of Carpentaria and coastal and sub-coastal regions of north-eastern Queensland during the dry-season and some resident in the south-eastern Gulf and western Cape York Peninsula (Marchant & Higgins, 1993).

Adults and juvenile birds typically arrive on the Atherton Tablelands in July and leave for the Gulf in December (Marchant & Higgins, 1993).

16.2.7.2 Local (Atherton Tablelands) Movements

To date, there have been no telemetry studies conducted on Sarus Crane individuals present on the Atherton Tablelands or elsewhere. The daily movement patterns of Sarus Crane between the known roosting sites on the Atherton Tablelands and the foraging areas are not understood.

Numerous direct observations of Sarus Crane in the vicinity of the project site were made between 2010 and 2013. Individuals roosting at the West Barron Storage irrigation impoundment located ~ 7 km to the north of the project sites northern-most boundary point (**Figure 16.2**), typically left in the early-mid morning on a south-easterly direction at an altitude of between 30-300 m above the ground, passing between Mt Uncle (710 m) and Mt Aunt (710 m) and the north-eastern edge of the project site, before heading south towards large newly ploughed maize fields located near Rocky Creek (c. 55K 333992 E 8100152 S), approximately 3 km from the MEWF site boundary, and elsewhere in the central Atherton Tablelands area (e.g. Kairi, Yungaburra, Tolga and Atherton).

Although abundances of flying *Grus spp (*Sarus Crane and Brolga*)* were observed to be highest during the early morning and dusk, flights between foraging areas were observed during the entire day. Small flocks (up to 20-30 individuals) were often seen circling upwards on thermals to estimated heights of 1000-3000 m above ground, before making long-distance direct glides outside of observation range.

While the majority of Sarus Crane individuals return to their roost sites on dusk, some individuals fly in full darkness up to 1-3 hours after sunset (Graham Harrington, pers. com.). Several *Grus spp.* individuals were recorded during night-vision goggle surveys for Spectacled Flying-fox (see **Chapter 18).**

Although the majority of Sarus Cranes were observed flying outside the boundaries of the MEWF project site during field work conducted between 2010 and 2013, several observations were made of flocks consisting of up to 20 individuals flying directly across the site, between elevations of 30 m to 400 m above the ground (**Plate 16.1, 16.2, 16.3**).

Plate 16.1 Ten Sarus Cranes flying over the centre of the MEWF project site ~50 m above Powerlink's high-tension powerlines (photograph by J. Little)

Plate 16.2 Five Sarus Cranes flying across MEWF project site in vicinity of proposed tower #65 (photograph by J. Little)

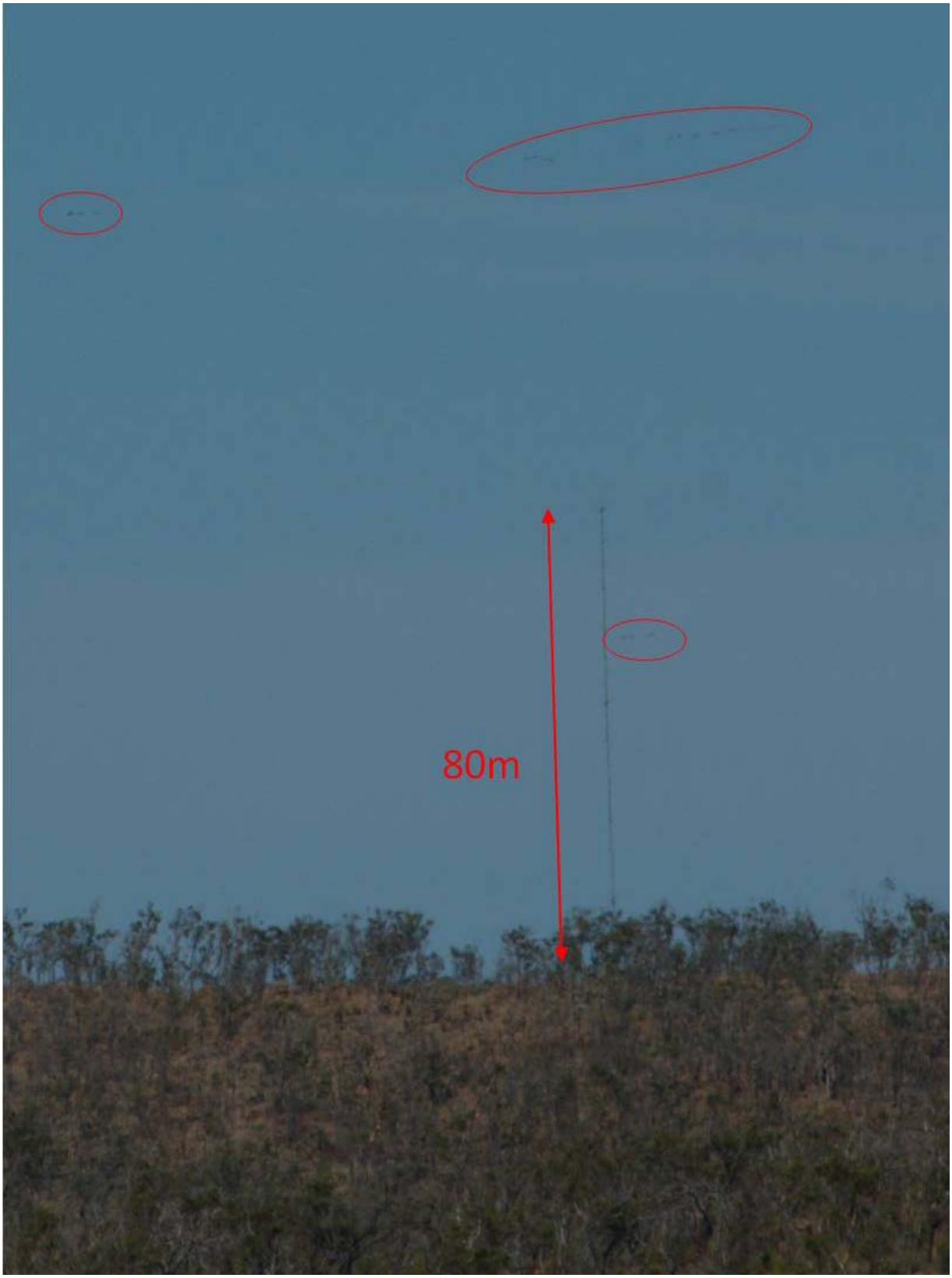

Plate 16.3 Multiple small flocks of Sarus Cranes flying within proposed rotor sweep area in vicinity of proposed turbine #50

16.2.8 Social, Cultural and Economic Value

16.2.8.1 Social Value

Sarus Cranes and Brolgas are the focus of a local community festival, Crane Week, held in September each year (http://www.craneweek.org/).

The Atherton Tablelands is world renowned as a major bird watching location. The large Sarus Crane and Brolga feeding and roosting aggregations on the Atherton Tablelands are a major attraction for bird watching tours.

On the Atherton Tablelands, Sarus Cranes are counted each year by volunteers coordinated by Birdlife Australia North Queensland. The surveys have been undertaken since 1997. There have been no studies specifically quantifying the economic or cultural values of any Australian Sarus Cranes.

16.2.9 Conservation and Biodiversity Values

The Atherton Tablelands was nominated and accepted as an Important Bird Area (IBA) due to the fact the area supports more than 1% of the total global population of the Sarus Crane, which is listed as vulnerable by the International Union for the Conservation of Nature (IUCN, 2013). The Atherton Tablelands IBA covers all of the main feeding and roost sites for Sarus Crane on the central section of the Atherton Tablelands (BA, 2013).

16.2.10 Patterns of Recruitment and Dispersal

As previously described in Broad-scale Movements, juvenile Sarus Crane accompany their parents from the breeding grounds in the Gulf of Carpentaria to the Atherton Tablelands or other dry season foraging refugial areas including western Cape York Peninsula, the south-east Gulf of Carpentaria, Eastern Northern Territory and the Kimberley (Marchant & Higgins, 1993).

The annual recruitment rate of Sarus Crane on the Atherton Tablelands, over a 6-year period from 1997 to 2001, was estimated to be 6.58% with no significant variation between years (Grant, 2006).

16.3 Potential Impacts

16.3.1 Mortality due to Turbine/Powerline Collision

Collision risk modelling conducted by Ian Smales of Biosis Research Pty Ltd, using point count bird utilisation data collected on the project site by RPS Group predicts that the mean number of collisions per annum for *Grus spp.* (Sarus Crane together with Brolga) ranges from 0.14 to 0.83 individuals per annum depending upon the value of the avoidance rates (90%, 95%, 98% and 99% dynamic avoidance and 99% static avoidance) (**Appendix 22**). There is no empirical information available on the Sarus Crane to predict whether the modelled avoidance rates are realistic. To date, few wind farms have been constructed within the range of either of the two Australian crane species and there is no actual data on turbine collision risk for *Grus spp.,* however, the large size of cranes and their relatively low mobility suggest that cranes may be vulnerable to collision (USFWS 2009). It is important to note that observations of crane species monitored at operational wind farms both nationally and internationally have shown a low collision risk which is suspected due to behavioural avoidance (Derby *et al* 2012).

Potential limitations of the BIOSIS *Grus spp.* turbine ccollision risk modelling conducted for the MEWF project are that it is based on flight data obtained during one twelve-month period which may or may not be representative of longer-term movements by *Grus spp.* and that these movements may be affected by a wide

range of environmental influences (Smales, 2013). Another limitation of the BIOSIS collision risk model is that it was only based upon a 12 hours of available flight time over a 6 month period for which the species is typically present on the Atherton Tablelands (July to December – Marchant & Higgins, 1993). As previously described in **Section 16.2.7,** an unknown proportion of the total population of *Sarus Crane* undertake nocturnal flights at certain times. Therefore, the model is likely to underestimate the total turbine collision risk as it only includes diurnal movements.The Sarus Crane is typically present on the Atherton Tablelands between July and November each year (Marchant & Higgins, 1993). Given that only three surveys (a total of 30, 20-minute point counts) were conducted during this period when the species was potentially present on the Atherton Tablelands (August and November 2012, July 2013), and that only all point count surveys were conducted within a single year, then it may be the data obtained during the point counts is not representative of the species typical utilisation patterns of the site and surrounding area.

16.3.1.1 Barrier Effects

It is suggested that long arrays of wind turbines may create partial barriers to some bird movements, forcing birds to travel further and thus increase their energy expenditure (Drewitt & Langston, 2006). Overseas research indicates that occasional gaps at least 1500 m wide between turbine clusters can avoid such impacts on Common Cranes (*Grus grus*) (Hotker *et al*., 2006). Given the observed Sarus Crane flights across the site within the proposed rotor sweep area (RSA), and the lack of any information on avoidance behaviour for the species, it is possible the operating wind turbines could potentially disrupt the movements of individuals across the site. However, if our limited observations are representative of typical movement patterns of the species within and around the site over the long-term, only a small proportion of the total population could be potentially affected by barrier effects.

16.4 Cumulative Impacts

Turbine and Powerline Collison Mortality

There is, at present, only one wind farm operating within the currently recognised distribution of Sarus Crane, i.e. the RATCH Windy Hill Wind Farm near Ravenshoe (refer to **Chapter 2** for a description of this project).

Stage 1 of the proposed High Road Wind Farm (also owned by RACL) has received Federal Government environmental approval. Stage 1 of the High Road Wind Farm comprises 17 x 2-3 MW turbines with a hub height of 80 m and a blade length of 45 m located in cleared land adjacent to wet sclerophyll forest. An assessment of a 50-60 turbine wind farm (no specifications available) at Archer Point, near Cooktown is currently underway (Larissa Hale, Balkanu Cape York Development Corporation, pers. comm.). All of these approved or proposed wind farms are located within the Australian distribution of Sarus Crane.

ROAM (2012) modelled the wind and solar resources in the vicinity of the National Electricity Market (NEM) network, and found that the coastal area between Townsville and Princess Charlotte Bay and inland to approximately Georgetown, which includes the Atherton Tablands where a significant proportion of the total Australian population of Sarus Cranes overwinters, has an enormous potential for wind energy and it is possible that area will continue to attract interest from wind energy developers into the future.

High Tension Powerlines

Powerline collisions are known to be the major source of mortality for Sarus Cranes overwintering on the Atherton Tablelands (ACN, 2013). Collisions with powerlines have been identified as a significant threat to Sarus Crane in parts of the species overseas range, with ~1% of the total Indian population being killed each year (Sundar *et al*., 2000; Sundar & Choudhury, 2003).

Brolgas, the closest relative to Sarus Cranes, are known to fatally collide with powerlines (Goldstraw & Du Geusclin, 1991). Powerline Collision Risk modelling conducted by BIOSIS for the Brolga (*G. rubicundus*) at the proposed Stockyard Hill Wind Farm in Victoria, predicted that approximately 1 adult animal every five years would collide with powerlines (Smales, 2013).

Likelihood of Cummative Wind Energy Impacts on the Sarus Crane

Cumulatively, it is possible that multiple wind farms in a given geographic region could lead to an increased risk of turbine collision mortality as an individual bird ranges across the area occupied by a number of these developments. This may be particularly pertinent for species that range over much of the cleared agricultural land of the Atherton Tablelands when foraging, such as Sarus Cranes. There have been no systematic bird and bat turbine collision mortality monitoring conducted at the single operating wind farm, Windy Hill, nor has PVA modelling been required as part of other wind farm approvals despite the potential for collision mortality of Sarus Cranes. Similarly there is currently no information available on turbine avoidance rates, or estimated powerline collision mortality for the species. Therefore, it is not possible to accurately quantify the potential cumulative impact of additive mortality of multiple windfarms on the species without further research e.g. an understanding of the foraging patterns of the species.

16.4.1 Assessment of the Significance of Potential Impacts

Under the EPBC Act, an action will require approval from Federal Environment Minister if the action has, will have, or is likely to have a significant impact on a listed species or ecological community. The three criteria for assessing the significance of impacts on a migratory species as outlined in the *Matters of Environmental Significance – Significant Impact Guidelines 1.1 EPBC 1999* (DotE, 2013) are addressed in **Table 16.1**.

Table 16.1 Significant Impact Assessment for Sarus Crane

Sarus Crane (*Grus antigone*)	
Will the proposed works..	
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	The total area of impact of the site is 2.4% of the total site. The development does not prevent access to different areas of the site and does not prevent habitat utilisation. The proposed project is unlikely to significantly impact the non-breeding foraging or roosting habitat for G. antigone on the Atherton Tablelands.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The MEWF project is unlikely to introduce any invasive species that are harmful to Sarus Crane on site. There are no identified suitable breeding places or large areas known to be utilised by this species. An Environmental Management Plan and Weed Management Plans will be implemented to prevent the spread of weeds on site. The proposed project is unlikely to result in the establishment of an invasive species within the important non-breeding foraging and roosting habitat of *G. antigone* on the Atherton Tablelands.
Seriously disrupt the lifecycle (breeding feeding, migration or resting behaviour) of an ecologically significant proportion of a population of a migratory species.	Due to the lack of suitable habitat available to these species for breeding, feeding and resting etc., it considered highly unlikely the activities of construction and decommissioning will impact on the migratory species on site. On the basis of the current temporally limited (< 1 year) utilisation surveys that have been conducted, the proposed project is unlikely to seriously disrupt the lifecycle of G*. antigone* on the Atherton Tablelands. Implementation of Bird and Bat Adaptive Management Plans in which comprehensive mitigation measures are introduced will reduce the likelihood of impact on this species.

16.5 Impact Mitigation Strategies

16.5.1 Turbine Collision Mortality Avoidance/Reduction

16.5.1.1 Preconstruction Phase

Further utilisation surveys are recommended using a combination of an advanced avian radar system to obtain numerical data on *Grus spp.* abundance and flight behaviour (height & flight paths). The radar surveys will need to be augmented with direct visual observations during the day-time and thermal imaging video to enable species identification and night vision devices at night time to assist with target identification (i.e. separation of *Grus spp.* from other night flying fauna). These surveys should continue for at least 1-2 years (prior to and during construction) to account for between year variations in Sarus Crane utilisation patterns in the vicinity of the site. For example, the presence of large numbers of Sarus Crane within close proximity to the project site is likely to be dependent upon the quantity and type of crops that are grown. The utilisation data obtained from the addition surveys will enable automated turbine curtailment mitigation rules for use with a radar-SCADA (supervisory control and data acquisition) system to be developed.

Additionally, the radar derived utilisation data is likely to be less error prone than the point count data used in the Biosis numerical collision risk model (Biosis, 2013). Visual estimates of horizontal distance of birds from the observer and their vertical heights above the ground are notoriously inaccurate especially in a topographically complex site such as the proposed Mt Emerald Wind Farm. A comparison of visual estimates of horizontal distance and flight height for several species of small to large size seabirds with data obtained from a marine radar system at the Tarahoa Wind Farm in New Zealand, found that human observers could not provide accurate estimates (Stephen Fuller, pers. comm.). In many instances during the point counts surveys on the project site, it was not possible to directly see the ground surface directly below an observed bird. Furthermore, the large number of observers used in the point count surveys and the lack of any attempt to standardised detectability or estimation of horizontal and vertical distances of the targets from the observers are a potentially high source of bias in the data.

Numerical collision risk modelling should be repeated using the available additional utilisation survey data.

16.5.1.2 Operational Phase

Validation of the numerical collision risk model assessments of annual mortality and/or annual number of flights-at-risk should be undertaken in the operation phase of the project. This will be achieved by conducting statistically valid turbine mortality surveys for Sarus Crane (together with scavenger removal and detectability trials) (see **Chapter 18** Spectacled Flying-fox Impact Assessment for a detailed description of carcass surveys).

Verification of the effectiveness of the radar-SCADA mitigation rules for *G. antigone* should also be undertaken during the operation phase, and fine-tuning of these rules implemented if detected mortality levels exceed those predicted by the collision risk models.

Visual surveys, together with radar, thermal imaging and night-vision devices, should be undertaken to estimate operating turbine avoidance rates for Sarus Crane. There are few studies that have compared the predicted turbine collision mortality from numerical collision risk models with actual observed mortalities, to allow verification of the commonly used avoidance rates (e.g. 98% and 99% avoidance).

The design of all of the above studies will require consultation with a biostatistician and pilot studies to be conducted.

16.6 References

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17.0 Bare-rumped Sheathtail Bat Impact Assessment

Three species of EPBC listed threatened microchiropteran bats were assessed as moderately to highly likely to occur on (or in the immediate vicinity of) the proposed MEWF project site (**Appendix 20**):

- Greater Large-eared Horsehoe Bat, *Rhinolophus robertsi* listed as endangered under the EPBC;
- Bare-rumped Sheathtail Bat, *Saccolaimus saccolaimus nudicluniatus,* listed as critically endangered under the EPBC; and
- Semon's Leaf-nosed Bat, *Hipposideros semoni,* listed as endangered under the EPBC.
- On the basis of RPS ecological investigations, the Bare-rumped Sheathtail Bat (*S. saccolaimus nudicluniatus*), was the only EPBC listed threatened microchiropteran bat species to be confirmed on the site (**Appendix 24**). The Bare-rumped Sheathtail Bat is listed as critically endangered under the EPBC Act due in particular to the lack of records of this species across the predicted range and the common threat of habitat clearance impacting microchiropteran bat populations throughout Australia (Curtis *et al*., 2012). The purpose of this chapter is to assess the potential impacts to the Bare-rumped Sheathtail Bat from the proposed MEWF project. Due to the similarity of predicted and realised impacts on the Greater Large-eared Horseshoe Bat and the Semon's Leaf-nosed Bat to that of the Bare-rumped Sheatail Bat it is expected that mitigation strategies proposed here will be effective for each of the three species. Sections 5.9 to 5.11 of the EIS Guidelines (**Appendix 2**) are considered here.

17.1 Existing Environment

17.1.1 Species Ecology

17.1.1.1 Distribution

Northern Territory

The species was first recorded in 1979 from the Kakadu lowlands and has subsequently been collected from Howard Springs, Kapalga, Port Roper, Coombe Point, Keep River and Jasper Gorge (Milne *et al.,* 2009).

North Queensland

Live & Dead Specimens

Specimens of the Bare-rumped Sheathtail Bat have been collected or observed at the following locations in North Queensland:

- Hartley's Creek Crocodile Park. A single injured male was found in a kangaroo enclosure in 2011 and was rehabilitated in captivity for several months before being released (Whybird *et al.,* 2011).
- Cairns Centenary Lakes:
  - A single individual was first located and photographed in a large hollow bearing *Melaleuca leucodendra* in April 2011 by Hidetoshi Kudo (http://www.kankyo-gi.net/album/Centenary%20Spotlighting/Bats/index.html).
  - A total of 20 individuals were photographed at the site on 26/9/2012 (http://www.kankyo-gi.net/album/Centenary%20Spotlighting/Bats/index.html).
  - A total of 13 individuals were recently trapped at the same location on 17/10/2013 (Brian Venables, 21/10/13, pers. comm.

- Iron Range:
  - » One dead individual collected at the base of a flag pole near the Ranger Station in 2013 (Brian Venables, pers. comm.).
  - » Between 10-15 individuals were flushed from a roost in a *Eucalyptus tetradonta* at Iron Range in January 2002 (Murphy, 2002). Although not independently verified, the description given was highly indicative of *S. saccolaimus* i.e. typical emballonurid head structure, dark dorsal cover with white flecks.
- Jerona Sanctuary, Giru. Specimens collected during clearing of *Eucalyptus platyphylla* woodland (Compton & Johnson, 1982) with four specimens in the QLD Museum collection.
- Alligator Creek. Six records in the QLD Museum collection.
- Magnetic Island. One specimen in the QLD Museum collection.
- Attack Creek. One specimen in the QLD Museum collection.
- Shipton's Flat (south of Cooktown). One specimen in the QLD Museum collection.
- Bloomfield River (south of Cooktown). One specimen in the QLD Museum collection.

Ultrasonic Call Detection

The presence of the Bare-rumped Sheathtail Bat has been confirmed at the following locations in North Queensland using full spectrum ultrasonic call detection devices:

- Townsville Ring Road, Townsville (Balance Environmental, 2012);
- Horseshoe Lagoon, near Giru (south of Townsville) (RPS, 2013);
- Mount Emerald Wind Farm, near Walkamin (2011-2013) (**Appendix 23**); and
- Iron Range (Julie Broken-Brow, pers. comm., 2013).

Project Site Distribution

On the basis of ultrasonic call detection, the presence of the Bare-rumped Sheathtail Bat has been confirmed with high confidence at 5 locations within the site (**Figure 17.1**). Industry research towards the end of the MEWF bat program indicates a high degree of uncertainty with regards to the ability of the Wildlife Acoustics SM2+BAT detectors fitted with SM-UX microphones to adequately sample any microchiropteran calls within the rotor sweep zone due to their limited detection volume, which is typically on the order of tens of metres depending upon the species of bat (Paul Ullrich, Field Application Engineer, Wildlife Acoustics, Inc). Given the flight behaviour of this species (typically fast and high above the ground), it is anticipated their presence across the site was underestimated using ultrasonic detectors.

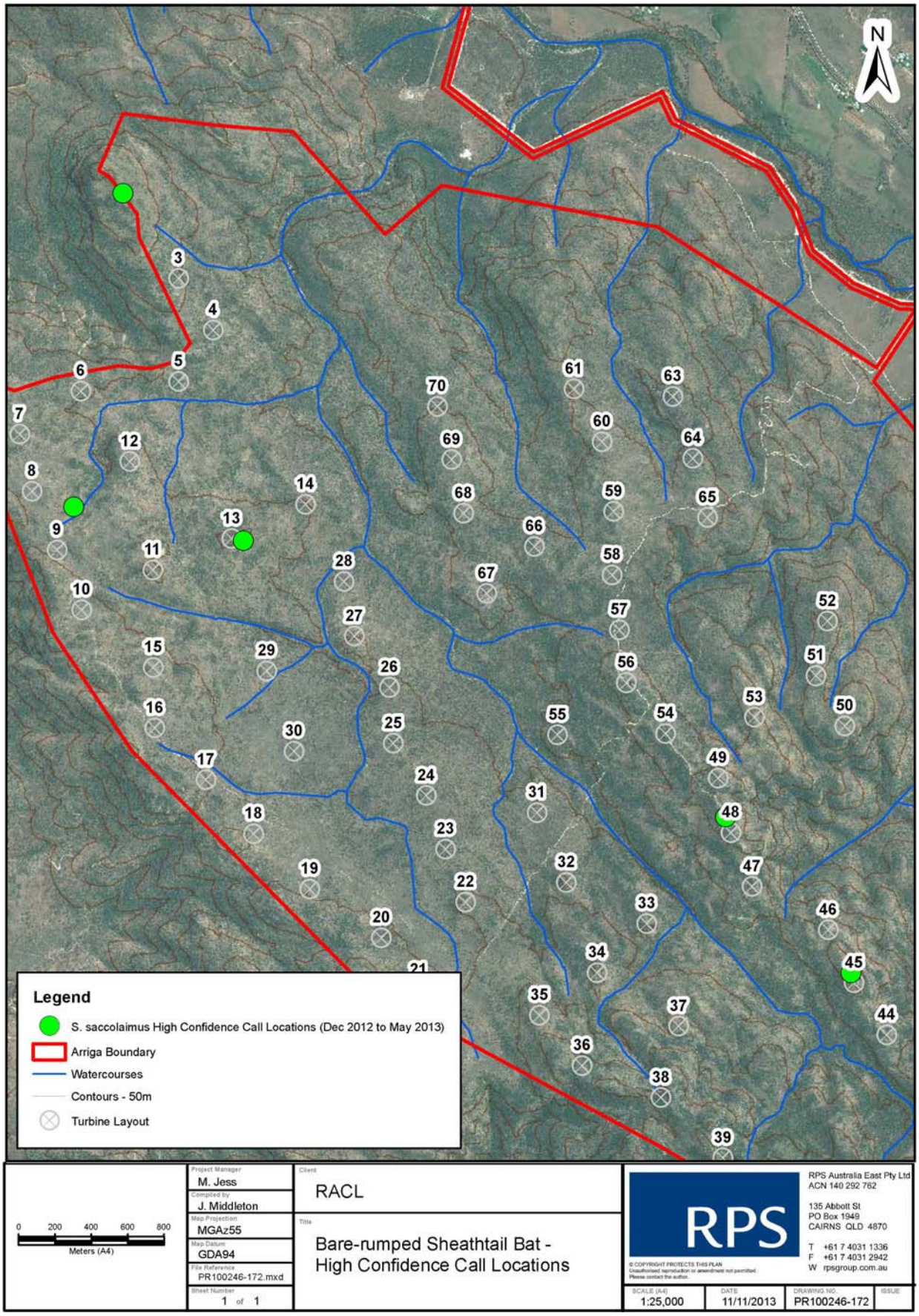

Figure 17.1 Locations of Bare-rumped Sheathtail Bat High-Confidence Calls

17.1.1.2 Critical Habitat & Abiotic Factors

The species has been recorded from tropical woodland and tall open forests (Curtis *et al*., 2012). In Queensland, the species is known predominately from coastal lowlands, including rainforests and eucalypt woodlands (Duncan *et al*., 1999).

The species is considered to be an obligate hollow-roosting species (Milne *et al.*, 2009). It is known to roost in wide hollows of various tree species including *Melaleuca leucadendra*, *Eucalyptus platyphylla* and *Eucalyptus tetrodonta.*

What constitutes critical habitat for the species is not understood, nor are any abiotic factors currently known to be critical to its survival therefore the species foraging and fly over habitat includes the whole of the site **(Figure 17.2).** For this reason, it is not possible to assess the importance of habitat (including habitat utilisation) in a local, regional and national context.

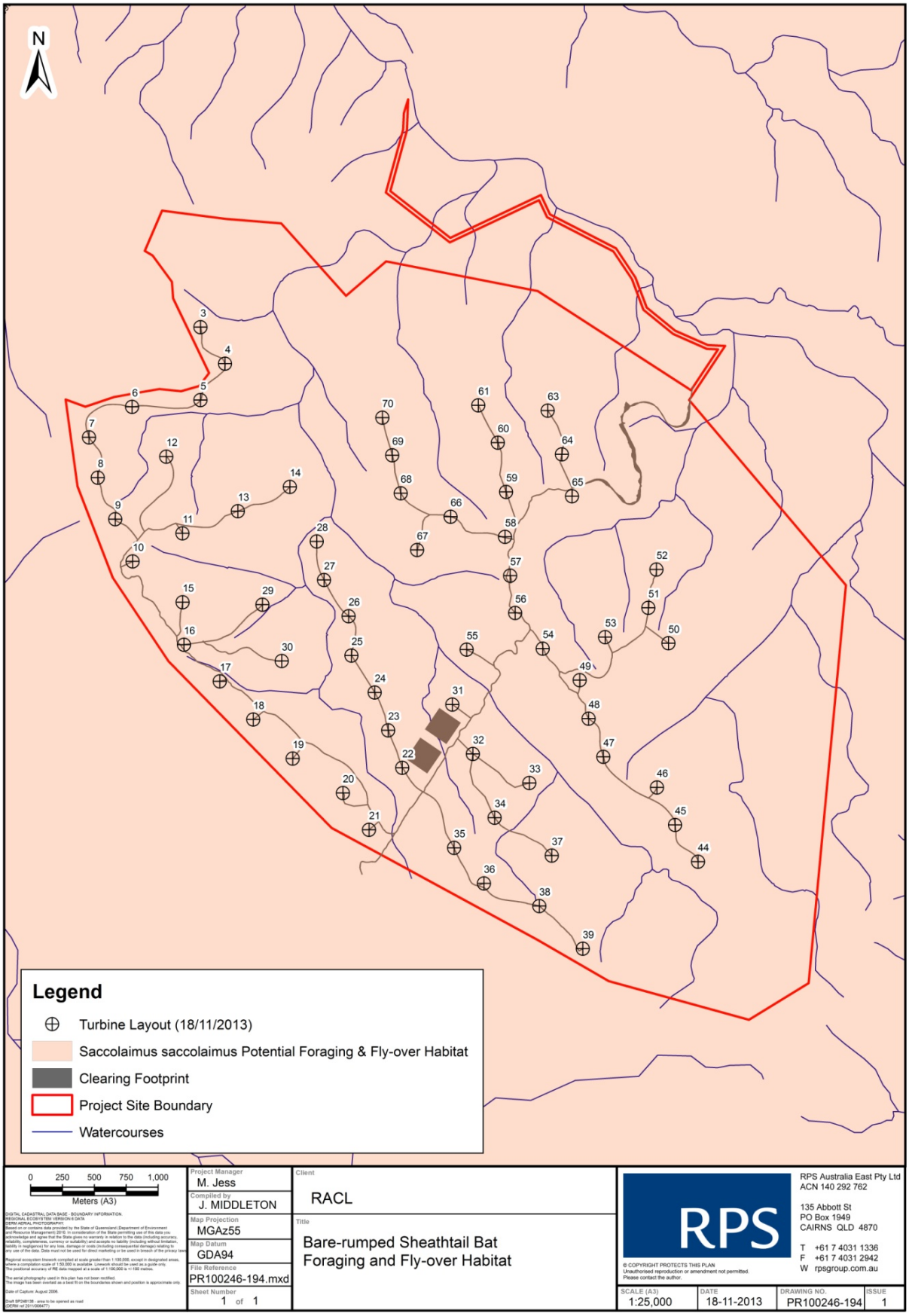

Figure 17.2 Potential foraging and fly over habitat for the Bare-rumped Sheathtail bat at the proposed MEWF site.

17.1.1.3 Population Viability

Population estimates for most species of microchiropteran bats are non-existent (Hein *et al*., 2013), making it difficult to assess the impacts of wind energy projects on bat species (Arnett & Baerwald, 2013). There are no published population estimates for the Bare-rumped Sheathtail Bat in Australia. Therefore, viability of the population is not able to be currently assessed at any scale (local, regional and national). There is no published information on the minimum habitat area required for a population to be viable.

17.1.1.4 Genetic Diversity

Investigations of the genetic diversity of the species at the local, regional and national scale have not been previously undertaken; therefore it is not possible to currently examine the relationship between local and regional populations.

The genetics of the species are currently being studied by Kyle Armstrong (Adelaide University) with the primary aim of this work to resolve their long-standing taxonomic issues, and to stabilise the nomenclature so conservation and management decisions can be based on an understanding of species boundaries and distributional limits.

17.1.1.5 Movement Patterns

No information is available on the movements of this species in Australia. Julie Broken-Brow (University Queensland) is currently undertaking a PhD on this species involving radio-tracking individuals. This data may provide information of foraging movements over the next several years.

17.1.1.6 Conservation and Biodiversity Values

The entire project site is likely to represent suitable potential foraging and roosting habitat i.e. habitat crticial to the survival of the species.The dominant regional ecosystems present on the project site are well represented elsewhere in the Einasleigh Uplands and Wet Tropics bioregions (total area of ~267,000 ha).

17.1.1.7 Social, Cultural and Economic Value

Bats are one of the most economically important, non-domesticated animals, and their conservation is important for the maintaining ecosystem integrity (Boyles *et al*., 2011). On the continental USA alone bats have an estimated value of $22.9 billion per year through their pest suppression services. There have been no studies specifically quantifying the economic values of any Australian microchiropteran bat species; however it can be inferred that these values would also be significant in Australia, due to similar agricultural practices.

There have been no studies specifically quantifying the social or cultural values of any Australian microchiropteran bats.

17.1.1.8 Evidence of Successful Translocations

Only a few intentional translocations of microchiropteran bat species have been attempted anywhere in the world (i.e. Hawaii, New Zealand and Scotland) and all attempts have been unsuccessful (Ruffell *et al.,* 2009), with the exception of the relocation of a small number of individuals (18) of two species of horseshoe bats (*Rhinolophus ferrumequinum* and *R. hipposideros*) from a large colony into relict colonies in Switzerland (Weinberger *et al*., 2009).

Translocations of the Bare-rumped Sheathtail Bat are probably not a feasible action to avoid or mitigate impacts from the proposed MEWF development given the expected low chance of success. Bare-rumped Sheathtail Bat colonies appear to be easily disturbed, as they have been observed to readily fly away from their roosting hollows when approached at close range (Murphy, 2002) although, some specimens have been collected from large hollow trees pushed over during clearing activities (Curtis & Dennis, 2012).

17.1.1.9 Patterns of Recruitment and Dispersal

No information is currently available on patterns of dispersal and recruitment for the species and there is limited information on other microchiropterans in Australia to make useful comparisons.

17.2 Potential Impacts

17.2.1 Construction Phase

17.2.1.1 Habitat Destruction

Based upon the maximum road width and the maximum size of lay-down pads provided by the preferred turbine supplier and a preliminary track layout (directly linking each of the turbines along ridges) the maximum expected clearing footprint is in the order of 57 ha. This is unlikely to be critical to the Bare-rumped Sheathtail bat considering the dominant regional ecosystems present on the project site are well represented (total area of ~267,000 ha) elsewhere in the Einasleigh Uplands and Wet Tropics bioregions.

17.2.1.2 Habitat Degradation

There is a moderate to high potential for the introduced Grader Grass *(Themeda quadrivalvus)* to become established in inaccessible parts of the site as it is present along much of the Kippen Drive access road. Other exotic grasses that are known to invade undisturbed sclerophyll woodland include Thatch Grass (*Hyparrhenia rufa*), Pigeon Grass (*Setaria pumila*), Gamba Grass (*Andropogon gayanus*), Molasses Grass (*Melinis minutiflora*) and Buffel Grass (*Cenchrus ciliaris*), and are either present on the site or are known to occur in the Atherton Tablelands area. Broadleaf weeds of concern which similarly have a deleterious effect include *Hyptis suaveolens and* Japanese Sunflower (*Tithonia diversifolia*).

All of these 'high biomass' exotic grasses and broadleaf weeds are considered to be fire promoters (i.e. they can significantly increase available fuel loads and the frequency and intensity of fires). Increased fire intensity and frequency could result in the destruction of mature canopy trees, inhibit the recruitment of native plants and reduce the abundance of standing tree hollows. Changes in the intensity and frequency of fires across the MEWF site could therefore potentially have a significant impact on the local population of Bare-rumped Sheathtail Bat though the loss or degradation of existing roost trees (or reduction in the likelihood of the development of future roost sites) and reduction in availability of insect prey (Duncan *et al*., 1999; Woinarski & Milne, 2002).

It is possible without strict weed management protocols during construction and operation of the MEWF, the establishment of fire promoting introduced grasses such as Gamba Grass could lead to a grass–fire cycle on the MEWF site, where a decline in tree cover facilitates further grass invasion, leading to more severe fire and further tree decline. Such a self-reinforcing cycle has the potential to change dry sclerophyll open forests and woodlands to treeless grasslands, as has occurred elsewhere in the world following grass invasions (Whelan *et al*., 2006).

17.2.2 Operation Phase

17.2.2.1 Collision and Barotrauma

Bat fatalities at wind turbines are due to either the result of traumatic injury following direct collisions with moving turbines (Horn *et al.,* 2008) and possibly from barotrauma (damage to body tissues due to a change in pressure) (Baerwald *et al.,* 2008). However, recent forensic pathology research has queried the incidence of barotrauma, and suggests most injuries are consistent with traumatic turbine collision injuries, with barotrauma considered a minor cause of death (Grodskey *et al*., 2011; Rollins *et al*., 2012).

Large numbers of bat fatalities have been recorded at wind farms in the eastern United States and Europe (Fieldler, 2004; Arnett, 2005; Johnson, 2005; see references in Barclay *et al.,* 2007; Rodrigeuz *et al.,* 2008). In the United States, several species of migrating or tree-roosting bats account for the majority of wind farm mortalities (Arnett *et al.,* 2008). Average annual mortality rates of 20-40 bats per turbine have been recorded at several sites, but mortality rates of 1-3 bats per turbine are more typical (Arnett *et al*., 2008; Rydell *et al.,* 2010). In Europe, the bat species that comprise more than 98% of wind farm fatalities belong to four aerial-hawking species that feed predominately in the open air or at least several meters above vegetation (Rydell *et al.,* 2010). In the US and northern Europe the majority of bat fatalities at winds farms occur between late July and early October which coincides with migratory movements (see references in Rydell *et al.,* 2010), and in the United States, for the Mexican Freetail Bat outside of its regular migratory movements (Piorkowski, 2006).

There is little published research examining microbat mortalities at Australian wind energy facilities. Hull and Cawthen (2012) conducted mortality searches at two wind farms in Tasmania (Bluff Point with 37 turbines, 66 m diameter blades and 60 m towers; Studland Bay with 25 turbines, 90 m diameter blades and 80 m tower) from 2002-2010. Fifty-four carcasses were detected, 38 of which were confirmed to be *Chalinolobus gouldi*, with another 14 likely to be a *Vespedalus* sp. (probably *V. darlingtoni*) (Hull & Cawthen, 2012). *C. gouldi* is known to be a high-flying, open air forager, whereas *V. darlingtoni* forages in the mid-story with occasional higher flights (Hull & Cawthen, 2012).

There is some evidence that microbats actively “investigate” turbine rotors (Horn *et al.,* 2008), whether to assess them as roost sites (Cryan, 2008) or foraging for insect prey in the vicinity of the turbines (Ahlén, 2004; Horn *et al.,* 2008). Bats are often concentrated in areas of high insect abundance (Nichols & Racey, 2007) and are more likely to begin foraging when large numbers of insects are aggregating (Griffin *et al*., 1960). It appears that microbats fly around wind turbines regardless of whether they are moving or stationary (Ahlen, 2002; Horn *et al.,* 2008). It is therefore not likely microbats (and their insect prey) are attracted to wind turbines due to the heat, sound or magnetic fields generated by the nacelles or the movement of the rotors as hypothesised by Kunz *et al.* (2007). Wind turbines are typically coloured pure white or light grey and these colours have been shown to be amongst the most attractive colours to insects (Long *et al*., 2010). It is possible flying insects that are attracted to the white/light grey wind turbines may become trapped within the rotor wake vortices (Arnett *et al*., 2008; Johnson & Kunz, 2004), although this is yet to be confirmed.

Modification of remnant vegetation during the construction of wind farms, including the construction of roads and power-line easements, and the creation of clearings around each turbine may create ideal conditions for the aerial insect prey which most insectivorous bats feed upon (Grindal and Brigham 1998).

Barclay *et al.* (2007) conducted a meta-analysis of published bat mortalities at 33 North American wind energy facilities (with turbine hub height ranging in size from 24 - 94 m and blade diameters between 18 - 90 m) and found that fatalities increased exponentially with turbine hub height. Other factors that have been demonstrated to influence bat-turbine collision/barotrauma fatalities include geographic location (Arnett *et al*.,

2008) and wind speed, with more bats killed on low-wind nights (Fiedler, 2004; Arnett, 2005; Arnett *et al*., 2008; Horn *et al.,* 2008).

17.3 Cumulative Impacts

17.3.1 Wind Farms

There is, at present, only one wind farm operating within the currently recognised distribution of *S. saccolaimus nudicluniatu*s, i.e. the RACL Windy Hill Wind Farm (WHWF) near Ravenshoe (refer **Volume1 Chapter 2** for a description of this project). There has been no systematic monitoring of microchiropteran turbine collision mortality conducted at this site.

Stage 1 of the proposed High Road Wind Farm (also owned by RACL) (~30 km to the south of the MEWF site) has received Federal Government environmental approval, and assessments for Stage 2 of the project are currently underway. Stage 1 of the High Road Wind Farm comprises 17 2-3 MW turbines with a hub height of 80 m and a blade length of 45 m located in cleared land adjacent to wet sclerophyll forest. Stage 2 of the High Road Wind Farm may comprise an additional 28 turbines (of the similar specifications as Stage 1); 12 of which are located within wet sclerophyll forest and 16 on cleared land, and is currently undergoing environmental assessment.

An assessment of a 50-60 turbine wind farm (no specifications available) at Archer Point, near Cooktown is currently underway (Larissa Hale, Balkanu Cape York Development Corporation, pers. comm.). All of these approved or proposed wind farms are located within the Australian distribution of *S. saccolaimus.*

ROAM (2012) modelled the wind and solar resources in the vicinity of the National Electricity Market (NEM) network, and found that the coastal area between Townsville and Princess Charlotte Bay and inland to approximately Georgetown has an enormous potential for wind energy and it is possible that area will continue to attract interest from wind energy developers into the future.

The most likely cumulative effect of these proposed wind farms on the Bare-rumped Sheathtail Bat is likely to be elevated turbine collision related mortality and potential loss of roosting habitat.

17.3.2 Habitat Loss & Degradation

Habitat loss is recognised as a key threat to the species (Schulz & Thomson, 2007). Legislation restricting land clearing in Queensland has last year (2013) been substantially modified. It is now permissible to clear remnant forest if it can be proven that the land has high agricultural potential (e.g. cropping and horticulture) and if a proposed development is economically viable. In addition, many clearing activities are now self-assessable, including logging, extractive industries, thinning, maintaining fence lines, firebreaks, roads and constructing and maintaining built infrastructure. These legislative changes could result in a limited increase in the loss of sclerophyll forest and woodland roosting and foraging habitats within the distribution range of *S. saccolaimus,* particularly on the relatively rich agriculturally suitable volcanic derived soils of the western Atherton Tablelands area e.g. Dimbulah, which could have the potential to adversely affect the species. The lack of sufficient irrigation water however is likely to limit further agricultural development in this area.

17.3.3 Significance, Certainty and Irreversibility of the Relevant Impacts

17.3.3.1 Habitat Clearing & Degradation

The potential significance of the impact of habitat clearing on this tree-hollow roosting bat will depend upon whether any roosting colonies occur within the proposed clearing footprint, and the size of any such colony. The availability of potential roost trees for the species could decline over time across the site if invasive fire

promoting grasses become established in inaccessible areas where mechanical or chemical control in extremely difficult or impossible. This potential risk may be reduced with careful attention to weed control and hygiene during the construction and operation phases.

17.3.3.2 Turbine Collision/Barotrauma

The significance of the impact of turbine collision and possibly barotrauma on the Bare-rumped Sheathtail Bat may be influenced by the following factors:

- the size of the local populations;
- their ability to avoid turbines;
- the sex, reproductive status and age classes of bat fatalities; and
- the patterns of temporal and spatial habitat utilisation of each species on the site.

Without basic ecological information on population size or utilisation for the Bare rumped Sheathtail Bat it is not possible (at this stage) to make an informed assessment of the significance of potential turbine collision/barotrauma fatalities on these species. Further utilisation surveys, using technologies capable of determining abundance and flight heights e.g. radar, would be required before such an assessment can be made.

17.3.4 Assessment of the Significance of all Potential Impacts

Under the EPBC Act, an action will require approval from Federal Environment Minister if the action has, will have, or is likely to have a significant impact on a listed species or ecological community. The nine criteria for assessing the significance of impacts on a critically endangered species as outlined in the *Matters of Environmental Significance – Significant Impact Guidelines 1.1 EPBC 1999* (DotE, 2013) are addressed in **Table 17.1** below.

Table 17.1 Significant Impact assessment for the Bare-rumped Sheathtail Bat

Bare-rumped Sheathtail Bat – Critically Endangered	
Will the proposed works..	
Lead to a long term decrease in the size of a population?	Any confirmed records of individual Bare-rumped Sheathtail Bat can be considered as belonging to an important population given the current lack of understanding of the population structure of the species throughout its currently known distribution range. It is not known whether the species occurs in discrete isolated populations (e.g. Jeroma, Townsville, Iron Range, and Hartley's Creek) or is continuously distributed in suitable habitat between the isolated known locations. There is a possibility an unknown number of Bare-rumped Sheathtail Bat individuals could be killed due to turbine collisions or barotrauma given their known flight behaviour (i.e. high, fast fliers that feed on aerial insects). It is not possible to assess the significance of potential mortalities due to turbine collision or barotrauma on the important population of the species because it is not feasible to obtain the necessary demographic parameters (e.g. population size, age at first reproduction, mortality rates etc) for *S. saccolaimus* (or any other closely related taxa) to conduct Population Viability Analysis or Population Biological Removal to examine the viability of the important population.
Reduce the area of occupancy of the species?	There is currently no information on whether operating wind turbines similar to those proposed, act as a barrier to the movement of any species of microchiropteran bats. Miderman *et al.* (2012) showed that bat activity (as measured by the number of detected call passes per hour) declined significantly with increasing wind speed in close proximity to small wind turbines (up to 18 m hub and 13 m blade diameter). The decline in activity was present to a lesser extent at greater distances from the wind turbine (20-25 m). It is not known how this observed avoidance effect would scale up with larger wind turbines. Given the high numbers of bat deaths reported at some overseas wind farms using turbines similar to those proposed; it is unlikely that microchiropteran bats avoid the vicinity of operating wind turbines (due to noise, movement) to the extent that they act as a barrier to their movement or reduce the area of occupancy of the wind farm through displacement due to disturbance as has been frequently demonstrated for many bird species (e.g. Fielding *et al*., 2006; Fox *et al*., 2006; Masden *et al*., 2009). The construction of the proposed wind farm infrastructure will result in the loss of ~57 ha of potential roosting habitat for the species. This represents 2.4% of the total area of the project site. The Bare-rumped Sheathtail Bat has been reported to be prone to disturbance with individuals readily abandoning their roost site when approached closely by people on foot. Little is known about what the critical roost site requirements for the species are; therefore it is not possible to assess the availability of suitable roost sites on the project site. The loss of approximately 57 ha of sclerophyll woodland and open forest could potentially be significant if it includes a large number of roost trees. Design phase roost tree searches to inform track and turbine location together with detailed searches of hollow bearing trees and provision of artificial nest boxes in the proposed clearing footprint immediately prior to construction may help reduce impact from loss of roosting trees.
Fragment an existing important population into two or more populations?	There is no information about the extent of any important population present on the project site. However, it is unlikely the important population is restricted to the project site given the occurrence of similar continuous dry sclerophyll woodland and open forest habitat to the south, and elsewhere in the region. The turbine avoidance behaviour of the species and the likelihood of the wind farm acting as a barrier to the movement of the species or the degree of displacement that may occur are not currently understood. However, even if the species is displaced from large areas of the MEWF project site, areas of continuous similar habitat exists around the periphery of the site outside any likely zone of disturbance due to turbine noise or movement, which could be utilised by the species. It is unlikely that movement of the species will be reduced by the wind farm and therefore, that any important population could be fragmented into two or more populations.

Bare-rumped Sheathtail Bat – Critically Endangered	
Will the proposed works..	
Adversely affect habitat critical to the survival of a species?	What constitutes critical habitat for the species is not currently understood therefore it is not possible to make a reliable assessment of the significance of the loss of 57 ha of potential foraging (and potentially roosting) habitat due to clearing. However, the dominant regional ecosystems present on the project site are well represented (total area of ~267,000 ha) elsewhere in the Einasleigh Uplands and Wet Tropics bioregions. The BIOCLIM distribution model for the species only indicates a narrow coastal section of the Wet Tropics bioregion as potential habitat (Thomson et al., 2001); however, this is certainly an underestimate of their potential range as the modelling was based on a very small number of record locations.
Disrupt the breeding cycle of a population?	Reproduction in the Bare-rumped Sheathtail Bat varies between geographic regions, but in Queensland it is known that females give birth to a single young between late December and early January, and lactate during the wet season (Churchill, 2008). If potential mortalities preferentially affect a particular age or sex class e.g. females of reproductive age, as has been shown elsewhere (Reynolds, 2006), then this has the potential to disrupt the breeding cycle.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The proposed development will result in the clearing of 57 ha of potential foraging or roosting habitat for Bare-rumped Sheathtail Bat. There is a moderate risk of invasive fire promoting grasses spreading from existing loci on the site or become established on the site in areas where chemical and mechanical control would not be feasible. Associated changes in fire intensity and frequency could result in a decrease in the quality of existing habitat e.g. fewer potential roost trees and changes in prey availability. Without an understanding of the viability of the existing important population it is not possible to assess the likelihood of the above potential impacts resulting in a decline in the population of the species. Weed control and vehicle hygiene management during and post-construction will reduce the risk of this impact.
Result in invasive species that are harmful to a vulnerable species being established in the vulnerable species habitat?	There is a moderate risk of invasive fire promoting grasses spreading from existing loci on the site or become established on the site in areas where chemical and mechanical control would not be feasible. Associated changes in fire intensity and frequency could result in a decrease in the quality of existing habitat e.g. fewer potential roost trees and changes in prey availability. Weed control and vehicle hygiene management during and post-construction will reduce the risk of this impact.
Introduce disease that may cause the species to decline?	There are no infectious diseases of Australian microchiropteran bats that are currently known to result in high levels of mortality (ARWH, 2013). It is not likely the proposed development will facilitate the spread of any diseases that may cause the species to decline.
Interfere with the recovery of the species?	The recovery plan for the Bare-rumped Sheathtail Bat does not identify any populations that are currently known to be under threat nor are any specific conservation measures aimed at the Bare-rumped Sheathtail Bat (Shulz & Thomson, 2007). While the loss of tree hollow availability due to land clearance has been listed as a primary threat to the species by Schulz & Thompson (2007), additional potential impacts on the Bare-rumped Sheathtail Bat include: ▪ Timber collection and the targeted removal of hollow-bearing and dead trees along road reserves, in parks and other urban situations; ▪ Competition for hollows by European/Asian honey bees and feral birds such as the Common Myna (*Acridotheres tristis*); ▪ Disease such as Australian bat lyssavirus; and ▪ The loss or degradation of habitat such as tropical forests due to anthropogenic climate change (Curtis *et al.* 2012). The project is considered unlikely to interfere with the recovery of the species.

17.4 Proposed Mitigation Strategies

Mitigation measures are proposed below to avoid or reduce the identified potential impacts of the project on this species.

17.4.1 Pre-construction

17.4.1.1 Wind Farm Re-Design Measures

Under current best practice wind farm assessment guidelines (EPHC, 2010), it is acknowledged that it is more effective to modify the design of a wind farm to reduce predicted impacts than it is to implement 'active' management strategies in the operation phase.

Redesign measures that have been applied at some Australia wind farm sites to reduce impacts on birds and bats include:

- preferentially located wind turbines in the lowest risk areas;
- reduction in the total number of turbines;
- identification and establishment of appropriate, infrastructure-free zones around locations; of habitat importance of importance to key taxa; and
- changing the model of turbine or altering hub height (EPHC, 2010).

It is not currently possible to propose effective redesign measures due to the lack of long term utilisation data or collision risk estimates for threatened micro chiropteran bat species.

Collision Risk Modelling

If it is possible to identify each threatened bat species using radar (together with other methods such as thermal imaging video) on the basis of wing beat frequency and flight behaviour (e.g. height, speed), then it may be possible to conduct quantitative collision risk modelling. Bruderer & Popa-Lisseanu (2005) were able to reliably discriminate bats from migrating birds using radar on the basis of wing beat frequency and size, and that small, medium and large bats could also be separated using wing-beat frequency. Bruderer *et al.* (2010) were able to discriminate 41 species of Palaearctic and African passerine birds on the basis of wing-beat frequency patterns. At the very least, radar utilisation studies could potentially be used to determine collision risk for all high-flying microchiropteran bats (low flying bats are not likely to be able to be observed on radar due to ground clutter interference), assuming it is possible to reliably differentiate microchiropteran bats from insects and small passerine birds. It may be possible to indirectly estimate the collision risk for the Bare-rumped Sheathtail Bat based on the relative calling activity for each species from the ultrasonic call monitoring.

If it is not possible to obtain data suitable for collision risk modelling for each of the threatened microchiropteran bat species, then a precautionary approach based on a set of informed assumptions should be adopted instead using confirmed information for the taxon and/or closely related taxa (EPHC, 2010). Unfortunately there is little published relevant ecological information available for any closely related bat species. All assumptions and inherent uncertainties to be used in the assessment should be agreed by the relevant authorities and reviewed by experts on the particular bat taxon (EPHC, 2010). According to EPHC (2010), there is little basis for undertaking collision risk modelling using informed scenarios, as there is little basis for making informed assumptions about rates of wind farm mortality for key bat species. There is no published research documenting rates of bat turbine mortality for wind farms within the distribution range of Bare-rumped Sheathtail Bat. Bat mortality monitoring has been required for many Australian wind farms but

apart from a Studland Bay and Woolnorth Wind Farms in Tasmania, no published data has been made available.

The data obtained from utilisation surveys required for collision risk modelling includes the following:

- an estimate of the annual maximum number of individuals that could encounter and interact with the turbine array;
- an estimate of the annual number of flights at risk of collision; and
- the amount of available flight time per annum, accounting for annual and monthly cycles that affect presence at the site and/or frequency of flights (EPHC, 2010).

Further investigations would be required in order to obtain data that would allow these pre-construction redesign mitigation options to be investigated however given the complexity, cost, extended duration and uncertainty around efficacy of methodology necessary to determine these parameters, it is recommended that any preconstruction investigations are preferentially targeted at operational mitigation measures, such as identification of turbine cut in speed reductions. A number of construction and operational phase impact reduction strategies are proposed below in **Section 17.4.2.**

A potential methodology to gather additional utilisation information for the species is outlined below:

Call Activity Monitoring

- Continuation of continuous dusk to dawn passive ultrasonic call monitoring surveys at the 10 existing towers locations and establishment of additional towers would provide a more complete coverage of the representative habitat where turbines are proposed to be located. Extension of monitoring towers and the use of full spectrum bat detectors may also be considered (**Appendix 23**).

Threatened Bat Utilisation Radar/Thermal Imaging/Call Surveys

- Conduct microchiropteran utilisation surveys in the vicinity of each acoustic monitoring tower using a portable X-band weather radar (including video capture card and storage) operating in vertical mode in conjunction with thermal imaging video and ultrasonic call detectors on balloons or tall towers to collect data suitable for collision risk modelling for each threatened species and for all bats in general (i.e. abundance and flight height data).
- Investigate the potential to positively identify each threatened bat species using radar on the basis of their wing beat frequency and flight behaviour.

Effectiveness

Acoustic bat call surveys can provide useful information for understanding the conditions and time periods when bats are more active and therefore, more at-risk of collisions. However, a meta-analysis of 94 pre-construction bat activity (based on ultrasonic call surveys) and 75 post-construction bat fatality studies at wind farms in the USA and Canada, found that acoustic data gathered prior-to construction cannot accurately predict bat fatalities (Hein *et al.,* 2013). If the relationship between bat activity and mortality at the MEWF site turns out to be weak or non-existent, then using call activity data to inform redesign options and risk assessment may not be valid (Hein *et al*., 2013). It is still uncertain whether it has been possible to effectively sample bat calls within the proposed rotor sweep area on Mt Emerald given the microphones of the detectors are located only 6 m above the ground at an angle of 45° and the effective sampling range of the microphones has recently been reduced to 10-20 meters. The use of higher towers would address this uncertainty.

The use of radar to study microchiropteran bat utilisation patterns at wind farms is in its infancy, although it has been widely used to study nocturnal migrating bird utilisation patterns at wind farms. Radar is not likely to be able to provide the required utilisation information on its own but must be used in conjunction with other survey methods to validate the data obtained by the radar e.g. thermal imaging video, ultrasonic detectors and light-enhancing night vision devices.

17.4.2 Construction Phase

To reduce the potential impact to roosting Bare-rumped Sheathtail Bat colonies that may occur on the site, a Species Management Program (SMP) (inclusive of marking habitat trees for spotter catchers, avoid clearing hollow-bearing trees where possible, and using spotter catchers to remove identified bat colonies) will be prepared.

A preliminary species management program will include:

- Staged clearing works to allow bats to leave roosting sites;
- No vegetation clearing to occur at night (bright lights can interfere with bat behaviour);
- The use of noise to encourage bats to leave roosting sites e.g. noise cannons are currently the preferred method;
- Spotter-catchers with demonstrated experience in microchiropteran bat removal will be on site for the entire clearing exercise to monitor clearing works and assist with clearing hollows as each hollow containing tree is felled; and where possible timing for clearing works to occur outside the breeding season (tropical wet season).

17.4.2.1 Identification of High Risk Turbine Collision Conditions

To provide base line data for the proposed mitigation measure of increasing turbine cut in speed (**Section 17.4.3** below) collection of the following information will be required during the construction phase of the project:

- The relationship between environmental conditions including insect abundance at various heights, wind speed, rain, illumination, cloud cover and bat call activity will be examined for a period of at least one year to identify bat turbine collision high risk conditions. This assessment will require the use of fixed beam vertical profile radar (e.g. Detect's Vesper radar system) in conjunction with thermal imaging video and ultrasonic call detectors to quantify patterns of insect and bat abundance at different heights. Vertical profile radar has the potential to enable discrimination of different microchiropteran bat species on the basis of wing beat frequency.
- Establish automated weather stations (e.g. temperature, humidity, wind speed, illumination etc.) at typical monitoring tower locations to enable relationships between bat call activity and weather condition to be examined to identify high risk periods. Richards (1989) found that the call activity of microchiropteran bats at a single site on the Atherton Tablelands (750 m ASL) was almost entirely restricted to periods when the minimum night time air temperature was above 15°C. The drop in winter calling activity was assumed to be a response to low insect abundance (Richards, 1989).

17.4.3 Operation Phase (Active Management Options)

17.4.3.1 Increase Turbine Cut-in Speeds

At present, the most proven method of mitigating microchiropteran fatalities due to barotrauma and turbine collisions is offered by curtailing the operation of wind turbines during high-risk periods (i.e. when bats are foraging in the vicinity of turbines) by either changing the wind-speed trigger at which the turbines are

allowed to begin turning or by altering blade angles to reduce rotor speed (Arnett *et al.,* 2010; Baerwald *et al.,* 2010). Increasing the turbine cut-in speed to 5 ms^{-1} reduced bat fatalities by at least 44% at a single wind farm in Pennsylvania, US, with a commensurate loss in energy output of <1% of total annual output (Arnett *et al.,* 2009; Arnett *et al.,* 2010).

This proposed mitigation option would consist of the following:

- At each turbine or sufficient representative turbines, establish full-spectrum ultrasonic bat call detector (e.g. Wildlife Acoustics SM2+BAT) at hub height fitted with multiple, directional microphones at various heights within and below the rotor sweep area. Wildlife Acoustics SM2+BAT units have 3G network remote data download capability, which would enable data to be analysed remotely at any time http://www.wildlifeacoustics.com/products/song-stream-remote-access). The most time and cost efficient method of analysing the large amount of bat call data to detect the presence of threatened species would be to work with bat call experts to develop automated call classifiers (http://www.wildlifeacoustics.com/products/song-scope-overview).
- Conduct bat carcass searches at each turbine to quantify collision rates and examine the relationships between actual bat mortality and environmental conditions. Confounding factors associated with observer detectability and scavenger removal rates of bat carcasses will need to be taken into account. The following approaches are recommended:
- Conduct bat carcass detection bias studies comparing sniffer dogs and humans to quantify searcher efficiency. Sniffer dogs have been proven to detect significantly more bat carcasses than human searchers (Arnett, 2010). However, the training period and costs for carcass detection dogs are long and high respectively. There is currently only one commercial bird and bat collisions detection dog service offered in Australia (Emma Bennett, Elmoby Ecology). Conduct bat carcass scavenger removal studies to allow calibration of human/sniffer dogs obtained counts. Ensure that scavenger swamping (i.e. scavengers may be unable to process and removal all provided carcasses) does not occur which may underestimate removal rates (Smallwood *et al*., 2010).
- Conduct studies to examine the influence of vegetation structure on searcher detection eff*icien*cy (e.g. Morrison 2002). The effects of vegetation structure are likely to become more pronounced with time after construction as turbine sites will revegetate at different rates depending upon substrate type (e.g. Bare rock pavement, moderately deep soil) and location on the site (e.g. high altitude southern section likely to receive more water input from cloud stripping than northern turbines).
- The most appropriate carcass search area (the fall zone of struck bats) around the turbines should be determined by using the monte-carlo model developed by Hull & Muir (2013) using ballistics theory (takes into account wind effects and the energy imparted to the struck target by the blades). The model was benchmarked against actual mortality data from two Australian wind farms and found to be accurate (Hull & Muir, 2013). For a turbine with an 80 m hub such as is proposed for MEWF, bat sized carcasses were predicted to occur out to a maximum distance of about 70 m from the turbine base (Hull & Muir, 2013).
- The use of automated collision/micro-avoidance detection systems e.g. Tads and WT-bird at each turbine to identify direct turbine collision rates and to assess avoidance rates should be investigated.
- To reduce potential bat mortalities due to turbine collision risk and/or barotrauma, the operation of high-risk turbines should be curtailed in response to identified high-collision risk conditions (e.g. high insect abundance, low wind speed, and/or high threatened bat call activity levels) (proactive approach) and following excessive deaths (reactive response). If some wind turbines are found to consistently contribute to excessive bat deaths, then their permanent curtailment during nocturnal hours or further operational restriction should be considered.

Effectiveness

This is one of the only post-construction mitigation methods that has demonstrated effectiveness at significantly reducing bat turbine collision/barotrauma mortalities. However, it would be necessary to determine the relationship between environmental factors, such as wind speed, and the abundance/activity of the threatened bat species at the MEWF site before these cut-in speed thresholds could be validated. It is therefore recommended that these activities commence during the construction phase of the project (see above).

17.4.3.2 Acoustic and Electromagnetic Bat Deterrents

Despite showing some promise in laboratory tests, acoustic deterrents have not proven effective at deterring foraging bats from the vicinity of operating turbines due to the rapid attenuation of ultrasonic sound in air (Spanjer, 2006; Horn *et al.,* 2008).

There is some evidence that microchiropteran bats exhibit avoidance of radar installations. Nicholls and Racey (2007) examined bat activity along an electromagnetic gradient at ten radar installations in Scotland and showed that bat activity and foraging effort per unit time were significantly reduced in habitats exposed to an electromagnetic field (EMF) strength of greater than 2 $v.m^{-1}$, when compared with matched sites exposed to no EMF. Nicholls and Racey (2009) showed that the electromagnetic signal from a small radar unit with a fixed antenna generally reduced the foraging activity of microchiropteran bats within 20 m of the unit. However, no corresponding decrease was observed when the radar antenna was rotating, which was attributed to the reduced length of time that a bat would have been exposed to pulse-modulated microwave radiation and that the field strength in the rotating mode was ¼ that in the fixed position at all distances from the source (Nicholls and Racey, 2009).

Further investigation of potentially promising deterrent technologies should be examined as they become available.

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18.0 Spectacled Flying-fox Impact Assessment

This Chapter specifically considers the impacts of the proposed MEWF project on the Spectacled Flying-fox, *Pteropus conspicillatus,* which is listed as vulnerable under the EPBC Act. The potential impacts on this species may be considered a Matter of National Environmental Significance (MNES), due in part to the role the Spectacled Flying-fox plays in the wet tropics for dispersing key fruiting species and its contribution to genetic diversity. For this reason, the Wet Tropics World Heritage Area (WTWHA) has also been listed as a controlling provision.

18.1 Assessment Methodology

The study area focussed on ridge habitats representative of locations where wind turbines are proposed. Two methods were trialled between late 2012 and mid 2013, to collect spatially and temporally replicated habitat utilisation data (abundance and flight height) suitable for incorporation into numerical collision risk models (refer to **Appendix 25** for full methodology):

(a) light-enhancing night vision goggles/infrared spotlight; and

(b) thermal imaging video

Significant effort was placed in the development and conduct of the methodologies with the understanding this was a novel approach, untested in Australia, on a species that has been understudied due to the challenges in obtaining sufficient ecological data. This was recognised as a risk, however every effort was undertaken to provide information to DotE on the species, and these methods were selected for trial as they were the only affordable method with any potential to obtain the required data. At the time of developing the survey methodologies, commercially available bat and avian radar systems, which were assessed as having the best potential to gather the required data, were deemed not cost effective (capital cost in the order of $1m) and research suggested cheaper, marine radar systems would not be suitable.

The tested methods proved suitable for collection of utlisation data on site; however detailed abundance and flight height data proved difficult to obtain for the following reasons:

Night-vision goggles:

- limited detection range (<150 m), so that no data able to be collected on the proportion of individuals flying above the proposed rotor sweep area (134 m above the ground);
- difficult to accurately separate *Pteropus spp*; and
- difficult to accurately estimate horizontal and vertical distance of the target from the observer as the units did not allow binocular vision i.e. depth perception.

Thermal Imaging video:

- not possible to estimate target vertical distance (flight height) based by wing span of Spectacled Flying-foxes and measured image pixel size due to the apparent size of the targets being dependent upon the temperature scale used to view the images;
- Inability to reliably identify *Pteropus spp*. from other targets, and more importantly to separate *P. conspicillatus* from the either *P. scapulatus (Little Red Flying-fox)* or *P. poliocephalus (Grey-headed Flying-fox)*; and
- a large amount of time and cost involved in processing recorded video (1-3 hours per hour of video).

Opportunistic records of flying and foraging Spectacled Flying-fox and other *Pteropus spp.* were recorded whilst conducting other night-time survey activities (e.g. live quoll trapping), and opportunist records of signs (i.e. food splats and ejecta).

18.2 Existing Environment

18.2.1 Recruitment and Dispersal Probabilities Pre and Post Construction and Operation

18.2.1.1 Recruitment

Little direct research has been conducted on determining the recruitment rates of Spectacled Flying-foxes in the Wet Tropics and due to the difficulty in obtaining this information it was deemed outside the scope of this project. *Pteropus spp*. are characterised by having relatively low annual recruitment rates (Pierson and Rainey, 1992), however it was difficult to make inferences from other *Pteropus spp* when there is a paucity of information across the genera.

18.2.1.2 Dispersal

To date there is no published information on the patterns of dispersal of juvenile Spectacled Flying-foxes or any other Australian *Pteropus spp.*

- Radio telemetry and satellite tracking have shown that individual Spectacled Flying-foxes in the Wet Tropics region undertake regular movements between colonies (Fox *et al*., 2012). It is not known whether any movement occurs between the Wet Tropics, Iron Range and Papua New Guinea, or what movements occur within New Guinea and Indonesia (Fox *et al*., 2008).
- GPS tracking of Spectacled Flying-foxes individuals undertaken by CSIRO has found that the maximum distance flown from the roost to a foraging site is 43.4 km (DERM, 2010).

18.2.1.3 Inter-colony Movements

The variation in both the fly-out and ground-based counts of Spectacled Flying-fox at known roost sites is often greater than can be accounted for by recruitment (i.e. births) and/or mortality. This clearly suggests that animals are regularly moving between known and unknown roost sites.

Spectacled Flying-foxes exhibit distinct patterns of seasonal dispersion with animals moving away from known roost sites during the dry season, typically followed by an influx of animals back into these known sites starting in September, during the build up to the wet season (Shilton *et al.,* 2008).

18.2.1.4 Foraging Movements

Australian *Pteropus spp.* have the capability to range in excess of 600 km in a year (Spencer *et al*. 1991) and can have daily feeding ranges of over 50 km (Spencer & Miller, 2006)

Parsons *et al.* (2007) conducted a dietary study of Spectacled Flying-foxes at four roost sites within the Wet Tropics during 2004-2005. The study showed that, in addition to rainforest fruits, which are a primary component of their diet, the species also utilises a wide variety of plant resources including myrtaceous pollen and nectar from non-rainforest habitats such as wet and dry sclerophyll (Parsons *et al.,* 2006). The dietary composition of the Spectacled Flying Fox at the four individual roosts could not be predicted by the habitat types located within a typical foraging distance of 20 km (Parsons *et al.*, 2007), suggesting that animals typically foraged at distances greater than 20 km from the roost. It is possible that competition for food resources in close proximity to the roosts sites are high thus forcing the animals to forage further afield (Parsons *et al*., 2007).

Satellite telemetry conducted by CSIRO indicates some Spectacled Flying-fox individuals that roost at Tolga Scrub forage as far west as Dimbulah, approximately 26 km due west of the project site, and it is highly likely

that they flew directly over the project site. CSIRO's research indicates that at least some individuals are capable of undertaking extremely long-distance movements in short periods, for example 2000 km in three days (David Westcott, CSIRO, pers. com. 18/10/13).

Genetic studies of the Spectacled Flying-fox conducted by Fox (2008) support this with the finding that there is no significant genetic differentiation between the Wet Tropics, Iron Range and Papua New Guinea populations, which indicates movement between these populations occurs or has occurred in the recent past.

18.2.2 Critical Habitat Requirements

Essential roosting, breeding and mating habitat for Spectacled Flying-foxes includes rainforest, gallery forest, Melaleuca swamps, mangroves and eucalypt forest (DERM, 2010; Curtis & Dennis, 2012). Most camp sites are located within 6.5 km of rainforest (Richards, 1990), however at least one colony located at Mareeba is approximately 16 km from the nearest rainforest (Shilton *et al.*, 2008). Ongoing satellite-telemetry tracking of Spectacled Flying-foxes by CSIRO researchers is assisting with the discovery of new roost sites (James Hammond, DotE, pers. comm., 16/10/13).

What constitutes essential foraging habitats for the species is not well understood (DERM, 2010). Spectacled Flying-foxes forage in a wide variety of habitats including rainforest, wet and dry eucalypt forest and woodlands, melaleuca swamps, littoral and coastal mixed forests and mangroves, farmlands and urban and suburban gardens (Curtis & Dennis, 2012). Certainly the majority of the MEWF site is potential habitat for both foraging and fly over of this species (**Figure 18.1**).

There is an estimated total of 2,101,367 ha of potentially suitable foraging habitat (**Table 18.1**; **Figure 18.2**) within a 43.4 km buffer (the maximum foraging range of Spectacled Flying-foxes) of the 49 currently located camps within the Wet Tropics bioregion (data provided by David Westcott, CSIRO) based on latest regional ecosystem mapping (version 6.1, DEHP, 2013). In addition, to these habitats, there is an additional 531,857 ha of non-remnant vegetation and cleared land (**Table 18.1**), some of which is likely to contain Spectacled Flying-fox food plants, including pastures with isolated trees and *Solanum mauritianum* shrubs. This estimate of potentially suitable foraging habitat is not likely to increase significantly with the discovery of any additional camps, unless they occur in either the north (Cooktown area), south of the Wet Tropics (e.g. Bluewater State Forest, Paluma) or west (Mt Windsor Tableland, Kirrama Range to Koombaloomba Dam).

Table 18.1 Total Area of Potential Spectacled Flying Fox Foraging Habitats Within 43.4 km of the project site

Broad Vegetation Group (at 1:5,000,000 scale)	Area (ha)
Rainforests, scrubs	690,961
Wet eucalypt open-forests	79,293
Eastern eucalypt woodlands to open-forests	1,018,622
Eucalypt open-forests to woodlands on floodplains	43,415
Eucalypt dry woodlands on inland depositional plains	41,592
Eucalypt low open-woodlands usually with spinifex understorey	54,902
Callitris woodland - open-forests	2,534
Melaleuca open-woodlands on depositional plains	64,254
Acacia dominated open-forests, woodlands and shrub lands	15
Coastal communities or heaths	49,198
Wetlands (swamps and lakes)	7,714
Mangroves and tidal salt marshes	48,868
Non-remnant	531,857
TOTAL	**2,633,224**

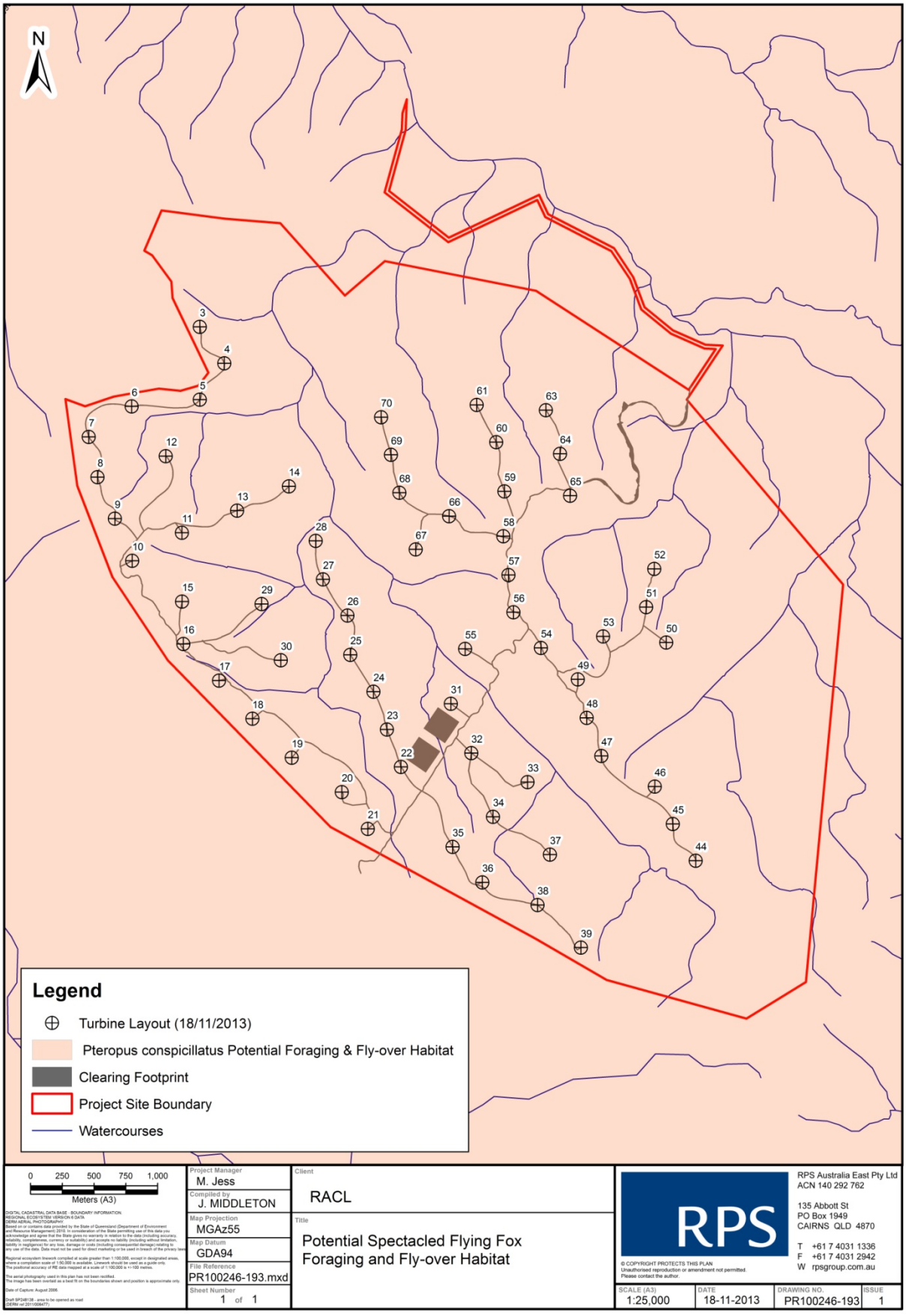

Figure 18.1 Potential foraging and fly over habitat for the SFF over the proposed MEWF site.

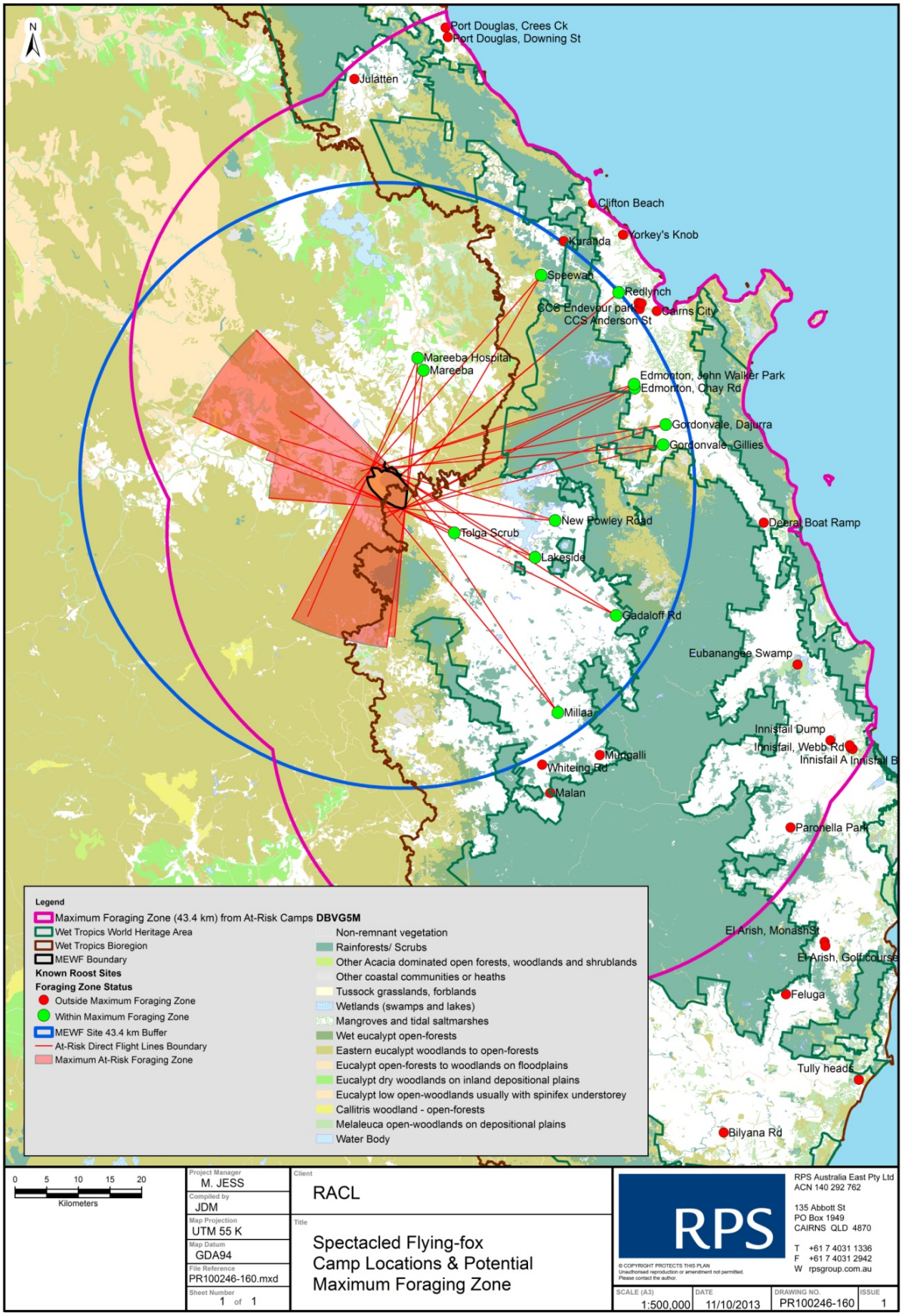

Figure 18.2 Potential Foraging Areas for Known Spectacled Flying Fox Camps

18.2.2.2 Critical Habitat on MEWF Site

The project site consists of ~2422 ha of dry sclerophyll woodlands and open forest dominated by myrtaceous tree species known or likely to be utilised as pollen and blossom food sources for Spectacled Flying-foxes including *Eucalyptus reducta, E. portuensis, E. tereticornis, E. crebra, E. shirleyi, E. cloeziana*, *Corymbia leichhardtii, C. clarksoniana, C. abergiana*, *Lophostemon grandiflorus, Melaleuca viridiflora* and *M. monantha.*

In addition, the riparian habitats present in the deeply dissected rocky creek lines on the eastern boundary of the project site contain tree species that possess fruits known to be eaten by *Pteropus* spp*., e.g. Pleiogynium timorense* (Burdekin Plum).

18.2.3 Population Status

18.2.3.1 Wet Tropics Population Size

Current estimates of the total population size of the species, and population trends are not able to be accurately assessed due to incomplete understanding of the locations of camps throughout the Wet Tropics Bioregion (Westcott *et al.,* 2001; DERM, 2010).

Shilton *et al.* (2008) conducted monthly sampling of 23 colonial roost sites of Spectacled Flying-fox across the entire Wet Tropics Bioregion for a period of 23 months (May 2004 - March 2006) using a ground-based day time survey methodology. The monthly population estimate of the Spectacled Flying-fox was found to vary from 275,000 in February 2005 to a low of 70,000 during the dry season in May 2004 and August 2005. The mean monthly population size was 176,116 (±71,666 SD, n=23).

CSIRO have continued monthly ground-based counts of all of the known Spectacled Flying-fox camps in the Wet Tropics since May 2004 following on from the work of Shilton *et al.* (2008). **Figure 18.3** shows the total population count for each month from 2004 until 2010. It is clear that the population size shows distinct seasonal variation, with pronounced apparent declines during the dry season months due to dispersal to unknown roost sites, and an apparent increase in the late wet season.

18.2.4 Status of the population in the impact area relative to non-impact areas

An assessment of the effectiveness of thermal imaging video and light-enhancing night-vision goggle surveys to collect data on Spectacled Flying-fox abundance and flight heights is provided in **Appendix 25**. Despite considerable survey effort over rugged terrain, estimates of abundance or flight height data for Spectacled Flying-fox could not be accurately extrapolated (**Appendix 25**). In addition, surveys could not be conducted off site due to limited resources. No other studies have attempted to systematically census foraging (actively or flying) Spectacled Flying-fox away from their known roost sites in the Wet Tropics Bioregion or elsewhere (Cape York and Papua New Guinea).

A total of three Spectacled Flying-fox individuals were confirmed on the site during the three years of surveys by RPS Group: two individuals were observed flying overhead during night-vision goggle surveys at very close proximity and were illuminated by an 100 W IR spotlight on the 2nd October 2012; and a single individual was observed foraging in a flowering *Melaleuca viridiflora* on the 19th March 2013 (**Appendix 25**).

The average number of *Pteropus* spp*.* observed during the 22 surveys conducted at a total of four sites between 2 October 2012 and the 28 May 2013 was 2.95 (± 2.42 SD) individuals recorded per night. The maximum number of *Pteropus* spp*.* individuals recorded during all of the surveys was 20 individuals on 26 February 2013 at c. UTM 55K 328934 8102042 using thermal imaging equipment.

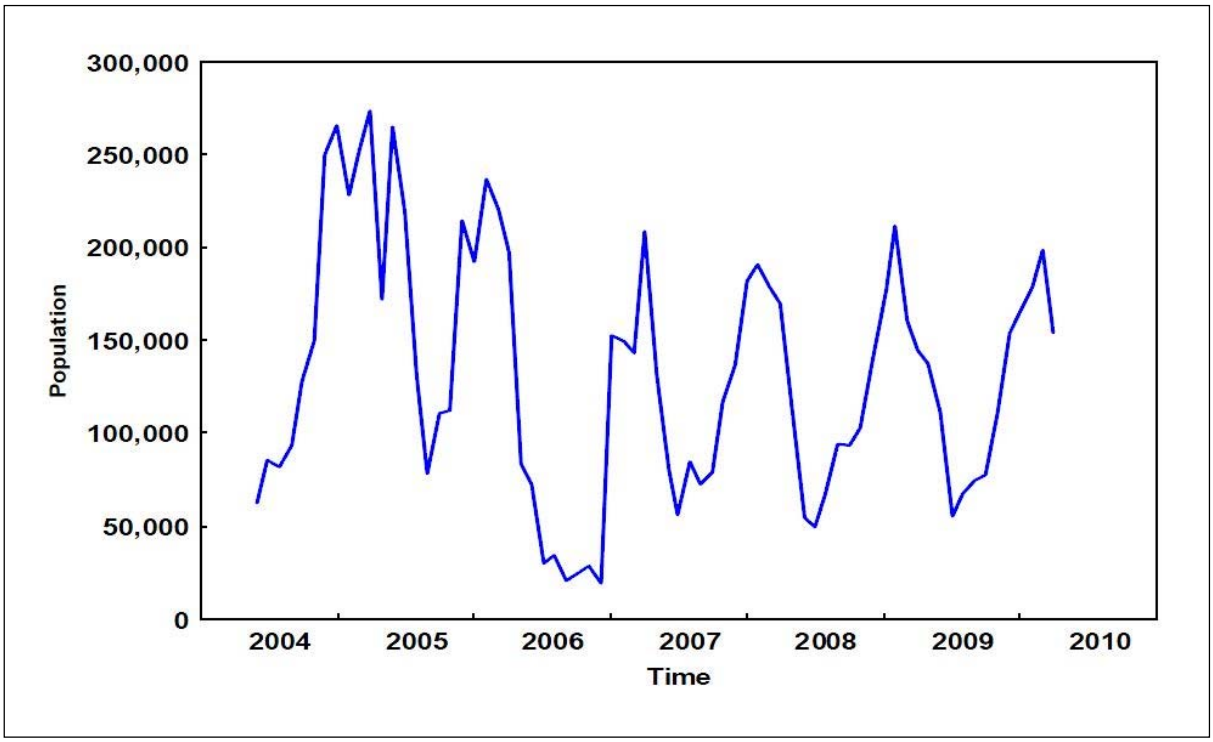

Figure 18.3 CSIRO Monthly Spectacled Flying-fox Population Counts (taken from RRRC, 2010)

18.2.5 Population Viability

Megachiropterans (flying fox family) typically exhibit demographic characteristics that lead to a reduced capacity for population increase after suffering a decline. They are long-lived, show late sexual maturation, low reproductive output and long duration of maternal care. Due to their nocturnal habits, high mobility and tendency to roost in inaccessible locations (e.g. outermost canopy). Megachiropteran bats are a difficult group to obtain demographic information on.

Fox (2008) derived age estimates from counting the cementum layers of the teeth of dead Spectacled Flying-foxes (n=361) from the Tolga Scrub colony that were killed by paralysis ticks and used this information together with other demographic variables obtained from the dead animals (e.g. sex ratios, reproductive status etc.) and annual population census data obtained from fly-out counts to produce life history tables for the species. Fox's (2006) study confirmed that like other Megachiropteran bats, the Spectacled Flying-fox exhibited a long lifespan (i.e. 93% of sample were older than six years; and the oldest was 13 years), a late age at first reproduction, high annual rate of mortality (35% of the sample population for 2001-2002). Fox also showed that the mortality rate of the Tolga Scrub colony during the study period (2001-2002) were twice what could be realistically sustained. It was not certain whether the mortality rates during the study, which was during a bad paralysis tick season, were atypical (Fox, 2008).

McIlwee and Martin (2002) also produced life history tables for Spectacled Flying-fox using demographic parameters derived from captive and wild populations or estimated from other *Pteropus* species. They modelled the effects of the operation of a single electrocution grid, that was estimated to have killed between ~21,000 and 24,000 individuals in the 2000 growing season (Booth, 2002), and found that this level of mortality would result in rapid declines in the species population. However such mortality rates are considered most unlikely to occur with the MEWF project.

18.2.6 Genetic Diversity

Fox (2008) examined the genetic diversity of 10 microsatellite loci of Spectacled Flying-fox from samples collected from 718 individual bats from 11 colonies across the entire range of the species including the Wet Tropics, Iron Range and Papua New Guinea. The results of this study found:

- A high rate of gene flow throughout the entire distribution of the species, suggesting a single panmictic (i.e. random breeding and free interchange of genes) population. Low levels of genetic differentiation between Australian and Papua New Guinea populations suggesting at least some long-distance movement of individuals; and
- Evidence of a genetic bottleneck in the three sampled Atherton Tablelands populations, perhaps attributed to the slow contraction and expansion of critical rainforest roosting habitats during the last glacial maximum.

18.2.7 Economic, Social and Cultural Values

There are positive and negative values associated with economic, social and cultural values attributed to flying foxes within the region

Economic

- ***Positive*** – The Spectacled Flying-fox is a major pollinator and/or seed disperser of a wide range of tree species and helps maintain the ecological integrity of the Wet Tropics World Heritage area and adjacent habitats. The Spectacled Flying-fox contributes significantly to the maintenance of the ecosystem services provided by the Wet Tropics World Heritage area including the provision of clean water and air, soil preservation, carbon sequestration, human psychological well-being etc.
- ***Negative*** - Fruit loss, loss of amenity for people living in very close proximity to camps (e.g. clean up costs), aircraft collision.

Social

- ***Positive*** - Support in the community for annual flying fox counts, animal carers raising injured bats, opposition to colony dispersals and shooting (web sites).
- ***Negative*** - Loss of amenity effects for residents living in close proximity to camps associated with noise, smell, disease risk, faeces and fruit splat.

European Cultural Heritage Natural Significance

- ***Negative*** - Damage to farmers' fruit crops.
- ***Positive*** - Wildlife carer>15,000 signatures on petition to stop shooting flying foxes as of 30/10/13 (http://www.change.org/petitions/flying-foxes-under-threat-in-qld).

Indigenous Cultural Heritage

A total of 18 indigenous tribal groups have traditional connections to the Wet Tropics World Heritage Area including: Bandjin, Djabugay, Djiru, Girramay, Gugu-Badhun, Gulnay, Kunggandji, Jirrbal, Koko Muluridji, Kuku-Yalanji, Mamu, Ngadjon-jii, Nywaigi, Warrgamay, Warungnu, Yidinji, Yirrganydji and Wulgurukaba.

An additional 33 indigenous language groups have connections to the potential distribution range of Spectacled Flying-fox that occurs outside of the Wet Tropics World Heritage Area [from Horton 2000 using the SPRAT distribution map, DotE (2013)], including:

- Western Cape: Anggamudi, Mpalitjanh, Teppathiggi, Tjungundji, Yupangathi, Anguthimri, Awngthim, Luthigh, Yinwum, Mbeiwum, Winda Winda, Wik, Bankanh Kunjen, Kokomini.
- Eastern Cape: Yahhaigana, Wuthathi, Kuuku-ya'u, Uutaalnganu, Kaantju, Umpila, Kuuku-yani, Umbindhamu, Lamalama, Mutumui, Kokowarra
- Gulf: Agwamin
- North East: Gugu-Badhun, Yilba, Bindal, Biri and Yuru

The Spectacled Flying-fox is likely to have been hunted traditionally by some or all of the above indigenous tribal/language groups. Spectacled Flying-fox are included in the list of species that may be lawfully taken by Eastern Kuku Yalanji people (Jabalbina, 2013).

The current levels of indigenous hunting of Spectacled Flying-fox throughout the species Australian range are not currently known but the species is unlikely to be a major dietary item of indigenous peoples. It is not known whether the Spectacled Flying-fox plays a significant role in indigenous spiritual life.

18.2.8 Conservation and Biodiversity Values

Spectacled Flying-foxes have been identified by Westcott *et al.* (2001) as being a "significant component of World Heritage Values in its own right and also contributing to two ecological processes that are important in maintaining other values of the Wet Tropics World Heritage Area (WTWHA) and ensuring the ongoing evolution of the area". Spectacled Flying-foxes are known to be a major pollinator and plant seed disperser, including large-fruited species that are listed as having World Heritage Values (Westcott *et al.,* 2001). The Spectacled Flying-fox is a representative of the mixing of Australian and Asian biota and represents a unit of biodiversity in the WTWHA (Westcott *et al*., 2001).

18.3 Potential Impacts

18.3.1 Mortality Due to Turbine Collision

The operation of 63 turbines (80 m hub and 50-54 m blades) has the potential to cause an unknown number of Spectacled Flying-fox deaths due to turbine collision each year during the operation life of the project (25-50 years). Due to the inability to collect data suitable for numerical collision risk modelling with thermal imaging video and light-enhancing night vision goggles (**Appendix 25**), it is not possible to quantify the collision risk to this species. At least three individual Spectacled Flying-fox were positively identified during the field surveys and up to 20 *Pteropus* spp. individuals were observed on a single night with night-vision goggles. It has recently become known that the Grey-headed Flying Fox *(Pteropus poliocephalus),* which is also listed as vulnerable under the EPBC Act, has an established breeding population in the Wet Tropics and is known to roost at Ingham (David Westcott, CSIRO, pers. comm.). The Grey-headed Flying -fox has the potential to occur anywhere in the Wet Tropics, although most likely at significantly lower abundances than the Spectacled Flying-fox.

Several studies have suggested that birds avoid wind farms, however few have qualified avoidance rates (see Larsen & Guillemette, 2007; Masden *et al.,* 2009; Pearce-Higgins *et al.,* 2009). No avoidance data is available for any mega-chiropteran bats from any operational wind farms in Australia or overseas. Deaths of Spectacled Flying-fox individuals due to collision with man-made objects such as powerlines have been well documented (DERM, 2010). The MEWF site, particularly those areas above 900 m, is frequently covered in cloud for long periods during the evening at any time of the year (Jeff Middleton, pers. obs.). It is not known to what extent Spectacled Flying-fox are capable of flying in conditions of limited visibility such as total cloud cover. If the Spectacled Flying-fox is capable of flying during periods of total cloud cover, then it is reasonable to assume their ability to avoid operating turbines could be significantly reduced during these

conditions. The mean duration and extent the MEWF site is obscured by low cloud is not known and would require a sensor network to be established to collect this data.

The potentially high spatial and temporal variation in the utilisation of the site by the Spectacled Flying-fox associated with this same variation in food availability within the site and in the surrounding area indicates that only long term survey strategies would provide sufficient data. Even then, it may be very difficult to obtain an adequate data set, a known constraint to research on the species to date. Long-term preconstruction radar studies using systems capable of measuring wing-beat frequency and thus, capable of providing accurate species identification, in conjunction with visual observation using thermal imaging video/image enhancing night vision, are currently the best option available to provide a meaningful estimate of the risk of turbine collision by Spectacled Flying-fox.

It is possible but not probable that a significant proportion of the population of Spectacled Flying-fox from all of the camps (**Figure 18.1**) that are within the maximum foraging zone distance around the MEWF site, could potentially fly within the proposed rotor strike area (i.e. 26-134 m above the ground) whilst foraging within the site or traversing the site to forage in adjacent areas during the proposed operational life of the project. On the basis of documented flying-fox collisions with aircraft (Parsons *et al*., 2007), it is estimated the majority of Spectacled Flying-fox individuals will fly below 150 m above the ground, which is approximately at the upper limit of the proposed rotor strike sweep area (134 m above the ground). It is unknown what proportion of flights are likely to occur under the lower limit of proposed rotor sweep area i.e. below 26 m above the ground. Repeated observations of the nightly fly-out of Spectacled Flying-fox individuals from the Cairns Library camp indicates a large proportion of the total population quickly reach a height of >35 m above the ground before heading off in constrained 'streams' to their nightly foraging areas (Jeff Middleton, pers. obs.).

Spectacled Flying-foxes are known to occur in high densities when foraging on spatially concentrated food resources e.g. lychee orchards, mass flowering myrtaceous trees etc. (Jeff Middleton, pers. obs.). Dense concentrations of fruit bats do occur in northern Australia en route to and from their camps (EPHC, 2010). No wide spread, mass flowering events associated with the numerous myrtaceous tree species were observed on the MEWF site during the three years of regular site visits (November 2010 to August 2013). However, no systematic surveys of myrtaceous tree flowering were conducted as part of the EIS field work. The flowering periodicity and intensity of eucalypts and other myrtaceous species is known to be spatially and temporally variable between species and sites (Setterfield & Williams, 1996; Law *et al*., 2001; McGoldrick & MacNally, 2005). There is a likelihood mass flowering of myrtaceous trees (*Eucalyptus, Corymbia, Lophostamen* or *Melaleuca*) will occur within localised areas on the MEWF site or within the potential maximum foraging zone area for each particular Spectacled Flying-fox camp (see **Figure 18.2** – map of the maximum foraging areas) at some times during the estimated 20+ years operation life of the proposed wind farm.

There is the potential for these patchy mass flowering events to attract large numbers of Spectacled Flying-fox for the duration of flowering, which could last for periods of months, however given the large area of similar habitat surrounding Mt Emerald and closer to the colonies the probability of a significant number of bats foraging on such events at the site would reasonably be limited. It is possible that high density concentrated 'streams' of Spectacled Flying-fox (including some *P. poliocephalus*) could transit over the MEWF site. If these localised mass flowering events happen to coincide with peaks in the populations of the camps (wet season months) then the potential for large mortality levels due to turbine collision could be increased. It is noted however, that these patchy myrtaceous flowering events are unlikely to be restricted to the MEWF area alone and in isolation of the extensive areas of similar vegetation surrounding the site and it is likely that foraging numbers would be spread across this area. The size of separate foraging groups exploiting each patch is highly difficult to predict and would depend on many variables. Similarly, as shown in **Figure 18.2** above, there are limited site fly over sectors within a large available surrounding foraging area for bats from each of the known colonies foraging in forests to the north south and west of the site.

It is not possible to determining the significance of the impacts of turbine collision mortality without long-term utilisation data and collision risk modelling. However, it is considered possible to mitigate against these impacts (see **Section 18.5.2** below).

18.3.2 Disturbance Leading to Displacement or Exclusion

It is not currently possible to make an informed prediction about the potential for the operating turbines to displace Spectacled Flying-fox individuals from the vicinity of the turbines due to avoidance behaviour associated with disturbance (most likely visual). In a large wind farm, such as MEWF, even this relatively small exclusion area around each turbine, could amount to a significant area within which Spectacled Flying-fox individuals are entirely excluded or exhibit reduced utilisation in. It is possible the operating wind farm could potentially reduce the abundance of Spectacled Flying-fox individuals foraging on the MEWF site and could also reduce the area outside the site available for foraging if animals exhibit a reluctance to detour around the site to access these areas however this is unlikely to be significant given the size of the available foraging area for the local colonies (see **Figure 18.2**). Loud noises (e.g. shotgun blanks) have been successfully used to disperse *Pteropus* spp. colonies in Australia (e.g. Phillips *et al*., 2007) and noise deterrents have been used to scare animals from fruit orchards (DAFF, 2013).

The maximum noise level directly above or beneath the wind turbine is likely to be in the order of ~ 100 dB, declining to ~40 dB at a distance of greater than 500 m. It is unlikely these operational noise levels would result in a significant disturbance to *P. conspicillatus* individuals given their apparent tolerance to similar noise levels e.g. leaf blowers, grass cutters, lawn mowers, and light and heavy vehicles) directly beneath or in close proximity (<50 m) to urban roost sites such as the Cairns Library camp (Jeff Middleton, pers. obs.).

18.4 Cumulative Impacts

There are a number of sources of potential impacts to the species within the region outlined below that may act in a cumulative manner and possibly result in additive mortality.

18.4.1 Wind Farms

There is currently only a single wind farm operating within the distribution of the Wet Tropics population of Spectacled Flying-fox, i.e. RATCH Australia's Windy Hill wind farm located near Ravenshoe (see **Chapter 2** for a description of the project).

Stage 1 of proposed High Road Wind Farm has received Federal Government environmental approval and assessments for Stage 2 of the project are currently underway. Stage 1 of the High Road Wind Farm comprises 17 x 2-3 MW turbines with a hub height of 80 m and a blade length of 45 m located in cleared land adjacent to wet sclerophyll forest.

Stage 2 of the High Road Wind Farm may comprise an additional 28 turbines, 12 of which are located within wet sclerophyll forest and 16 in cleared land. Stage 2 of the HRWF project is currently undergoing environmental assessment.

An assessment of a 50-60 turbine wind farm (no specifications available) at Archer Point, near Cooktown is currently underway (Larissa Hale, Balkanu Cape York Development Corporation, pers. comm.).

All of these approved or proposed wind farms are located within the distribution of the Wet Tropics population of Spectacled Flying Fox (and potentially Grey-headed Flying Fox).

ROAM (2012) modelled the wind and solar resources in the vicinity of the National Electricity Market (NEM) network, and found that the coastal area between Townsville and Princess Charlotte Bay and inland to

approximately Georgetown, has an enormous potential for wind energy and is generally counter cycled with wind resources in the southern states, a critical factor in achieving system reliability throughout the NEM. This area may therefore continue to attract interest from wind energy developers into the future. Approximately 50% of the potential distribution range of the Spectacled Flying-fox (DotE, 2013) overlaps with this identified area of high wind resources.

18.4.2 Damage Mitigation Permits

Recent changes to Queensland legislation have allowed the shooting of up to 1800 Spectacled Flying Foxes per year under damage mitigation permits (DEHP, 2013). Reporting of the number of Spectacled Flying-fox shot by commercial orchardists is likely to be underestimated due to the difficulties in locating the dead and fatally injured bats, and an underestimate in actual number shot.

Damage mitigation permits have also been issued to disperse Spectacled Flying-fox colonies in close proximity to urban settlements e.g. Cairns Library and Yungaburra. It is not understood what the cumulative impacts of mortality associated with shooting or colony dispersal will have on the overall population viability of Spectacled Flying-fox.

18.4.3 Accidental Electrocution

Accidental electrocution is currently considered to be a minor threat to the species (DERM, 2010).

The human population of Far North Statistical Division (which includes the majority of the predicted distribution range of Spectacled Flying-fox) is predicted to increase from ~283,000 in 2011 to 408,399 by 2031 (http://www.oesr.qld.gov.au/subjects/demography/population-projections/publications/qld-govt-pop-proj-lga/index.php). Approximately 70% of the regions predicted population growth will occur in the Cairns Local Government Area which includes 21 of the 49 known Spectacled Flying-fox camp sites (Adam McKeown, CSIRO, pers. comm.). Several of the known major camp sites are located within close proximity to rapidly expanding urban areas. It can be reasonably expected that this projected increase in the human population of the region will be associated with some increase in the total amount of powerlines. However, it is a local government requirement that all new subdivisions are serviced by underground power, so the numbers of Spectacled Flying-fox killed by accidental electrocution is not expected to increase.

18.4.4 Habitat Loss & Degradation

Large-scale clearing of remnant closed rainforest within the distribution range of Spectacled Flying-fox is no longer occurring. However, the ongoing clearing of drier vegetation communities throughout the region, particularly along the coast and to west of the Atherton Tablelands (DERM, 2010) is likely to have an adverse impact on the species given the importance of these habitats for foraging (Parsons *et al*., 2006).

Legislation restricting land clearing in Queensland has recently been amended. It is now permissible to clear remnant forest if it can be proven that the land has high agricultural potential (e.g. cropping and horticulture) and that the proposed development is economically viable. In addition many clearing activities are now self-assessable including logging and other extractive industries, thinning, maintaining fence lines, firebreaks, roads, and constructing and maintaining built infrastructure.

These legislation changes could result in an increase in the loss of sclerophyll forest and woodland within the distribution range of Spectacled Flying-fox, particularly on the relatively rich agriculturally suitable volcanic derived soils of the western Atherton Tablelands area e.g. Dimbulah, which could have the potential to adversely affect the species and the values of the World Heritage Area (DERM, 2010). Given the lack of available irrigation required for economic cropping in this area, the likelihood of further extensive clearing is currently low.

It is possible that the ongoing degradation of vegetation within small remnant areas such as Tolga Scrub which have high edge to interior ratios could reduce the longevity and suitability of known camp sites (DERM, 2010).

18.4.5 Cyclones

Shilton *et al.* (2008) examined the impact of the category four Tropical Cyclone Larry on the distribution and abundance of Spectacled Flying-fox in the Wet Tropics region. There was no evidence of significant amounts of direct mortality as a result of the cyclone (Shilton *et al*., 2008). Within two weeks of Cyclone Larry, the population estimate pre and post-cyclone were similar (199,000 compared with 168,000) (Shilton *et al*., 2008). In the ensueing six months following Cyclone Larry, ~90% of the estimated pre-cyclone population of ~199,000 animals (derived from CSIRO ground counts) were not able to be located (Shilton *et al*., 2008). Spectacled Flying-fox typically roosted in smaller camps post-cyclone than pre-cyclone (Shilton *et al.*, 2008).

Predicted increases in cyclone intensity and frequency in the region as a result of anthropogenic driven global warming (Walsh & Pittock, 1998) could also potentially accelerate the degradation of camps located in small isolated vegetation remnants.

18.4.6 Climate Change

As a result of climate change (rising temperatures, change in seasonal rainfall, increasing drought conditions and extreme weather events), bushfires are predicted to increase in frequency and intensity (Hennessy *et al.,* 2005).

Fire is likely to interact with particular elements of climate change, for example drought and with other stressors, such as invasive species (Williams *et al.,* 2009). In the savannas and the rainforests, an example may be the interaction between cyclones and fire, given that substantial tree fall (e.g. Cook & Goyens, 2008) may be followed by fires. In the savannas, the current threats posed by invasive grasses are likely to add to any threats to biodiversity posed by climate change and the threats of invasive grasses in the future are unlikely to abate.

Research has shown *Pteropus* spp. are highly susceptible to temperature extremes, with temperatures beyond a threshold of 42°C causing wide-spread mortality (Welbergen *et al*., 2008).

18.4.7 Paralysis Tick

Fatal envenomation of the Spectacled Flying-fox by paralysis ticks (*Ixodes holcyclus*) has been confirmed to be a key cause of mortality for the species on the Atherton Tableland and is acknowledged as a moderate threat to the species (DERM, 2010). The incidence of the paralysis tick has been shown to be positively correlated with high rainfall. It is thought the relatively recent spread of the exotic weed, *Solanum mauritianum,* is partly responsible for the observed increase in the incidence in paralysis tick related Spectacled Flying-fox mortality (Buettner *et al.,* 2013). *S. mauritianum* harbours more ticks than other food plants utilised by the species (J. Maclean, pers. comm. in Buettner *et al.,* 2013).

18.5 Assessment of the Significance of Impacts

In order to decide whether an action is likely to have a significant impact, it is necessary to take into account the nature and magnitude of potential impacts. In determining the nature and magnitude of an action's impacts, it is important to consider matters such as:

- The sensitivity of the environment which will be impacted;
- The timing, duration and frequency of the action and its impacts;

- All on-site and off-site impacts;
- All direct and indirect impacts;
- The total impact which can be attributed to the action over the entire geographic area affected, and over time;
- Existing levels of impact from other sources; and
- The degree of confidence with which the impacts of the action are known and understood.

The significant impact assessment for the Spectacled Flying Fox is detailed in **Table 18.2** below.

Table 18.2 Significant Impact Assessment for Spectacled Flying-fox

Spectacled Flying-fox (*Pteropus conspicillatus*) – Vulnerable	
Will the proposed works..	
Lead to a long term decrease in the size of a population?	Without mitigation, the proposed action has an unknown possibility to lead to a long-term decrease in the size of the Wet Tropics population of Spectacled Flying-fox given that: ▪ a large proportion of the total estimated Wet Tropics population is present in the 13 camps that occur within the maximum foraging distance of the site (43.4 km) including the largest surveyed colony located at Gordonvale. The mean monthly total population size of the 13 colonies between April 2004 and May 2013 is 47,949 (± 24,158 SD). The total population size for the 13 colonies ranged from 4000 to 105,000 in any given month during the same period (David Westcott, pers. comm., CSIRO); ▪ there is some potential for a large proportion of total population of the nearby colonies to forage on the site during sporadic mass flowering events of myrtaceous plants or traverse the site on their way to forage in adjacent areas; ▪ it is likely to be extremely difficult to predict spatial and temporal patterns of the species food resource (myrtaceous pollen and nectar) availability on the site or adjacent areas to identify potentially high risk areas or periods without long-term monitoring; ▪ the available information indicates that Australian *Pteropus spp*. typically fly below 150 m above the ground which is within the proposed rotor sweep area of the wind turbines; ▪ there are large knowledge gaps concerning the species ability to avoid turbines, due to there being few wind farms located within the species distribution range and the lack of any avoidance/collision mortality monitoring at these sites; ▪ the higher elevations of the MEWF site (>900 m a.s.l; 180 ha, ~7.75 % of the total area of the site) are frequently shrouded in low cloud during the evening and up until mid-morning which is likely to increase the risk of turbine collision mortality for *Pteropus spp* when present; ▪ there is a high degree of uncertainty with the interpretation of population trends from data obtained from fly-out and ground based transects monitoring of camps due to an inability to locate all camps within the Wet Tropics. This uncertainty could easily under or over estimate unsustainable declines in the species Wet Tropics population; and ▪ there is no long-term utilisation data for the site or the adjacent areas, nor has numerical collision risk modelling been undertaken for the species for the proposed development due to the inability to accurately estimate flight height and abundance data. A cautionary approach to the assessment of risk is prudent given the lack of this information and as yet unknown significance of the confirmed presence of Spectacled Flying-fox foraging on the site and traversing over the site to forage in adjacent areas (e.g. Dimbulah region).
Reduce the area of occupancy of the species?	The project is unlikely to reduce the area of occupancy of the species given the high mobility and extensive range of colonies.

Spectacled Flying-fox (*Pteropus conspicillatus*) – Vulnerable	
Will the proposed works..	
Fragment an existing important population into two or more populations?	The project is unlikely to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of a species?	Key habitat is available to the Spectacled Flying-fox on the MEWF site however this habitat is not critical to the survival of the species and with a small portion (2.4%) of the site affected it is unlikely to have an impact.
Disrupt the breeding cycle of a population?	The proposed action could potentially disrupt the breeding cycle of an important population, if mass turbine collision fatalities occur at a sensitive time in the life cycle e.g. when females have dependent young left at the camp site while they forage, or if females are preferentially at a higher risk of collision due to some behavioural factor. Implementation of mitigation measures from a Spectacled Flying-fox Management Plan will reduce the likelihood of disruption to the breeding cycle of the SFF population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	There is no key habitat on the site that will be modified, destroyed, removed, isolated or decreased such that the availability or quality of habitat for the species is likely to decline. The majority of foraging habitat is also widely available to the species offsite and around the region.
Result in invasive species that are harmful to a vulnerable species being established in the vulnerable species habitat?	The project has little potential to lead to the introduction of invasive species that are harmful to the Spectacled Flying-fox. Implementation of Pest and Weed Management Plans may mitigate against any potential threats.
Introduce disease that may cause the species to decline?	Disease is not currently identified as a threat to this species. It is not anticipated that the project would result in an increased threat to the species of disease.
Interfere with the recovery of the species?	If unsustainable turbine collisions were to occur the proposed MEWF site would interfere with the recovery of the species. However with effective mitigation measures at the operational phase of the project it is expected that this risk may be minimised.

Further research (described in the following section) is required before the significance of the above impacts can be assessed with substantive confidence.

18.6 Mitigation Strategies

18.6.1 Pre-construction Phase

18.6.1.1 Wind Farm Re-design

The reduction and mitigation of impacts are considered most effective and less costly when they are implemented at pre-construction and construction phases of the development than active post-construction management strategies (EPHC, 2010).

Spectacled Flying-foxes were confirmed to occur on the site, however due largely to the inability to accurately separate the species from other *Pteropus spp*., and the inability to reliably estimate flight height; it was not possible to use this data for the purpose of estimating turbine collision risk or to identify potentially high-risk areas of the site or periods. This information is considered essential in order to mitigate potential impacts at the planning and design phase of the development such as:

- redesign to preferentially site turbines into areas of the lowest risk areas of the site;
- reduction of the number of turbines;

- identification and establishment of appropriate, infrastructure free zones around locations of habitat resources of importance or attraction e.g. myrtaceous trees; and/or
- Changing the model of turbine to be used or altering the hub height (EPHC, 2010).

Pre-construction Radar Utilisation Studies on Project site

Long-term pre-construction and construction monitoring (1-3 years) using a combined bird and bat radar systems (Verhoef *et al* 2003; Verhoef *et al.,* 2004) together with thermal imaging video/light-enhancing devices will be required to quantify the turbine collision risk to Spectacled Flying-foxes given the high variability (between year and within year) in population size of the known camps present within the maximum foraging distance (43.4 km) of the site, and the high spatial and temporal variability in available myrtaceous food resources occurring within the potential foraging zone of each of the camps occurring within a 43.4 km buffer of the proposed MEWF site (**Figure 18.2**).

Bird and bat radar systems currently represent the most effective method of assessing spatial and temporal variation in habitat usage of nocturnally flying animals such as Spectacled Flying-fox, in addition to allowing the collection of abundance and flight height data suitable for incorporation into a numerical collision risk model. Nocturnal bird and bat utilisation surveys for wind farms in the US and Europe typically used radar surveys to inform real time adaptive collision risk management (temporary turbine shut down) and assess risk for nocturnally active migrating birds and bats.

- Long-term pre-construction radar studies together with visual observation truthing (e.g. high-powered search-lights) will be conducted to determine spatial and temporal variation in habitat utilisation by Spectacled Flying-foxes over the project site.
- The information collected with radar studies (abundance, flight heights, tracks) is neccessary to assess turbine collision risk and to identify areas and periods (e.g. 1-2 hours after dusk and before dawn, low total cloud cover, periods of peak flowering etc) that pose unacceptably high risk of potential turbine collision requiring mitigation strategies.

Assessment of Operational Turbine Avoidance and Collision Mortality Surveys at Windy Hill Wind Farm

There is a major knowledge gap regarding the ability of Spectacled Flying-foxes, or any other *Pteropus spp*., to avoid turbine collisions, which is essential to more accurately assessing the potential risk to the species from the project.

The only existing wind farm located within the Wet Tropics distribution of Spectacled Flying-fox is the Windy Hill Wind Farm which began operation in 2000. The wind farm consists of twenty Enercon E40 turbines, which have a rotor diameter of 40 m and a hub height of 44m (rotor sweep zone from 24 m to 64 m). The Windy Hill Wind Farm is located within the maximum foraging distance (43.4 km) of 8 known Spectacled Flying-fox camps (Tolga Scrub, Lakeside, New Poley Road, Gadaloff Road, Whiteing Road, Mungali and Malanda). It is also possible that other camps may also occur somewhere within the 209,981 ha of rainforest that occurs within the maximum potential foraging distance (43.4 km) of the Windy Hill site. The Windy Hill Wind Farm presents the only opportunity to examine rates of turbine collision mortality and avoidance rates for Spectacled Flying-foxes that may assist in assessing the potential risk of the MEWF to the species.

The following studies are recommended to be conducted at the Windy Hill Wind Farm site:

- Trial the effectiveness of automatic micro-avoidance detection systems based on visual detection such as TADS (Desholm, 2003), or bird and bat to assess avoidance rates of Spectacled Flying-fox; and
- Conduct ground-based turbine mortality surveys at WHWF site, standardising for scavenger removal rates and detectability.

Population Viability Analysis or Potential Biological Removal

Following the completion of pre-construction habitat utilisation surveys and collision risk modelling, an evaluation of the predicted level of mortalities on the two species will be required in order to determine whether the potential impacts are ecologically significant.

Population Viability Analysis is an appropriate approach to model and predict the effects in terms of altered extinction probability for the species. However, there is still a large degree of uncertainty associated with several key demographic parameters that are essential for PVA modelling but are not well understood for Spectacled Flying-foxes and the Grey headed Flying-fox and would be required to be estimated based on best available information.

An alternative to PVA is Potential Biological Removal (PVB) Modelling, which was first used with determining sustainable take levels for marine mammals (Wade, 1998), but has recently used to determine the maximum allowable collision mortality of White-fronted Geese (*Anser alibfrons frontalis*) for a wind farm in Japan (Sugimoto and Matsuda, 2011) and for 46 species of waterbirds from wind farms along the Atlantic Coast of the US (Watts, 2010). PBR has advantages over PVA in that it requires relatively little demographic information (Dillingham & Fletcher, 2008; Watts, 2010).

CSIRO have been collecting monthly counts of every known Spectacled Flying-fox colony within the Wet Tropics since April 2004. These estimates of total population size would be essential for PVA or PVB modelling. Many of the required demographic parameters for the species have been estimated or measured directly by Fox (2008) as part of life history table modelling. This information exists with the CSIRO however is currently inaccessible.

18.6.1.2 Effectiveness of Wind Farm Re-design

The effectiveness of pre-construction mitigation options is likely to be highly dependent on the duration of the utilisation surveys, given the likely high temporal variation in flowering of myrtaceous tree species within the project site and in the surrounding areas within the maximum foraging area of all known and unknown Spectacled Flying-foxes camps (i.e. within a 43 km buffer around the site). Studies would need to be of long enough duration to characterise the temporal variation in habitat utilisation associated with food availability. Little research has been undertaken to determine patterns of flowering phenology of the myrtaceous plants of the Wet Tropics and adjacent Einasleigh Uplands bioregions, and the environmental factors affecting flowering phenology.

The use of radar has not been trialled in Australia; however its use is now common as part of American and European wind farm bird and bat risk assessments. The effectiveness of radar systems for preconstruction utilisation surveys at the project site will need to be assessed as it is dependent upon topography (which influences ground clutter levels) and prevailing environmental conditions.

Using avoidance and collision mortality rates for the Spectacled Flying-fox (and Grey-headed Flying-fox) obtained from WHWF to help assess the collision risk the project site may not be valid as there are significant differences between the Windy Hill Wind Farm site and the project site such as:

- Windy Hill turbines are significantly smaller those proposed for the MEWF site which will have a rotor diameter of 100-108 m and a hub height of 78m The proposed turbines for the MEWF project will have a rotor sweep area between 6.25 - 7.29 times greater than those of the Windy Hill turbines. By contrast the rotational speed of the rotor at MEWF is lower at around 16 rpm compared to Windy Hill at 36 rpm.
- The Windy Hill Wind Farm is located entirely on cleared pasture on gently undulating low hills unlike the project site which is located almost entirely within remnant dry sclerophyll woodland and open forest on complex terrain.

- The Windy Hill Wind Farm only covers an area of 57 ha (minimum convex polygon around turbines) compared with ~1527 ha (minimum convex polygon around turbines) for the MEWF site.

However, it currently presents the only opportunity to examine the potential impacts of an operating wind farm on *Pteropus* spp.

It may not be possible to obtain the required demographic information for Spectacled Flying-fox to enable either PVA or PBR analysis to be conducted.

18.6.2 Operational Phase

18.6.2.1 Automatic Shut-down of Turbines Using a Bird & Bad Radar/SCADA (supervisory control and data acquisition) System in Response to Detected High-Risk Criteria

It is proposed to use an advanced avian radar system in conjunction with a Supervisory Control and Data Aquisition (SCADA) system to automatically curtail specific turbines that are identified as high risk of turbine collision in real time.

The SCADA-radar systems continually monitor collision risk criteria based on target count, sizes and other criteria. When the system identifies high risk conditions at specific turbines, it automatically idles these turbines as a risk mitigation measure. Once the system has identified that the risk levels have returned to normal conditions, the idled turbines are restarted. The risk criteria are established for the wind farm based upon pre-construction flying-fox site utilisation data collected by a radar system over at least one year.

The system will incorporate frequency modulated continuous wave (FMCW) X-band radar capable of operating simultaneously in horizontal and vertical modes which are able to assess the animal's flight path, speed and flight height. In addition to automatically idling high risk turbines, the SCADA-radar systems can also incorporate deterrent devices such as laser beams, bright lights and long-range acoustic devices. Previous preliminary investigations of visual/acoustic deterrent systems (e.g. very bright halogen lights, recordings of shotguns and screaming bats) have shown some promise in NSW (Dr Greg Richards, pers. com) to deter flying-foxes from fruit orchards. Detect Merlin Avian Radar system fitted with radar-controlled Long Range Acoustic Devices (LRADs) and lasers has been used successfully to deter birds from landing on a toxic tar sands tailings dam at a tar sands process site in Canada (http://www.capp.ca/rce/about-the-program/awards/2012-2/presidents-award/). The system is reported as being 97.5% effective at deterring birds from approaching the tailing dam (http://www.capp.ca/rce/about-the-program/awards/2012-2/presidents-award/).

There are several suppliers of advanced avian/bat radar systems capable of being incorporated in to the wind farm SCADA system; Detect's Merlin Avian radar (Florida, US) and Robin Radar (Netherlands).

Mortality Surveys

The effectiveness of the SCADA-radar risk mitigation system will be tested by conducting spatially and temporally replicated collision mortality surveys utilising both humans and sniffer dogs and calibrated for carcass removal and different vegetation structure. The survey methodology design will be developed in consultation with a biostatician to ensure it is statistically rigorous.

Automatic Collision Detection Systems

Given the large size of the site, the large number of proposed turbines and the complexity of the topography, conducting mortality surveys at a frequency and scale that would enable timely and appropriate reactive responses to detected mortalities are likely to be resource and labour intensive. Therefore it is proposed to

trial the use of Automated Collision Detection Systems (ACDS) to help target the ground based carcass searches.

Several automatic bird and bat collision detection systems have been tested under field conditions or have been used in operational wind farms including: WT-Bird (Wiggelinkhuizen *et al.,* 2010; Wiggelinkhuizen *et al.,* 2006; ECN, 2011); ID Stat (Delprat, 2011); and Old Bird (Old Bird, 2012). However further research would be needed to prove their effectiveness at the MEWF site.

A prototype of the **WT-Bird®** Bird Collision Monitoring System was been tested at a single 2.5 MW turbine in the Netherlands for a period of several years. The system counts actual collisions and stores thermal imaging video registrations for species recognition. The system has to be able to differentiate collision sounds from the large range of sounds produced by the operating turbine. During field tests microphones, mounted on and within the wind turbine, were able to detect the majority of impacts of a 50 g, 7 cm object with the moving rotor blades (Verhoef *et al.*, 2003; Verhoef *et al.,* 2004; Wiggelinkhuizen *et al.,* 2006). Although the field tests showed that the prototype system successfully detected some bird and bat collisions but the numbers were too small to enable validation of the system. The price of one WT-Bird system is ~ €30,000 (Brabant & Jacques, 2009).

ID Stat is a system designed to detect bird and bat collisions developed in France in 2011. The system relies entirely on directional microphones with no associated visual recording devices used (see **Appendix 26** for presentation). To detect collisions, directional microphones are placed within the hub of the turbines at the base of each rotor. The microphones detect potential collisions and the accompanying software filter out the background noise as well as noise from rain. Once a collision is detected, the relevant information such as date, time, turbine ID, sensor ID are stored using data loggers and a message can be sent to the user via GSM network. Field tests have indicated that the system is capable of detecting collisions of dead chicken chick (30g), other small birds (4 to 7 g) and an artificial bird target (2.5 g) fired at an operating turbine with a customised air gun (Delprat, 2011).

The Old Bird system used microphones and thermal imaging video. Rather than using computer software to discriminate distinctive acoustic patterns of collision sounds from other loud mechanical noises produced by the wind turbine, this system relied upon a time-delay method to localise where the collisions have occurred (Old Bird, 2012).

There are a number of automatic systems that have been used to monitor the activity of flying birds and bats in the close vicinity of operating wind turbines including: TADS (Thermal Animal Detection System) (Desholm, 2003; Desholm, 2005), that uses thermal imaging video cameras; and VARS (Visual Automated Recording System), that uses a combination of active infrared video cameras together with infra-red lamps (Coppack *et al.,* 2011a; Coppack *et al.* 2011b). Both systems could potentially be modified for the monitoring of collisions (Collier *et al.,* 2011). Collier *et al.* (2011) provides a detailed review of both systems. Another system for monitoring bird activity close to operating turbines, ATOM (Acoustic/Thermographic Offshore Monitoring System, utilising acoustic detectors and thermal imaging video was under development in 2011 but has not yet undergone field testing (ACJV, 2013). The TADS system has been used to monitor seabird collisions with wind turbines at two offshore wind farms in Denmark (Desholm, 2005; Desholm, 2006; Drewitt & Langston, 2006). During more than 2400 hrs of monitoring, the system detected only 15 birds and bats flying in close proximity to the test turbine and only recorded a single collision involving a small bird or bat (http://www.technologyreview.com/news/407299/massive-offshore-wind-turbines-safe-for-birds/page/1/).

In addition to ACDS, advanced bird and bat radar systems including DeTect and Robin Radar, have the potential to be able to monitor Spectacled Flying-fox activity in close vicinity to operating turbines (Collier *et al.,* 2011).

Temporary turbine shut-down in response to detected mortalities exceeding acceptable predetermined levels (determined by PVA or PBR)

If, despite the operation of the automatic SCADA-radar system, carcass searches find that numbers of dead Spectacled Flying-foxes exceed predetermined threshold levels at individual turbines or across the entire site then appropriate adaptive mitigation actions will be required to be implemented e.g. temporary shutdown of turbines, until such time as the risk of collisions has returned to acceptable levels. The *threshold mortality levels* will need to be determined from Population Viability Analysis (PVA) or more likely by Population Biological Removal method (PBR) given the uncertainties in the Wet Tropics population estimates and demographic parameters. Qld Damage Mitigation Permits for shooting Spectacled Flying-foxes are set at 1800 individuals per year which corresponds to less than 1.5% of the 2005 population estimate of ~269,000 which was the best available data at the time of the submission of the culling proposal; James Hammond, DotE, pers. comm.).

The duration that identified high-risk turbines are required to be shut-down for would need to be determined by radar monitoring or other visual survey methods (thermal imaging video/light-enhancing night-vision devices).

Satellite Telemetry

The provision of financial assistance to CSIRO to support their research project collecting satellite telemetry of Spectacled Flying-fox including movement data obtained from individuals from the Tolga Scrub camp and other camps within the potential maximum foraging area (**Figure 18.2**), may assist with identifying high collision risk periods when Spectacled Flying-foxes are foraging within the MEWF site or in surrounding areas.

18.6.2.2 Effectiveness

Radar systems have been used successfully for pre-construction bird and bat wind farm utilisation studies in the US, Europe and New Zealand but are yet to be trialled in Australia. However, there is a paucity of independent peer-reviewed research on the effectiveness of any bird and bat radar/SCADA systems. Only a few avian radar systems integrated with mitigation SCADA are currently in use at operational wind farms. The DeTect Merlin radar/SCADA system is deployed at three wind farms:

- the Peñascal Wind Farm, in Texas USA (since April 2009)
- Bahace Wind Farm, southern Turkey (since 2010)
- Gulf Wind Farm, Texas USA (since 2010)

According to Detect (2013), the Merlin radar-SCADA system in operation at the Penascal Wind Farm since 2009 has achieved its operating goal in preventing any major migratory bird collision mortality, resulting in shut-down times of less than 32 hours per year.

Robin Radar is currently developing the mitigation rules for an operating wind farm in Bulgaria, and the SCADA integrated system is proposed to be in place in November, 2013 (Addy Borst, Robin Radar, pers. comm.).

The effectiveness of any radar/SCADA would depend upon having detailed pre-construction utilisation data for the species over the site to develop most effective mitigation rules for the system.

The performance of a bird and bat radar system is dependent on a multitude of factors, such as the species studied, their flight behaviour, the terrain of the study site and meteorological conditions (Shamoun-Baranes *et al.,* 2008). There have been few studies investigating commercial bird and bat radar detection capabilities.

Dokter *et al*. (2013) quantified the detection capabilities of a prototype Robin Radar X-band marine radar system and found that the effective detection range for single birds flying at low altitude for an X-band marine radar based system was estimated at 1.5 km. Within this range the proportion of individual flying birds that were detected by the radar was 50 ± 6%, with a detection bias towards higher flight altitudes and larger birds (Dokter *et al.,* 2013). Studies would need to be conducted to quantify the detection capabilities of any radar system that may be used on the project site.

Another factor that may limit the effectiveness of avian radar systems used in a mitigation capacity is that the operating wind farms can interfere with radar systems and require technical mitigation to work effectively (Brenner *et al.,* 2008). If the system works according to the manufacturer's specifications, then the rapid automatic idling/shutdown of turbines in response to detected high risk Spectacled Flying-fox movements would be an effective method of minimising collision related mortality.

The effectiveness of any automated collision or micro-avoidance detection systems similar to WT-Bird or TADS etc would need to be determined on site through detailed trials.

Carcass searches in the vicinity of at risk turbines are likely to accurately quantify the actual Spectacled Flying-fox mortality provided that studies to determine detectability and scavenger removal rates are conducted beforehand, and surveys are conducted at suitable frequency and spatial replication. Current methods of bird and bat carcass detection are labour-intensive and therefore monitoring typically is only undertaken at a small scale i.e. a subset of all turbines (Wiggelinkhuizen & Boon, 2010).

18.7 Offsets

Assuming Spectacled Flying-fox occurs in some numbers within the project site at certain times of the year, and assuming individuals may typically fly in or near the path of the rotor blades, it is possible that individuals may be killed. It may not be possible to effectively avoid or mitigate potentially high levels of turbine collision mortality for Spectacled Flying-fox through redesign, or during the operational phase of the project. With the lack of data on mega-chiropteran life history and ecology generally, and the lack of information on collision risk, it may be reasonable to consider offsets. Some potential offset options could include:

- Support current research projects examining the movement and abundance of the species in the Wet Tropics;
- Subsidising the costs of netting fruit orchards in the Wet Tropics that experience damage from Spectacled Flying-fox. This action may reduce the number of Spectacled Flying-fox individuals that are shot under State Damage Mitigation Permits. However, the number of animals that can be directly culled under Damage Mitigation Permits is only 1800 per year, although the actual number of deaths would probably be much greater i.e. starvation of dependent young following the death of their mothers, and significant under-estimate of dead animals given shooting occurs at night and not all carcasses are recovered;
- Provide financial and material support to animal carers to raise orphaned young and injured individuals; and
- Provide financial assistance to CSIRO to support their research project collecting satellite telemetry of Spectacled Flying-fox.

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19.0 Hazards and Risks

19.1 Aviation Impacts

Rehbein Airport Consulting was engaged to provide an assessment of likely impact upon aircraft operations likely to be undertaken within the vicinity of the site. The report is summarised in this chapter. Their full assessment is included for reference in **Appendix 27** with additional community consultation over potential impacts to agricultural aviation considered in **Appendix 9**.

This study considered in detail the likely impact of the location, height and blade rotation of the proposed wind turbines on the nearest aerodromes; air navigation and air traffic management services; transiting air routes; designated airspace such as Danger, Restricted or Prohibited areas; any other aviation activity; and electromagnetic interference (EMI) with airborne radio.

19.1.1 Existing Environment

19.1.1.1 Civil Aviation Safety Authority (CASA) Requirements

CASA's role is to regulate the safety of civil air operations in Australia. This includes operation of aircraft and personnel, aerodromes and designated flight paths. Wind Farms are considered by CASA as a potential obstacle and as such legislation considers this risk.

Civil Aviation Safety Regulation (CASR) 139.365 requires the proponent of a proposed structure "…*the top of which will be 110m or more above ground level…*" to notify the Civil Aviation Safety Authority (CASA) of their intention and to provide the proposed height and location of the building or structure. If the proposed obstacle, building or structure is deemed to be hazardous to aircraft operations CASA may direct the proponent to light or mark the hazard in accordance with the Manual of Standards (MOS Part 139 — Aerodromes). CASA formerly provided guidance material on lighting of wind farms in Advisory Circular AC 139-18(0) *Obstacle Marking and Lighting of Wind Farms,* now withdrawn.

Following a recent risk review of manmade objects located away from regulated aerodromes CASA is contemplating the development of a regulatory framework similar to that of the United States Federal Aviation Administration for marking and lighting of obstacles. The United States regulations define obstacles as buildings, objects and structures of 150m or more in height. In conjunction with rulemaking activity, CASA intends to review Advisory Circular 139-08(0) on reporting of tall structures and will consider reviewing the withdrawn Advisory Circular 139-18(0) on lighting of wind turbines to refer to lighting requirements for structures 150 metres or more above ground level. Updated guidance material is normally released with new regulations, following a process that may require two years to complete. However, guidance contained in AC 139-18(0) on lighting of wind turbines to fulfil duty of care obligations continues to be relevant.

19.1.1.2 Australian Defence Force (ADF) Requirements

The legislative instruments protecting civil aircraft safety can be assumed to replicate the interests of the Australian Defence Force (ADF) aircraft operations and as such input from the ADF could be expected if the proposed activity has a potential impact on military flying operations. CASA may liaise with the RAAF Aeronautical Information Service (AIS) as that organisation maintains the tall structure database on behalf of the aviation community.

19.1.1.3 Other Aviation Activities

As with ADF, Airservices Australia, the provider of Air Traffic Control Services and Air Navigation Services has an interest in assessing proposed tall structures to ensure there is no impact upon the performance of ground based navigation aids and radar facilities.

19.1.2 Impact Assessment

This study considered in detail the likely impact of the location, height and blade rotation of the proposed wind turbines on the nearest aerodromes; air navigation and air traffic management services; transiting air routes; designated airspace such as Danger, Restricted or Prohibited areas; any other aviation activity; and electromagnetic interference (EMI) with airborne radio.

The proposed wind farm will not impact upon aircraft operations to and from Cairns Airport or Mareeba and Atherton Aerodromes. Nor will it interfere with airborne radio or navigation aid performance. Flights operating under the Visual Flight Rules (VFR) should not be affected by the proposed wind farm as these flights are required to be conducted at a minimum height of 500 ft above ground level outside populous areas and will be above the level of the turbines. The structures will be sufficiently conspicuous by day, and at night local en route lowest safe altitudes (LSALTs) will provide clearance required for flights under the Instrument Flight Rules (IFR) and night operations under the Visual Flight Rules (Night VFR).

Investigation undertaken by REHBEIN Airport Consulting suggests the impact, if any, of the proposed wind farm upon radar and radio performance in the region will not be of operational significance. However, it would be prudent to confirm whether Airservices Australia has any concerns about the potential impact of the wind farm.

Low level flying operations such as agricultural aerial spreading and spraying operations or power transmission line inspections may be affected on the downwind side of the turbines over land on which the turbines are directly positioned, or over portions of some adjoining properties that are sited downwind from the turbines. This is due to wind shear, turbulence and downdrafts in the wake of the turbine rotors presenting a critical hazard to aircraft such as agricultural aircraft operating at low level and high weights during application of chemicals and seeding. However, agricultural spraying operations are normally conducted at very low levels and often require calm or very light wind conditions of less than 8 knots (15km/h). At these wind speeds it is reasonable to assume the wake can extend for a distance of 6 rotor diameters or 600m downwind of the nearest turbine based on the proposed rotor diameter of approximately 100m. Given the distances from wind turbines to cultivated areas of land on adjacent properties outside the wind farm boundary there should be minimal impact on agricultural aerial operations.

Apart from aerial agricultural operations over the wind farm, the risk to civil aviation activities if any that this wind farm may pose is negligible. However, as with any reported tall structure that may pose a risk, regardless of its negligible risk, the position of the proposed wind farm should be shown on appropriate air navigation charts to assist pilots operating in the region. Additionally, hazard lighting in accordance with MOS 139, Chapter 9, Section 9.4 should be installed on sufficient turbines in the Mount Emerald Wind Farm to define the extremities of the site. The lighting should be operated in a manner consistent with a general duty of care towards aviation, such as during the period 1 hour before sunset to 1 hour after sunrise, and during conditions of reduced visibility caused by smoke, dust or haze. Implementation of such mitigation measures will ensure all the safeguards put in place by CASA to reduce the risk posed by tall structures, including wind turbines, to the safety of civil aircraft operations are satisfied.

19.1.3 Mitigation Measures

Once the wind farm is approved the layout, detail and construction timing will be provided to CASA and the ADF to ensure that any amendments to charts and designations can be made accordingly.

A commitment to cease operation of the wind farm for the duration of downwind aerial spraying for lands within 5km of the wind farm would tend to negate any impact on local agriculture. Impacts to local tourism are difficult to quantify as any number of contributing factors may influence tourist economics. There does not seem to be any evidence to support wind farms have a negative impact on tourism, however, in many jurisdictions local operators and authorities have taken advantage of the opportunity and turned wind farms into a positive.

19.2 Telecommunications Impacts

19.2.1 Existing Environment

Given the wind turbines have such a large physical structure, there is potential for inference with communication services to occur. The different effects wind farms can have on communication services are summarised below:

- **Near field impact:** A property of a transmitting and/or receiving antenna is a "near field" zone that is present around the antenna. Any object that can conduct or absorb radio waves, placed within the near field zone, can alter the behaviour of the antenna.
- **Obstruction impact:** If a conductive object is placed within the advancing wavefront of a radio wave, wave energy can be absorbed, detrimentally affecting the signal detected at the receiver.
- **Reflection and scattering impacts:** If an object that's reflective to radio waves exists in the advancing wavefront, it may reflect energy away. The reflected signal may be reflected to the transmitting or receiving antenna which can interfere with the desired signal.
- **Electromagnetic fields / RF interference:** The operation of a wind turbine generator, and associated electrical transmission infrastructure, creates an electromagnetic emission that can, theoretically, interact with radio communication.

In assessing radio communication impact by wind farms, radio systems are commonly broken into a number of different categories based on type. For the purposes of electromagnetic impact investigation, the following categories of services are considered:

- **Point-to-point:** Radio links that transmit and receive between two fixed points fall under this category. For example, network backhaul commonly utilises point-to-point communication. These commonly include radio communication services.
- **Point-to-multipoint:** A central location transmits to, and sometimes receives from, a number independent of locations. Television and radio broadcasting and reception, mobile phones (to the cell site mast) and land mobile systems fall under this category.
- **Radar:** Radar transmits a signal which is reflected back to the transmitting station (some systems involve communication between a radar station and a transponder). Services that utilise radar technology include aircraft detection and weather services.

19.2.2 Impact Assessment

Parson Brinckerhoff (PB) was engaged to investigate any potential impacts to radio wave communication services and radar communication services in the locality as consequence of Mt Emerald Wind Farm. The

full findings of the investigation are detailed within the Electromagnetic Interference Assessment within **Appendix 28**.

For this investigation, PB identified existing radio communication sites and services and their associated paths. This data was obtained from the Australian Communication and Media Authority's database of registered radio communication licenses (RADCOM). Twenty-eight radio communication sites were found within a 10 km distance of the wind farm boundary, with an associated 222 registered assignments. This data was mapped against the proposed wind farm layout, provided by RACL. Communication towers and service paths that were within three kilometres of the wind farm were selected for further investigation. To this selected data, standard exclusion zones were calculated and the wind farm was assessed considering these zones. No turbines were assessed to intrude on near field exclusion zones surrounding the identified radio towers.

19.2.3 Mitigation Measures

Parson Brinckerhoff recommends that, to avoid obstruction interference, no turbines intrude on the calculated 2nd Fresnel zone for point-to-point radio links. PB suggests if the consulted licensees verify the RADCOM data is correct and there is agreement over radio path and tower setback distances, Mt Emerald Wind Farm Pty Ltd investigates mitigation options to avoid any interference. PB has determined that one turbine is located 4 m away from a 2nd Fresnel exclusion zone, presenting the possibility of the turbine encroaching on the exclusion zone depending on the orientation of the rotor. PB is in the process of seeking more precise coordinates from the relevant telecommunications tower operators/licensees.

PB believes point-to-multipoint impacts should be minimal. However, they recommend the position of registered point-to-multipoint license holders is sought with respect to the wind farm development. PB has initiated consultation with these license holders that are located within 3 km of the wind farm.

19.3 Fire and Bushfire Impacts

Fires have the potential to impact flora, fauna, and infrastructure within the MEWF site. The fire risk varies throughout the study area dependent on topography and fuel load. The bushfire danger season is approximately from August to late October in north Queensland when the dry season is nearing its end and both temperatures and wind speeds are on the increase. Fire is an important landscape function and should be managed in respect to vegetation communities, cultural significance and human safety.

19.3.1 Existing Environment

At a regional perspective, agricultural areas with typically little remaining natural vegetation generally have a low bushfire risk. Comparatively, areas of remnant or regrowth vegetation have bushfire hazard levels mapped between medium and high depending on a variety of factors such as fuel load, vegetation type, species composition and moisture level. The main uses of fire in the region are associated with cane fires and controlled burns undertaken by state agencies such as the Queensland Parks and Wildlife Service.

Accidental fires on the MEWF site would most likely result from lightning strike, vehicle ignition, camp fires, or operational construction work such as the use of powertools (grinders, etc).

Fire mapping based on interpretation of satellite imagery obtained from the Northern Australia Fire Information (NAFI, 2011) indicates that the entire site was burnt most recently in 2009. No other fires were mapped on the site back until at least 2004. It should be noted that the pixel size of the MODIS satellite imagery is approximately 300 m^2 so the mapping is unable to provide a realistic indication of the degree of the spatial heterogeneity of fires.

From visual assessments of the extent of scorching on trees, the fires are presumed to have been relatively hot and ferocious – extending completely into the crowns of trees in the canopy of vegetation to 10 m high. Emergence of epicormic shoots and young branchlet formation provide evidence that the fires severely affected sections of ridgeline vegetation (particularly smaller trees such as *Corymbia abergiana*). Dense, monospecific stands of low wattle regrowth (believed to be *Acacia calyculata*) have developed as the dominant shrub layer in areas where fire appears to have had the severest impact. Little other ground layer vegetation is present in these situations except for clumps of tussock grasses (an *Aristida* sp.).

The 2009 fires do not appear to have affected the whole project area. For example, the flat-bottomed valley in the interior and the western ridgeline has remained relatively unburnt and show fewer signs of severe fire events. In this sense, it is believed that fire passes through the project area on a periodic basis – enough to limit the development and build up of high fuel loads. For example, sections of woodland or open forest where the pronounced effect of recent fires was not evident, did not support a conspicuously 'heavy' fuel load in the ground layer, and in fact, were relatively easy to traverse. In these circumstances, grasses such as *Themeda triandra* and *Heteropogon triticeus* are invariably present and favour the under-canopy environment afforded by the structural formation of woodland to open forest, rather than sparser open woodland. Generally, it was found that ironbarks (*Eucalyptus drepanophylla* and *E. granitica*) are sparsely represented in these vegetation communities.

19.3.2 Impact Assessment- Construction and Decommissioning

19.3.2.1 Natural Fire Events

The MEWF project has limited potential to cause increased impacts upon vegetation or fauna associated with natural fire events as it is unlikely to significantly change existing fire patterns. However, the project may impact on the potential for unnatural fire events particularly during construction and decommissioning.

19.3.2.2 Unnatural Fire Events

There are a number of flammable materials and ignition sources in use during construction and decommissioning of a wind farm which may increase the risk of fire. Particular activities may also serve to increase that risk for example improper handling and storage of flammable substances, disposal of cigarette butts, or fuel load under work areas.

All mobile construction equipment should be with spark arresters to prevent accidental spark ignition of combustible material. Where naked flames are required, for example when oxy-acetylene equipment is used or where steel is being cut by grinders, two full fire extinguishers shall be located within 10m of the work area.

19.3.3 Impact Assessment – Operations

Research and operations over the past 20 years suggest that there is little chance of operational wind farms to create a fire risk (Macintosh and Downie, 2006) in Australia.

Wind turbines have the potential to create fire hazard in two ways: mechanically in which turbine bearings wear out, electrical shorts occur or cables are damaged for example; and lightning strikes due to the turbines height (Flynn, 2004). A review of available data reveals three wind turbine fires being reported in Australia with the root cause of each being attributed to mechanical issues. In each case the fires did not spread beyond the turbine due mostly to the passive nature of the turbines (few flammable materials), their lightning protection equipment, and in part due to the wind farms fire management strategy.

It is also possible for fires suppression systems to be installed in the nacelle of modern wind turbines. Systems are either retrofitted to existing turbines or installed as an option within the factory, and given the relatively low cost of these systems when compared with the overall price of the turbine, there is becoming increasingly more popular with both wind farm owners and their insurers.

The impact of a bushfire on WTG's at the MEWF site should be limited. Fires will be hot and fast and are unlikely to burn for long enough periods in the vegetation surrounding a turbine to cause any more than superficial damage to the base. Cleared areas under the turbines and the access track also create buffers. It is also unlikely that damage from flames could reach the nacelle or blade tips. The greatest risk will be to the substation, and other associated maintenance infrastructure on site which can if damaged, interfere significantly in the wind production capability on site.

19.3.4 Mitigation Measures

A detailed Fire Management Plan is under development by RACL (**Appendix 29**) to identify the approach to fire management during the Design, Construction and Operations Phases. Fire management strategies will include:

- Open fires will be banned on the project. Fires include open barbeques, billy fires, brush burning and rubbish burning.
- Adoption of lightning protection measures for both turbines and substations.
- Unnecessary build-up of flammable material near working areas will be prevented, with vegetation and other flammable material being stockpiled well clear of hot work activities.
- Water trucks (also used for dust suppression) will be available for use as fire trucks in the event of fire.
- All vehicles will be equipped with portable fire extinguishers.
- Fire extinguishers and a water cart will be available to the welding crew. All appropriate crew members will be trained in the use of fire fighting equipment.
- Emergency Response Plan shall include details on local contacts for fire fighting assistance.
- Construction management liaison with local Rural Fire Service personnel during high fire periods.

19.4 Climate Extremes and Climate Change

Over the period of 2006-2010 the Australian Government's Marine and Tropical Sciences Research Facility (MTSRF), on behalf of the Reef and Rainforest Research Centre (RRRC), conducted research into regional climate change projections for the tropical rainforest region of North Queensland, based on a range of current global models, simulations and current data analysis (Suppiah, *et al* 2010).The study area consisted of the majority of the Queensland extending from Cape York to Hervey Bay and west to the latitude of Karumba. MEWF site occurs within an area designated as the tropical rainforest region of North Queensland.

The models indicated a range of plausible changes in temperature, mean rainfall and increased rainfall intensity, potential evaporation and possible changes in El Nino Southern Oscillation (ENSO), and tropical cyclone behaviour could potentially occur within the study area however there was considerable variability and uncertainty in relation to the timing, intensity and spatial extent of changes. Changes are likely to become more apparent over the next 30-100 years depending on the rate of CO_2 increase. However the work recognised the need to develop better methods to produce improved climate change projections under enhanced greenhouse conditions, particularly the ability of models to simulate the ENSO, which is known to significantly affect the regions rainfall and cyclone activity.

A summary of climate change projections from Suppiah *et al* (2010) report is outlined belowin sections 19.4.1 to 19.4.3.

19.4.1 Temperature

The projections show that the inland areas of the MTSRF study region will warm faster than the coastal areas. For a medium emissions scenario the best estimate regional annual average temperature increase by the year 2030 is 0.8°C, with a range of uncertainty of 0.6 to 1.1°C. Larger increases are projected for 2050 and 2070.

19.4.2 Rainfall

Global Climate Model simulations suggest an increase in heavy rainfall events in north-eastern Australia under enhanced greenhouse conditions.

Changes are to be expected in both the mean values and in the magnitudes and frequency of extreme rainfall events. Changes in rainfall are projected to be more complex than temperature changes, as their signs and magnitudes show strong spatial variations and model to model variation is high. For a medium emissions scenario the best estimate (50th percentile) regional average rainfall change for 2030 is -1% with a range of uncertainty of -8 to +6% and changes by 2050 and 2070 are dependent on emissions scenario. For 2050, the ranges of uncertainty for regional average rainfall change for the different scenarios span the range -16 to +11%. The corresponding range for 2070 is -26 to +18% (Suppiah *et al*, 2010). Spatial patterns of changes to rainfall were also predicted to be highly seasonal particularly after 2070.

19.4.3 Tropical Cyclones

Significant environmental damage has occurred on the Tablelands as a results of storms (inclusive of both hail and mini-tornado), and cyclones. The Tablelands is vulnerable to tropical cyclones from November to April annually (TRC, 2008). While storm intensity often diminishes considerably by the time systems reach inland areas, highly destructive systems can still affect the Mt Emerald area.

RRRC (2010) concluded that since there is a strong observed relationship between tropical cyclone frequency and ENSO, uncertainty associated with ENSO under climate change conditions will also create uncertainty in future tropical cyclone behaviour in the region.

There is uncertainty about changes to tropical cyclone behaviour due to climate change. However, a recent review of tropical cyclone characteristics simulated by models suggests an increase in globally averaged tropical cyclone intensity by 2-11% by the year 2100 (Suppiah *et al*, 2010). This leads to an increase of the order of 20% in the precipitation rate within 100 km of the storm. These models also suggest a decrease in cyclone frequency in the southern hemisphere, with mixed changes in northern Australia.

19.4.4 Impact Assessment

Studies of the sensitivity of ecosystems to climate change conducted by James Cook University, CSIRO Sustainable Ecosystems and others suggest that enhanced greenhouse conditions can have significant impacts on ecosystems of the tropical rainforest region, as well as economy and tourism, and human settlements.

A possible reduction in rainfall, higher temperatures and increased potential evaporation, and increase in rainfall intensities and possible change in ENSO and tropical cyclone behaviour suggest potential for widespread impacts in northeast Queensland, particularly in the tropical rainforest and Great Barrier Reef regions.

Notwithstanding the considerable variabilities in projections by MTSRF, the intensity of extreme rainfall events is projected to increase even under slightly reduced average rainfall conditions, which could increase run off intensity, resulting in enhanced soil and in stream erosion with potential decrease in stream water quality and aquatic ecosystem function.

Similarly an increase in the number of hot days (beyond a threshold) and a reduction in the number of cool day could impact agricultural yields and increase human comfort, bushfire prevalence and energy demand. Rainfall and temperature changes could also increase native plant and animals stress resulting in ecosystem degradation, however there is currently no conclusive evidence of changes to rainfall patterns.

Notwithstanding the uncertainties surrounding the magnitude and temporal and spatial extent of climate changes discussed above, potential cumulative impacts from the MEWF project could include:

- Increased bushfire frequency and impact on vegetation patterns and sensitive plant and animal species survival, including weed invasion;
- Increase in run off turbidity as a result of earthworks and track erosion and reduction in aquatic ecosystem function; and
- Potential incremental loss of montane heath vegetation community from track and turbine construction clearing activities.

19.4.5 Mitigation Measures

Potential impacts identified above are considered to be manageable through careful implementation of planned bushfire, weed management, clearing and erosion and sediment control strategies during the construction and operational phases of the project. These measures are discussed in detail in **Chapter 14**.

19.5 Health and Safety

Wind farms have number of health and safety issues associated with their construction, operation and decommissioning. Both construction and decommissioning risk elements are not unique to wind farms and are considered in each contractor's code of practice. These are short term and offer very little risk to the general community. Operation of a wind farm does however carry some potential health and safety hazards that are unique to the industry. The health impacts of noise, electromagnetic fields and shadow flicker are considered below.

19.5.1 Wind farm noise and health

There has been considerable media attention to the alleged negative health effects from wind energy. This media attention has translated into widespread community concern, including amongst residents living in proximity to the proposed MEWF site.

The matter of wind farm noise and health was considered by Pierpont (2009), who described various health symptoms apparently related to infrasound emissions from wind turbines, and collectively termed "wind turbine syndrome". The thesis proposed by Pierpont – with conclusions drawn from case reports - is that low frequency noise and infrasound from wind turbines has a direct effect on the human body resulting from impacts to the body's motion sensing system (inner ear) and from vibrations to internal organs. Wind turbine syndrome is apparently associated with symptoms such as headaches, sleeplessness and anxiety. NSW Health (2011) made the following observations in relation to the Pierpont findings:

> *This 'study' is not a rigorous epidemiological study; it is a case series of 10 families drawn from a wide range of locations. This work has not been properly peer-reviewed, nor has it been published in the peer-reviewed literature. The findings are not scientifically valid, with major methodological flaws*

> *stemming from the poor design of the study. This 'study' is not of sufficient scientific rigour. It raises hypotheses, it does not prove them.*

The matter of public health and the relative contribution of fossil fuel and renewable energy generation is also a matter of public interest. Two recent publications by Doctors for the Environment (2011) and the Climate and Health Alliance (2012) address the this issue in terms of health impacts from energy generation, specifically the relative impacts of fossil fuels and renewable energy.

Doctors for the Environment Australia (DEA) – a voluntary organisation of medical doctors in all Australian states and territories working to address the diseases caused by damage to the Earth's environment – made a submission to the Senate Community Affairs Committee *Inquiry into the Social and Economic Impacts of Rural Wind Farms* (DEA, 2011). DEA has "…*an established policy that business as usual using fossil fuels is unsustainable and a health hazard and it strongly supports an urgent transition to renewable energy*." DEA made the following observations in relation to the health impacts of coal energy generation:

> *Coal is responsible for a significant disease burden in our community through its mining to its processing, transport and burning for power generation. The air pollution released by mining and burning coal is an unhealthy chemical cocktail including fine and coarse particles, sulphur dioxide, nitrogen dioxide and trace elements.*
>
> *Health impacts from air pollution include worsening of asthma and chronic bronchitis, increased risk of lung cancer, increased risk of heart attack in those with heart disease, increased risk of premature death, and poorer lung development in children. Mercury is also released into the atmosphere from the burning of coal may accumulate in the food chain, and is toxic, particularly to the developing nervous system.*In comparing these impacts with those from renewable energy sources, DEA noted that "*Wind power and other renewable energies have the potential to reduce threats to health through reduction in air pollution and mitigation of climate change."*

The Climate and Health Alliance (CAHA) is "…a coalition of health care stakeholders who wish to see the threat to human health from climate change and ecological degradation addressed through prompt policy action" and includes the Public Health Association of Australia (PHAA), Royal College of Nursing Australia (RCNA), Royal Australasian College of Physicians (RACP) and Australian College of Rural and Remote Medicine (ACRRM). CAHA (2012) recently issued a position statement on health and wind turbines, which noted the following:

> *An examination of the health effects of any form of energy generation is meaningless unless it is placed into the context of alternative means of energy generation. Australia's current energy systems are heavily reliant on the burning of fossils fuels such as coal and gas for electricity generation. These energy sources are not only implicated in driving climate change but, particularly in the case of coal, also pose significant risks to human health. A shift away from fossil fuels to clean renewable energy to reduce greenhouse gas emissions will therefore also reduce risks associated with the mining, transportation and combustion of coal, which contributes to increased risk of developmental delays, lung cancer, heart disease, chronic obstructive pulmonary disease, asthma and other conditions.*

In consideration of the relative health burdens of renewable energy and fossil fuels, CAHA concludes that "…the deployment of wind turbines [is] an important source of zero emissions renewable energy for electricity generation to replace highly polluting and harmful fossil fuels to reduce climate risk as well as direct harm to human health".

Both DEA and CAHA conclude that adverse health impacts from fossil fuel energy generation are a significant public health issue and that wind energy, comparatively, has a negligible impact on human health.

Reviews of Wind Farms and Health Impacts

A number of reviews of the perceived impacts of wind turbine operation on human health have been undertaken over the last five years, both in Australia and internationally. Some of these reviews are summarised below:

National Health and Medical Research Council (2010)

The National Health and Medical Research Council (NHMRC) - Australia's peak body for developing health advice for the community - undertook a review of literature on the potential impacts of wind turbines on human health (NHMRC, 2010a). The objective of the review was to ascertain if the following statement could be supported by the evidence: *There are no direct pathological effects from wind farms and that any potential impact on humans can be minimised by following existing planning guidelines*. The review noted that this statement was supported by an expert review commissioned by the American and Canadian Wind Energy Associations (Colby *et al*. 2009) which is summarised below.

In a public statement accompanying the review (NHMRC, 2010b), the NHMRC noted that:

> *Concerns regarding the adverse health impacts of wind turbines focus on infrasound, electromagnetic radiation, shadow flicker and blade glint produced by wind turbines. While there is currently no evidence linking these phenomena with adverse health effects, the evidence is limited.*
>
> *While a range of effects such as annoyance, anxiety, hearing loss, and interference with sleep, speech and learning have been reported anecdotally, there is no published scientific evidence to support adverse effects of wind turbines on health.*

The review (NHMRC, 2010a) noted that "*Based on current evidence, it can be concluded that wind turbines do not pose a threat to health if planning guidelines are followed*" and concluded:

> *The health effects of many forms of renewable energy generation, such as wind farms, have not been assessed to the same extent as those from traditional sources. However, renewable energy generation is associated with few adverse health effects compared with the well-documented health burdens of polluting forms of electricity generation.*
>
> *This review of the available evidence, including journal articles, surveys, literature reviews and government reports, supports the statement that: There are no direct pathological effects from wind farms and that any potential impact on humans can be minimised by following existing planning guidelines.*

The public statement (NHMRC, 2010b), concluded that:

> *…it is recommended that relevant authorities take a precautionary approach and continue to monitor research outcomes. Complying with standards relating to wind turbine design, manufacture, and site evaluation will minimise any potential impacts of wind turbines on surrounding areas.*

The review (NHMRC, 2010a) also noted that many factors can influence the way noise from wind turbines is perceived. Citing a study by Pedersen & Persson Waye (2007), the review noted that "…*being able to see wind turbines from one's residence increased not just the odds of perceiving the sound, but also the odds of being annoyed*". This observation was corroborated by a study of 725 residents living near wind farms in the Netherlands (Pederson et al, 2009), which found that annoyance was strongly correlated with a negative attitude toward the visual impact of wind turbines on the landscape.

Victorian Department of Health (2013)

The Victorian Department of Health released a document in April 2013 titled *Wind farms, sound and health: Technical Information* along with a less technical summary *Wind farms, sound and health: Community Information*.

The investigation concluded that in relation to the sounds produced by wind farms and their potential impact on health:

> *"The predominant sounds produced by wind farms are in the mid to high frequencies. Wind farm sound, including low levels of low frequency sound, may be audible to nearby residents.*
>
> *Audible noise from any source, including wind farms, can cause annoyance, resulting in prolonged stress and other health effects. The potential for health impacts depends on acoustic factors (including sound pressure levels and other characteristics of the noise) and non-acoustic factors (including individual noise sensitivity and attitude to the source).*
>
> *Infrasound is audible when the sound levels are high enough. The hearing threshold for infrasound is much higher than other frequencies. Infrasound from wind farms is at levels well below the hearing threshold and is therefore inaudible to neighbouring residents.*
>
> *There is no evidence that sound which is at inaudible levels can have a physiological effect on the human body. This is the case for sound at any frequency, including infrasound."*

The Massachusetts Department of Environmental Protection and Department of Public Health (2012)

The Massachusetts Department of Environmental Protection and Massachusetts Department of Public Health (2012) engaged an independent expert panel to "…*identify any documented or potential health impacts* [or] *risks that may be associated with exposure to wind turbines*…" The Panel - comprising seven individuals with backgrounds in public health, epidemiology, toxicology, neurology and sleep medicine, neuroscience, and mechanical engineering - conducted an extensive review of the scientific literature as well as other reports, popular media, and public comments. A focus of the Panel's review was "…*to examine the plausibility or basis for health effects of turbines (noise, vibration, and flicker)*".

The Panel's findings in relation to operation of wind turbines and noise and vibration generated the following conclusions:

> *"Literature on human response to wind turbines relates to self-reported "annoyance," and this response appears to be a function of some combination of the sound itself, the sight of the turbine, and attitude towards the wind turbine project.*
>
> *There is limited evidence from epidemiologic studies suggesting an association between noise from wind turbines and sleep disruption.*
>
> *There is insufficient evidence that the noise from wind turbines is causing health problems or disease.*
>
> *Impacts on the human body's vestibular system from wind turbine infrasound have not been demonstrated scientifically, with available evidence demonstrating that infrasound levels near wind turbines cannot impact the vestibular system.*
>
> *There is no evidence for a set of health effects, from exposure to wind turbines that could be characterised as a "Wind Turbine Syndrome".*
>
> *There is no demonstrable association between noise from wind turbines and measures of psychological distress or mental health problems.*

None of the evidence reviewed suggests an association between noise from wind turbines and pain and stiffness, diabetes, high blood pressure, tinnitus, hearing impairment, cardiovascular disease, and headache/migraine."

19.5.2 Electromagnetic Fields

Electricity generates both electric and magnetic fields (EMF). These fields emanate from the wires delivering electricity to our homes and all devices which use electricity in the home. Therefore, Australians are routinely exposed to these fields in their everyday lives. Refer to **Appendix 28** for a more detailed assessment of EMF.

Electric fields are shielded by many common building materials and the earth and reduce with increased distance from the source. Magnetic fields, on the other hand, are more difficult to shield but diminish with distance from the source. Bundling individual wires closely together reduces the magnetic field emitted.

Studies have consistently demonstrated that prolonged human exposure to weak electric fields does not result in adverse health effects. Whether chronic exposure to weak magnetic fields is equally harmless remains an open question. While there is no evidence that these fields cause immediate, permanent harm, laboratory studies on animals and cell cultures have shown that weak magnetic fields can effect several biological processes (hormone and enzyme levels and the rate of movement of some chemicals through living tissue) (ARPANSA, 2009).

Human studies, known as epidemiological studies, are based on the occurrence and distribution of disease in the population or community. To date no epidemiological studies have produced solid evidence linking EMF exposure to disease. The majority of scientists and Australian radiation health authorities in particular, do not risk. Moreover, the evidence available is inconclusive and does not allow health authorities to decide whether there is a specific magnetic field level above which chronic exposure is dangerous or compromises human health (ARPANSA, 2009).

Guidelines

There are currently no Australian standards regulating exposure to EMF. The National Health and Medical Research Council (NHMRC, 1989) issued guidelines aimed at preventing immediate health effects resulting from exposure to these fields. The recommended magnetic field exposure limit for members of the public (24- hour exposure) is 1,000 milligauss (mG) and for occupational exposure (whole working day) is 5,000mG. **Table 19.1** shows the typical EMF measurements from various common sources.

Table 19.1 EMF measurements from common sources.

Source	Typical Measurement (mG)	Range of Measurement (mG)
Television	1	0.2 – 2
Refrigerator	2	2 – 5
Kettle	3	2 – 10
Personal computer	5	2 – 20
Electric blanket	20	5 – 30
Hair dryer	25	10 – 70
Distribution power line (under the line)	10	2 – 20
Transmission power line (under the line)	20	10 - 200
Source: Energy Networks Association (2006)		

19.5.2.2 Impact Assessment – Construction and Decommissioning

Operational electrical infrastructure is required in order to produce EMF. During the construction and decommissioning phases, the Proposal does not include operational electrical infrastructure. Therefore, EMF impacts will be limited to the operational phase only of the Proposal.

19.5.2.3 Impact Assessment – Operation

There are three potential sources of EMF associated with the proposal as discussed in the following sections.

Grid Interconnection Power Line

The magnetic fields associated with a transmission line at any moment in time depend on a range of factors, including the amount of power flowing in the line and the distance of the measurement point from the conductors. Typical levels of magnetic field under a 330kV high-voltage transmission line range from 5-50mG at a distance of 30m from the centre of the easement (NGH, 2008). The strength of the field falls away rapidly with increase distance. High-voltage lines can produce magnetic fields of up to 200mG under the line. These figures are far less than the 1,000mG limit recommended for 24-hour exposure.

Underground Cabling

The 33kV underground lines connecting the wind turbines to the substation would be located at a depth of approximately 1m below ground level. At this depth, a maximum magnetic field of 10mG could be expected, which is insignificant when compared with the 1,000mG limit recommended for 24-hour exposure.

Substation

EMF from the substation would be less than 100mG in the vicinity of the transformers and other electrical components (HPA, 2004). These levels are well below the NHMRC limit of 1,000mG for the public or 5,000mG for occupational exposure. The substation will not be accessible by the public due to the surrounding security fence. The fence will be placed at a distance where the level of electromagnetic radiation is negligible.

19.5.2.4 Mitigation Measures

To ensure that there would be no unnecessary exposure to EMF from the Proposal, the following mitigation and management measures will be implemented:

- Electrical cables will be placed below ground where possible to shield electrical fields;
- Wires will be bundled to reduce the magnetic field emissions;
- Appropriate security around emitting structures (e.g. Substation) will be placed and maintained to restrict public access and limit potential exposure; and
- Non-staff that need to go near the emitting structures would be accompanied by a trained and qualified staff member.

19.5.3 Shadow Flicker

Shadow flicker is the fluctuating light levels caused by intermittent (moving or changing) shadows. If a location is in the shadow of a moving object, then there will be a momentary reduction in light intensity as the shadow passes by. This is most noticeable in an enclosed room that is lit by the sun, when the shadow falls across the window that is providing the light. Wind turbines can cause shadow flicker from the moving

shadow of the wind turbine blades. Shadow flicker can also be caused by any moving objects that cast a shadow, such as vehicles or aeroplanes. Refer to **Appendix 30** for the full report.

The rate of flicker for a three bladed, horizontal axis wind turbine is three times the rotational speed of the wind turbine rotor. For example, a three bladed wind turbine with a rotor speed of 20 revolutions per minute (rpm) results in a flicker frequency of 1 Hertz (once per second). If the alternating light levels caused by the shadow flicker are of significant intensity and affect the whole light source of a room (i.e. the whole window is shadowed), it can disturb reading and other light-sensitive tasks, thus causing annoyance.

In order for a wind turbine to cause shadow flicker at a given location, the following conditions have to be satisfied. If any one of these conditions is not met, then shadow flicker will not occur, or will have a diminished impact, at that location.

- The sun must be in the correct position in the sky to cast a shadow of the turbine onto the location. This will only occur for certain times of day and days of the year.
- Wind direction will have an impact on shadow flicker impact, as the area of the shadow cast by the wind turbine will depend on which direction the wind turbine is pointing (yaw), which in turn is dependent on the wind direction.
- There has to be unobstructed line of sight between the wind turbine and the location.
- The sun must not be significantly obscured by cloud or diffused by the atmosphere (significant diffusion typically occurs for angles of less than 3° above the horizon).
- The wind turbine has to be operating (i.e. the blades rotating).
- The dimension of the part of the blade causing the shadow has to be large enough to cast significant shadow. The largest dimension of blades is the chord near the root, which may be up to 4 m on large turbines, and the smallest is the depth of the blade near the tip, which may be 0.3 m or less. The latter is not sufficient to cast any noticeable shadow. If the blade is edge-on to the sun, then the shadow will be very small.
- The shadow must fall over most of a room's natural light source, i.e. window or skylight. If the windows are large (compared to the size of the shadow), or do not face the wind turbine, then the room's light levels will not vary significantly.

The sun's position varies with the time of day and the time of year. This means that the locations affected by shadow flicker from wind turbines vary with the time of day and time of the year.

A shadow flicker assessment was prepared for the proposal by Parsons Brinckerhoff using the methodology described in the *Draft National Wind Farm Guidelines* (EPHC, 2010). The assessment report is attached as **Appendix 30**.

The model used for the calculation of flicker effects contains a mathematical model of the sun's position in the sky for a given location and time of year. Also contained in the model is information relating to the three dimensional positions and sizes of the turbines and the locations where the flicker is to be calculated. This information is combined to calculate the times for which the turbine rotors will cast shadows over the locations of interest. Shadow flicker is assumed to occur when the centre of the sun passes behind any part of a turbine rotor.

A comparison between the realistic and worst case assessment assumptions are summarised in **Table 19.2.**

Table 19.2 Shadow Flicker Assessment

Assessment assumptions		
	Realistic Scenario	**Worst Case Scenario**
Sunlight cover	Data obtained from Walkamin Research Station	Direct sunlight during all daylight hours (i.e. no clouds are ever experienced over the wind farm site)
WTG operational hours	Operational hours based on power curve and 9530 mast data (on-site)	The wind turbines are always operating (i.e. it is always windy, and the turbines are never inoperable due to maintenance or faults)
WTG orientation	Based on 9530 mast data	The wind turbines are always turned in the horizontal plane to face the sun (i.e. the turbine rotor casts the max possible shadow)
WTG visibility	All the WTGS are visible except those screened by the topography	
Maximum distance for influence	2km	
Minimum sun height over horizon for influence	3^{O}	
Dimensions of receptor window	Represented by a vertical rectangle facing each turbine; termed as a "greenhouse" configuration, 10m wide and 2m high, centred 1.5m off the ground (any shadow on any part of this rectangle is included in the count).	

In addition to the above assumptions, these calculations are based on the following WTG parameters:

- WTG rotor diameter 101 m;
- WTG hub height 80 m;
- WTG blade chord of 3.4 m.

A conservatively large receptor window of 10 m in width and 2 m in height has been considered to adequately include borderline situations where a receptor is just marginally exempt from experiencing the effects of shadow flicker. The *Draft National Wind Farm Development Guidelines – July 2010* suggest the effects of shadow flicker are dependent on the blade dimensions and recommend an assessment distance of 265 times the maximum blade chord. Based on the maximum blade chord of the Siemens 101-3.0 WTG of 3.4 m, the assessment distance is 901 m; however, a more conservative assumption of 2 km has been used in this assessment to account for the varying levels of human sensitivity to the intensity of shadow flicker.

The worst case assessment for each receptor results in the number of shadow flicker hours that the dwelling could potentially experience in a year. However, the occurrence of all these assumptions at one time is considered highly unlikely as cloud cover will occur over the project site, for example. Therefore, the worst case shadow flicker results serve as a starting point from which a more realistic situation is derived using measured data from reference sites recording sunlight information.

A reduction factor has been applied to account for cloud cover at the MEWF to convert the worst case shadow flicker results to a more realistic annual estimate. This is based on recorded information on sunlight and cloud cover by the Bureau of Meteorology (BoM). The closest reference site is the Walkamin Research Station, located 6 km northeast of MEWF. This information is applied to the worst case shadow flicker assessment on a monthly average basis, measured using a Campbell-Stokes device. The cloud cover reduction factor is applied to the worst case results for the annual aggregate value only. The worst case shadow hours experienced in a day remains a realistic assumption as a dwelling may experience no cloud cover on the day of the year that has the maximum shadow flicker.

Results

A total of 11 receptors have been identified to be located within the 2km distance from a turbine in the surrounding area of the wind farm (**Table 19.3, Appendix 30**).

Table 19.3 Receptors located within 2 km from turbine.

Receptor No.	Worst case annual shadow flicker	Realistic annual shadow flicker	Allowable annual shadow flicker	Max daily shadow	Allowable daily shadow
	hrs:min	hrs:min	hrs:min	hrs:min	hrs:min
R05	4:24	2:22	30:00	0:13	0:30
R26	5:27	2:43	30:00	0:15	0:30
R27	0:00	0:00	30:00	0:00	0:30
R30	0:00	0:00	30:00	0:00	0:30
R32	0:00	0:00	30:00	0:00	0:30
R35	0:00	0:00	30:00	0:00	0:30
R36	0:00	0:00	30:00	0:00	0:30
R49	8:39	4:53	30:00	0:13	0:30
R60	0:00	0:00	30:00	0:00	0:30
R78	9:49	5:00	30:00	0:14	0:30
R89	0:00	0:00	30:00	0:00	0:30

The results of the shadow flicker assessment including worst case results and realistic results using average sunshine statistics show that none of the receptors are expected to experience shadow flicker for more than 30 hours per year in both the worst and realistic case scenarios, or 30 minutes per day in the worst case scenario.

Based on these results, the calculated levels of shadow flicker caused by MEWF on the receptors listed are substantially less than the limits prescribed by the *Draft National Wind Farm Development Guidelines*.

19.5.4 Epilepsy/Seizure

The chance of conventional horizontal axis wind turbines causing an epileptic seizure for an individual experiencing shadow flicker is less than 1 in 10 million.

Harding et al. (2008) examined wind turbine shadow flicker and the potential for photosensitive epilepsy and concluded that:

> "*Flicker from turbines that interrupt or reflect sunlight at frequencies greater than 3 Hz poses a potential risk of inducing photosensitive seizures. At 3 Hz and below the cumulative risk of inducing a seizure should be 1.7 per 100,000 of the photosensitive population. It is therefore important to keep rotation speeds to a minimum, and in the case of turbines with three blades ensure that the maximum speed of rotation does not exceed 60 rpm, which is normal practice for large wind farms.*"

EPHC (2010) note the following in relation to the risk of epileptic seizures from wind turbine shadow flicker:

- There is a negligible risk of epileptic seizures being caused by conventional horizontal axis wind turbines, for the following reasons:
  - » Less than 0.5% of the population is subject to epilepsy at any one time, and of these, approximately 5% are susceptible to strobing light (Epilepsy Action Australia, 2009).

- » Most commonly (96% of the time), those that are susceptible to strobe lighting are affected by frequencies in excess of 8 Hz and the remainder are affected by frequencies in excess of 2.5 Hz. Conventional horizontal axis wind turbines cause shadow flicker at frequencies of around 1 Hz or less.
- » Alignment of three or more conventional horizontal axis wind turbines could cause shadow flicker frequencies in excess of 2.5 Hz; however, this would require a particularly unlikely turbine configuration.

Hence, both Harding et al. (2008) and EPHC (2010) conclude that large wind farms are highly unlikely to cause epileptic seizure events.

19.5.5 Blade Throw

Blade throw involves the detachment of a turbine blade, or a fragment thereof, and its ejection from the turbine assembly. This poses a potential risk to nearby people and property and as such consideration of the following matters, is discussed further below:

- The probability of blade throw occurring;
- Whether the proposed turbines are certified against relevant standards;
- Overspeed protection mechanisms including 'fail safe' mechanisms (e.g. Back up (battery) power in the event of a power failure);
- Operational management and maintenance procedures including any regular maintenance inspections;
- Provisions for blade replacement; and
- The separation distance between turbines, neighbouring dwellings and property boundaries.

Blade Throw Probability

An analysis of potential safety risks from the Kittitas Valley Wind Power Project (Kammen, 2003) assessed the human health risks of separation and throwing of a whole or partial wind turbine rotor blade. The analysis involved theoretical calculations of individual risk (IR) – the probability that a member of the public will die from an accident if he/she is permanently at a certain place without protection – and assessment of actual probabilities of a blade fragment striking a member of the public.

The theoretical calculations indicated that for a 2MW wind turbine with a rotor diameter of 80 metres, the IR is 1 in a million within 150m of a turbine. As stated above, this probability assumes that an individual is permanently at a certain place without protection. When considering the actual probabilities of a blade fragment striking a member of the public, Kammen (2003) noted the following:

> *The risk levels for a blade…thrown from a wind turbine…depends on the assumptions one makes about the probability of a person(s) being at the exact spot where a flying object might land at that exact moment in time. Given the rural, sparsely populated nature of the area…that probability appears to be very low.*

Kammen (2003) assessed the probability of a blade fragment striking a vehicle on an adjacent highway (with an average daily traffic volume of 2,800 vehicles) and causing a mortal accident. The assessed probability, using conservative assumptions, was 1 in one billion.

By way of comparison Kammen (2003) considered the relative risks of common day to day activities causing death and found that the following activities have a 1 in one million chance of causing death:

- Spending one hour in a coal mine, with death caused by black lung disease;

- Travelling 10 miles by bicycle, with death caused by accident;
- Travelling 300 miles by car, with death caused by accident;
- Living 2 months in an average stone or brick building, with death from cancer caused by natural radioactivity; and
- One chest x-ray taken in a good hospital, with death from cancer caused by radiation.

All the above risks are 1,000 times more likely than the risk presented by the proposed Kittitas Project.

Kammen (2003) concluded that: "It appears reasonable, therefore, to determine that the proposed project does not present a significant risk to public health or safety." Given the similar circumstances of the Proposal, it is reasonable to conclude that the risk of blade failure causing death is greater than 1 in one billion.

Rogers *et al.* (2011) undertook research into setback standards for wind turbines aimed at minimising the probability of blade fragment impact with roads, structures and infrastructure (i.e. fixed objects) and concluded that a setback distance of 463 metres from these objects was desirable for a Vestas 2.0 MW turbine model.

The research did not explicitly consider the risk of blade throw to people, or non-stationary objects, which would have a much lower risk of blade fragment impact when compared with stationary objects.

A key input to the Rogers *et al.* (2011) analysis was a "…*commonly accepted probability of blade failure per turbine per year*…" of 1 in 3,800 based on datasets analysed by Rademakers and Braam (2005). This probability was calculated following a statistical analysis of blade failures reported by EMD (Denmark) for the period 1984 to 2000 and ISET (Germany) for the period 1991 to 2001. It is important to note that the technical specification for structural testing of rotor blades (IEC 61400-23) was first introduced in 2001.

Turbine Certification and Operational Safeguards

All turbines under consideration for the Proposal will require certification against International Electrotechnical Commission (IEC) standards. IEC 61400 is a class of international standards, specifying design requirements made to ensure that wind turbines are appropriately engineered against damage from hazards within their planned lifetime. IEC standard 61400-23, introduced in 2001, applies specifically to structural testing of wind turbine blades. GL Garrad Hassan (2010) notes:

> *The occurrence of structural manufacturing defects in rotor blades has…diminished dramatically due to improved experience and quality control in the industry, centred on a small number of companies who make blade manufacture their main or sole business. Design practice has also evolved to improve structural margins against any manufacturing deficiencies. Even in the rare event of blade failure in modern machines, detachment of whole blades is highly unusual.*

GL Garrad Hassan (2010) undertook a literature review of wind turbine failure and certification processes and made the following observations:

> *The reduction in failures* [over the last 20 years] *coincides with the widespread introduction of turbine design certification and type approval. This process requires full scale strength testing of every certified design of turbine blades. It also often requires a dynamic test that simulates the complete life loading on the blade. The certification body will also perform a quality audit of the blade manufacturing facilities and perform strength testing of construction materials. This approach has effectively eliminated blade design as a root cause of failures. Unfortunately, this does not mean that blade failures do not occur, but when they do, the rootcause is some other factor.*

The main causes of blade and tower failures are now a control system failure leading to an over speed situation, a lightning strike or a manufacturing defect in the blade. The latter cause does not often lead to detachment of blade fragments.

GL Garrad Hassan (2010) also notes in relation to lightning strikes that:

Lightning protection systems for wind turbines have developed significantly over the past decade and best practice has been captured in industry standards to which all modern turbines comply. This has led to a dramatic drop in events where lightning causes structural damage.

Overspeed protection mechanisms for wind turbines are manufacturer-specific. REpower turbines, for example, incorporate an uninterruptible power supply (UPS) (i.e. a battery) in each wind turbine to shut the turbine down safely in the event of a power failure. Furthermore, each individual blade has an independent electronic pitch motor with its own UPS, so that each blade can be pitched out of the wind in an emergency.

Pitching a single blade out of the wind is enough to stop the rotor from spinning. Other manufacturers have similar systems.

Turbine Separation Distances

Separation distances between individual wind turbines are not regulated by any standard. Rather the distance between adjacent turbines in a wind farm is a compromise that a proponent must make between:

- A greater number of turbines (leading to higher energy yield for the wind farm and potentially lower cost of infrastructure per turbine); and
- A reduced energy yield per turbine and greater turbulence due to increased wake effects from the adjacent turbines.

Final spacing is dependent upon site certification from the turbine manufacturer regarding the loads on the turbine (closer spacing means higher turbulence and thus higher loads) and finding an optimum generation balance between the number of turbines and wake effects. The separation distance varies according to the predominant wind direction. As a rule-of-thumb, if the wind is predominantly from one direction (eg the south -east) then the turbines can be spaced relatively close together (2 - 2.5 rotor diameters) perpendicular to this direction (eg north - south) as their wakes will not interfere with the adjacent turbines. However if there are turbines downwind, the spacing is generally 5 to 10 rotor diameters.

19.6 Unexploded Ordnance

The MEWF site has been identified as a live firing training ground for allied mortars and grenades by Allied Forces during training and development phases of World War II. To ensure the safety of personnel and civilians working in the vicinity of the site, with regard to any impacts from potential UXO contamination and to identify the potential risk of uncovering either buried, unexploded ordnance or explosive devices an assessment was undertaken by RPS UXO specialists (**Appendix 31**), who deliver the full findings of this investigation.

19.6.1 Existing Environment

The Atherton Tablelands was a strategically significant staging area for Allied forces during the second half of World War II. In excess of 100,000 troops passed through the area between 1942-1945 for pre-deployment or repatriation purposes where the region experienced significant exposure to live firing practices and subsequent potential UXO contamination.

Reports indicate that given the scale of operations in the vicinity of the project site, the north western sector experienced heavy bombardment by Allied mortar forces, resulting in significant UXO contamination. Despite Japanese attacks on the Australian mainland during WWII, no direct bombing of the project site or surrounding lands took place. The nearest enemy bombing took place 75km North at Mossman, well outside the boundaries of the project.

Tolga, 7km ESE of the southern end of the project boundary, was home to the 13th Army Advanced Ordnance Depot as well as the Rocky Creek Military Hospital, the largest military hospital in the country during the Allied services occupation of the Atherton Tablelands. As a result, the Australian Defence Force (ADF) has categorised the eastern face and adjacent lowlands of Mt Emerald as both 'Substantial' and 'Slight' for the possibility of containing UXO contamination. Records show that areas subject to camp conditions of WWII era are prone to UXO discovery – outside of those areas designated as firing ranges – as ground forces were often prone to casual contamination of their surrounds.

There have been few changes to the general vicinity of the site since its employment by Allied forces as a live firing range. In support of Powerlink's Chalumbin to Woree transmission lines a number of support towers were erected onsite, however no additional alterations or invasive works have been made. Due to the rural nature of the site, minimal development has taken place within the project footprint, resulting in a largely unaltered state of the site.

19.6.2 Impact Assessment

Nine confirmed UXO contamination sites have been identified in vicinity of Tinaroo-Tolga with the Walkamin Mortar/Grenade range situated in the north-eastern quadrant of the project site as the closest source of 'substantial' contamination.

RPS has identified that a high level of Allied firing practices occurred in and around the project area (**Appendix 31**), with one dedicated HE impact area within the boundaries of the site. In particular, there is the potential for High Explosive (HE) Mortars (primarily 2, 3 and 4.2 inch) and hand grenades to have landed within the boundaries of the project site. State and Federal records confirm the presence of numerous firing points, areas where mortars would be fired *from*, in conjunction with recoded discoveries of UXO in close proximity to the site.

It remains widely accepted that a small percentage of approximately 10% of ammunition fired failed to function as designed resulting in the current situation of UXO contamination.

In addition, due to the nature of the site, being predominantly rural regional landscape, it is considered unlikely for any UXO landing / penetrating the ground in such areas to have been readily identified, and as such may have remained until the present day.

Activities in which UXO contamination could be considered a potential hazard are:

- Enabling works
- Intrusive Site Investigations (Trial holes/trenches, boreholes, window samples)
- Excavations and Piling Works

Blast and fragmentation effects are the more obvious impacts from detonation of UXO's, however the potential for fire and chemical contamination from the degradation of unexploded bombs must be considered.

The findings of this investigation are detailed within the Assessment for Potential Historic Unexploded Ordnance Contamination by RPS (**Appendix 31**).

19.6.3 Mitigation Measures

Based on the risk assessment carried out for the site, RPS recommended that the following mitigation strategies be implemented in support of works taking place on site:

- Detailed Geotech investigations.
- Explosives Safety & Awareness Briefings / Explosives Site Safety Guidelines - Personnel conducting intrusive works should attend an Explosives Safety & Awareness Briefing.
- Explosives Engineer Supervision - Explosives Engineer should be present during any excavations/trial pits taking place at the site.
- Intrusive Magnetometer Survey - conduct an intrusive Magnetometer survey ahead of proposed piling and borehole locations across the site to reduce the risk of encountering deep buried UXO. The type of survey methodology required would be dependent upon ground conditions and the works taking place.
- Non-Intrusive Magnetometer Survey - As an alternative to Explosives Safety Engineer Supervision, and considering the specific conditions on site, it may be feasible to carry out a Non-Intrusive Magnetometer survey ahead of shallow excavations/works in certain areas. Final Works Programme - RPS EES would recommend that, once the full extent of the works has been confirmed / finalised, they are contacted to discuss the most suitable mitigation approach. RPS would take into account further details regarding the specific locations, site conditions and methodologies of the proposed works to determine the most practical and pragmatic approach available to deliver the required mitigation.
- Mitigation measures for UXO's discovered on site are under the jurisdiction of the local Police and subsequently the Department of Defence as conditioned by the Department of Environment and Heritage Protection (**Appendix 32**). Removal or destruction of the device is up to the discretion of these parties and its impact on MNES is dependent on public safety factors.

19.7 References

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20.0 Environmental Risk Assessment

This chapter presents the Environmental Risk Assessment (ERA) which has been undertaken to identify and manage the impacts that may be created by the construction, operation and decommissioning of the wind farm at the MEWF Site. The EIS Guidelines (**Appendix 2**) provide specific instruction on the requirement for the EIS to detail this information and in particular mitigation of cumulative impacts on the site.

The purpose of an environmental risk assessment is to evaluate the likelihood (or probability) of an aspect of the environment to be impacted by a particular hazard or stressor, and anticipate the consequence of this adverse effect. Through utilisation of this tool multiple environmental stressors can be evaluated (including natural or human induced), to assist in the identification and management of these impacts at a project scale. Through identification of the environmental risks and assessment of the proposed mitigation measures against these risks we can ascertain the value of the mitigation measures and strategies outlined in the Preliminary EMP (**Appendix 33**) Any residual risks to the receiving environment after all measures have been implemented are also considered below.

20.1 Legislation framework

A multi-criteria analysis has been used in this assessment in accordance with the Australian Standard As/NZ 4360 Risk Management where the likely hood of an activity is assessed against the severity (consequence) of the action. These are the:

- AS/NZS ISO 31000-2009 Risk management – Principles and guidelines; and
- Handbook 436-2004 – Risk management guidelines

20.1.1 Evaluating Likelihood

Table 20.1 below identifies the criteria in which likelihood is assessed. The likelihood of the impact is described as ranging between improbable and almost certain.

Table 20.1 Likelihood Definitions

LEVEL	DESCRIPTOR	DESCRIPTION	GUIDELINE
6	Almost Certain	Is almost guaranteed to occur in every situation	Occurs every day
5	Likely	Is expected to occur in most circumstances	Common or repeating occurrence - occurs more than once per week
4	Probable	Will probably occur in most circumstances	Known to have occurred “has happened” - occurs once every 2 to 4 weeks
3	Possible	Could occur	Could occur / “heard of it happening” - occurs one to two times during the project.
2	Unlikely	Could occur but not expected	Not likely to occur - may occur once during the project
1	Improbable	Occurs only in exceptional circumstances	Practically impossible.

20.1.2 Evaluating Consequence

Table 20.2 identifies the criteria used for assessment of consequence including consideration of the natural environment, legal and government, heritage and community/reputation.

Table 20.2 Consequence Definitions

LEVEL	DESCRIPTOR	NATURAL ENVIRONMENT	LEGAL/GOVERNMENT	HERITAGE	COMMUNITY/REPUTATION/MEDIA
6	Catastrophic	Catastrophic environmental effects with significant impacts to matters of national environmental significance.	Investigation by authority with significant prosecution and fines. Imprisonment.	Total destruction of items of high cultural or heritage significance.	Forced shut down and curtailment of operations. Irreversible damage to reputation and operations.
5	Disaster	Very serious environmental effects with impairment of ecosystem function. Long term widespread effects on significant environmental areas.	Investigation by authority with significant prosecution and fines. Very serious litigation, including class action.	Highly offensive infringements of cultural heritage values.	Very serious widespread social impacts with potential to significantly affect the well being of the local community. Serious media coverage and damage to reputation.
4	Major	Serious environmental effects with some impairment of ecosystem function. Relatively widespread medium-long term impacts. resources	Major breach of regulation with potential major fine and/or prosecution by authority. Major litigation.	Major permanent damage to items of high cultural or heritage significance. Significant infringement and disregard of cultural heritage values.	On-going serious social issues. Adverse national media coverage. Reputation damaged.
3	Moderate	Moderate effects on biological or physical environment but not affecting ecosystem function. Moderate short-medium widespread impacts.	Serious breach of regulation with investigation or report to authority with prosecution or moderate fine possible.	Substantial damage to items of moderate cultural or heritage significance of cultural heritage/sacred locations.	Ongoing social issues. Adverse regional media attention, community concern. Moderate impact to reputation.
2	Minor	Minor effects on biological or physical environment. Minor short-medium term damage to small area of limited significance.	Minor compliance issues. Minor prosecution or fine possible.	Minor damage to items of low cultural or heritage significance. Mostly repairable. Minor infringement of cultural heritage values.	Minor medium term impacts on local community. Minor adverse local media attention and community concern.
1	Insignificant	Limited damage to minimal area of low significance.	Low level compliance issue, on the spot fine possible, prosecution unlikely.	Low level repairable damage to commonplace structures.	Low level social impacts. Local concern or complaints.

20.1.3 Evaluating Risk

The risk matrix (**Table 20.3**) provides a risk rating from the combination of likelihood of occurrence and consequence, should the impact occur. Potential impacts with a risk rating of 1 to 3 are considered to present a negligible to moderate environmental risk whereas a risk rating of 4 to 6 is considered to present a moderate to very high environmental risk.

Table 20.3 Risk Matrix

		CONSEQUENCE					
		Insignificant	Minor	Moderate	Major	Disaster	Catastrophic
LIKELIHOOD	Almost Certain	4	4	5	5	6	6
	Likely	3	4	4	5	5	6
	Probable	2	3	4	4	5	5
	Possible	2	2	3	4	4	5
	Unlikely	1	2	2	3	4	4
	Improbable	1	1	2	2	3	4

Table 20.4 summarises the matters associated with the proposed MEWF project that have the potential to result in some environmental impact as discussed in the specialist reports, background reports and assessments provided in each chapter above. This summary also provides the capacity to quantify the residual risks to environmental values once mitigation strategies have been implemented.

An assessment of residual impacts is also provided below.

Table 20.4 Environmental Risk Assessment Incorporating Key Mitigation Measures.

Environmental issue	Project Phase	Source or nature of Risk	L	C	R	Mitigation Measure	L	C	R
Landscape and Visual Impact	C	Landscape modification	5	3	4		4	2	3
	O	Turbine Lighting				N/A			
	C	Works area lighting	3	2	2	▪ Compliance with approved working hours	2	2	2
Noise and Vibration	C/D	Construction noise and vibration	4	2	3	▪ Compliance with approved working hours; ▪ minimise construction noise impacts; ▪ consultation and notification with potentially affected residents; ▪ Selection of construction plant on the basis of low inherent potential to generate noise and vibration.	3	2	2
	C/O/D	Increased vehicle movements	5	2	4	▪ Fitting equipment with noise control equipment (such as mufflers) and low-noise reversing alarms; and ▪ Regular inspection and maintenance of equipment to ensure noise emissions do not exceed typical levels consultation and notification with potentially affected residents	3	2	2
	O	Operation of wind turbines	3	4	4	▪ If there is exceedance use active noise control functions of turbines; ▪ Rectify any manufacturing defects or control settings; or ▪ Acoustic treatment of receiver dwellings	2	4	3
Traffic and Transport	C/D	Increase in traffic volume	3	2	2	▪ Warning signage and access timetable ▪ Intersection treatments, widening and vegetation removal. ▪ Procedures to monitor traffic impacts	2	2	2
	C/D	Damage to local road service	3	3	3	▪ Road dilapidation surveys ▪ Pavement upgrades where required	3	2	2

Environmental issue	Project Phase	Source or nature of Risk	L	C	R	Mitigation Measure	L	C	R
Air quality	C	Dust nuisance	3	3	3	▪ Minimisation of the daily vehicle movements on access tracks; ▪ Provision of armouring on access tracks (gravel); ▪ Employment of a water truck during construction; and ▪ Dust suppression additives. ▪ Use of wind breaks (natural tree-line, erosion fences); ▪ Seeding with fast growing non-invasive, sterile grass species; ▪ Armouring (hydromulching, gravel); and ▪ Watering.	2	2	2
Downstream Water Quality	C	Increase erosion and land instability leading to poor downstream water quality	4	4	4	▪ Implementation of an Erosion and Sediment Control Plan including: ▪ Sediment fences, mulch berms, check dams etc vegetative buffer ▪ Clean water diversions ▪ Land stabilisation ▪ Temporary and permanent drainage control through the sites; ▪ Upstream clean water diversions; ▪ Dirty water treatment strategies; ▪ Temporary pavement/batter erosion prevention (surface stabilisation) ; ▪ Final pavement sealing (gravel seal minimum); ▪ Final fill batter stabilisation treatments	3	2	2
	C	Modification to drainage patterns	3	2	2	▪ Temporary and permanent drainage control through the sites; ▪ Upstream clean water diversions; ▪ Dirty water treatment strategies; ▪ Temporary pavement/batter erosion prevention (surface stabilisation) ; ▪ Final pavement sealing (gravel seal minimum); ▪ Final fill batter stabilisation treatments	2	2	2

Environmental issue	Project Phase	Source or nature of Risk	L	C	R	Mitigation Measure	L	C	R
Waste Minimisation	C/O/D	Release of hazardous waste due to improper handling and/or disposal	3	4	4	▪ Oil and lubricants and other regulated waste will be removed from site and disposed of using a licensed specialist contractor; ▪ Weed free vegetative waste will be spread across the site	1	4	2
		Litter and refuse waste	5	2	4	▪ Solid waste will be removed from site and disposed of in collection bins at the contractor's camp.	2	2	2
Hydrology	C/O/D	Potential spills into waterways and aquifers	2	4	3	▪ bunded chemical storage areas ▪ Spill kits readily available	2	2	2
		Increased runoff concentrating flows	3	3	3	▪ Implementation of an Erosion and Sediment Control Plan including: ▪ Sediment fences, mulch berms, check dams etc vegetative buffer ▪ Clean water diversions ▪ Land stabilisation ▪ Stormwater diversion banks / drains (e.g. whoa-boys) are to be placed on steep tracks with upstream erosion control ▪ Additional stormwater diversion banks / drains (e.g. whoa-boys) are to be placed at a distance of 10 m back from each side of the top of the watercourse embankment.	2	3	2
		Destruction of riparian vegetation	3	3	3	▪ Use existing crossings ▪ Avoid vegetation clearing and consult botanist ▪ Watercourse banks will be reinstated as near as possible to their former profile, stabilised and revegetated as necessary to prevent scouring. ▪ Any weed establishment is to be controlled in accordance with the methods detailed in the Weed Management Plan.	2	2	2
Aviation		Aircraft impact with infrastructure	2	5	4	▪ Consultation with CASA and ADF to ensure amendments to charts and designations are made accordingly	1	5	3
		Impact on safety of downwind aerial spraying operations	2	5	4	▪ Agreed shutdown protocols with aerial operators when conditions and proximity of aerial spraying operations increase risk	1	5	3

Environmental issue	Project Phase	Source or nature of Risk	L	C	R	Mitigation Measure	L	C	R
Telecommunications	O	Disruption of telecommunications, navigation and radar signal interference.	3	2	2	▪ Siting of turbines to restrict intrusion on the point to point radio links.	2	2	2
EMF	O	Human exposure to EMF	2	5	4	▪ electrical cables will be placed below ground where possible to shield electrical fields; ▪ wires will be bundled to reduce the magnetic field emissions; ▪ appropriate security around emitting structures (e.g. substation) will be placed and maintained to restrict public access and limit potential exposure; and ▪ non-staff that need to go near the emitting structures would be accompanied by a trained and qualified staff member.	1	3	2
Fire and Bushfire	O	Environmental damage from Substation/transmission line fire	2	4	3	▪ Fire suppression systems ▪ Environmental Buffers	1	1	1
	O	Environmental damage from bushfire resulting from wind farm operation	2	4	3	▪ Fire suppression systems ▪ Environmental Buffers ▪ Fire Fighting equipment	1	4	2
	C	Environmental damage from ignition from construction activities	3	4	4	▪ Cleared construction areas ▪ Retardants ▪ Fire fighting Equipment/Officer ▪ Spill kit for flammable liquids ▪ Appropriate storage of flammable products	2	2	2
	C/O	Damage to adjoining properties from bushfire resulting from construction or operation of windfarm	3	4	4	▪ Fire suppression systems ▪ Cleared construction areas ▪ Retardants ▪ Fire fighting Equipment/Officer ▪ Spill kit for flammable liquids ▪ Appropriate storage of flammable products	2	4	3

Environmental issue	Project Phase	Source or nature of Risk	L	C	R	Mitigation Measure	L	C	R
Unexploded ordnance	C	Blast and fragmentation effects	3	5	4	▪ Detailed Geotech investigations. ▪ Explosives Safety & Awareness Briefings / Explosives Site Safety Guidelines ▪ Explosives Engineer Supervision ▪ Intrusive Magnetometer Survey ▪ Non-Intrusive Magnetometer Survey	1	5	3
Flora	C	Clearing of conservation significant plants	5	3	4	▪ Preclearance surveys ▪ Micrositing of turbines ▪ Buffers around conservation significant vegetation ▪ Minimising clearing ▪ Rehabilitation and Environmental Monitoring Plans ▪ Translocation strategies	2	3	2
	C/D	Loss of montane heath habitat	6	3	5	▪ Utilisation of pre-cleared tracks and land for access roads and construction pads. ▪ Avoid niche plant habitats such as rock outcrops and ledges ▪ Site-based rehabilitation & revegetation plan will be prepared, which details priority areas, key conservation zones, habitat re-creation, suitable plants for revegetation and timelines for monitoring rehabilitation progress and efficacy.	4	3	4
	C/O/D	Increased bush fire intensity and degradation of habitatfrom invasive grass weed spread	3	4	4	▪ Seal internal roads ▪ Weed Management Plan – including monitoring and control weekly ▪ No introduced plants for use on site	2	4	3
	C/O	General habitat fragmentation	3	4	4	▪ Utilisation of pre-cleared tracks and land for access roads and construction pads. ▪ Avoid niche plant habitats such as rock outcrops and ledges ▪ Weed control plan ▪ Site-based rehabilitation & revegetation plan will be prepared, which details priority areas, key conservation zones, suitable plants for revegetation and timelines for monitoring rehabilitation progress and efficacy.	2	3	2

Environmental issue	Project Phase	Source or nature of Risk	L	C	R	Mitigation Measure	L	C	R
Northern Quoll	P/C	High Quality Denning Habitat loss	4	4	4	▪ (L and C assessed at more conservative level due to knowledge gaps) ▪ Avoid clearing high-quality denning and foraging habitats ▪ Telemetry studies to determine preferential denning habitat ▪ Implement site rehabilitation plan including habitat re- creation, nest box trials.	3	4	4
	P/C/O	Habitat degradation		4	4	▪ Avoid clearing high-quality denning and foraging habitats ▪ Weed monitoring and control ▪ Fire Management Plan	3	3	3
	P/C	Construction mortality	3	5	4	▪ Avoid denning habitat – trap track animals ▪ Avoid construction during denning with juveniles ▪ Saturation Trapping ▪ Use of Spotter/Catcher	3	3	3
Sarus Crane	O	Turbine Collision	4	3	4	▪ Turbine Operation Curtailment (L and C assessed at more conservative level due to knowledge gaps) ▪ Radar utlisation surveys for turbine curtailment ▪ Numerical Collision Risk Modelling	3	2	2
Bare-rumped Sheathtail Bat	P/C	Loss of roosting habitat	3	4	4	▪ (L and C assessed at more conservative level due to knowledge gaps) ▪ Minimizing area of cleared vegetation ▪ Implementation of Micro bat Management Plan Construction Phase protocols. Key draft elements to include: ▪ Avoidance of clearing of any roosting trees identified during preconstruction surveys and micro siting of turbine and track location. ▪ Use of Spotter/Catcher	2	3	2

Environmental issue	Project Phase	Source or nature of Risk	L	C	R	Mitigation Measure	L	C	R
	P/C	Turbine Collision and Barotrama	5	4	5	▪ Turbine Operation Curtailment - reduce turbine cut in speeds ▪ (L and C assessed at more conservative level due to knowledge gaps) ▪ Continue and expand ultrasonic call surveys; sample within Rotor Swept Area (RSA) (higher towers & balloons) ▪ Collect weather and insect abundance/height data ▪ Identify high-risk conditions/times and seasons ▪ Conduct radar utilisation at call survey locations sampling at RSA; quantify abundance and flight heights. ▪ Conduct numerical risk modelling (for *S. saccolaimus only* or for entire microchiropteran bat community – depending on radar data quality)	3	4	4
Spectacled Flying Fox	O	Turbine Collision	4	5	5	▪ (L and C assessed at more conservative level due to knowledge gaps) ▪ Adaptive management strategy in accordance with Significant Species Management Plan. Key elements of this plan to include: ▪ Trial visual and acoustic automated collision detection systems (TADS/WT-Bird etc.) ▪ Conduct carcass searches (calibrated for scavenger removal and detectability); validate collision risk model. ▪ Conduct call activity surveys at turbines within RSA ▪ Curtail operation of all/some of turbines during high-risk conditions or in response to detected excessive collision mortality ▪ Operate avian and bat radar SCADA system to implement automatic turbine shut-down	3	3	3
General Fauna	C	Mortality of individuals	3	3	3	▪ Spotter catcher present prior to and during all clearing activities.	2	2	2
	C/O/D	Habitat and Behavioural Disturbance	5	2	4	▪ Minimizing area of cleared vegetation ▪ Avoid vehicular use of site at night where possible ▪ Restrict speed limits at night ▪ Weed monitoring and control ▪ Develop and implement ecological burning regime	3	2	2

Environmental issue	Project Phase	Source or nature of Risk	L	C	R	Mitigation Measure	L	C	R
	C	Fragmentation of populations	3	2	2	▪ Minimizing area of cleared vegetation ▪ Develop and implement ecological burning regime	2	1	1
Cultural Heritage	C	Damage or disturbance to areas/items of cultural heritage	3	3	3	▪ There are no items known within the impact area ▪ Preparation and implementation of CHMP	2	3	2
	C	Uncover items of significance	2	3	2	▪ Follow Category 5 Duty of Care Guidelines from the Aboriginal Cultural Heritage Act.	2	1	1
Social and Economic Matters	P/C/O/ D	Visual Amenity Impacts on neighbouring properties	4	3	4	▪ Access track cutting revegetation ▪ Consider options for use of colour to reduce visual contrast between project structures and visible background. ▪ Locate substation away from direct views from roads and residential dwellings. ▪ Enforce safeguards to control and minimise fugitive dust emissions. ▪ Screening vegetation of properties in consultation with residents	3	3	3
	P/C/O/ D	Noise impacts on neighbouring properties	4	4	4	▪ Amend turbine layout ▪ Turbine pitch adjustment noise reduction ▪ Selection of lowest noise output turbine ▪ Reduction of indoor noise via acoustic treatment of dwellings (ie air conditioning, cladding) if necessary in consultation with owners.	3	3	3

20.2 Environmental Management Plan

An Environmental Management Plan (EMP) is a site or project specific plan developed to ensure that appropriate environmental management practices are followed during the construction, operation and in the case of MEWF, decommissioning of the project (DIPNR, 2004).

This chapter meets the requirements of Section 5.11 (d) and (e) of the Guidelines to provide:

- An outline of an EMP that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing; and the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.

It should be noted the document presents a framework for further development following the outcomes of the EIS/EPBCA referral and Queensland Development Application processes and therefore is preliminary in nature. Similarly, commercial details of the construction and operation phases are yet to be finalised, therefore many system and operational details are not available. Nonetheless, the EMP aims to identify sources of actual and potential environmental harm identified through the EIS process and what actions, processes and/or strategies will be adopted to avoid, prevent or minimise the likelihood of environmental harm being caused.

The Preliminary EMP aims to identify all sources of environmental harm, including but not limited to the actual and potential impacts of construction, operation and decommissioning, including land clearing and turbine activity, the potential impact of these sources and what actions will be taken to prevent the likelihood of environmental harm being caused. The EMP aims to provide for the review and 'continual improvement' in the overall environmental performance of all ERAs that are carried out with the proposed MEWF operations.

The EMP aims to address the following matters:

- Identification of environmental issues and potential impacts.
- Environmental commitments - a commitment by senior management to achieve specified and relevant environmental goals.
- Control measures for routine operations to minimise likelihood of environmental harm.
- Contingency plans and emergency procedures for non-routine situations.
- Organisational structure and responsibility.
- Effective communication.
- Monitoring of mitigation measures and residual impacts.
- Conducting ongoing environmental impact assessments.
- Staff training.
- Record keeping.
- Periodic review of environmental performance and continual improvement.

The draft EMP is provided in **Appendix 33**. **Table 20.5** below provides a summary of the sections provided in the document.

Table 20.5 Environmental Management Plan Elements

Section	Section Name	Purpose
1	Introduction	▪ Provides a background to the Environmental Management Plan ▪ Describes the purpose and scope of the EMP ▪ Provides the site layout
2	Management Systems	This section outlines the proposed elements of an EMS: ▪ RACL Environmental Policy ▪ Project Responsibilities ▪ EMP Frameworks ▪ Training and Inductions ▪ Reporting and Auditing ▪ Complaints Procedure ▪ Review and Update ▪ Legislative Requirements ▪ Related Documentation
3	Detailed design	This section describes the preconstruction management actions that RACL will implement to mitigate against potential impacts during the construction, operational and decommissioning phases. This includes impacts to: ▪ Flora ▪ Fauna ▪ Water Quality
4	Construction EMP	This Section indentifies the environmental issues, potential impacts of the project and RACL's approach to minimise the likelihood of environmental harm from construction operations. This section addresses the following elements: ▪ Flora ▪ Fauna ▪ Erosion and Sediment Control ▪ Management of Flammable and Combustible Substances ▪ Noise and Vibration ▪ Air Emissions ▪ Waste Management ▪ Fire Management
5	Operational EMP	This section identifies the environmental issues, potential impacts of the project and RACL's approach to minimise the likelihood of environmental harm from the operational wind farm. This section addresses the following elements: ▪ Access and Landholder relationships ▪ Flora management ▪ Fauna Management ▪ Erosion and Sediment Control ▪ Management of Flammable and Combustible Substances ▪ Noise ▪ Waste management

Section	Section Name	Purpose
6	Decommissioning EMP	This section identifies that activities to be undertaken decommission the project. IT includes the final land use options and rehabilitation programs. This section is addresses the following elements: ▪ Access ▪ Flora and Fauna management ▪ Erosion and Sediment Control ▪ Management of Flammable and Combustible Substances ▪ Noise and Vibration ▪ Air Emissions ▪ Waste Management ▪ Clean up and rehabilitation

20.3 Mitigatation Measures Costings

Table 20.6 provides the costings for each mitigation measure specified in the EMP, for the proposed MEWF site. As detailed in each chapter some mitigation measures are dependent on the outcome of further studies therefore a detailed subcosting is not suitable.

Table 20.6 The Indicative Costings for Proposed Mitigation Strategies

Mitigation Strategy	Indicative Cost	Responsibility
FLORA		
Pre-construction Phase		
Weed Management Plan	$12,000	RPS
Fire Management Plan	$12,000	RPS
Rehabilitation Plan	$15,000	RPS
Threatened Plant Translocation Plan ▪ Locate host transplant sites (fieldwork and property negotiation) ▪ Compile translocation species' backgrounds and appropriate methodologies per species. ▪ Establish initial trial plots/translocations. ▪ Develop and implement monitoring strategy.	$16,000	RPS
Conservation Significant Plant Management Plan	$15,000	RPS
Construction Phase		
Detailed plant survey of south-west montane heath habitat - GPS mapping of avoidance patches.	$16,000	RPS
Micro positioning of turbines to minimise clearing and disturbance to conservation significant plants and important vegetation types.	$40,000	Supervising Botanist
Site based seed and propagule collection - for rehabilitation	$10,000	RPS
Weed monitoring and control	$10,000	RACL/RPS
Operation Phase		
On-going propagation of special plant species (conservation significant, narrow endemics) Records to be kept of seed collection, propagation trials and success/unsuccessful species.	$190/hr supervising botanist	RPS/RACL
Weed monitoring and control	$10,000 PA	RACL/RPS
Interpretive Literature & Information Field Guide to Conservation Significant & Important Plants and Habitats - Mt Emerald Wind Farm - booklet Weed Identification Guide	Approximate cost: $7,600 each guide. Supplied as electronic file (pdf).	

Mitigation Strategy	Indicative Cost	Responsibility
General Fauna Pest Management Plan	$12,000	RPS
NORTHERN QUOLL		
Pre-construction Phase		
Habitat Utilisation Study (live-trapping, GPS collars, radio-telemetry)	$200,000 – 1 year	RPS
Regional Ground-truthing of Habitat Suitability Model (camera trapping)	$50,000 – 2 months field work	USC
Construction Phase		
Trapping/GPS-radio telemetry/searching construction footprint areas		
Staff Costs (2 teams of two people – depending upon number of machines in operation and number of sites constructed simultaneously)	$100,000 **per month** (for the duration of construction involving Dozing, blasting, excavating etc) during critical maternal den phase (3 months)	RPS supervised sub-consultants / contractors
Equipment (GPS-VHF collars, radio receivers, trap hire etc)	$50,000 – 1 year	
Sniffer dogs & operators	$~50,000 **per month** (for the duration of construction involving dozing, blasting, excavating etc) during critical maternal den phase (~3 months).	Lloyd & Amanda Hancock (Sadder Springs Environmental Centre)
Clearing/trench work spotter catcher (1 x 2 people)	$30,000 **per month** (for the duration of construction involving dozing, blasting, excavating etc)	RPS supervised sub-consultants / contractors
Supervising senior ecologist	$10,000 **per month** (for the duration of construction involving dozing, blasting, excavating etc)	RPS
BIRD & BAT		
Pre-construction Phase		
Radar utilisation surveys Robin Radar FMCW x 2 units for full site coverage) OR Vertical profile radar (trailer/skid mounted) e.g. Detect Vesper	$1.5M – purchase cost (inc operator training and analysis) $260,000 (inc purchase and freight to Australia) or US$10,000/week hire	RPS supervised sub-consultants / contractors
Ground-truthing surveys (in conjunction with radar) – 2 teams of 2 people	$180,0000 – 3 months field work	RPS supervised sub-consultants / contractors
Ultrasonic call monitoring	$10,000	Balance Environmental
SFF population viability analysis	$50,000	CSIRO, USC & RPS

Mitigation Strategy	Indicative Cost	Responsibility
Operation Phase		
Turbine collision mortality surveys (2 teams of two people)	$50,000 – 1 year	RPS supervised sub-consultants / contractors
Automated Collision Detection study (investigation of available systems including WT-Bird, Old Bird, ID Stat etc)	$150,000	RPS
Avoidance studies (2 teams of two people)	$50,000 – 1 year	RPS supervised sub-consultants / contractors
Equipment hire (thermal imaging video, night vision goggles/active ultrasonic detection)	$10,000 – 1 year	RPS
Bat call analysis	$20,000 – 1 year	Balance Environmental
SCADAR-Radar automatic curtailment of at risk turbines	Unknown loss of electricity production, amount will vary. System Operation costs <$50,000/year	
Support of CSIRO SFF satellite telemetry studies to help identify high risk periods	$20,000/year?	
Offsets for unacceptable SFF impacts (fruit orchard netting, supporting carers)	Amount determined by DotE	

20.4 Residual Impacts

Implementation of appropriate mitigation measures will minimise the majority of impacts to acceptable levels. As identified in **Table 20.7** the impacts which remain significant (i.e. Risk Level 4 or greater) after all appropriate measures are applied are as follows;

Flora

- Loss of montane heath habitat above 900m ASL in the wet tropics bioregion (Risk Level 4).

To reduce the impact from turbines to the montane heath habitat in the wet tropics bioregion, RACL reduced the number of turbines in this area (**Table 20.7**). Dropping three turbines from above 900m has reduced the impact on this habitat by 2.755 ha. Additionally, the reduction in the turbine layout of a total seven turbines now reduces habitat loss by a total of 4.743 ha. Residual impacts on the montane heath above 900m are discussed further in **Chapter 22** Offsets Program.

Fauna

- Northern Quoll – High Quality Denning habitat loss - Risk Level 4
- Bare-rumped Sheathtail Bat – turbine collision and barotrauma - Risk Level 4

Potential impacts to fauna from high quality denning habitat loss (Northern Quolls), turbine collisions and barotraumas (Bare-rumped Sheathtail bat) remain a Level 4 moderate risk due to the lack of suitable data collection to date.

Other Level 3 residual moderate risk impacts include:

- Flora
  - » Increased bush fire intensity; and
  - » Habitat degradation from introduction of invasive grasses and tall weeds (e.g. *Hyptis suaveolens*).

- Northern Quoll
  - Habitat degradation; and
  - Construction mortality.
- Spectacled Flying Fox
  - Turbine collision.

It is anticipated the preconstruction and construction utilisation surveys will fill information gaps such that the proposed mitigation strategies for these residual moderate impact risks can be fine-tuned, resulting in a significant reduction in residual risk. Offset strategies for the residual impacts of the project are discussed in **Chapter 22**.

Table 20.7 Area of Impact from Development Footprint of the Proposed MEWF Project.

Infrastructure Component	Cleared Area (ha)									
	20-7-2012 Turbine Layout (70 turbines)					18-11-2013 Turbine Layout (63 turbines)				
		WT Only					WT Only			
	WT & EU	All elevations	<900 m	>900m	EU Only	WT & EU	All elevations	<900 m	>900m	EU Only
Existing Access Tracks (cleared to 10 m wide) inc. new entrance road but subtracting the section of existing entrance road up to the point of intersection with the new entrance rd.	12.67	2.41	2.11	0.29	10.26	12.67	2.41	2.11	0.29	10.26
Proposed Access Tracks (cleared to 10 m wide)	24.57	10.19	5.46	4.72	14.38	20.83	7.48	4.90	2.58	13.35
Substation	4.00	0.00	0.00	0.00	4.00	4.00	0.00	0.00	0.00	4.00
Contractors Lay Down Pad	4.00	0.00	0.00	0.00	4.00	4.00	0.00	0.00	0.00	4.00
Triangular Turbine Pad (0.2479)	17.35	6.45	3.22	3.22	10.91	15.62	5.45	3.22	2.23	10.16
TOTAL	**62.59**	19.04	10.80	8.24	43.55	**57.11**	15.34	10.23	5.10	41.78

*the existing access tracks are ~5m wide; the existing track area together with the proposed new eastern entrance road = 8.648927 ha

20.5 References

Department of Infrastructure Planning and Natural Resources (2004) Guideline for the preparation of EMP NSW gov.

Standards Australia 2007, *Risk Management Guidelines - Companion to AS/NZS 4360: 2004, HB 436:2004/Amdt 1:2005*, Standards Australia, Sydney.

Standards Australia 2009, *Risk management – Principles and guidelines, AS/NZS ISO 31000-2009,* Standards Australia, Sydney.

http://www.environment.gov.au/ssd/research/ecol-risk.html#further (2013)

http://www.planning.nsw.gov.au/rdaguidelines/documents/emp_guideline_publication_october.pd

21.0 Cumulative Impacts

Cumulative impacts can be defined as the additional changes caused by a proposed development in conjunction with other similar developments, or as the combined effect of a set of developments, taken together. In practice the terms 'effects' and 'impacts' are used interchangeably (SNH, 2013).

This chapter discusses the potential cumulative impacts from the construction and operation of the proposed MEWF project, and the surrounding proposed and active developments. The EIS Guidelines (**Appendix 2**) state that the *EIS must identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known current and potential future expansions or developments by the proponent and other proponents in the region and vicinity)*. Where cumulative impacts have been discussed elsewhere in the document, they will be summarised here.

Residual impacts are those risks that remain once mitigation measures have been applied to a development. Those residual impacts could result in cumulative impacts when combined with the impacts from other developments, and as such they will be considered here. The residual impacts are determined through the impact assessments in **Chapters 7 -19** (and their associated technical reports) and are summarised in **Chapter 20.** The residual impacts of the proposal are ecological in nature:

Flora

- Loss of montane heath habitat above 900m ASL in the wet tropics bioregion (including, loss of specific ridge environment habitat (main *Homoranthus porteri* habitats);
- Increased bush fire intensity;
- Habitat degradation from introduction of invasive grasses and tall weeds (e.g. *Hyptis suaveolens*).

Fauna

- Northern Quoll High Quality Denning habitat loss, habitat degradation, construction mortality;
- Bare-rumped Sheathtail Bat – turbine collision and barotraumas;
- Spectacled Flying-fox – turbine collision.

It is anticipated the preconstruction and construction utilisation surveys will fill information gaps such that the proposed mitigation strategies for these residual moderate impact risks can be fine-tuned, resulting in a significant reduction in residual risk, however for the purpose of this assessment they must be considered at the current level of risk.

The cumulative impact assessment considers projects in the same spatial and temporal scale and are further identified at a local and regional scale. These developments are described below.

21.1 Local Projects/Activities

Impacts at a local scale are projects within a 5km radius of the proposed MEWF project site (**Figure 21.1**). There are no new developments of a large scale near the project, and regional relevant projects are all identified as land use activities.

21.2 Land Use

Land surrounding the subject site is utilised for a diverse and evolving array of land uses, as a result of the changing nature of the agricultural industry, the size of surrounding land holdings, topography and soil

characteristics. While the majority of the area surrounding the project site has been extensively cleared and is historically used for livestock grazing and agricultural pursuits, a number of recent approvals issued upon adjacent properties reflect the changing land uses in the area, from passive agricultural and pastoral uses to more intensive farming practices and other industrial and agribusiness practices.

Figure 21.1 shows the approved and committed developments in the region that could contribute to potential cumulative impacts when combined with the proposed MEWF project, including;

- Outdoor Sport and Entertainment Facility (Drag strip) - Lot 13 on SP103361, Springmount Road, Arriga which includes the potential use of the site for intensive motor racing uses;
- Hard Rock Quarry (greater than 100,000 tonnes per year) and Concrete Batching Plant approval associated with the existing processing activities which have occurred on site for a number of years - Lot 3 on RP741713, Springmount Road and Borzi Road, Arriga;
- Tablelands Sugar Mill over Lot 1 on SP100452, Springmount Road, Arriga, located approximately 3 km from the site;
- Ethanol Distillery (Tablelands Sugar Mill) located on Lot 1 on SP100452, Springmount Road, Arriga; and
- Peanut Shell storage approved over Lot 141 on SP123888, located at Channel/Hansen Road, Walkamin (Lot 141 on SP123888).

Concurrently, there has also been an increase in the intensity of existing farming operations over a number of Lots on Oakey Creek Road, including change from grazing livestock to sugar cane production, as a direct result of the Arriga Sugar Mill increasing its capacity.

Other uses which are currently established within the immediate vicinity of the site on Channel Road, which highlight the diversity of rural uses in the area, include:

- A large poultry farm (Lot 6 on SP101513);
- Diverse nursery/farming operation with workers accommodation (rural workers accommodation) located on Lot 1 on RP717403 and Lot 291 on SP219087;
- Intensive organic farming on Lot 407 on NR4480;
- Banana farm (Lot 1 on RP719462); and
- Nursery (Lot 289 on NR7038 and Lot 407 on NR 4480).
- Springmount Waste Management Facility (Lot 13 on SP103361), located to the north-west of the site on Springmount Road, Arriga
- Lotus Glen Correctional Centre property comprises an area of approximately 800 ha and is located approximately 1.5 km to the north of the project area on Hansen Road / Chettle Road.
- Mt Uncle Distillery, located approximately 5 km from the project site boundary, contains a cafe, retail shop and fruit plantations, and generates a number of tourist vehicle movements to the area, seven days a week, throughout the year.

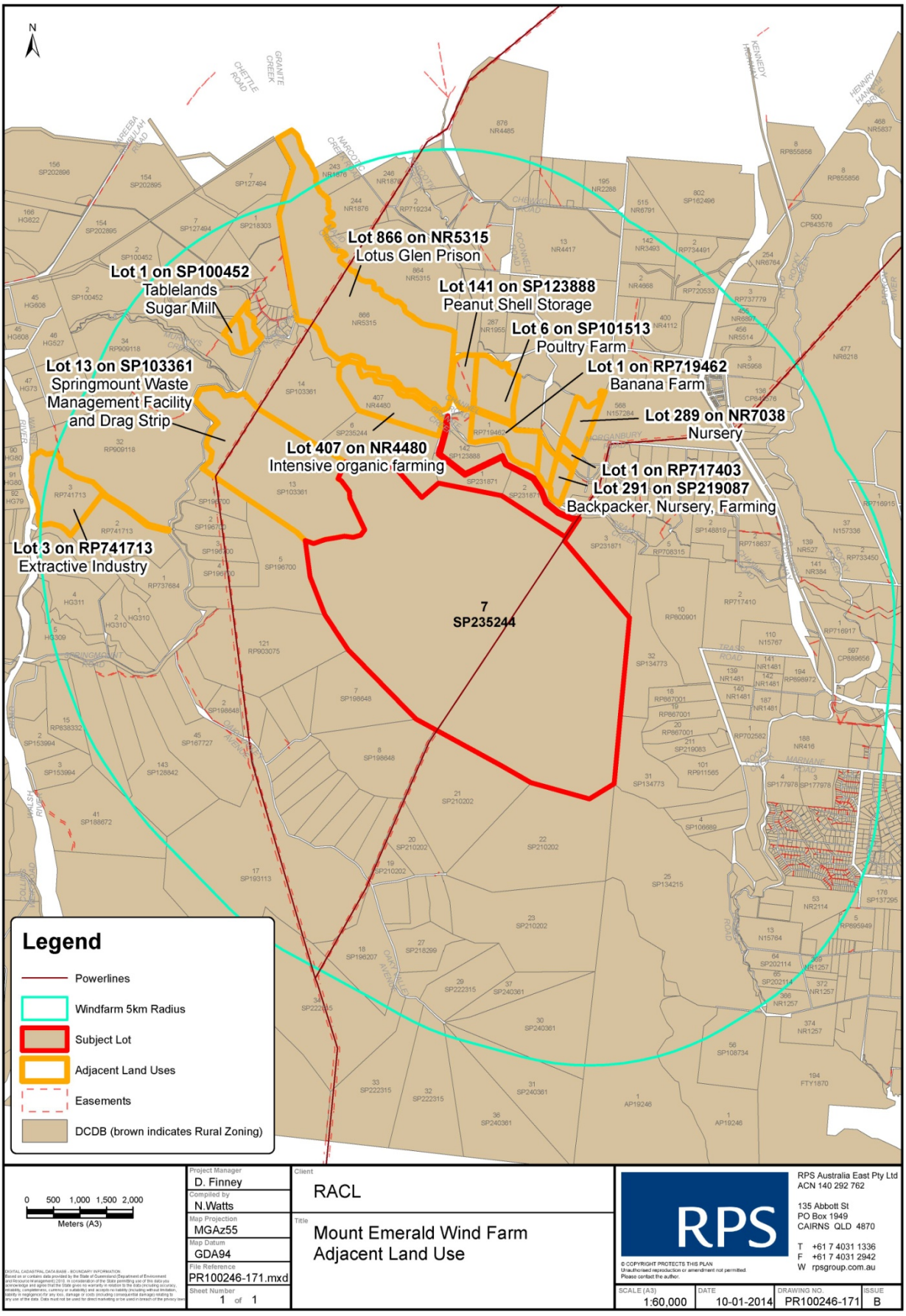

Figure 21.1 Adjacent Land Uses

21.3 Regional Projects/Activities

Projects considered at a regional scale where there are related activities or impacts are considered here and are presented in **Figure 21.2.**

21.3.1 Mining Operations

- Watershed Project - Vital Metals (EPBC Referral 2010/5495). Vital Metals Limited is currently developing a tungsten resource under Mineral Development Licence (MDL) 127 at the Watershed deposit some 23 km north-west of Mt Carbine on the boundary between Cook and Mareeba Shires in North Queensland with a proposed area of disturbance of approximately 589 ha.
- Baal Gammon Expansion – Consolidated Tin Mines Ltd (CTM) (Snow Peak majority shareholder). CTM is proposing to expand the current Baal Gammon mine (mining application MLA 20692), in the vicinity of the water catchments of Toy Creek and Bussy Creek which flow into the Walsh River.

21.3.2 Wind Farms

- High Road Stage 1 - of the proposed High Road Wind Farm (also owned by RACL) has received Federal Government environmental approval. Stage 1 of the High Road Wind Farm comprises 17 x 2-3 MW turbines with a hub height of 80 m and a blade length of 45 m located in cleared land adjacent to wet sclerophyll forest. This project is situated approximately 30 km to the south of the MEWF site and consists of 330ha of subject land.
- High Road Stage 2 - of the High Road Wind Farm comprises an additional 28 turbines; 12 of which are located within wet sclerophyll forest and 16 in cleared lands, is currently undergoing environmental assessment. The subject site consists of 670ha of land.
- Windy Hill - Operating since 2000 and comprising 20 wind turbines with a hub height of 46m and a rotor diameter of 44m with a generating capacity of 12MW. Windy Hill was the first wind farm made operational in Queensland and is situated near Ravenshoe (50 km to the south of the proposed MEWF site). The site consists of 169 ha of subject land.

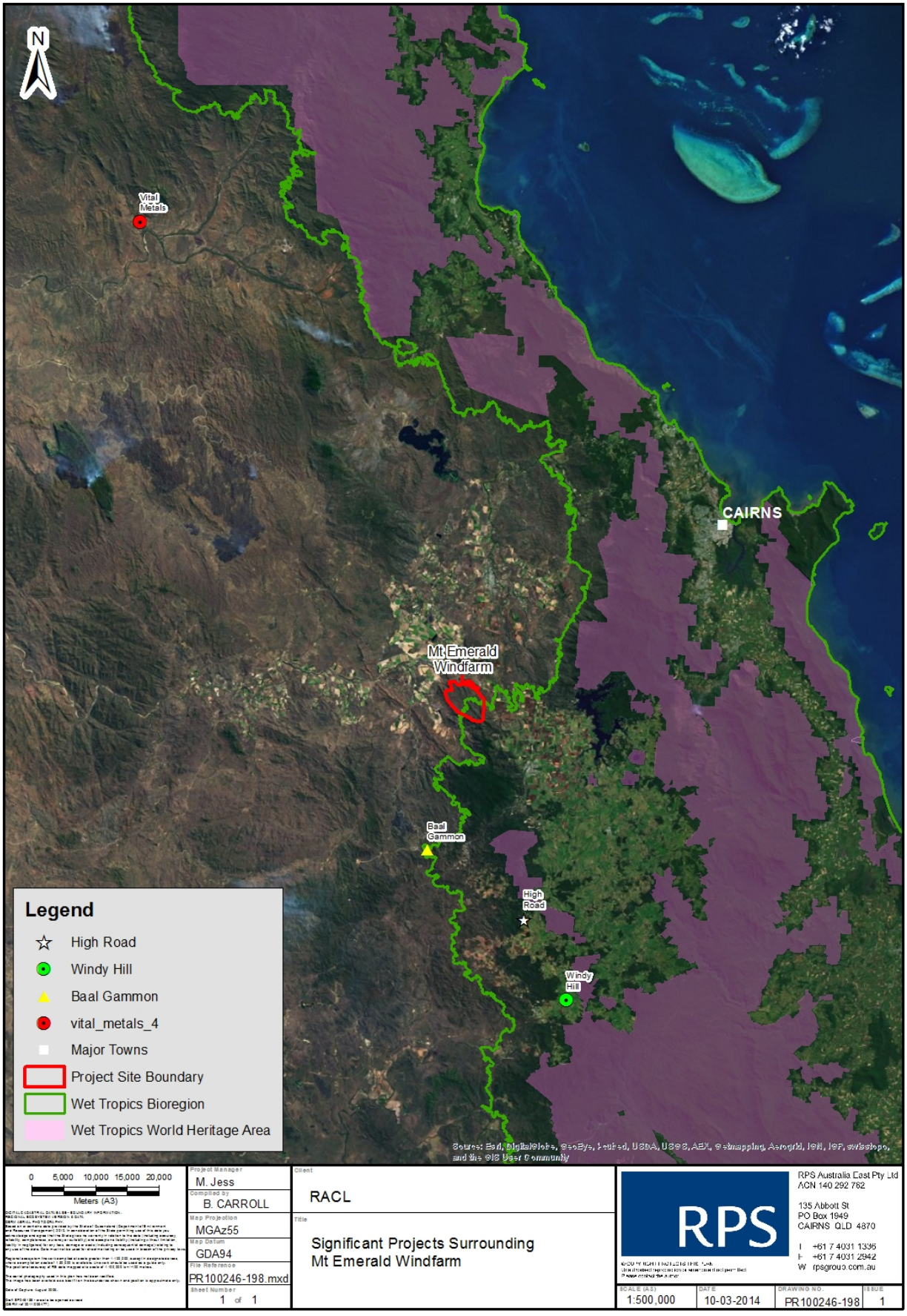

Figure 21.2 Regional Developments with Potential Cumulative Impacts

21.4 Cumulative Impact Assessment

An assessment was conducted to consider projects by RACL and other proponents, and the potential impacts from these on the significant flora and fauna found on the proposed MEWF site.

Table 21.1 presents this assessment and a summary of the cumulative impacts.

In summary, significant cumulative adverse effects are not anticipated on MNES flora and fauna as a result of the proposed MEWF. As identified in **Table 21.1**, none of the individual projects are expected to cause significant impacts to flora or fauna following the implementation of proposed and likely mitigation and management measures and the projects considered together will not cause impacts that interact with or increase the extent of the impacts of other projects.

The cumulative benefit from the construction and operation wind farms in the region will result in significant short and long term net economic benefits to the community, and environmentally, reduce the potential loss of habitat through clearing for coal mine operations.

Table 21.1 Cumulative Impact Assessment

	Local		Regional				
Species/Threat	**Land Use Activities**		**Mining**		**Wind Farms**		**Summary of Cumulative Impacts**
	Light Industrial and Urban: ▪ Sport and Entertainment facility ▪ Hard Rock Quarry ▪ Tablelands Sugar Mill ▪ Ethanol distillery ▪ Prison ▪ Urban expansion (all operational)	**Farming:** ▪ Poultry ▪ Organic ▪ Banana ▪ Nursery (all operational)	**Watershed Project - Vital Metals (EPBC Referral 2010/5495)**	**Baal Gammon Expansion – Consolidated Tin Mines Ltd (CTM)** **(Snow Peak majority shareholder)**	**Windy Hill Wind Farm (Operational)**	**High Road Wind Farm – Stage 1 and 2** **(Feasibility)**	
Northern Quoll							
Loss of denning habitat	The surrounding land uses are rural and residential in nature and are not anticipated to impact on denning habitat of quolls as they are not considered suitable habitat for the species. The Mareeba Shire Planning Scheme has identified potential zones for future urban expansion that includes areas of remnant eucalyptus woodland and open forest that forms a potential movement corridor for Northern Quoll individuals between the Barron River and the large intact block of remnant dry eucalypt woodland to open woodland on sandy plains surrounding the Mareeba Wetlands.	The surrounding land uses are rural and residential in nature and are not anticipated to impact on denning habitat of quolls as they are not considered suitable habitat for the species.	The total area of mining leases E, F, G, is 589.43 ha. The watershed project site has been found to contain the Northern Quoll. However, habitat and den sites were not documented within the proposed development footprint. Mitigation measures have been incorporated during the development process to prevent destruction of potential habitat. These include minimisation of clearing activities and protection of existing water bodies to prevent contamination.	The site is approximately 200ha in size. There is limited information available on activities of North Quoll on this project site; however the headwaters of Toy Creek (nearby) are known to support high densities of the species. Previous contamination to the Walsh river have occurred from site activities and may lead to an increase in quoll mortalities should this reoccur. However, high quality rehabilitation, including the construction of waste rock dumps which may function as denning habitat, will minimise cumulative impact in the longer term. This project recognises the impacts to fauna of operation and mitigations measures are proposed to minimise any impacts.	The Windy Hill Wind Farm has been operational since 2000, with the total size of the subject land being 169 ha. The site is located on pastoral land near the township of Ravenshoe and does not contain habitat suitable to denning of the Northern Quoll.	There is potentially suitable habitat for the Northern Quoll at the High Road Wind Farm site. Stage 1 of the subject land is 330ha and Stage 2 is 670ha with approximately 8% cleared for the development footprint. Further studies will determine the site utilisation activities of the Northern Quoll and if required mitigation strategies will be implemented to protect denning habitat. Only a small percentage of the site would be cleared for the project footprint and would consist of less than 30 hectares. The development footprint is linear in design and does not consist of an area significant enough to fragment a population (road widths 10m).	Implementation of mitigation measures at each project will remove potential impacts to Northern Quoll denning habitat. Temporal differences in project schedules will also minimise any temporary impacts to habitat removing any potential barrier effects that could arise from works. Cumulative impacts from these projects are expected to be minimal.
Habitat degradation	The existing surrounding land uses are rural and residential in nature and are not considered key suitable habitat for the species.	The existing surrounding land uses are rural and residential in nature and are not considered key suitable habitat for the species. The lack of sufficient irrigation water is likely to limit further agricultural development in this area therefore it is unlikely that potential habitat will be impacted by further development.	The introduction of exotic pasture grasses and weed species disadvantages Northern Quolls by inhibiting movement and hunting ability through high density stands of exotic pastures and also fosters more intense fire regimes. Appropriate Management Strategies through the EMP process mitigate these impacts to the species. High quality rehabilitation, including the construction of waste rock dumps which may function as denning habitat, will minimise cumulative impact in the longer term. This project has implemented stringent mitigation to protect endangered species on site.	The site is approximately 200 ha in size. There is limited information available on activities of North Quoll on this project site; however the headwaters of Toy Creek (nearby) are known to support high densities of the species. Previous contamination to the Walsh River has occurred from site activities and may lead to an increase in Quoll mortalities should this reoccur. However, high quality rehabilitation, including the construction of waste rock dumps which may function as denning habitat, will minimise cumulative impact in the longer term. This project recognises the impacts to fauna of operation and mitigation measures are proposed to minimise any impacts.	The Windy Hill Wind Farm has been operational since 2000. The site is located on pastoral land near the township of Ravenshoe and does not contain habitat suitable to Northern Quoll.	There is potentially suitable habitat for the Northern Quoll at the High Road Wind Farm site. Further studies will determine the site utilisation activities of the Northern Quoll and if required mitigation strategies would be implemented to protect key habitat areas. Only a small percentage of the site would be cleared for the project footprint and would consist of less than 30 hectares. Quolls are known to to have extensive ranges (Burnett *et al*, 2013), across the MEWF project site. Internal roads do not create fragmentation and the small footprint created is not expected to impact on quoll habitat and movement activities. The implementation of an EMP would also reduce any potential impacts through weed or fire degradation.	Implementation of mitigation measures at each project will remove potential degradation impacts to Northern Quoll habitat. Temporal differences in project schedules will also minimise any temporary impacts to habitat removing any potential barrier effects that could arise from works. Cumulative impacts from these projects are expected to be minimal.

	Local		Regional				
Construction mortality	The surrounding land uses are rural and residential in nature and are not anticipated to impact on mortality during construction.	The surrounding land uses are rural and residential in nature and are not anticipated to impact on mortality during construction	The watershed project site contains habitat suitable for the Northern Quoll. Comprehensive mitigation strategies are known to have been employed during construction activities. Additionally, stringent mitigation strategies will be employed on the MEWF site to prevent construction mortalities from occurring.	The Baal Gammon project site contains habitat suitable for the Northern Quoll. Further information is not available however the implementation of mitigation strategies in anticipated.	The Windy Hill Wind Farm has been operational since 2000 and will not have additional construction activities on site.	Mitigation measures under a Species Management Plan should prevent mortalities during construction of a wind farm. Cumulative impacts from this and other wind farms in the region due to construction mortality should be minimal.	Construction related activities of one project are not expected to increase the effects caused by other projects in this assessment. Temporal variation in project development will also reduce any potential impacts on populations.
Sarus Crane							
Turbine collision	It is unlikely that any operational land use activity will contribute to Sarus Crane mortality as these structures are stationary and typically long standing. Should new powerlines be located in the area, they may contribute to mortality as there have been recorded mortalities nationally and internationally.	An increase in farming activities may increase the population of Sarus Cranes that forage in the region thereby increasing the potential for collision with turbines. This should be offset with a greater species carrying capacity due to increased food supply.	Areas to be disturbed for mining are not considered suitable habitat for this species. There is no evidence of a requirement for increased electricity capacity to this site therefore the potential impact of collision risk with powerlines is not expected to increase.	Areas to be disturbed for mining are not considered suitable habitat for this species. There is no evidence of a requirement for increased electricity capacity to this site therefore the potential impact of collision risk with powerlines is not expected to increase.	There have been no systematic bird and bat turbine collision mortality monitoring conducted at the single operating wind farm, Windy Hill, although anecdotally (K Forde pers comm.) mortality was negligible including nil Sarus Cranes. There is currently no information available on turbine avoidance rates, or estimated powerline collision mortality for the species. Therefore, it is not possible to accurately quantify the potential cumulative impact of additive mortality of multiple windfarms on the species without further research e.g. an understanding of the foraging patterns of the species.	There is currently no information available on turbine avoidance rates, or estimated powerline collision mortality for the species. However, collision risk modelling at the proposed MEWF site indicated that mortality impacts are expected to be low and internationally it has been observed that avoidance behaviours are typical for the species.	Bird fatalities are a known impact of wind farm operations world wide. Collision risk studies have ascertained that with effective mitigation strategies such as radar, fatalities are low. Further research being conducted into these strategies will increase the confidence is such results both nationally and internationally.
Bare-rumped Sheathtail Bat							
Turbine collision	Current industrial activities are not expected to impact on the rates of mortality of the Bare-rumped Sheathtail Bat as these areas have a long history of clearance and do not contain habitat suitable for the species.	Current farming activities are not expected to impact on the rates of mortality of the Bare-rumped Sheathtail Bat as these areas have a long history of clearance and do not contain habitat suitable for the species.	Surveys on the site indicated that there was no evidence of the Bare-rumped Sheathtail Bat.	The presence of the Bare-rumped Sheathtail Bat on this project site is unknown. If present there is potential for individual roost sites to be destroyed during expansion activities.	There is no available habitat suitable to the Bare-rumped Sheathtail Bat at the Windy Hill Wind Farm.	There is potentially suitable habitat available to the Bare-rumped Sheathtail Bat at the High Road Site. Ecological surveys are currently being conducted and should the project progress a comprehensive set of mitigation measures will be applied to protect the species from mortality associated to a variety of factors including turbine collision risk and barotrauma.	Bat fatalities are a known impact of wind farm operations worldwide. This species is so poorly known that the potential loss of habitat – in particular roosting sites remains critical, therefore any clearing activities for mining, urban development or wind farm development are considered a potential threat. Mitigation strategies for clearing, spotter catcher and habitat avoidance have been employed on new developments. Temporal variation in project development will also reduce any potential impacts on populations.

	Local		Regional				
Barotrauma	Current industrial activities are not expected to impact on mortality rates of the Bare-rumped Sheathtail and therefore will not result in a cumulative impact on the species.	Current farming activities are not expected to impact on the mortality rates of the Bare-rumped Sheathtail Bat and therefore will not result in a cumulative impact on the species.	Surveys on the site indicated that there was no evidence of the Bare-rumped Sheathtail Bat. The nature of operation of the project do not provide suitable habitat for the bat around mining activities and there are expected to be no residual impacts from this project that would result in cumulative impacts with the MEWF project.	The presence of the Bare-rumped Sheathtail Bat on this project site is unknown. If present, there is potential for individual roost sites to be destroyed during expansion activities, however appropriate mitigation measures will minimise any disturbance and potential mortality.	There is no available habitat suitable to the Bare-rumped Sheathtail Bat at the Windy Hill Wind Farm.	There is potentially suitable habitat available to the Bare-rumped Sheathtail Bat at the High Road Site. Ecological surveys are currently being conducted and should the project progress and the species is located, a comprehensive set of mitigation measures will be applied to protect the species from mortality associated to a variety of factors including Turbine collision risk and barotrauma.	Bat fatalities are a known impact of wind farm operations worldwide. This species is so poorly known that the potential loss of habitat – in particular roosting sites remains critical, therefore any clearing activities for mining, urban development or wind farm development are considered a potential threat. Mitigation strategies for clearing, spotter catcher and habitat avoidance have been employed on new developments. Temporal differences in development of these projects also support the population.
Spectacled Flying-fox							
Turbine collision	Current industrial activities are not expected to impact on mortalities of SFF and are not expected to contribute to a cumulative impact on the species.	There is potential for an increase in farming activities to increase the number of SFF around the proposed MEWF due to foraging activities. This could increase the potential for turbine collision however; the lack of sufficient irrigation water is likely to limit further agricultural development in this area. Current agricultural activities are not expected to contribute to a cumulative impact on the species.	The nature of construction and operation of the project do not provide suitable habitat for the SFF around mining activities and there are expected to be no residual impacts from this project that would result in cumulative impacts with the MEWF project.	The nature of construction and operation of the project do not provide suitable habitat for the SFF around mining activities and there are expected to be no residual impacts from this project that would result in cumulative impacts with the MEWF project.	There are limited records of fatalities to the SFF at the Windy Hill Wind Farm, although anecdotally (K Forde *pers comm*.) mortality was negligible including nil Flying Foxes. Extensive mitigation strategies that have been outlined at the proposed MEWF site require more detailed survey however they are expected to yield positive results. These strategies can be employed at other wind farms in the region to reduce any potential mortalities to the species from turbine collisions.	There is potential for cumulative impacts on the SFF to occur due to turbine collision at wind farm sites in remnant vegetation in the region. Extensive mitigation strategies that have been outlined at the proposed MEWF site require more detailed survey however they are expected to yield positive results. These strategies can be employed at other wind farms in the region to reduce any potential mortality to the species from turbine collisions.	Bat fatalities are a known impact of wind farm operations worldwide. This region is the first to consider the impacts of wind turbines and other developments on the SFF. Information about bat mortality from wind generation is limited. Mitigation strategies such as radar and protection of foraging habitat throughout the region are key strategies. Further research being conducted into these and additional strategies will increase the confidence in mitigation measures nationally and internationally for bat species. Temporal variation in development activities will reduce any potential impacts that result from clearing activities around foraging habitat.
Flora							
Loss of montane heath habitat above 900m ASL	There is no suitable habitat within the existing land use areas and there will be no cumulative impacts resulting from the proposed MEWF project and these activities.	There is no suitable habitat within the existing land use areas and there will be no cumulative impacts resulting from the proposed MEWF project and these activities.	There is no suitable habitat on the project site and there will be no cumulative impacts resulting from the proposed MEWF project and these activities on montane heath habitat.	Potential decrease in area of habitat available for *Homoranthus porteri* in local region. Clearing of ridges on the wind farm where *H. porteri* occurs will results in a reduction in available habitat resources for the species.	Unlikely to have any significant cumulative impacts due to lack of suitable habitat.	Unlikely to have any significant cumulative impacts due to lack of suitable habitat.	Cumulative impacts at the local and regional project scale are expected to be minimal due to implementation of management strategies.

	Local		Regional				
Loss of specific ridge environment habitat (main *Homoranthus porteri* habitats)	There is no suitable habitat within the existing land use areas and there will be no cumulative impacts resulting from the proposed MEWF project and these activities.	There is no suitable habitat within the existing land use areas and there will be no cumulative impacts resulting from the proposed MEWF project and these activities.	There is no suitable habitat on the project site and there will be no cumulative impacts resulting from the proposed MEWF project and these activities on montane heath habitat.	Potential decrease in area of habitat available for *Homoranthus porteri* in local region. Clearing of ridges on the wind farm where *H. porteri* occurs will results in a reduction in available habitat resources for the species.	Unlikely to have any significant cumulative impacts due to lack of suitable habitat.	Unlikely to have any significant cumulative impacts due to lack of suitable habitat.	Most projects considered in the region are not within the habitat zone of rare and threatened flora species found at the MEWF site. The Baal Gammon site may have populations of this species and mining activities are unlikely to extend to the ridge top environs, with predicted habitat occurring outside of the development footprint.
Altered fire frequency/ inappropriate fire regime.	There is no suitable habitat for rare and threatened species (found at the MEWF site) within the existing land use areas. There is potential for fire to extend from land use areas into the MEWF project areas however fire management strategies employed by Local Council, Rural Fires Services and industry serve to protect the surrounding habitat as much as possible.	There is no suitable habitat for rare and threatened species (found at the MEWF site) within the existing land use areas. There is potential for fire to extend from land use areas into the MEWF project areas however fire management strategies employed by Local Council, Rural Fires Services and industry serve to protect the surrounding habitat as much as possible.	This project has developed appropriate Fire Management Plans to protect the project area from fire. Habitat crucial to rare and threatened species found on the proposed MEWF project site is not found in this location. Distance serves as a buffer to fire activities between sites.	It is expected that this project will develop appropriate Fire Management Plans to protect the project area from fire. Distance serves as a buffer to fire activities between sites.	Unlikely to have any significant cumulative impacts due to lack of suitable habitat.	Unlikely to have any significant cumulative impacts due to lack of suitable habitat.	The implementation of fire management strategies is essential for projects in the region. Inappropriate fire regimes are more likely in the land use zone around the MEWF site due to the mix of agricultural, residential activities however the Mareeba Shire Council is responsible for this area. Larger projects have approved fire management strategies. The cumulative risk is minimal.
Habitat degradation from weed introduction and pathogens.	There is no suitable habitat for rare and threatened species (found at the MEWF site) within the existing land use areas. There is potential for weed and pathogen incursions to extend from land use areas into the MEWF project areas Weed Management Strategies employed by Local Council, the State government and industry serve to protect the surrounding habitat as much as possible.	There is no suitable habitat for rare and threatened species (found at the MEWF site) within the existing land use areas. There is potential for weed and pathogen incursions to extend from land use areas into the MEWF project areas Weed Management Strategies employed by Local Council, the State government and industry serve to protect the surrounding habitat as much as possible.	This project has developed appropriate Weed Management Plans to protect the project area from weed and pathogen Introduction. Habitat crucial to rare and threatened species found on the proposed MEWF project site is not found in this location. Distance serves as a buffer to weed introduction however it is crucial that projects continue to maintain these services.	It is expected that this project will develop appropriate Weed Management Plans to protect the project area from weed and pathogen introduction.	Unlikely to have any significant cumulative impacts due to lack of suitable habitat.	Unlikely to have any significant cumulative impacts due to lack of suitable habitat.	The implementation of weed management strategies is essential for projects in the region. The cumulative risk is minimal.

22.0 Offsets

22.1 Context

As a controlled action subject to the provisions of the EPBC Act, the residual significant impacts of the project on MNES will require offsets. Residual significant impacts are those that remain after avoidance and mitigation measures have been implemented. Offsets for these impacts are to be delivered in accordance with the EPBC Act Environmental Offsets Policy (EPBC Act Offsets Policy), released by the Australian Government in October 2012. The full detail of RACL's approach to offset delivery is outlined in the Mount Emerald Wind Farm Offsets Assessment Guide Preliminary Results (**Appendix 33**) and Draft Offset Management Plan (**Appendix 34**). To address Section 5.13 of the Final Guidelines for an Environmental Impact Statement (EIS) for the Mount Emerald Wind Farm April 2012, a summary of the project's Preliminary Results and Offset Plan is provided below, as developed by CO2 Offset Specialists.

22.2 Offset requirements of the project

Project development requires the removal of approximately 57 ha of remnant vegetation for the construction of the turbine pads, the contractors lay down pad, access tracks and a substation. Based on an assessment of the project's residual impacts, the offset requirements have been identified and are presented in **Table 22.1**. The offset requirements outlined below are not cumulative as some environmental values occur within the same area.

Table 22.1 Summary of the project's offset requirements under the EPBC Act Environmental Offsets Policy

Environmental Value	EPBC Act Status	Species Distribution Within Project Area	Impact Area (Ha)
Threatened Fauna			
Northern Quoll (*Dasyurus hallucatus*)	E	A number of individuals of both sexes and different ages were detected across the subject site, predominantly in rocky areas in both ridges and valleys. Quolls were detected through cage trapping, camera traps and scat identification. It was concluded that northern quolls are abundant and widespread across the site.	57.7
Spectacled Flying-fox (*Pteropus conspicillatus*)	V	No suitable roosting habitat (rainforest) is present on the subject site; however, the species may forage on site during mass flowering of Myrtaceous trees, and/or fly over site at rotor height between suitable nearby foraging areas.	57.7
Bare-rumped Sheathtail bat (*Saccolaimus saccolaimus nudicluniatus*)	CE	The subject site contains suitable habitat for this species, particularly in the lower reaches of Granite Creek where *E. platyphylla* is present. Calls potentially belong to this species have been recorded across the site.	57.7
Threatened Flora			
Grevillea glossadenia	V	Widespread in rocky habitat of the Wet Tropics bioregion section of site. Relatively common along ridges above 900 m, but rarely found under woodland cover.	10.2
Homoranthus porteri	V	More or less confined to south west ridges of the Wet Tropics bioregion section, with two isolated populations in Einasleigh Uplands bioregion.	5.1

*E- endangered; CE- critically endangered; M- migratory; V- vulnerable
based on the number of individuals surveyed, (not habitat)

22.3 Project offsets

Under the EPBC Act offsets policy there are three primary options available for offset delivery: direct offsets, other compensatory measures and advanced offsets. RACL has undertaken a preliminary assessment to identify suitable direct land based offsets to meet the offset requirements of the project, taking into account:

- The requirements of the EPBC Act offsets policy;
- Proximity to the existing project area;
- The characteristics of the offset area (vegetation, topography, ecosystems) and their similarity to the characteristics of the project area; and
- Connectivity to existing reserves (e.g. National parks, state forests).

Based on this assessment a potential direct land based offset area has been identified. The suitability of the offset area has yet to be ground-truthed to determine the actual extent of environmental values on the ground. Should the offset area prove to be unviable following field surveys an alternative direct offset option will be identified. However, a preliminary assessment of the offset area against the EPBC Act Offsets Assessment Guide (the offsets assessment guide) has been undertaken. This assessment indicates that there is sufficient potential to configure a compliant offset on the identified property. Offsets will be implemented in accordance with MNES flora and fauna national recovery plans and/or the threat abatement and recovery recommendations listed in the Department of the Environment (DotE) Species Profile and Threats Database thereby ensuring that the offsets are effective, timely, reasonable and scientifically robust.

In the event that direct offsets do not fulfil the entire project's offset requirements, other compensatory measures will be explored in order to meet any shortfall. Other compensatory measures are proposed which include plant translocations, research opportunities, the development of literature and interpretive material and the revegetation of adjacent road verges.

22.3.1 Offset Methodologies

The offsets assessment guide utilises a balance sheet approach to measure and compare values between the impact area and the offset area. The guide is used as a tool by Australian Government assessment officers to determine the suitability of the proposed offset. The offsets assessment guide requires the following values:

- Size of the impact area;
- Current quality of impact area;
- Start quality of the offset area;
- Future quality of the offset area with offsets;
- Future quality of the offset area without offsets;
- Risk of ecological loss of mnes-specific value with an offset;
- Risk of ecological loss of mnes-specific value without an offset;
- The time over which ecological loss is averted;
- The time until ecological benefit; and
- The confidence in results of the future quality of the offset area and the risk of loss with and without offsets.

The quality of the impact and offset area (current, start and future) was determined by identifying the key ecological attributes of each MNES and comparing it to the values presented in **Table 22.2.** Key ecological attributes were summarised using the Species Profile and Threats database, recovery plans and relevant published literature. Habitat quality was ranked from one (poor) to 10 (high). Qualitative scores incorporate attributes that would affect habitat quality including, disturbance (e.g. introduced species, fire, current land use), connectivity, previous species records and the presence of microhabitat features necessary to each MNES assessed. The draft EIS prepared by RPS was reviewed for information about the current habitat quality of the impact area and offset area (where applicable).

Table 22.2 Habitat Quality Scores

DESCRIPTION	QUALITATIVE SCORE	QUANTITATIVE SCORE
This area provides no habitat value for species.	Nil	Nil
The species or community is unlikely to occur or may occur in low densities as habitat features are lacking. Broad scale habitat may be present but micro habitat is lacking. The area may be exposed to disturbance effects limiting the sustainable presence or affecting the ecological quality of the species habitat or community.	Low	1-2
The species has the potential to occur based on the presence of some habitat features however the successful establishment of a population in the area is limited by disturbance. Essential habitat may be lacking for a stage within the species life cycle (if applicable).	Low-Moderate	3-4
This area supports, or is likely to support, the species/community due to the presence of macro and microhabitat features however, the site is exposed to disturbance effects that may hinder the success of the population or has poor connectivity.	Moderate	5-6
The species is known or likely to occur in this area based on the presence of suitable macro habitat as well as most micro features the species requires. This area is exposed to little disturbance.	Moderate-High	7-8
This area achieves the primary habitat values for the species including species-specific essential conditions and resources for all life cycle stages (if applicable). Habitat type is >50 ha and/or is ecologically connected with other suitable habitat. This area is exposed to little or negligible levels of disturbance.	High	9-10

Source: Appendix 33 – Table 2: Habitat quality scores for the project site and the offset area (p 7)

22.3.2 Environmental values of the proposed offset area

The proposed offset area is approximately 583.48 ha in size and is situated across six contiguous lots (based on the Digital Cadastral Database, current as of 11 August 2013) that adjoin the project area (**Figure 22.1)**. It is located in the Mareeba Shire Council local government area and is zoned as rural (general rural). The offset area fringes the southern boundary of the project area and is connected to the Herberton Range State Forest, Baldy Mountain Forest Reserve and the Herberton Range National Park via the Herberton range. Due to the close proximity of the offset area and the project area, they share similar environmental features such as topography, geology, climate, and vegetation communities and fauna diversity.

The offset area is characterised by high elevation ridges and valleys composed of remnant vegetation communities. The Queensland Government's regional ecosystem (RE) mapping has been assessed to identify the vegetation communities present within the offset area and the types of habitat for MNES that may be present. The majority of the remnant vegetation communities are listed as least concern under the *Vegetation Management Act 1999* (Qld; VM Act), however approximately 159 ha of of concern montane heath community (RE 7.12.57) is mapped within the offset area. An assessment of the EPBC Act Protected

Matters Search Tool database indicates that the northern quoll, spectacled flying-fox, *Grevillea glossadenia* and *Homoranthus porteri* and/or their habitat are likely to occur in the offset area. The Atlas of Living Australia has records within the offset area of the *Grevillea glossadenia* and *Homoranthus porteri*. In addition, extensive flora and fauna surveys of the project area were carried out between 2010 and 2013. During these survey efforts a northern quoll was detected by an infrared camera trap near the northern boundary of the offset area.

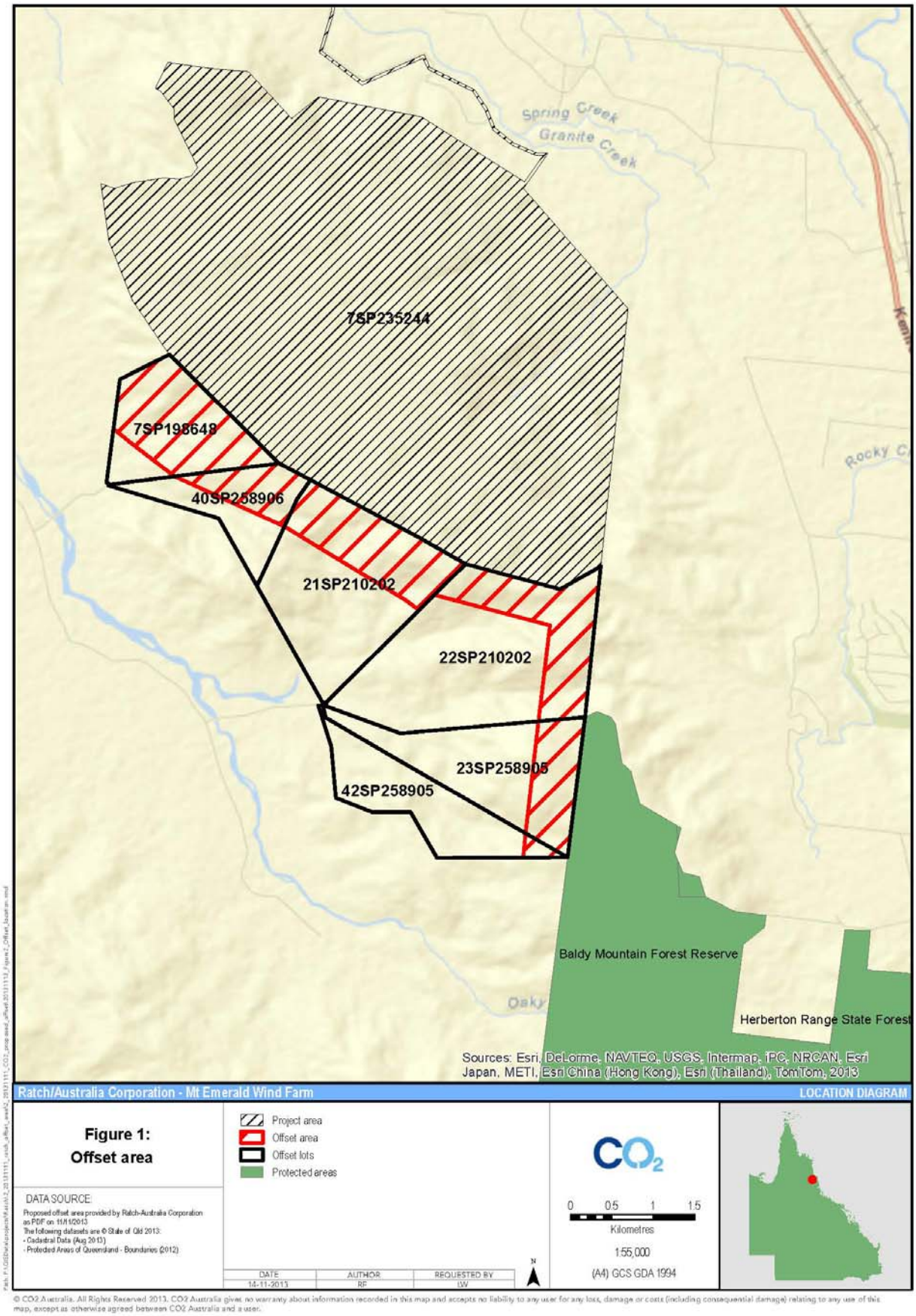

Figure 22.1 Proposed offset area

22.3.3 Offset potential of the proposed offset area

A preliminary desktop assessment of the environmental values within the offset area demonstrates that management and protection of this area has the potential to acquit the project's offset requirements as outlined in **Table 22.3**. The proposed offset area is mapped as containing approximately 583 ha of northern quoll habitat (347 ha denning and 236 ha foraging), 360 ha of spectacled flying-fox foraging habitat and 391 ha of Bare-rumped Sheathtail Bat roosting habitat.

In addition to containing suitable fauna habitat, the proposed offset area is mapped as containing approximately 167 ha of *Grevillea glossadenia* habitat and 117 ha of *Homoranthus porteri* habitat. This mapped habitat includes a vegetation community (RE 7.12.57) that was found to support both *Grevillea glossadenia* and *Homoranthus porteri* populations in the project area. The Atlas of Living Australia has known records within the offset area of *Grevillea glossadenia* and *Homoranthus porteri*.

The actual extent and quality of the habitat within the offset area will require field verification; however, as the offset area neighbours the project area, the habitat quality within the offset area is expected to be similar to the baseline conditions identified during flora and fauna survey efforts.

Table 22.3 Potential offset availability within the offset area

OFFSETS ASSESSMENT GUIDE PARAMETER	MNES				
	northern quoll	spectacled flying-fox	bare-rumped sheathtail bat	*Grevillea glossadenia*	*Homoranthus porteri*
Size of impact area:	57.7 ha	57.7 ha	57.7 ha	10.2 ha	5.1 ha
Quality of impact area:	8	3	7	7	7
Start quality of offset area:	8	3	7	7	7
Future quality with offset:	9	4	8	8	8
Future quality without offset:	6	3	6	6	7
Confidence in results:	50%	70%	70%	70%	50%
Risk of loss with offset:	2%	2%	2%	2%	2%
Risk of loss without offset:	5%	5%	5%	5%	5%
Confidence in results:	70%	70%	70%	70%	70%
Time over which loss is averted:	20 years	20 years	20 years	20 years	20 years
Time until ecological benefit:	5 years	Immediate	Immediate	5 years	5 years
Minimum offset area:	315**Error! Bookmark not defined.** ha	213 ha	300 ha	50 ha	57 ha
Minimum % of impact offset:	100%	100%	100%	100%	100%
Maximum offset area:	347**Error! Bookmark not defined.** ha	360 ha	391 ha	167 ha	117 ha
Maximum % of impact offset:	112%	155%	133%	346%	207%

[1] Includes denning habitat only; however, 236 ha of potential foraging habitat is also available within the proposed offset area.
Source: Appendix 33 – Table 8 – Offsets assessment guide results (p 23)

The proposed offset area is not currently reserved by law or planning regulations or agreed to under other schemes or programs; therefore, securing and managing the proposed offset area will deliver a new conservation gain for impacted MNES.

Through consultation, RACL has determined that the landholders of the identified lots are amenable to securing the offset area for conservation purposes; however, further assessments of the offset area are necessary and relevant contractual agreements will be required to be negotiated and established. In addition, if approved by DotE, the offset area will need to be secured in through a legally-binding mechanism such as a:

- Conservation park, nature refuge, resource reserve or national park as recognised by the *Nature Conservation Act 1992* (Qld).
- Conservation agreements under the EPBC Act.
- Voluntary declaration under the VM Act.
- Statutory covenant under the *Land Title Act 1994* (Qld) for freehold land or *Land Act 1994* (Qld) for non-freehold land.

22.4 Offset Implementation

RACL is committed to offsetting the residual impacts of the project on MNES and has developed an approach to offset implementation which ensures offsets deliver an overall conservation gain for the impacted species and are delivered in a timely manner. An overview of offset implementation, including tasks and timeframes, is provided in **Table 22.4**. These tasks and timeframes are subject to change due to a number of variables, including regulatory approval, regulatory requirements, landholder negotiation, climatic conditions, land access, stakeholder inactivity and other unexpected delays.

Table 22.4 Implementation Plan

IMPLEMENTATION TASK	TIMEFRAME
Assessment of the proposed offset area against the offsets assessment guide for each impacted MNES, including field surveys where required	Preliminary assessment complete The offsets assessment guide will be updated following field surveys post wet season
Negotiations to establish an offset agreement with the landholder of the offset property	July 2013 – ongoing
Preparation of a detailed offset proposal for submission to DotE	Following field surveys post wet season
Preparation of an Offset Area Management Plan for submission to DotE	Draft plan completed February 2014
Registration of a relevant instrument on land title to protect the offsets environmental values in perpetuity	November 2014 Subject to DotE approval of OAMP and RAC Board Approval for project construction.
Implementation of the Offset Area Management Plan	November 2014 Subject to DotE approval of OAMP and RAC Board Approval for project construction.

22.5 Offset Area Management

The purpose of the MEWF Offset Area Management Plan (Appendix 33) is to identify the management objectives and actions necessary to fulfil a statutory requirement for the provision of an offset for the Mount Emerald Wind Farm Project under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) Environmental Offsets Policy 2012*. This management plan is intended to support a statutory covenant under the Queensland Land Title Act 1994, which will protect the offset from clearing until the objectives and outcomes of the plan have been achieved. This management plan will be recorded on property title and is binding on current and future landholders.

The management plan is a draft only and is based on desktop information. A field survey will be undertaken prior to finalisation of the management plan to determine site specific management actions. Additionally, the management plan will finalised based on consultation with the regulator and the landholders.

Specifically, the Offset Management Plan consists of the following components:

Summary Information:

- Departmental reference details;
- Legislative triggers and impacts requiring offset;
- Offset area details;
- How the offset will be secured;
- Description of the values impacted on the clearing area and the values located on the offset area.

Management Plan:

- Management objectives and outcomes;
- Any restrictions imposed on the use of the offset area;
- The activities that will be undertaken to achieve the objectives and outcomes;
- Threatened plant management;
- Monitoring requirements;
- An analysis of the risks to achieve the management objectives and outcomes;
- A map that shows spatially the areas subject to the management plan;
- A reporting programme;
- Consent between the landowner/s and the delegate.

22.5.1 Management, Monitoring and Reporting

The offset area will be managed to improve and/or maintain habitat for the threatened species listed under the EPBC Act and is to be protected in perpetuity through a statutory covenant. Translocated *Grevillea glossadenia* and *Homoranthus porteri* individuals will be managed to establish a self-sustaining population. The offset area will be actively managed and monitored for a period of 10 years.

Ongoing monitoring is required to ensure the offset area management plan achieves the objectives outlined above. Monitoring activities will be undertaken to assess how the offset is progressing over time and inform ongoing management activities should additional management activities be required. **Table 22.5** outlines the draft Management, Monitoring and Reporting Schedule over a ten year time frame as reported in **Appendix 34**.

Table 22.5 Offset area management, monitoring and reporting schedule

ACTION	UNDERTAKEN BY	DETAILS (LOCATION, METHOD, TIMING AND FREQUENCY)	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	CORRECTIVE ACTIONS
Weed Management													
Weed distribution survey	TBD	Conduct biennial surveys to determine the occurrence and distribution of weeds. Map the extent and density of weed infestations with GIS.	✓		✓		✓		✓		✓		• Investigate alternative weed management regimes or techniques. • Develop an updated weed management regime. • Submit the proposed revised weed management program, as part of a revised Offset Management Plan, to the Department of the Environment. • Implement the revised and approved plan.
Weed control plan	TBD	Develop a weed treatment control plan at the start of management and update as required based on the results of weed distribution surveys.	✓										
Active weed control	TBD	• Implement annual weed control measures to reduce the density and area of occupation in the offset area in accordance with the weed control plan. • Weed control methods will be chosen based on the results of the weed control surveys to suit individual weed species. Weed control to include a combination of biological, mechanical and herbicide control methods.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Short term monitoring of weeds	TBD	Monitoring of targeted weed infestations will be conducted as follow up after weed control events to ensure infestations have been sufficiently eradicated and to conduct re-control where required.	As required										
Weed prevention/hygiene	All approved visitors to the offset area	Prevent the movement of weed material from weed infested areas into the offset area. Ensure that all vehicles and equipment entering the offset area are clean and free of weed seed prior to entry.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Managing access by livestock													
Fencing	TBD	The majority of the offset area is not accessible to livestock given its topography. Areas considered to be accessible would be fenced with a four strand barbed wire, stock proof fence.	✓										• Interim exclusion options will be used if fence construction or repairs are delayed. • Conduct quarterly audits of the offset area until actions are completed as agreed
Installation of watering points	TBD	Establish three watering points adjacent to, but outside, the boundary of the offset area. In the case where livestock are present in the offset area and the perimeter fencing is down (due to fire, tree fall) the watering points will facilitate the removal of livestock from the offset area	✓										
Fire management													
Fire management plan	TBD	Develop a fire management program of actions and submit to the Department of the Environment for approval (based on the results of the weed baseline distribution survey)	✓										• Investigate alternative fire management regimes or techniques • such as prescribed burning • Develop updated fire management regime • Submit the revised fire management regime to the Department of Environment for approval • Implement revised and approved plan.
Firebreaks	TBD	• If appropriate, establish firebreaks around the perimeter of the offset • area to prevent unplanned fires entering the offset area, • Inspect firebreaks and maintain as required.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Fuel loads	TBD	• Monitor fuel loads during short term weed monitoring events and annual weed inspections • Maintain fuel loads through annual weed control to include a combination of biological, mechanical and herbicide control.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Pest management													
Pest animal control	TBD	• Conduct annual control program of wild dogs through localised live trapping, shooting and baiting (where appropriate) • Consideration to be given to limit the likelihood of baiting mortality to native species, such as the northern quoll • Baiting program to use 1080 or sodium fluoroacetate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	• Investigate reasons for poor pest animal control. • Develop updated pest animal program • Submit the proposed revised pest animal management program, as part of a revised Offset Management Plan, to the Department of Environment for approval • Implement the revised and approved plan

ACTION	UNDERTAKEN BY	DETAILS (LOCATION, METHOD, TIMING AND FREQUENCY)	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	CORRECTIVE ACTIONS
Translocation of threatened plants													
Species translocation management plan	TBD	Develop a species translocation plan outlining specific management measures associated with the translocation of Grevillea glossadenia and Homoranthus porter to the offset area.	✓										
Site preparation	TBD	Prior to planting, reduce ground cover within the planting site so as not to limit the establishment of any of the translocated species.	✓										
Planting	TBD	Undertake planting during a suitable time of year. General management measures for the translocated plants will include but not be limited to the following: • Track each plant with a unique code and record a GPS location. • Water each plant immediately after planting. • Monitor predation by insects and apply insecticide onto the foliage if required. Any weeds occurring within the vicinity of translocated individuals will be hand removed whilst watering.	✓										• Replace dead plants in order to achieve the required number of individuals
Watering	TBD	Water translocated plants immediately after planting and every week for the first four weeks following translocation (if required).	✓										
Monitoring													
Photo monitoring	TBD	Establish four photo monitoring points within the offset area to enable a visual assessment of changes over time including the following: • Mark photo monitoring points with flagging tape and the GPS points recorded (Figure 2 of Appendix A). • Take annual photographs in north, south east and west directions. Maintain a record of the photographs, including GPS co-ordinates, date and time of each photograph, the direction in which the photograph was taken; and the height above the ground at which the photograph was taken.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	• Investigate reasons for why management actions are not achieving desired outcome • Revise management strategies and implement as required
Opportunistic visual monitoring	TBD	Undertake visual monitoring opportunistically during the implementation of management actions to assess the following: • the status of fencing in the offset area • the status of weeds in the offset area • areas of erosion and/or areas with high erosion potential • firebreaks and fuel loads • evidence of pest animals in the offset area (including feral cats and dogs).	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Fauna surveys	TBD	Targeted surveys will be undertaken annually in year 1 and year 2, then every two years. The fauna survey methodologies will be developed in consultation with DotE and will be consistent with Australian Government fauna survey guidelines. All surveys will be undertaken by a suitably qualified person (e.g. fauna ecologist). More detail regarding fauna surveys is provided in Section 1.2. Prior to undertaking the fauna monitoring program, ensure all necessary licenses relating to the capture of wildlife are current, including animal ethics approval and DEHP wildlife trapping permit. Prepare report on the statistical analysis of changes in species diversity and provide to DotE within three months of monitoring completion.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	• Investigate reasons for low native species diversity • Develop a program improve or manage fauna species diversity • Submit the proposed management program, as part of a revised Offset Management Plan, to the Department of Environment for approval Implement the revised and approved plan
Biocondition assessments	TBD	Two permanent transects for undertaking BioCondition assessment will be established and marked using flagged star pickets or other markers (See Eyre et al. 2011). Biennial BioCondition assessments will be undertaken in accordance with the BioCondition Methodology (version 2.1, Eyre et al. 2011).	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Monitoring of translocated *Grevillea glossadenia* and *Homoranthus porteri* populations	TBD	Monitor the translocated Grevillea glossadenia and Homoranthus porter populations in order to assess the success of the translocation program. Conduct monitoring monthly for the first 12 months and then quarterly for the next four years. Table 14 lists the parameters to be monitored and the performance criteria against which they will be assessed.	✓ Monthly	✓ Quarterly	✓ Quarterly	✓ Quarterly							• Investigate reasons for why the translocation program is not achieving desired outcome • Revise the Translocation Management Plan and implement as required

ACTION	UNDERTAKEN BY	DETAILS (LOCATION, METHOD, TIMING AND FREQUENCY)	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	CORRECTIVE ACTIONS
Reporting													
Annual report submitted to Department of the Environment (DotE)	TBD	Provide an annual report to DotE by 30 June. It will include: • results of monitoring activities • the outcomes of management actions including annual weed surveys and pest animal control • a general description of climatic conditions and other factors that may impact the offset area (fires, drought, flood, etc).	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

**Includes total project impact area.
Source: Volume 3 - Appendix 34 – Table A1 – Offset area management, monitoring and reporting schedule (pp B-1 – B-3)

23.0 Environmental Record

It is a requirement under the MEWF EIS Guidelines Section 5.15 that RACL provide details as to their Environmental Record. This information is summarised below and provided in more detail in **Appendix 36**.

23.1 Responsible Environmental Management

RATCH-Australia Corporation Limited (RACL) as the party taking action has a satisfactory record of responsible environmental management. This is encapsulated in our Corporate Social Responsibility Policy (CSR) and our Carbon Policy (CP) (attached) which cover two important environmental considerations for the power generation industry – community and climate change considerations. Furthermore, RATCH-Australia requires responsible environmental management outcomes from its O&M provider, Transfield Worley Power Services, who on behalf of RATCH-Australia provide operational level environmental management.

23.2 Proceedings

Tablelands Regional Council commenced enforcement proceedings in the Queensland Planning and Environment Court against RATCH-Australia on 24 August 2012 in relation to periodic noise monitoring requirements for Windy Hill wind farm. On 7 December 2012 the council withdrew the proceedings.

23.3 Environmental Policy and Planning Framework

RATCH-Australia works closely with our Operations and Maintenance (O&M) provider, Transfield Worley Power Services (TWPS), to ensure that environmental management is given an appropriate focus in our business. A brief overview of the operational environmental management approach (TWPS) is discussed below.

Transfield Worley Power Services is committed to ensuring that when working with RATCH-Australia to ensure that its activities are safe for the environment and the greater community. TWPS' environmental objectives and how they meet RATCH-Australia's environmental standards is outlined in TWPS' Health, Safety and Environment Policy (TMC-6032-SA-0001).

Key principles that form the basis of TWPS' approach to environmental management are:

- All incidents are preventable;
- No task is so important that the risk of injury to people or damage to the environment is justified and;
- Effective HSE management is a critical foundation for sustainable management.

Transfield Worley Power Services' Environmental Policy is supported by an Environmental Management System certified to ISO 140001. As a part of that certification, TWPS carry out environmental management planning to ensure the activities carried out meet all RATCH-Australia's contractual and environmental requirements by:

- Establishing and implementing management strategies that address the environmental risks, safeguards and issues identified during site visits;
- Meeting as a minimum standard of all relevant supplied standards, procedures, guidelines, environmental policy, including environmental management practices;

- Manage the operation and maintenance activities to ensure full compliance with all legislative requirements, statutory approvals/licences and RATCH-Australia's requirements;
- Implement environmental planning procedures and practices to work activities to ensure that environmental protection principles are considered such as pollution prevention and resource conservation and to ensure the contract is undertaken with due consideration of the community; and
- Identify gaps in environmental documentation or procedures.

Routine practices and processes underpin the implementation of the environmental management system, plan and objectives. Key processes include annual planning, training needs analysis, toolbox talks, Better Ways, Job Analysis, incident investigation, workplace inspections, auditing, management reviews, and monthly management meetings.

23.3.1 Planning

The environmental risk assessment process is critical part of environmental management planning and is undertaken in accordance with Transfield Worley Power Services' hazard procedure (TMP-2000-EV-0001). The output from the risk assessment is the Environmental Risks Register, which will include a list of environmental issues and risks, a corresponding risk management strategy, a broad qualitative assessment of the level of associated risk and the documents where the corresponding detailed management strategies are covered.

The ranking (or determination of significance) for each risk is based on the following:

- The nature of the risk (using Hazard-Pathway-Impact analysis);
- Relative scale of the potential impact; and
- Likelihood of occurrence.

The risks posed by each hazard are assessed using the Hazard-Pathway-Impact model. This is a functional assessment model identifying the elements of risk susceptible to various control approaches and directs the correct application of the hierarchy of controls as:

- The Hazard (that which may cause harm), which may be controlled by elimination or substitution.
- The Pathway (how harm may occur), which may be controlled by engineering or administrative controls.
- The Impact (the nature of the harm that may occur), which may be controlled by measures such as spill control equipment and emergency response procedures.

The broad risk levels are classed as follows:

- Low Environmental Risk – Involves few or predictable hazards, minor in nature. Managed by routine procedures.
- Medium Environmental Risk – No significant or unusual hazards involved, but history of minor incidents. Managed by routine procedures and training. Specific management and monitoring responsibilities assigned.
- High or Extreme Environmental Risk – Significant or unusual hazards involved with potential for serious impact. Detailed research and management planning required at senior levels.

23.3.2 Implementation

The effective implementation of the systems and procedures identified during the planning phase is the key to achieving no injuries to anyone, anytime. This includes environmental harm.

Communication and consultation is seen as a critical process for the implementation of Transfield Worley Power Services environmental management system approach. Training is one of the primary methods for communicating the requirements of the environmental management to the workforce. The environmental hazards register is also used to assist in the development of induction programs and the identification of training needs.

The structured training program is supported by other communication methods such as toolbox talks, team meetings, committee meetings, management meetings, etc. that help maintain awareness of procedures and issues. The communication process is also used to obtain feedback and suggestions from the workforce.

23.3.3 Review

Review of all aspects of the HSE management process is required to ensure the effectiveness of the planning and implementation process. Transfield Worley Power Services uses a range of tools and metrics to do this, including workplace audits and inspections, environmental monitoring and reporting, incident reporting and investigations and other monitoring processes such as external certification and review.

23.3.4 Improvement

Transfield Worley Power Services will regularly review the implementation and effectiveness of the environmental management whilst operating and maintaining the site to ensure it is meeting applicable legislative and contractual requirements and the environmental risks and challenges are managed effectively. The frequency of review will be at least annual; or more frequently in the event of significant non-conformance issues or as directed by the owner or other key stakeholders (e.g. Regulators).

23.4 Referrals under the EPBC Act

- Collector Wind Farm EPBC 2011 / 5899 – As lodged by Transfield Services
- High Road Wind Farm EPBC 2010 / 5721 - As lodged by Transfield Services
- Barn Hill Wind Farm Transmission Line - EPBC 2008 / 4557 - As lodged by Transfield Services
- Barn Hill Wind Farm EPBC 2008 / 4321 - As lodged by Transfield Services

24.0 Conclusion

24.1 Objectives of the EPBC Act

The following presents a discussion on the compliance of the project with the key objectives of the EPBC Act 1999 namely:

24.1.1 To provide for the protection of the environment, especially those aspects of the environment that are matters of National Environmental Significance;

To promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources;

To promote the conservation of biodiversity.

24.1.1.1 Fauna

Extensive surveys of flora and fauna have been undertaken at the proposed MEWF site over three years to develop a sound understanding of the ecology of site and its surrounds and so inform project feasibility and ultimately the ecologically sustainable design and operation of the project.

Of the 28 fauna species assessed for likelihood of occurrence under the EPBC Act, 12 species are not considered likely to occur on the site due to the lack of suitable habitats: principally closed rainforest, wet sclerophyll forest, and permanent wetlands or streams. An additional five species, the Squatter Pigeon, Eastern Bristlebird, Star Finch (eastern), Northern Bettong, and Brush-tailed Rabbit Rat are also considered unlikely to occur on the site given knowledge of their known current distributions. Nine species are considered to have a 'Moderate' likelihood of occurrence either due to the presence of suitable habitat or likelihood of overflying, but no positive sightings during field investigations. Of the EPBC-listed fauna, three threatened species were positively confirmed during the field surveys:

- The Northern Quoll (*Dasyurus hallucatus*)
- Spectacled Flying-fox
- Bare-rumped Sheathtail Bat

A significant population of the Northern Quoll is located on the site which is likely to be important to the genetic diversity of the regional population. The most probable significant impact to this species is directly through land clearing during construction and disturbance of breeding and denning locations. While it remains unknown whether ridge tops are the most favoured denning locations, it is known that the species utilise ridgetop habitats of the MEWF site. Although the overall impact of the site from clearing for the development footprint is only approximately 2.4% of the site or 57 ha, clearing will primarily occur on ridge tops, therefore mitigation measures specifically targeting this impact have been devised in the EMP.

The most significant potential impact to the Spectacled Flying-fox is predicted to be turbine mortalities through operation of the proposed MEWF project. This is also the case for the Bare-rumped Sheathtail Bat, however, preferential habitat for roosting and foraging is so poorly known that land clearing activities may also be a threat to the local population. It is considered unlikely the proposed MEWF project will impact any important habitat of these species or other listed MNES species that occur in the region.

From the six migratory species known to the area the Sarus Crane is the most vulnerable to impact from turbines during operation due to their large flocking and nocturnal flight behaviours. It is thought a general avoidance rate for birds of up to 90% may be applicable, although this figure has not been confirmed by

observational studies. It is unlikely that rotor strike will have a significant impact on any populations of the listed migratory species, with the possible exception of Sarus Cranes, given the majority of these species are relatively abundant and have extensive distributions throughout Northern Australia.

Mitigation measures which include preconstruction radar (providing improved utilisation understanding); and operational phase implementation of turbine curtailment technology (developed in Europe and United States) is proposed. Proposed mitigation measures to reduce and potentially remove impacts are summarised below.

On the basis of proposed mitigation measures summarised below the project is not anticipated to have impacts on World Heritage or National Heritage values such that it will result in loss of or degradation to that value.

24.1.1.2 Flora

Of the 22 flora species assessed for likelihood of occurrence, 14 species are not considered likely to occur on the site due to the absence of suitable habitat. Six species have a moderate to high chance of being present on the site although surveys did not locate any specimens. Two species were confirmed on site, *Grevillea glossadenia* and *Homoranthus porteri.*

The most probable significant impact to flora species listed under the EPBC Act is the clearing of ridges in the south-west of the site, and above 900 m ASL. This altitudinal zone is the key habitat for *Homoranthus porteri* - a species which occupies a restricted habitat range characterised by exposed, wind-sheared ridges.

Significant populations of *H. porteri* are found in this area and must be considered important on a regional scale when compared with other populations outside the site (i.e. Irvinebank, Watsonville, Toy Creek). The site's populations of the shrub by comparison with the regional populations are large, well-protected and represented by healthy thickets. Clearing of ridges where the shrub is found only on rock pavements is likely to have a significant impact and could disrupt the viability of the local population. Proposed impact mitigation measures summarised below focus on avoidance and minimisation of impact through detailed preconstruction surveys, micro siting of tracks and turbines, revegetation research and monitoring and provision provision of offsets to compensate for any residual impacts.

The shrub *Grevillea glossadenia* was found to be more resilient to landscape modification and has greater representation (in numbers and populations) than *H. porteri*. This species grows in association with *H. porteri*, but has a wider tolerance of habitat characteristics. It was found to respond to surface disturbance and is considered to be capable of active regeneration.

Recent information (Ford and Conn, 2013) has become available of the possible presence of a species of shrub considered to warrant a listing of critically endangered under the IUCN Red List for threatened species. This shrub, *Prostanthera albohirta*, could potentially occur along the south-west ridge above 900 m ASL - reinforcing the importance this narrow altitudinal determinant of high plant diversity on the wind farm site.

On this basis the project is considered to have adopted the principles of MNES protection, biodiversity conservation and ecologically sustainable development through the conservation and ecologically sustainable use of natural resources. An assessment of the projects promotion of the principles of ESD is discussed below.

24.1.2 To promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples.

To recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity

To promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in co-operation with, the owners of the knowledge.

RACL have conducted an extensive consultation program with local, state and federal government and community stakeholders including adjoining landholders since May 2009 during which a broad range of environmental concerns and issues were canvassed. The outcomes of such consultation have informed the numerous design modifications to date to minimise and manage potential impacts. An additional consultation session will be held post lodgement of the development application to seek further feedback on the overall amended project. Regular updates, in the form of newsletters have been, and will continue to be disseminated throughout the community and on relevant websites to ensure up to date information is available to all members of the community.

RACL have proposed a Community Consultative Committee for the MEWF similar to that developed and implemented at other wind farms around the country. The structure of this committee has been developed in conjunction with other companies and the Clean Energy Council's Engagement Officer to ensure the committee charter and proposed operating regime provide the best possible outcomes. A possible Chair has been approached and potential members identified, along with a timeline for commencement initiated.

A due diligence assessment of likely Indigenous cultural heritage significance has been undertaken by consultants Converge, including assessment of the preliminary corridor layouts and consultation with the traditional owners (identified as members of the Bar-barrum people). Consultation and meetings have occurred as part of the preparation and negotiation of a Cultural Heritage Management Plan. A component of the Cultural Heritage Management Plan outlines the undertaking of preconstruction Cultural Heritage survey to be conducted by members of the Bar-barrum people. Further proposed consultation will canvas potential project employment opportunities such as site rangers and environmental officers.

24.1.3 To assist in the co-operative implementation of Australia's international environmental responsibilities

No species or wetland listed under the Japanese –Australia Migratory Bird Agreement (JAMBA) or Chine Australia Migratory Bird Agreement (CAMBA) conventions occur on or near the site.

The project has the potential to significantly assist Australia in reaching its renewable energy and greenhouse gas reduction targets.

The project has an unknown potential to indirectly impact on World Heritage values through potential impacts on the Spectacled Flying Fox however this is considered to be manageable through the proposed monitoring and mitigation strategies.

24.2 Principles of Ecological Sustainable Development

The following presents a discussion on the compliance of the project with the key components of Ecologically Sustainable Development (ESD), as defined under the EPBC Act 1999.

24.2.1 Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations

This project is intended to supply approximately 650,000 megawatt hours which should supply sufficient renewable energy to power the equivalent annual needs of approximately 75,000 north Queensland homes over a 20 year period. The site has been selected primarily as it displays an excellent wind resource, there are few residences in close proximity to the site, and the site is traversed by the existing 275 kV Powerlink transmission line infrastructure, which further provides for ease of connection.

The site has been selected as it displays an excellent wind resource and is well placed in terms of access to existing electricity transmission infrastructure. It is expected the proposed wind farm will bring positive benefits (direct and indirect) to the local, regional and national economies throughout the life-cycle of the project.

At a direct level, wind farm development generates employment opportunities within the local area during construction and maintenance phases of the project. It is anticipated workers and contractors required for the project will include plant operators, truck drivers, mechanics, welders, fencers, electricians, labourers and other individuals typically used in a civil construction context.

The economic impact assessment undertaken of the MEWF site by Cummings Economics (2013) determined that the local benefits to the Tablelands' economy would be in the order of $30 million from a $382 million project with a projected 300 jobs to be created directly and indirectly (flow on effects) from the construction. Cummings Economics also estimates that during the operating phase, annual benefits will be of the order of 57 additional jobs (including flow-on effects) and about $5.6 million per annum addition to the Tablelands' Gross Regional Product (i.e. an approximate 0.3% increase in economic activity and employees). Net Present Value of an annual flow of benefits of $5.6 million per annum would be of the order of $100 million (over a 30-year period at discount rate 4% real [approximately 7% nominal]).

Direct job creation in geographically diverse areas, such as Mareeba, contributes to the development of skills and expertise in a growing industry and thereby stimulates rural economies generally.

There will be economic efficiency gains in meeting government objectives, by replacing fossil fuel electricity supply in areas where long transmission distances from generation sources lead to extra costs due to transmission loss and susceptibility to power disruptions.

There are also intangible benefits associate with wind farms, and renewable energy generally such as:

- Avoidance of greenhouse gas emissions associated with conventional fossil fuel generation;
- Insulates electricity market from fluctuations in fuel prices by increasing the diversity of the energy system (that is, wind can assist in times of peak demand); and
- Wind farm electricity generation requires comparatively little natural inputs such as water consumption.

It is acknowledged there are greenhouse gas emissions associated with the manufacture, construction, operation and decommissioning of a wind farm. The carbon abatement period, or time it takes to generate sufficient electricity (without any greenhouse gas emissions) to offset the emissions created in the creation

and installation of the facility has been the focus of many studies over the past 15 years. The payback period and carbon abatement for Mount Emerald Wind Farm has been estimated at just over 7 months.

A number of potential ecological impacts have been identified and assessed, the majority of which are assessed as low to moderate risk following implementation of proposed mitigation measures. Given the infancy of the Australian wind farm industry, particularly in tropical environments and the paucity of available scientific information on the ecology on four species of MNES (Bare-rump Sheathtail Bat, Northern Quoll, Sarus Crane and Spectacled Flying Fox) and recovery of the tropical montane heath at 900 m ASL, there remains however some uncertainty around impact prediction.

A rigorous program of additional preconstruction ecological research has been proposed to reduce these uncertainties and further minimise potential environmental risks through informed input into the detailed design process and refinement of operational monitoring and adaptive management based decision making. An additional benefit of such research and ongoing monitoring will be an increased understanding and ongoing regional management of the MNES and other species and importantly facilitate further wind farm development in tropical areas.

While issues of potential negative 'secondary' impacts have been raised in relation to agricultural aviation, adjacent farm operations, noise nuisance and reduced visual amenity and tourism, extensive investigation to date indicate that the likelihood of any significant impacts are low and manageable.

A variety of design options were considered during the conceptual stage of the wind farm development. The overall objective at this time was to identify the layout of the project to maximise electricity generation and deliver significant savings in greenhouse gas emissions whilst being commercially viable and socially and environmentally responsible.

Adjustments to the layout and the number of turbines was then performed with consideration given to constructability, environmental constraints and issues relevant to the local community especially noise and visual.

Following consultation with surrounding residents amendments were made to the turbine layout to reduce both the noise and the visual impact at the respective homes. Most notably this included;

- Moving the turbines off the top of the western ridgeline to further within the property to screen a significant portion of the turbine from views to landowners to the west of the site;
- Removal of turbines in the northeast of the site at the request of owners within this view shed;
- Removal of turbines in the southeast corner to significantly reduce the size of turbines visible to the residents of Rangeview.

The use of larger turbines reduced the preferred layout from 75 to 70 wind turbines and following detailed environmental investigations the wind turbine layout design was further modified to a currently preferred total of 63 turbines.

In addition to the reduction in greenhouse gases, opportunities to offset residual ecological impact and loss of habitat through the protection and enhancement of adjacent existing habitat will help achieve a net environmental benefit from the project. It could therefore be argued that an approval of the project is justifiable on the grounds of long-term and short-term economic, environmental, social and equitable considerations.

24.2.2 If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making.

The principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

As mentioned above some scientific uncertainty remains around ecological aspects of four MNES fauna species (three threatened and one migratory) and to a lesser extent two flora species. As a result, a number of additional preconstruction studies and mitigation measures have been proposed to prevent or minimise environmental impacts to these species.

The Pre-construction EMP presented below in **Table 23.1** contains a program of works aimed at avoiding, minimising or mitigating impacts through closing information gaps and preparation of a number of detailed management plans which will guide operations through subsequent construction, operation and decommissioning phases.

It is therefore considered that sufficient consideration of the principles of biodiversity and ecological integrity maintenance and inter-generational equity has been included in all phases of the project, including the proposed design, construction and future management of the project, to support project approval.

Table 24.1 Pre-Construction EMP

Species	Potential Impact	Impacting Phase	Proposed Mitigation Strategy	Essential Information Gaps	Management Actions Required	Monitoring, Reporting	Timing	Responsibilities	Relevant Agency
Fauna									
Bare-rumped Sheathtail Bat	Turbine Collision & Barotrauma	Operation	Turbine operation curtailment (increased cut-in speed & targeted turbine shut-down during high risk conditions or detected collision mortality.	1. Relationship between environmental factors (weather, insect abundance) and call activity. 2. Utilisation of the turbine rotor sweep area (RSA) (abundance and flight height data)	1. Continue and expand ultrasonic call surveys; sample within Rotor Swept Area (RSA) (higher towers & balloons). 2. Collect weather and insect abundance/height data. 3. Identify high-risk conditions/times and seasons. 4. Conduct radar utilisation at call survey locations sampling at RSA; quantify abundance and flight heights. 5. Conduct numerical risk modelling (for *S. saccolaimus* only or for entire microchiropteran bat community – depending on radar data quality).	Prepare Microchiropteran Bat Management Plan	Pre-construction	External Ecologist / Specialist (inc. Biostatistician)	DotE DERM
Spectacled Flying-fox / Grey-headed Flying Fox	Turbine Collision	Operational Phase	Turbine curtailment during high-risk conditions (active) or excessive mortality events (reactive).	1.Utitlisation of the RSA (abundance and flight height data) 2. Population Viability Analysis (PVA) to determine sustainable collision mortality levels	1. Conduct radar utilisation surveys. 2. Support CSIRO researchers to conduct satellite telemetry of more individuals from nearest colonies to site (Mareeba and Tolga Scrub). 3. Conduct numerical collision risk modelling (using radar/telemetry data).	Prepare Flying Fox Management Plan	Pre-construction	External Ecological / Specialist	DotE DERM
Northern Quoll	Habitat Loss	Construction	Avoid clearing high-quality denning and foraging habitats.	1. Denning and foraging habitat preferences especially of breeding females 2. Estimates of dispersion for PVA model	Preconstruction 1. Undertake additional telemetry studies on the project site to determine whether proposed turbine ridge habitats are used preferentially, particularly females with young; and offsite, to collect data on dispersion rates to refine the PVA (to assess the significance of potential impacts). 2. Redesign infrastructure layout to avoid high quality foraging or maternal denning habitat and/or inform Quoll Management Plan.	Prepare Quoll Management Plan	Pre-construction	External Specialist	DotE DERM
	Habitat Degradation (late dry season wild fires and weed invasion)	Construction and Operation	1. Weed monitoring and control. 2. Implementation of Ecological Fire Management (to avoid extensive wild fire in late dry season).	1. Long-term fine-scale fire history of site	1. Fire-scale mapping using Landsat imagery. 2. Control of existing weed infestations (especially invasive grasses along Kippen Drive and access tracks).	Prepare Weed Management Plan and Fire Management Plan	Pre-construction	External Specialist	DotE DERM
Sarus Crane	Turbine Collision	Operational Phase	Turbine curtailment during high-risk conditions (active) or excessive mortality events (reactive)	1.Utitlisation of the RSA (abundance and flight height data) 2. Population Viability Analysis (PVA) to determine sustainable collision mortality levels	1. Conduct radar utilisation surveys. 2. Support CSIRO researchers to conduct satellite telemetry of more individuals from nearest flocks. 3. Conduct numerical collision risk modelling (using radar/telemetry data) - updated	Prepare Bird Adaptive Management Plan	Pre-construction	External Ecological / Specialist	DotE DERM
Flora									
Significant Plants	Clearing of Conservation Significant Plants	Construction	Avoidance and micro-siting of turbines.	Detailed distribution of significant plants Relocation and translocation strategies.	Avoidance of disturbance to key plant habitats (see next point). Detailed plant survey of south-west montane heath habitat - GPS mapping of avoidance patches. Micro positioning of turbines to minimise clearing and disturbance to conservation significant plants and important vegetation types. Presence of Botanical advisor in pre clearance team. Instigate site-based seed and propagule collection for future rehabilitation work.	Final site-based floristic records. Records of seed collections as per Rehabilitation Plan. Conservation Significant Plant Management Plan	Preconstruction and ongoing throughout construction phase. Seed collection every 3 months after construction for at least 5 years.	External Botanist	DotE DERM

Species	Potential Impact	Impacting Phase	Proposed Mitigation Strategy	Essential Information Gaps	Management Actions Required	Monitoring, Reporting	Timing	Responsibilities	Relevant Agency
	Clearing of Conservation Significant Plants	Construction / Operation / Decommissioning	Translocation and revegetation strategies	Propagation viability of significant plants. Plant successional traits.	Prepare Significant Plant Management Plans including : Research propagation of *Homoranthus porteri, Melaleuca uxorum, Plectranthus amoenus* and *Grevillea glossadenia*. Conduct Revegetation trials. Investigate plant successional traits.	Conservation Significant Plant Management Plan Annual Revegetation Trial report	Preconstruction and ongoing as required First 3 years of operation	External botanist/ Nursery External Specialist	DotE DERM
Water Quality									
Aquatic Flora and Fauna	Reduced downstream water quality	Construction / Decommissioning and Operation	Maintenance of downstream water quality through water monitoring and management in accordance with a detailed Erosion and Sediment Control Plan	Background Water Quality(pH, Electrical Conductivity, Turbidity)	Conduct preconstruction water quality monitoring to inform construction water quality targets. Prepare Detailed Erosion And Sediment Control Plan (ESCP).	as per Approval Conditions and CEMP Annual Baseline Water Quality Assessment Report Monthly reporting against approval conditions	preconstruction and event based during construction and first year of operation	Pre-construction - External Specialist Construction-Environmental Officer	DEHP DotE

It is therefore considered that sufficient consideration of the principles of biodiversity and ecological integrity, maintenance and inter-generational equity has been included in all phases of the project: including the proposed design, construction and future management of the project such that approval of the project is supportable.

24.2.3 Improved valuation, pricing and incentive mechanisms should be promoted.

RACL is an independent power producer in Australia and owns a portfolio of power generation assets totalling 815 MW, including ownership or an interest in four thermal power stations, three wind farms, as well as the development rights to over 1000 MW of wind farms and other renewable projects.

The company is strongly focussed on the investment in and development of first class thermal, hydro, wind and solar power generation assets – one of its notable wind farms being Queensland's first operational wind farm: Windy Hill, which was commissioned in 2000 with 20 turbines producing up to 12 MW power on land leased from local farmers on the Atherton Tablelands

RACL's other assets in Australia include:

- The highly energy-efficient Townsville power station which uses clean coal seam methane fuel and a combined cycle configuration inputting 234 MW to Queensland's electricity supplies;
- The Collinsville (Qld) and Kemerton (WA) power plants;
- A 30% interest in BP's low carbon signature Kwinana Plant in Western Australia;
- The Starfish Hill (SA) and Toora (VIC) wind farms.

As a developer of renewable energy in Australia, implementing sustainable measures and ensuring the protection of the environment are fundamental to RACL's long-term objectives and philosophy. Investments in renewable energy are both environmentally and commercially sustainable and RACL currently owns three wind farms that are significantly reducing Australia's greenhouse emissions. In addition, RACL continues to improve the environmental ratings of its other power generation assets by continuously revising for economically possible ways of reducing its carbon emissions.

The extensive environmental programs proposed in the preconstruction and operational phases will come at significant cost. These costs have been factored into construction and operational budgets and ultimately asset valuation which will be subject to annual reviews to drive economic efficiencies and increase competitiveness within the Australian renewable energy market whilst assisting the Federal Government to achieve its Renewable Energy Target.

24.3 References

Ford, Andrew and Conn, Barry (2013). Rediscovery of *Prostanthera albohirta* C.T.White (Lamiaceae). *Telopea* **15**: 107-110.