Lord Howe Island Board

Biodiversity assessment

LORD HOWE ISLAND HYBRID RENEWABLE ENERGY PROJECT

STAGE 2: WIND TURBINES

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ACRONYMS AND ABBREVIATIONS

ASL	Above sea level
BA	Biodiversity Assessment
BOM	Australian Bureau of Meteorology
Cwth	Commonwealth
DPI	(NSW) Department of Planning and Infrastructure
EEC	Endangered Ecological Community
EIA	Environmental impact assessment
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Cwth)
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
ESD	Ecologically Sustainable Development
FM Act	*Fisheries Management Act 1994* (NSW)
Ha	hectares
ISEPP	*State Environmental Planning Policy (Infrastructure) 2007* (NSW)
Km	kilometres
LEP	Local Environment Plan
LHI	Lord Howe Island
LHIB	Lord Howe Island Board
LHIG	Lord Howe Island Group
M	Metres
MNES	Matters of National Environmental Significance under the EPBC Act (*c.f.*)
NPW Act	*National Parks And Wildlife Act 1974* (NSW)
NSW	New South Wales
NV Act	*Native Vegetation Act 2003* (NSW)
OEH	(NSW) Office of Environment and Heritage
SEPP	State Environmental Planning Policy (NSW)
SIS	Species Impact Statement
sp/spp	Species/multiple species
TSC Act	*Threatened Species Conservation Act 1995* (NSW)

1 INTRODUCTION

This Biodiversity Assessment (BA) has been prepared by NGH Environmental on behalf of the Lord Howe Island Board (the Board) to assess the biodiversity impacts of the proposed construction of two small to mid-sized wind turbines on Lord Howe Island.

This Biodiversity Assessment aims to:

- summarise the proposal
- identify the planning and ecological context of the proposal
- describe the biodiversity values of the proposal site and study area
- identify and assess the significance of potential impacts of the proposal
- determine whether a significant impact to threatened species or communities is likely, and whether a Species Impact Statement or Environmental Impact Statement will be required
- provide environmental safeguards to avoid or minimise identified impacts.

The BA forms part of a series of assessments contained in an overarching Environmental Report, prepared in accordance with the Lord Howe Island Local Environmental Plan (LEP) 2010. The ER will be used to support a development application for the project to be submitted to the Board for approval.

The Biodiversity Assessment is also intended to meet the assessment requirements of the NSW *Environmental Planning and Assessment Act 1979* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

2 PROJECT DESCRIPTION

The wind turbine proposal forms part of the Hybrid Renewable Energy Project (HREP), which aims to reduce diesel consumption and the costs of electricity generation on the island. The current proposal is stage 2 of the HREP. Stage 1 has been approved by the Board, and comprises an access road to the solar farm, a photovoltaic solar farm, a battery bank and associated infrastructure.

2.1 LOCATION

The proposed wind turbine site is located on Special Lease Portion 101 in the central lowlands and hills of the island, south of the existing diesel powerhouse and approximately 800 metres north of the airport (Figure 2-1). The location of the turbines, cabling, access road and other infrastructure at the site, as well as the solar farm site, is shown on Figure 2-2.

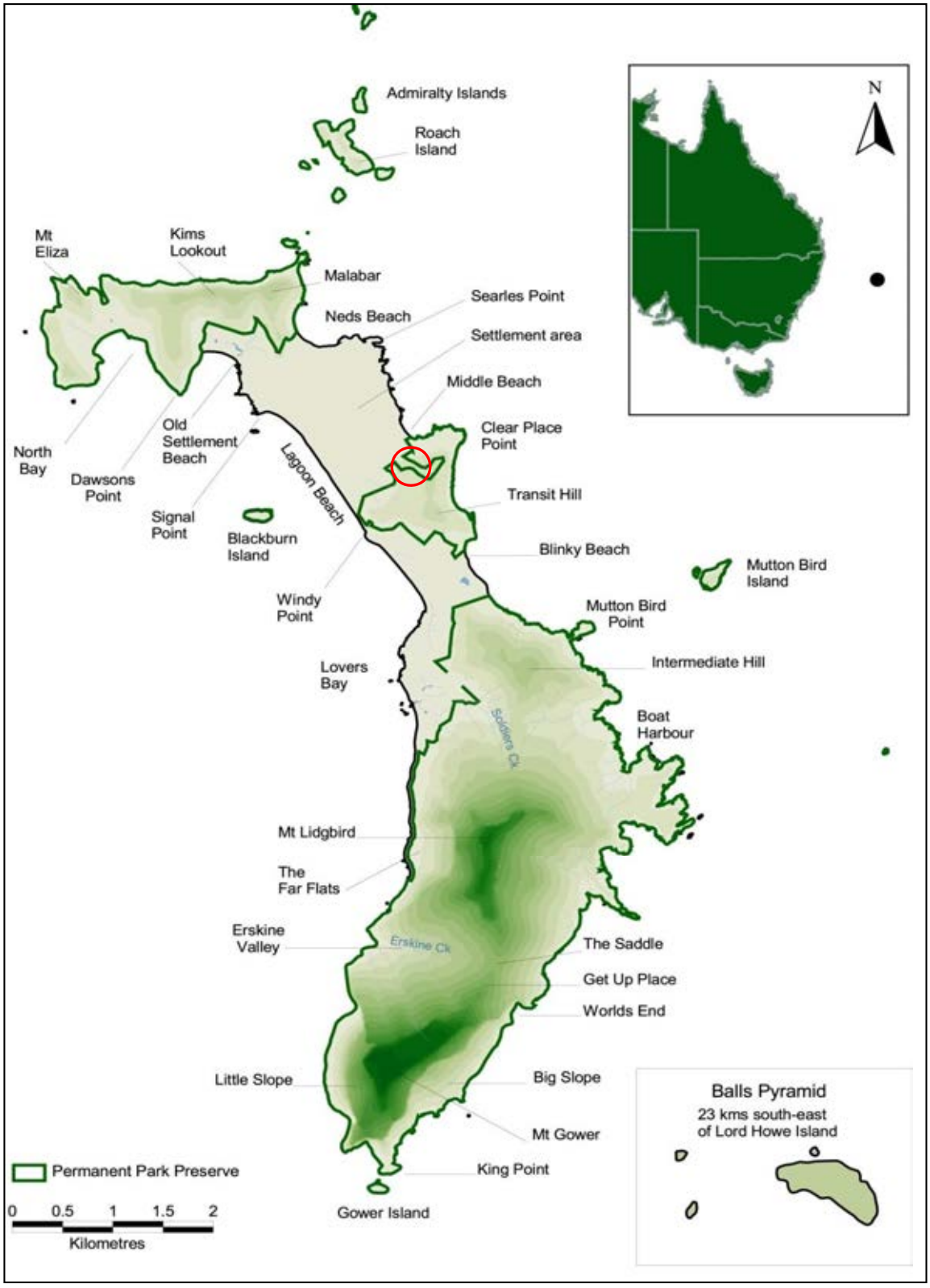

Figure 2-1 Location of the proposed works on the island, circled red (base image: DECC 2007)

2.2 INFRASTRUCTURE

2.2.1 Wind turbines

It is proposed that two small to medium wind turbines be constructed at the locations indicated on Figure 2-2. To account for potential errors in the LIDAR ground survey data, the precise turbine location may vary by up to 20 metres from the turbine locations indicated on Figure 2-2. Any variation in turbine position would not result in impacts which are different or greater than the impacts identified in this Biodiversity Assessment.

The turbines would have a maximum hub height of 55 metres and a maximum rotor diameter of 32 metres. Two commercially available turbine models within the specification range which meet the electricity generation requirements of the HREP have been used as examples for the assessment of environmental impacts.

The Vergnet 200 kW GEV MP-C LnN (low noise) turbine is a mid-sized turbine at the upper end of the proposed size range. The XANT 100 kW M21 Class 1A turbine model provides an example at the lower end. A comparison of the two turbine models is provided in Table 2-1 below.

The Biodiversity Assessment focuses on the installation of two Vergnet 200 kW GEV MP-C LnN (low noise) turbines as a notional preferred option, to provide a reference for the impact assessment. Other possible options/configurations include:

- one Vergnet 200 kW GEV MP-C LnN turbine
- two XANT 100 kW M21 Class 1A turbines.

Subject to project approval, the turbine model and number (one or two) would be selected following the competitive tender process.

Table 2-1 Comparison of proposed turbine models

Turbine	Hub height	Blade length	Max tip height	Features
Vergnet 200 kW GEV MP-C LnN	55m	15m or 16m	71m	Downwind, two blade, pitch regulated turbine. Cut in speed 3.5 m/s, cut out speed 25 m/s. Must be lowered during extreme winds (>30-42.5 m/s, 115-153 km/hr). Noise insulated nacelle and gearbox.
XANT 21 100 kW M21 Class 1A	31.8m	10.5m	42.3m	Downwind, three blade, variable speed turbine. Cut in speed 3 m/s, cut out speed 20 m/s. Survival wind speed 70 m/s (252 km/hr).

The Biodiversity Assessment focuses on the two 200 kW Vergnet turbine proposal, but also considers the differences in impacts of the other two options. Where there are any differences between the options in the type or extent of impact, these are identified in the report.

The turbine tower would be a galvanised or white or grey painted steel tube, with a nacelle housing the generator on top of the tower. Both turbine models can be lowered manually for maintenance and protection during storms. The turbines would automatically shut down when winds speeds are too low or too high for safe and effective operation. The Vergnet turbines are able to withstand maximum winds of 30 – 42.5 m/s (115-153 km/hr) in the operating position. The XANT turbines have a survival speed of 70 m/s (252 km/hr). Fastened to the ground, the Vergnet turbine can sustain up to 300 km/h wind gusts (a Category 5 hurricane). The highest wind gust ever recorded on Lord Howe Island was 96 knots (49 m/s or

178 km/hr), which occurred in January 1948 when a severe tropical cyclone passed to the east (Bureau of Meteorology 2014).

The turbines would be transported in standard 12 metre containers, and can be erected using winch systems without the need for a crane.

Turbine foundations and supports

The turbine towers would be mounted on concrete foundation pads and secured using three wire cable guys attached to ground anchors. Excavation would be needed to install the footings for the gin pole winch anchor, turbine tower pivot, tower cradle (to support the turbine lying down) and the guy wire anchors. Guy supports along the ridge crest (east-west axis) would be attached at or near ground level in bedrock anchors or steel rods cast in concrete footings. Guy supports to the sides of the ridge (north-south axis) would need to be attached to raised steel or concrete posts to achieve the required attachment level. The guy posts would range from 4.15 to 2.16 metres in height and would either be freestanding or braced. Any bracing for the posts would use rigid members rather than guy wires.

2.2.2 Transformers and cabling

Each turbine would be installed with a small kiosk transformer raising the output of the turbine from 400V to 6.6kV (Jacobs 2015b). Underground optical fibre cabling would be installed between the monitoring mast, turbine kiosks and the solar farm (approximately 280 metres) to meet Supervisory Control and Data Acquisition (SCADA) communication requirements. Underground 6.6kV high voltage cabling would be installed between the kiosks and the solar farm (approximately 170 metres). The cabling to the solar farm area would follow the alignment of the access road. Within the turbine paddock, cabling would be installed in exotic pasture, which would be reinstated following the works. Trenches would be in the order of 1000 to 1200 mm deep (Jacobs 2015a) and 600 mm wide. Bedding sand would be placed under, around and above the cabling and the trench would be backfilled with existing fill with cable markers in the trench. Direct buried cables may be required to have a nylon jacket for termite protection (Jacobs 2015c).

2.2.3 Access road

A 3.5 metre wide sealed access track with 1 metre wide shoulders within a 9 metre wide clear corridor would be constructed between the stage 1 solar farm on Portion 230 and the turbine sites on Portion 101. The road access would use an existing 50 metre long track in a road reserve passing through a narrow belt of native vegetation from Portion 230 to the Portion 101 turbine paddock; refer Figure 2-2. Approximately 35 metres of this track section would need to be widened to allow access by construction vehicles (Figure 6-1). The existing and proposed track alignment does not encroach on the Permanent Park Preserve, located south of the track. The proposal would extend the existing track into the Portion 101 paddock for a further 200 metres to access the turbine sites.

2.2.4 Fencing and landscaping

A fence or barrier would be constructed around the base of the guy mounts to prevent cattle scratching. To minimise fauna impacts, barbed wire would not be used. Disturbed areas would be rehabilitated and reseeded with pasture grasses (refer section 2.3.2).

2.3 CONSTRUCTION

2.3.1 Construction activities

Plant and equipment used during construction of the wind turbines may include a drilling rig, excavator, backhoe, trucks, generator, small crane and hand/power tools (Jacobs 2015c). Roadworks will also require a compactor, roller, grader and water truck. Cable trenching and laying equipment will be required for installation of the underground power and communications cabling. Concrete for the turbine footings would be mixed on-site, requiring local stockpiling and a mobile concrete agitator.

Excavation in the stiff to hard clay soils should be achievable with conventional excavation equipment (excavators/backhoes). Where shallow basalt is encountered along the ridgeline at the turbine sites, hydraulic rock picks/hammers or blasting may be required (Jacobs 2015a).

A site compound, lay-down, parking and stockpile areas would be established at the commencement of the construction phase. Temporary fencing may be required around some facilities. Following completion of construction, waste, materials and equipment would be removed and the temporary facility sites would be rehabilitated.

Construction activities would be carried out seven days a week (7am to 6pm) to enable the most time-efficient use of specialist contractors visiting the island.

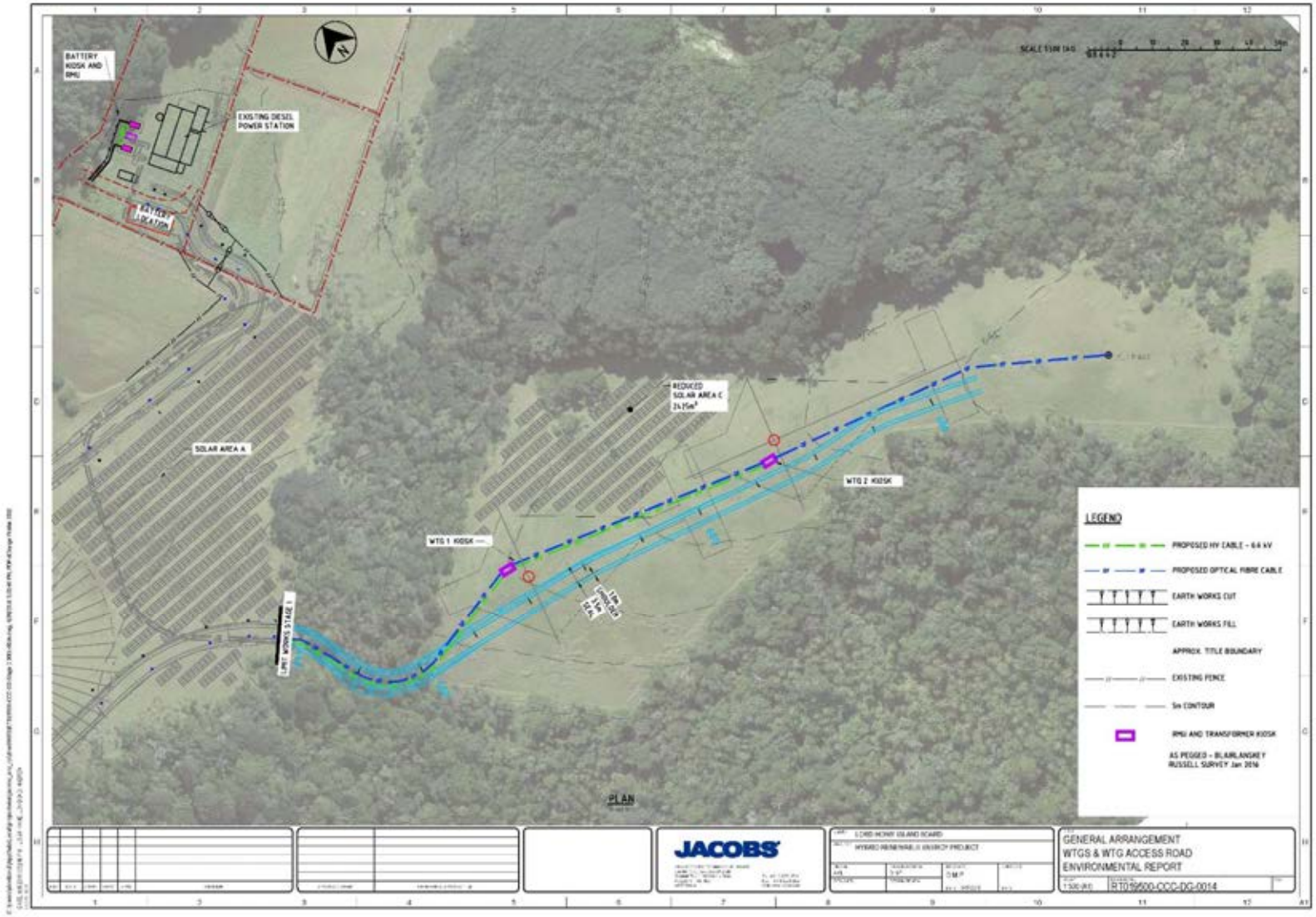

Figure 2-2 Plan of proposed wind turbine infrastructure

2.3.2 Access and materials delivery

The turbines and other construction materials would be delivered to the island via a commissioned barge or as part of regular cargo deliveries to the island's wharf. The commissioned barge would land at the beach, just south of the Waste Management Facility. Where possible, the barge delivery would avoid the winter period when winds are generally stronger and storms more frequent. Rigid plastic matting would be laid over the existing sand ramp and track between the beach and Lagoon Road to support the construction traffic. The barge delivery would comply with the Lord Howe Island Board Biosecurity Strategy (AECOM 2016) and requirements of Transport for NSW for entry into the Lagoon.

Materials would be taken to the site via the island road network, using Lagoon Road, Middle Beach Road and Anderson Road. Long components such as turbine blades may be transported to the site manually using trolley wheels. A 15 km/hr speed limit would apply to delivery and construction traffic and travel would be restricted to daylight hours to minimise risks to native birds. Construction traffic would be minimal during the dawn and sunset Flesh-footed Shearwater activity periods during the breeding season.

2.3.3 Site protection and rehabilitation

Standard sedimentation and erosion control measures would be implemented during the construction phase. Following completion of construction, waste, materials and equipment would be removed and temporary facility sites would be rehabilitated and reseeded with pasture grasses. Topsoil would be removed prior to works commencing, securely stockpiled and reinstated following the works. Disturbed pasture and road verge areas would be laid with exotic grass turf or sown with an infertile perennial ryegrass variety.

2.3.4 Duration, timing and staging

The installation of the approved Stage 1 components of the project (battery kiosk at the powerhouse, battery and control system building and PV solar panels) are scheduled from around March to October 2017.

It is proposed that the wind turbine kiosk HV, LV and communications cabling would be installed from around April – May 2017. Wind turbine site civil works would occur in March - April 2017. Turbine footings would be established in late April 2017. The turbines would be constructed during July - August 2017. Commissioning of the hybrid system components would occur progressively, with final commissioning of the integrated system expected to occur in August 2017 and the commencement of commercial operation in September 2017.

2.4 OPERATION

Activities involved in the operation of the wind turbines are likely to include:

- periodic inspection and maintenance of the turbines, including lowering
- periodic inspection and maintenance of the transformers and road access
- repairs and parts replacement as required
- lowering the turbines when extreme winds are forecast
- control of vegetation inside turbine fences as required
- monitoring of turbine performance and fauna impacts.

The turbines would shut down automatically when wind speed is too low or too high for safe and effective operation. The Vergnet turbine has a start-up wind speed of 3.5 m/s and a cut-out speed of 25 m/s. The smaller XANT turbine has a start-up wind speed of 3 m/s and a maximum wind speed of 20 m/s. The Vergnet turbines would be lowered when wind speeds are predicted to be extreme (>30-42.5 m/s).

The turbines would also have the capacity for automated regular shutdown during particular times, for example to minimise bird and amenity impacts.

Operational and routine maintenance activities are expected to be carried out by the two existing Board powerhouse staff during normal work hours. Unanticipated repairs and lowering the mast in advance of extreme winds may occur outside normal work hours as required.

Aviation navigation lighting would be installed on each turbine tower but would only be activated remotely during emergency or RAAF activities when the airport may be used at night.

2.5 REFURBISHMENT AND DECOMMISSIONING

The project's operational life is anticipated to be 20 years. After this time, components would either be refurbished to extend their operational life, or removed and replaced with new technology. Depending on nature of the refurbishment, the refurbished wind turbines may be covered by the original development approval, or require further assessment and approval. Subject to the approval consent conditions, the replacement of turbines or components with items of similar scale and impact is not expected to require new approval.

Decommissioning would be likely to involve the disconnection and removal of all generation components, the removal of turbine fencing, and the removal of exposed turbine footings and reinstatement of the original soil profile. As in the case of post construction rehabilitation, disturbed paddock areas would be revegetated using appropriate pasture plant species and restored to the original condition.

2.6 BIODIVERSITY OFFSET

The proposal includes the restoration of an area of natural forest close to the development site to offset the vegetation clearing required to widen the access road to the site. The offset proposal is detailed in Appendix G.

3 CONTEXT

3.1 SUBJECT SITE

The proposed turbine site is located on the midslope of a moderate gradient ridgeline on the northern side of Transit Hill (summit 135 metres), with a generally northwesterly aspect and an elevation of around 60 metres. The turbines would be sited in a cleared paddock around 1.5 hectares in size. The site carries exotic pasture and is primarily used for dairy cattle grazing, although the soils are relatively poor and the site is not prime agricultural land (LHIB 2015). The site is on basalt geology, with shallow clay soil and areas of outcropping rock. The paddock is surrounded by native closed forest vegetation. A 45 metre high monitoring mast was erected at the top (eastern) end of the proposed turbine paddock in 2014 to collect wind and solar resource and environmental data (Figure 5-8).

The proposed turbine site (Portion 101) is almost surrounded by the Permanent Park Preserve (refer Figure 2-1). The site is located approximately 800 metres north of the airport, and 250 metres from the edge of the island settlement to the north. The site is at the northern edge of a forest patch approximately 80 hectares in size extending across the island and bounded by cleared paddocks and the settlement to the north and the airport runway to the south. There is a gap of around 700 metres between the forest patch and the large area of continuous forest covering the southern part of the island. There is around 1,800 metres of disturbed and diffuse lowland habitat interspersed with houses between the forest patch surrounding the subject site and the forested area at the northern end of the island.

A narrow strip of native forest separates the wind turbine paddock from a larger cleared agricultural area and settlement housing to the north (refer Figure 2-2). The proposed access track would pass through this vegetation, requiring the widening of an existing 5 to 9 metre wide track corridor. The forest vegetation at the proposed access track site appears to be regrowth with no large trees, on shallow basalt soil with scattered surface rock 10 to 30 centimetres in diameter at the upslope (south-eastern) end of the patch.

3.2 LOCALITY

The Lord Howe Island Group is part of a volcanic ridge separating the Tasman and the New Caledonian Basins. Lord Howe Island is approximately 11 kilometres long, occupying 1,455 hectares. Landscapes on the island encompass shorelines, lowland plains and swamps, valleys, hills, mountains and cliffs. The climate is subtropical and moderate, windy with warm summers and cool, wet winters (DECC 2007). The biota has both Gondwanan and long distance dispersal elements, with a high level of endemism and significant species and communities (DEWHA 2009).

87% of the island carries original vegetation (Hunter 2002). 44% of the 241 recorded indigenous vascular plant species and 5 vascular plant genera are endemic (Hunter 2002, DSEWPC 2013). The terrestrial vertebrate fauna is dominated by birds (182 species). The other indigenous land vertebrates are 2 endemic reptiles and 2 microbats (1 now extinct) (DECC 2007). The terrestrial invertebrate fauna shows very high species richness and endemism.

Pickard (1983) and Hunter (2002) describe the vegetation communities of the island. 34 communities are defined for the purposes of the Biodiversity Management Plan (DECC 2007), including 7 closed forest communities, 6 scrub communities, 1 grass community, 2 specialised habitat communities (dune and cliff) and 2 aquatic communities. 18 communities are of conservation concern.

The southern mountains have the highest levels of overall species richness and endemicity, although other hot spots include Balls Pyramid, the eastern settlement area, the northern hills, offshore islands, Steven's Reserve and Transit Hill (DEWHA 2009).

The outstanding natural values of the island have been recognised through the inscription of the Lord Howe Island Group (LHIG) on the World Heritage Register, the inclusion of the group on the National Heritage register and the establishment of the Permanent Park Preserve which covers almost 75 per cent of the LHIG.

Lord Howe Island has experienced significant species loss due to human impacts and pest plants and animals. Nine land bird species and one seabird species have disappeared from the island (Hutton 1991). Two plant species are presumed extinct. Many threatened species occur on the island. Threatening processes include weed invasion, pest fauna and land clearing. Habitat loss and fragmentation pose significant threats to biodiversity. The Permanent Park Preserve is split into northern and southern sections, separated by the settlement area (DECC 2007).

11 plant species listed as threatened under the NSW TSC Act and/or the Commonwealth EPBC Act and 2 threatened communities listed under the TSC Act occur on the island. 26 bird species are listed as threatened under the TSC Act; 10 are vagrants or irregular visitors, 12 are resident or breeding seabirds and four are land birds (DEWHA 2009). 22 birds (most are vagrant or irregularly visiting seabirds), 5 invertebrates and 2 land reptiles are listed as threatened under the EPBC Act (refer Appendix E).

Over 600 exotic plants have been recorded on LHI, of which about 270 are naturalised (DEC 2007). 17 species are declared noxious weeds on the island (Le Cussan 2006). Several fauna species have been introduced to the island. Feral pigs and cats have been eradicated and goats have been reduced to non-reproductive individuals. The Ship Rat remains a problem, and has been implicated in the decline and extinction of five land bird species (DECC 2007).

Figure 3-1 Locality and landscape context of the subject site (Image: Google Earth)

3.3 PLANNING CONTEXT

3.3.1 National

As a World Heritage site, the Lord Howe Island Group must be managed in accordance with the provisions of the EPBC Act (DEWHA 2009). A Strategic Plan coordinates management of the LHIG World Heritage Property by the Lord Howe Island Board (LHIB) and various NSW and Commonwealth agencies over a 10 year timeframe (LHIB 2010).

Approval by the Commonwealth Environment Minister is required if an action is likely to have a significant impact on a Matter of National Environmental Significance, including properties listed on the World Heritage and National Heritage registers and threatened species and communities listed under the EPBC Act. This report considers impacts to biodiversity values protected under the EPBC Act; Assessments of Significance are provided in Appendix B and Appendix F. A separate referral to the Commonwealth has been prepared to determine whether the proposal is a 'controlled action' requiring approval by the Commonwealth.

3.3.2 State

The proposal requires approval under Part 4 of the *Environmental Planning and Assessment Act* (EP&A Act). Clause 228 of the EP&A Regulation lists factors that must be taken into account concerning the impact of an activity on the environment, including biodiversity impacts. Section 112 requires a Species Impact Statement or Environmental Impact Statement to be prepared, and the concurrence of the Director-General of OEH, if a development is likely to significantly affect threatened species and communities listed under the *Threatened Species Conservation Act 1995*. The *Lord Howe Island Act 1953* vests all land on the island in the Crown and establishes the Lord Howe Island Board as the development consent authority. The LHI Permanent Park Preserve was established under Section 19A of the Lord Howe Island Act, and is managed in accordance with a Plan of Management.

3.3.3 Local

The Lord Howe Island Board provides local government on the island, regulating planning and development through the LHI Local Environmental Plan 2010 (LEP). The proposal site is located on land classified Zone No. 7 Environment Protection under the LEP. Public utility installations and undertakings are permissible in the zone with Board consent. The Board cannot approve a development if it would result in the loss of significant native vegetation mapped under the LEP. Significant native vegetation within the study area is shown on Figure 3-2. The works would not affect Significant Native Vegetation mapped under the LEP.

The LEP details the required contents of an environmental report (Schedule 3), and clause 41 requires development applications to be advertised if they involve public utility installations or undertakings.

Figure 3-2 Significant native vegetation (green) mapped under clause 2 (3)(c) of the LHI LEP

4 APPROACH AND METHODS

4.1 BACKGROUND REVIEW

4.1.1 Database searches and threatened species evaluation

Database searches undertaken for this assessment include the threatened species and noxious weed databases listed in Table 4-1. The results of the searches are provided in Appendix D.

Table 4-1 Background searches undertaken for threatened entities and noxious weeds.

Resource	Target	Search date	Search area
OEH Wildlife Atlas database	Threatened flora and fauna and populations.	29/12/15	Lord Howe Island LGA
EPBC Act Protected Matters Search Tool	Threatened flora and fauna, endangered populations and ecological communities and migratory species.	29/12/15	10 kilometre radius
DPI Noxious Weed Database	Declared noxious weeds	29/12/15	LHIB Local Control Authority area

An evaluation of the likelihood of occurrence of threatened flora and fauna species and ecological communities within the study area was undertaken, based on habitat suitability and distribution records (refer Appendix B and Appendix E). The evaluations were used to determine subject species and communities for the Assessments of Significance (Appendix B and Appendix F).

4.1.2 Literature review

A wide range of previous survey and assessment reports, research papers and management plans were sourced and used to inform the site assessment and threatened species evaluations. These documents are referenced where relevant throughout the report.

4.1.3 Consultations

Hank Bower (Manager Environment/World Heritage, LHIB) provided field identifications of plants affected by the proposal and advice on local fauna issues. Ambrose Ecological Services was engaged by NGH Environmental to provide specialist assessment of forest bird and seabird impacts (Ambrose Ecological Services 2016). NGH Environmental and the Board also consulted Lisa O'Neill and Nicholas Carlile on potential impacts and mitigation options related to the Flesh-footed Shearwater, and Glenn Hoye (Fly By Night Bat Surveys Pty Ltd) in relation to microbat impacts. Specialist reports from these consultants are attached to the Biodiversity Assessment (Appendix B, Appendix C).

4.2 FIELD VISIT

Nick Graham-Higgs and Paul McPherson from NGH Environmental, and David Moir from Moir Landscape Architects visited the island and the subject site on 19-22 January 2016. The purpose of the visit was to:

- become familiar with the island environment, and management, social and economic context
- conduct an ecological site assessment
- conduct a visual and landscape assessment, consulting with affected residents and business operators as required
- consult with relevant Board staff, Board members and the Sustainable Energy Working Group.

Information gathered during the visit was used to inform the Biodiversity Assessment, Landscape and Visual Impact Assessment and Environmental Report, and further investigation and consultations.

4.3 ASSESSMENTS OF SIGNIFICANCE

Threatened species and communities with potential to be impacted by the proposal were identified in the threatened species evaluation (Appendix B and Appendix E). The potential impacts to these subject species were evaluated in formal Assessments of Significance under the NSW TSC Act and Commonwealth EPBC Act as appropriate.

Section 5A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) specifies seven factors which form the basis for the NSW Assessments of Significance. The Commonwealth Significant Impact Guidelines 1.1 provide criteria for the assessment of significance of impacts to Matters of National Environmental Significance.

The Assessments of Significance are provided in Appendix B and Appendix F and the results are summarised in sections 6.1.3 and 6.2.3.

5 FLORA AND ECOLOGICAL COMMUNITIES

5.1 FLORA SPECIES

5.1.1 Existing environment

Flora species recorded at the subject site during the field visit are identified in Appendix A. These lists are indicative of species composition and are not exhaustive.

The proposed wind turbine site carries exotic pasture grasses, clovers and weeds, with few native species. Groundcover at the site is dominated by the exotic grasses Kikuyu (**Cenchrus clandestinus*), Parramatta Grass (**Sporobolus africanus*) and Paspalum (**Paspalum dilatatum*), with a few common, hardy native species present around outcropping basalt.

Figure 5-1 Proposed wind turbine site, looking north-west along the ridgeline, with pasture dominated by the exotic pasture grass Kikuyu (*Cenchrus clandestinus*).

The forest affected by the clearing for the proposed access track widening and realignment is a diverse but common assemblage of trees and medium-tall shrubs, with the overstorey dominated by Maulwood (*Olea paniculata*), Lignum Vitae (*Sophora howinsula*) and Greybark (*Drypetes deplanchei*). The lower strata are likely to have been simplified by formerly dense Ground Asparagus cover and subsequent control treatments. The native sedge *Carex brunnea,* forb *Commelina cyanea* and exotic grasses occur along the disturbed road verge. The access track forest vegetation is shown on Figure 5-5.

Figure 5-2 Kikuyu dominated groundcover at proposed turbine site

Figure 5-3 *Howea forsteriana* Closed Forest on the north-eastern side of the turbine paddock.

5.1.2 Threatened, endemic and rare flora

Database search results

The Commonwealth EPBC Act and NSW Wildlife Atlas search results for the study area are provided in Appendix D. The EPBC Act database search indicates 6 flora species listed as threatened under the EPBC Act which are likely to occur within the 10 kilometre radius search area. These species, plus an additional five species, are listed as threatened in NSW under the TSC Act and were indicated for Lord Howe Island by the NSW Atlas search. The NSW search indicates a further two species now considered to be extinct. None of these species are likely to occur at the subject site, based on known habitat requirements and distribution (refer Appendix E).

Site inspection results

No threatened flora species, or species identified as locally significant in Hunter (2002) were recorded at the subject site during the site visit. Seven endemic taxa are present in the proposed access track clearing area; *Celtis conferta* ssp *amblyphylla, Howea belmoreana, Sophora howinsula, Xylosma maidenii, Cassinia tenuifolia, Trophis scandens* ssp *megacarpa* and *Parsonsia howeana.* These and most other species within the proposed clearing area are common and widespread on the island. The endemic tree Lignum Vitae (*Sophora howinsula*) is locally abundant at the site; this species is widespread and uncommon on the island, and protected within the Permanent Park Preserve (DECC 2007).

The threatened forb Sand Spurge (*Chamaesyce psammogeton*) occurs in the Coral Sand Beach and Dune community. This species is restricted to Blinkie Beach dune on Lord Howe Island (DECC 2007, LHIB 2012) and is highly unlikely to be present in the marginal, disturbed dune habitat at the proposed barge landing near the Waste Management Facility (Figure 5-9). There are records for the mangrove *Aegiceras corniculatum* on Cobby's Creek near the proposed barge landing site. This species has a very localised distribution on Lord Howe Island.

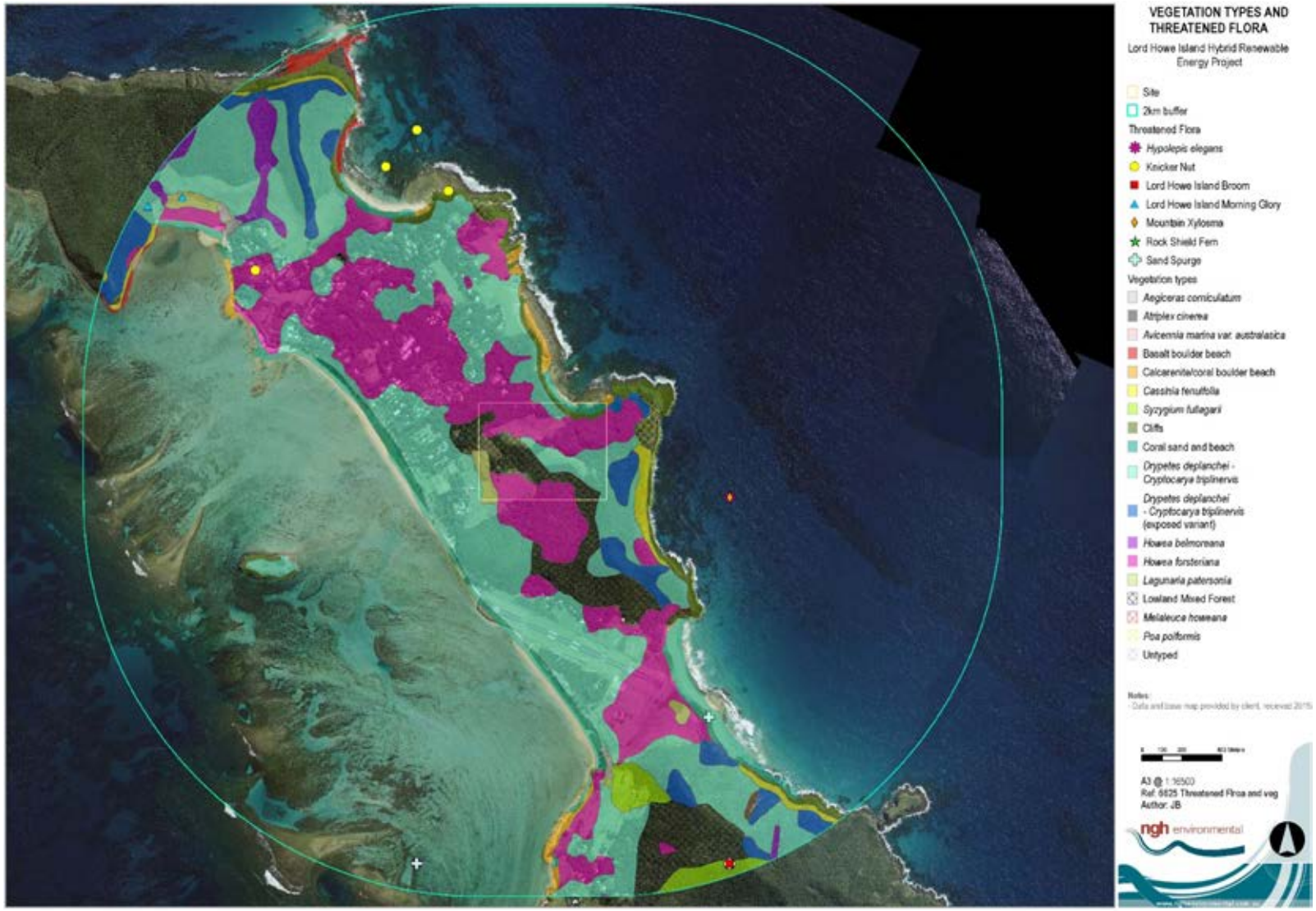

Figure 5-4 Vegetation communities and threatened flora records within 2 kilometres of the subject site

5.1.3 Weeds

Currently, 68 invasive weed species declared noxious under NSW Noxious Weeds Act 1993 occur on Lord Howe Island and are targeted for eradication under the Draft Lord Howe Island Weed Management Strategy (LHIB 2016). Category 3 weeds which are to be controlled under the Strategy include the invasive exotic grasses Kikuyu (*Cenchrus clandestinus*), Buffalo Grass (*Stenotaphrum secundatum*) and Panic Veldt Grass (*Ehrharta erecta*) (LHIB 2016).

Hunter (2002) noted a number of environmental weeds additional to those listed by the Board, including Kikuyu Grass (*Pennisetum clandestinum*), Umbrella Tree (*Schefflera actinophylla*), Yellow Guava (*Psidium guajava*), Peruvian Lily (*Alstroemeria pulchella*), Silky Oak (*Grevillea robusta*), Norfolk Island Pine (*Araucaria heterophylla*), Periwinkle (*Vinca major*), Pomegranate (*Punica granatum*), Cotoneaster (*Cotoneaster glaucophyllus*), Holly Fern (*Phanerophlebia falcata*) and Aralia (*Tetrapanax papyrifer*).

The EPBC Act search results (Appendix D) list weeds of national significance (WoNS) and other introduced plants that are considered to pose a particularly significant threat to biodiversity which are likely to occur on the island. They include Madeira Vine (*Anredera cordifolia*), Bridal Creeper (*Asparagus asparagoides*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Lantana (*Lantana camara*), African Boxthorn (*Lycium ferocissimum*) and Salvinia (*Salvinia molesta*).

The Lord Howe Island Weed Management Strategy (LHIB 2016) identifies the following Category 1 invasive plants which occur in the Transit Hill area; *Pittosporum undulatum*, *Cestrum nocturnum, Chrysanthemoides monilifera, Lantana camara, Lycium ferocissimum, Psidium cattleyanum, Toxicodendron succedaneum, Asparagus aethiopicus*, *A. plumosus, Setaria palmifolia* and *Cortaderia selloana.* These species are to be eradicated under the Strategy. Ground Asparagus (*Asparagus aethiopicus*) is a major weed in this area and is the most abundant and widespread weed species on Transit Hill (DECC 2007). In addition, the environmental weeds *Ageratina adenophora* and *Lilium formosanum* are known from the area (DECC 2007).

Ground Asparagus was recorded at the access track subject site, remnant from earlier control treatments. Kikuyu has invaded some more open areas within the forest following removal of the Asparagus. Sweet Pittosporum seedlings are present beside the existing road at the site. Cherry Guava seedlings are scattered in the paddock at the proposed turbine site.

Ground Asparagus, Sweet Pittosporum and Cherry Guava are included among the top 10 weeds on the island in the Weed Management Strategy and are targeted for eradication (LHIB 2016). These species displace native vegetation, are capable of being widely dispersed by birds and have invaded remote areas on the southern mountains.

5.2 ECOLOGICAL COMMUNITIES

5.2.1 Existing environment

Greybark-Blackbutt Closed Forest

The vegetation at the access track site belongs to the Greybark-Blackbutt (*Drypetes deplanchei–Cryptocarya triplinervis*) Closed Forest community described in the Biodiversity Management Plan (DECC 2007). The community is also dominant around most of the perimeter of the cleared paddock at the proposed wind turbine site, particularly on the southern and south-western sides of the block (Figure 5-4).

Characteristic species listed for this community in the Plan which are present at the subject site (access track) include *Drypetes deplanchei*, *Cryptocarya triplinervis, Howea belmoreana, Celtis confertus, Olea paniculata, Xylosma maidenii, Myoporum insulare, Parsonsia howeana, Trophis scandens* ssp *megacarpa, Carex brunnea* and *Commelina cyanea*. Canopy height in forest surrounding the site is generally 8 to 12 metres, with emergents up to 18 metres on the north-eastern side of the turbine paddock.

The Greybark-Blackbutt Closed Forest community occupies approximately 355 hectares on lowlands to 400 metres elevation and is the dominant lowland forest association on Lord Howe Island (DECC 2007). It occurs in two forms, on basalt and on calcarenite/coral sand. The vegetation at the subject site occurs on basalt. The form on calcarenite/coral sand is identified as being of particular conservation concern because of the extent of clearing/fragmentation and weed invasion (DECC 2007). The threats to the community include the weeds Kikuyu, Ground Asparagus, Sweet Pittosporum and Cherry Guava, rodent predation and windshear at forest edges (DECC 2007).

Figure 5-5 Existing access track, with disturbed Greybark-Blackbutt Closed Forest vegetation to be cleared to left (north-east) of the track.

The existing 5 to 9 metre wide track corridor passes through a narrow strip of Greybark-Blackbutt Closed Forest over a distance of approximately 50 metres. The track and turbine site paddock are currently grazed by cattle. A two strand electric fence excludes stock from surrounding forest areas. The forest edge shows signs of dieback caused by exposure and windshear. Regenerating forest trees and shrubs are present on the north-eastern side of the turbine paddock. Competition from Kikuyu and Buffalo Grass and cattle grazing are likely to be inhibiting the recolonization of cleared areas by native plants.

Significant Native Vegetation (SNV) mapped under the LEP occurs around the subject site; Figure 3-2. The works would not affect this vegetation.

Figure 5-6 North-western end of existing access track entering from cleared paddock.

Figure 5-7 South-eastern end of existing access track with dead Scalybark trees, one hollow-bearing.

Kentia Palm (*Howea forsteriana*) Closed Sclerophyll Forest

This community is present on the north-western side of the turbine paddock (Figure 5-3 and Figure 5-4). The community is an endemic association, often featuring dense stands of Kentia Palm. Characteristic species also include *Cryptocarya triplinervis, Drypetes deplanchei, Ficus macrophylla* ssp *columnaris, Pandanus forsteri, Olea paniculata, Coprosma putida, Elaeodendron curtipendulum, Myoporum insulare, Atractocarpus stipularis, Flagellaria indica, Smilax australis, Carex brunnea, Oplismenus imbecillus, Asplenium milnei* and *Pteris microptera* (DECC 2007).

The community occupies approximately 170 hectares on low, flat areas from sea level to 120 metres, but also extends to 360 metres. Two distinctive forms of the community are recognised, on calcarenite/coral sand and on basalt (DECC 2007). Both forms are present in the study area; the forest immediately adjoining the subject site occurs on basalt, and the geology transitions to calcarenite some distance into the forest to the north-east of the subject site.

The Biodiversity Management Plan identifies Kentia Palm Forest among communities of particular conservation concern, because of clearing and fragmentation (DECC 2007).

Lowland Mixed Closed Forest

An area of this vegetation community borders the cleared turbine paddock in the south-western corner of the site, to the southwest of the proposed access track (Figure 5-4). This is an endemic association comprising *Syzygium fullagarii, Melicope polybotrya, Guioa coriacea, Hedyscepe canterburyana, Olea paniculata, Pandanus forsteri, Zygogynum howeanum, Coprosma putida, Psychotria carronis, Xylosma maidenii, Cassinia tenuifolia, Flagellaria indica, Trophis scandens, Carex brunnea, Adiantum hispidulum, Pteris microptera* and *Nephrolepsis cordifolia*. The community occupies approximately 192 hectares, mostly in low–moderate exposure areas on slopes and valleys at low-moderate altitudes on basalt soils (DECC 2007). The Biodiversity Management Plan identifies Lowland Mixed Closed Forest among communities of particular conservation concern because of weed invasion (DECC 2007).

Other communities

The Coral Sand Beach and Dune Community is present in the vicinity of the proposed barge landing site at Cobby's Corner, in highly disturbed condition. Characteristic species in this community include *Spinifex sericeus, Cassinia tenuifolia, Dodonea viscosa, Cakile edentula, Crinum pedunculatum, Ipomoea brasiliensis, Calystegia soldanella, Canavalia rosea, Ficinia nodosa* and *Leucopogon parviflorus* (DECC 2007), and the exotics *Hydrocotyle bonariensis* and *Cakile edentula*. The project would use an existing sand ramp and

access track across the foredune, avoiding disturbance to this vegetation (refer Figure 5-9). The community is identified as being of particular conservation concern in the Biodiversity Management Plan because of a moderately restricted distribution, clearing and disturbance (DECC 2007). The community is also threatened by climate change and weed invasion.

The uncommon community Mangrove (*Aegiceras corniculatum*) Closed Swamp Scrub is present at the mouth of Cobby's Creek at Cobby's Corner, outside the area that would be directly affected by the works. This community is also of particular conservation concern because of a restricted distribution, grazing and trampling, weed invasion and climate change (DECC 2007).

Figure 5-8 Existing monitoring mast at the top (eastern) end of the proposed turbine paddock.

Figure 5-9 Proposed barge landing site near the Waste Management Facility on the Lagoon, with disturbed Coral Sand Beach and Dune Community vegetation.

5.2.2 Endangered Ecological Communities

The NSW Atlas search indicates two threatened communities listed under the TSC Act occurring on Lord Howe Island, both Critically Endangered:

- Lagunaria Swamp Forest on Lord Howe Island
- Gnarled Mossy Cloud Forest on Lord Howe Island.

Lagunaria Swamp Forest is restricted to low-lying swampy areas below 20 metres elevation in the mid island lowlands. Gnarled Mossy Cloud Forest is restricted to the summits of Mt Gower and Mt Lidgbird in the southern mountains. Neither has been recorded within or adjacent to the proposal site, and based on known habitat and distribution, neither community occurs there. No threatened communities were indicated in the EPBC Act search.

5.3 FAUNA

5.3.1 Existing environment

General

The proposed turbine site is an area of exotic grassland (1.5 hectares) surrounded by native closed forest. The site may be used for foraging by some insect and bird species, but is unlikely to provide limiting or essential habitat resources for local fauna. The microchiropteran Large Forest Bat, forest birds and seabirds use the air space above the paddock. The closed forest area at the access track site provides habitat for a

range of fauna species, particularly forest birds and invertebrates. The forest patch has less habitat value for species associated with weathered surface rock and deeper soils derived from calcarenite, such as the Flesh-footed Shearwater, Lord Howe Island Gecko and the Lord Howe Placostylus. The vegetation in this area appears to be regrowth with no live large trees. Two dead Scalybark trees are present on the south-western side of the track, the upslope (southern) one with a medium hollow providing potential roosting habitat for the Large Forest Bat (refer Figure 5-7). The narrow belt of forest at the track site provides a potential corridor linkage for mobile forest fauna.

Bird survey results

Specialist bird survey and literature/database review results for the proposal are contained in the bird impact assessment (Ambrose Ecological Services 2016), provided in Appendix B. A separate survey and assessment was conducted for the Flesh-footed Shearwater (O'Neill and Carlile 2016), also provided in Appendix B. The bird assessments are summarised in this section.

Typical of remote oceanic islands, the terrestrial vertebrate fauna of the Lord Howe Island Group (LHIG) is dominated by birds. A total of 182 species of birds are recorded from the LHIG, of which 20 are resident land birds, 14 are breeding seabirds, 17 are regular visitors and 120 are vagrants (McAllan *et al.* 2004 in Ambrose Ecological Services 2016). Nine of the land birds have become extinct since human settlement (all endemic species or subspecies). Eleven seabird species continue to have important breeding populations in the LHIG, with Lord Howe Island reputed to have more seabird species breeding in higher numbers than anywhere else in Australia (P. Fullagar, in Hutton 1998).

Bird surveys were conducted at the subject site by Ambrose Ecological Services during 21-25 February, 15-17 March and 3-7 July 2016. The first two surveys coincided with nesting and roosting periods for most target species and the presence of migratory species. The July survey coincided with the Providence Petrel nesting and roosting period and sampled typical winter conditions on the island, when low pressure systems produce heavy, low cloud cover, strong winds and rain squalls.

The number of bird flights, altitude, direction, ground distance flown over open paddock and identity of species were recorded during observation periods at 8 survey vantage points.

25 bird species were observed flying across the cleared paddock, including the Welcome Swallow (49.0% of total flights), Lord Howe Silvereye (26.2%), Magpie-lark (4.5%) and White-throated Needletail (4.0%). 75.1% of flights were orientated along a north-south axis across the paddock. Birds flying along an east-west axis along the paddock were mostly seabirds gaining height using westerly winds and thermals as they flew over the top of Transit Hill. The fewest observed flights were in the eastern and western ends of the paddock, reflecting the preference of forest birds to move through forest around the paddock rather than across the paddock itself.

86.5% of all observed flight events across the paddock were 12 metres above ground level or less, 11.5% were between 12 and 24 metres, and only 2% greater than 24 metres. Most birds flew across the paddock below forest canopy height. Birds flying at heights greater than 20 metres were mostly seabirds flying from the southern mountains or between coastlines or ocean areas, or terrestrial birds using thermals (eg Australian Kestrel) or flying long distances over forested areas (eg Lord Howe Pied Currawong).

5.3.2 Threatened, endemic and migratory fauna

Database search results

The Commonwealth EPBC Act and NSW Wildlife Atlas search results for the study area are provided in Appendix D. Threatened fauna records in the Board database within two kilometres of the subject site are shown on Figure 5-10. (The Masked Owl was introduced to the island from the mainland in the 1920's to control rats and is now considered a pest species.) There are no subject species records for the actual subject site in the Board database or NSW Wildlife Atlas. Within three hundred metres, the Board database has records for the Lord Howe Placostylus (120 metres, 190 metres), Grey Ternlet (70 metres), Sooty Tern (70 metres), Flesh-footed Shearwater (100 metres), Black-winged Petrel (170 metres) and Lord Howe Island Currawong (140 metres). The NSW Wildlife Atlas also has records for the Lord Howe Island Gecko, Lord Howe Placostylus, Lord Howe Island Currawong and Lord Howe Golden Whistler within 300 metres.

Rentz's Strong Stick Insect (*Davidrentzia valida*), a rare species protected under the Lord Howe Island Regulation 2014, is also likely to occur in forest habitat adjacent to the site (Hank Bower LHIB pers comm).

Bird survey results – threatened and endemic species

10 threatened bird species were observed flying across the cleared paddock during the 2016 bird surveys:

- Lord Howe Silvereye (*Zosterops lateralis tephropleurus*)
- Lord Howe Pied Currawong (*Strepera graculina crissalis*)
- Red-tailed Tropicbird (*Phaethon rubricauda*)
- Lord Howe Golden Whistler (*Pachycephala pectoralis contempta*)
- Sooty Tern (*Onychoprian fuscata*)
- Eastern Curlew (*Numenius madagascariensis*)
- Black-winged Petrel (*Pterodroma nigripennis*)
- White Tern (*Gygis alba*)
- Flesh-footed Shearwater (*Ardenna carneipes*)
- Little Shearwater (*Puffinus assimilis*).

The threatened species, excluding the Flesh-footed Shearwater, were responsible for 31.6% of the flights observed over the paddock during the survey. The endemic forest species Lord Howe Golden Whistler, Lord Howe Pied Currawong and Lord Howe Silvereye were responsible for 29.3% of the flights.

Flesh-footed Shearwaters have a significant breeding ground to the immediate north-east of the site. The sub-colony at Clear Place adjacent to the proposed turbine site could represent as much as 10% of the species' global population (Priddel *et al.* 2006 in Ambrose Ecological services 2016). Around dusk, birds were observed to fly into the paddock airspace from the east at high elevation, circle one or more times to reduce height before flying low into the forest into the colony (O'Neill and Carlile 2016). Individuals, small groups and, on one occasion, a very large flock were observed behaving in this way. Birds were also observed to walk into the paddock adjacent to the forest for launching at dawn during the breeding season.

An additional four threatened bird species have the potential to fly low over the subject site, but were not observed during the February and March 2016 survey periods:

- Providence Petrel (*Pterodroma solandri*)
- Kermadec Petrel (west Pacific subspecies) (*Pterodroma neglecta neglecta*)
- Masked Booby (*Sula dactyla*)
- Curlew Sandpiper (*Calidris ferruginea*).

The flightless Lord Howe Woodhen was observed at the forest edge near the south-eastern corner of the paddock during the February 2016 surveys.

Bird survey results - migratory species

7 listed migratory bird species were observed in or flying across the cleared paddock during the February and March 2016 bird survey periods:

White-throated Needletail (*Hirundapus caudacutus*)
Flesh-footed Shearwater (*Ardenna carneipes*)
Red-tailed Tropicbird (*Phaethon rubricauda*)
Pacific Golden Plover (*Pluvialis fulva*)
Eastern Curlew (*Numenius madgascariensis*)
Whimbrel (*Numenius phaeopus*)
Common (Brown) Noddy (*Anous stolidus*).

Collectively, they were responsible for 8.6% of the bird flights observed over the paddock during the February and March bird surveys (excluding the Flesh-footed Shearwater). An additional 14 migratory species have the potential to occur on or above the subject site, but were not observed during the February and March survey periods:

Fork-tailed Swift (*Apus pacificus*)
Wedge-tailed Shearwater (*Ardenna pacificus*)
Providence Petrel (*Pterodroma solandri*)
Masked Booby (*Sula dactyla*)
Cattle Egret (*Ardea ibis*)
Ruddy Turnstone (*Arenaria interpres*)
Sharp-tailed Sandpiper (*Calidris acuminata*)
Red Knot (*Calidris canutus*)
Curlew Sandpiper (*Calidris ferruginea*)
Red-necked Stint (*Calidris ruficollis*)
Latham's Snipe (*Gallinago hardwickii*)
Bar-tailed Godwit (*Limosa lapponica*)
Grey-tailed Tattler (*Tringa brevipes*)
Wandering Tattler (*Tringa incana*).

5.3.3 Subject species

The database searches, threatened species evaluation and bird survey and assessment results indicate that 32 listed threatened and migratory fauna species have potential to utilise habitat at the subject site, and be impacted by the proposed works. These subject species, their conservation status, the habitat affected and potential impacts resulting from the proposed works are identified in Table 5-1.

Table 5-1 Subject threatened and migratory fauna species

Species	Status	Habitat and potential impacts
Forest invertebrates		
Lord Howe Placostylus *Placostylus bivaricosus*	E TSC, E EPBC	Forest habitat loss and fragmentation
Forest birds		
Lord Howe Woodhen *Gallirallus sylvestris*	V EPBC, E TSC	Roads (construction traffic collision risk)
Lord Howe Island Currawong *Strepera graculina crissalis*	V EPBC, V TSC	Aerial habitat at turbine site (tower/guy wire collision and bladestrike risk)
Lord Howe Silvereye *Zosterops lateralis tephropleura*	V TSC	

Species	Status	Habitat and potential impacts
Lord Howe Golden Whistler *Pachycephala pectoralis contempt*	V TSC	
Seabirds		
Flesh-footed Shearwater *Ardenna carneipes*	M, V TSC	Aerial habitat at turbine site (tower/guy wire collision and bladestrike risk) Roads (construction traffic collision risk)
Black-winged Petrel *Pterodroma nigripennis*	V TSC	
Fork-tailed Swift *Apus pacificus*	M	Aerial habitat at turbine site (tower/guy wire collision and bladestrike risk)
White-throated Needletail *Hirundapus caudacutus*	M	
Little Shearwater *Pufinus assimilis*	V TSC	
Wedge-tailed Shearwater *Ardenna pacificus*	M	
Kermadec Petrel *Pterodroma neglecta neglecta*	V EPBC, V TSC	
Providence Petrel *Pterodrama solandri*	M, V TSC	
Masked Booby *Sula dactylatra*	M, V TSC	
Red-tailed Tropicbird *Phaethon rubricauda*	M, V TSC	
Cattle Egret *Ardea ibis*	M	
Pacific Golden Plover *Pluvialis fulva*	M	
Ruddy Turnstone *Arenaria interpres*	M	
Sharp-tailed Sandpiper *Calidris acuminata*	M	
Red Knot *Calidris canutus*	M, E EPBC	
Curlew Sandpiper *Calidris ferruginea*	M, E EPBC, E TSC	
Red-necked Stint *Calidris ruficollis*	M	
Latham's Snipe *Gallinago hardwickii*	M	
Bar-tailed Godwit *Limosa lapponica*	M	
Eastern Curlew *Numenius madagasariensis*	M, CE EPBC	
Whimbrel *Numenius phaeopus*	M	
Grey-tailed Tattler *Tringa brevipes*	M	
Wandering Tattler *Tringa incana*	M	
Brown (Common) Noddy *Anous stolidus*	M	
White Tern *Gygis alba*	V TSC	
Sooty Tern *Onychoprion fuscata*	V TSC	
Grey Ternlet *Procelsterna cerulea*	V-TSC	

M – listed Migratory species under the Commonwealth EPBC Act
V TSC - listed as Vulnerable under Schedule 2 of the NSW TSC Act
E TSC - listed as Endangered under Schedule 1 of the NSW TSC Act
V EPBC - listed as Vulnerable under the Commonwealth EPBC Act
E EPBC - listed as Endangered under the Commonwealth EPBC Act
CE EPBC - listed as Critically Endangered under the Commonwealth EPBC Act.

5.3.4 Pest fauna

The introduced Ship Rat, or Black Rat (*Rattus rattus*) is likely to be present at the subject site. Predation by the Ship Rat is a Key Threatening Process listed under the TSC Act. Rats are implicated in the extinction of at least 20 species (or subspecies) of birds, invertebrates and plants, and remain a threat to many endemic species (Wilkinson and Priddel 2011). The rat has been implicated with the extinction of five land bird species, two large land snails and, on the main island, the Lord Howe Island Phasmid. Rat predation has contributed to the decline of the Lord Howe Island Gecko, Lord Howe Island Skink and Lord Howe Island Placostylus populations. The Ship Rat is also damaging to a range of plant species, including the endemic palms (DECC 2007).

The introduced House Mouse (*Mus musculus*) is also widespread on the island and is implicated in the decline of the two endemic lizards. The Board has developed a Rodent Eradication Program involving aerial and hand broadcasting of bait in uninhabited areas and the establishment of bait stations within the settlement.

The introduced African Big-headed Ant (*Pheidole megacephala*) has become established in parts of the settlement area, generally in disturbed sites, but including Stevens Reserve (DECC 2007). This species displaces native ants and is a major threat to biodiversity on the island. A large, introduced slug has also established in the lowland forests and may impact the Lord Howe Placostylus and other invertebrate species (Hutton 2001b in DECC 2007). The introduced Red Imported Fire Ant and Yellow Crazy Ant have not been recorded on the island but are a significant quarantine risk.

The works under this proposal would stringently apply the Lord Howe Island Board Biosecurity Strategy (AECOM 2016). Additional safeguards have been included in section 6.2.4.

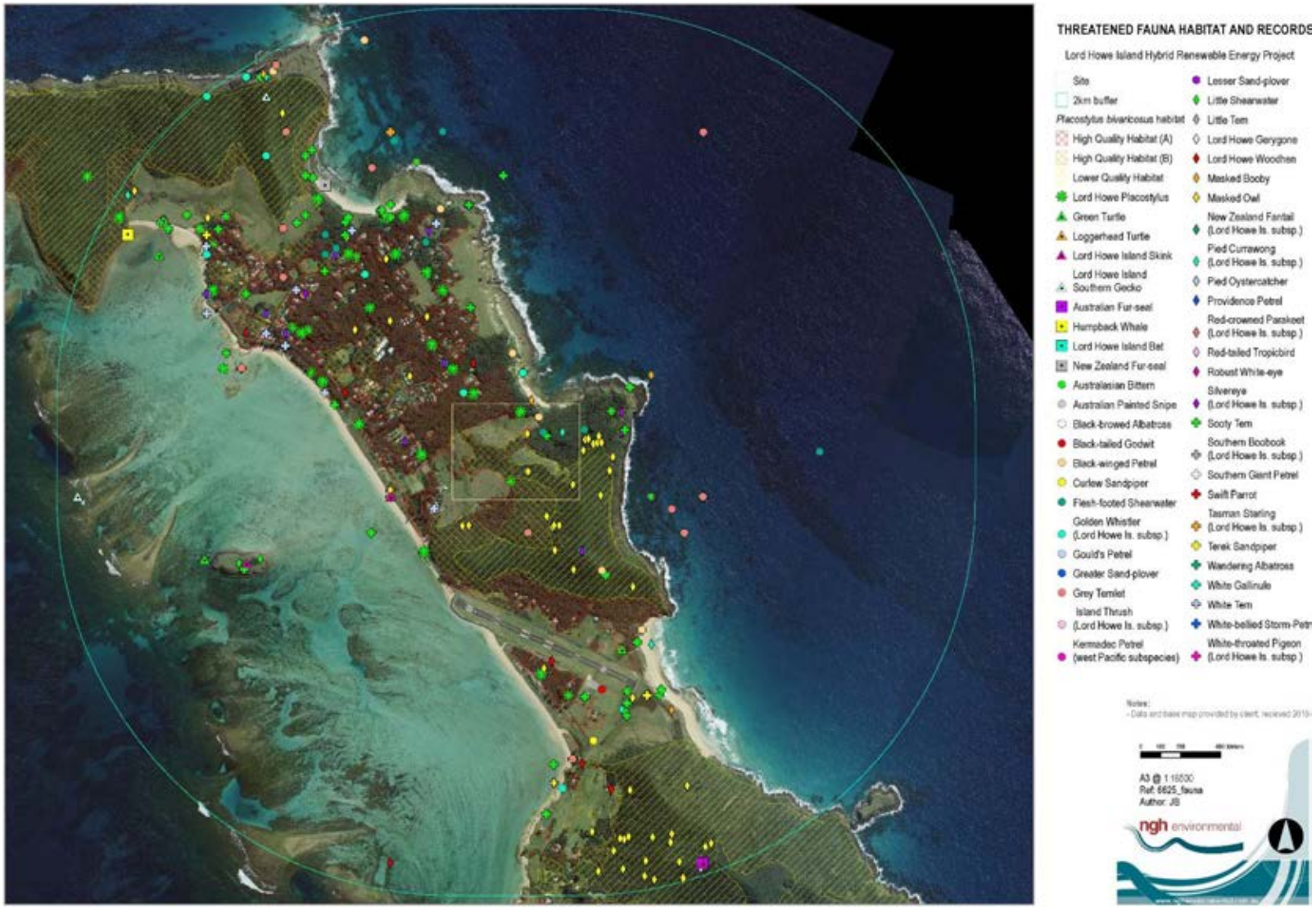

Figure 5-10 Threatened fauna records and *Placostylus bivaricosus* habitat within 2 kilometres of the subject site

6 ASSESSMENT OF IMPACTS

6.1 FLORA AND ECOLOGICAL COMMUNITIES

6.1.1 Construction impacts

The construction of the wind turbines would result in the temporary disturbance to and permanent loss of exotic pasture with little or no flora conservation value. An existing section of unsealed track in the north-west of the subject site would be upgraded and widened to provide construction access to the turbine site. This would result in the removal of a small area of Greybark-Blackbutt (*Drypetes deplanchei–Cryptocarya triplinervis*) Closed Forest (refer Figure 5-5 and Figure 6-1).

The clearing area would comprise a corridor up to 5 metres wide on the north-eastern side of the existing track over a distance of 35 metres, tapering at both ends (up to 170 m^2). Dead trees, palms and shrubs over a disturbed groundlayer would also be removed on the south-western verge of the existing track (up to 30 m^2). Minor peripheral impacts may affect the endemic Lowland Mixed Closed Forest community which is present on the south-western side of the proposed track widening. The total area of vegetation cleared would not exceed 200 m^2 and would be offset by restoration works located close to the subject site (refer section 6.1.4).

Figure 6-1 Vegetation clearing required for access track widening (red). Image: Google Earth

The proposed clearing would not affect threatened flora or ecological communities, or Significant Native Vegetation mapped under the LEP. A small number of individuals of the endemic species *Celtis conferta* ssp *amblyphylla, Howea belmoreana, Sophora howinsula, Xylosma maidenii, Cassinia tenuifolia, Trophis scandens* ssp *megacarpa* and *Parsonsia howeana* would be removed by the track clearing. These species are not uncommon locally and the loss of these plants would not significantly affect local populations. Where suitable these species would be included in plantings undertaken to offset the clearing impacts of the proposal (refer Appendix G).

The works have potential to introduce and spread weeds and disease at the subject site. Two dead Scalybark (*Syzygium fullagarii*) trees are present beside the access track at the subject site; the soil-borne

fungal pathogen *Phytophthora cinnamomi* may be responsible although this is considered unlikely. Phytophthora was detected in 2003 in a small avocado orchard on cleared land at the southern end of the settlement area (Auld and Hutton 2004), and the site has been quarantined for some time with ongoing treatments (Hank Bowers LHIB pers comm). The dead Scalybarks are situated at the exposed edge of the paddock clearing and the shape of the branch growth indicates wind shear (refer Figure 5-7). The Greybark-Blackbutt lowland rainforest association and Scalybarks in particular are very susceptible to windshear and dieback due to exposure (Olsen 2002 in DECC 2007).

Flora species which are present at the site and which are potentially susceptible to *P. cinnamomi* (based on effects on conspecifics elsewhere) include *Cassinia tenuifolia, Drypetes deplanchei, Cryptocarya triplinervis* and *Syzygium fullagarii* (Auld and Hutton 2004 in DECC 2007). Living specimens of *Cassinia tenuifolia, Drypetes deplanchei and Cryptocarya triplinervis* are present at the subject site. McDougall (2005) lists three *Sygygium* species (*S. cormiflorum, S. johnsonii* and *S. wesa*) as being field resistant to the infection, and one species thought to be susceptible (*S. kuranda*).

The pathogen Myrtle Rust has not so far been detected on the island (Commonwealth of Australia 2015). *P. cinnamomi* and Myrtle Rust infection are listed as Key Threatening Processes under the Commonwealth EPBC Act and the NSW TSC Act. Safeguards for preventing and controlling infection are detailed in the National Best Practice Guidelines for managing *Phytophthora cinnamomi* for biodiversity conservation (Gara *et al.* 2005) and the Arrive Clean, Leave Clean guidelines (DOE 2015).

The proposed works will provide opportunities for the proliferation of weeds and exotic pasture grasses at the subject site. Measures for preventing the introduction and spread of weeds and controlling weed infestations are contained in the LHI Weed Management Strategy (LHIB 2006) and the Noxious and Environmental Weed Control Handbook (DPI 2014).

With the implementation of best practice management, the risks related to weeds and disease at the subject site are considered manageable.

The community of conservation concern, Coral Sand Beach and Dune Community, would be at risk of peripheral impacts during the barge landing operation. Rigid plastic matting would be laid over the existing sand ramp and track between the beach and Lagoon Road to support the construction traffic. Some minor shrub and tree trimming may be required, but no track straightening, vegetation clearing or disturbance to groundlayer vegetation is expected.

The rare and localised mangrove *Aegiceras corniculatum* and uncommon community Mangrove (*Aegiceras corniculatum*) Closed Swamp Scrub on Cobby's Creek may be affected by a pollution incident at the proposed barge landing site near the Waste Management Facility on the Lagoon. The implementation of standard pollution control and spill response measures is considered adequate to manage this risk.

6.1.2 Operational impacts

The ongoing use of the wind turbines would not involve further disturbance to native vegetation. Operational impacts on flora and ecological communities would be negligible.

6.1.3 Threatened flora and communities

No threatened flora species or ecological communities would be affected by the construction or operation of the wind turbines.

6.1.4 Avoidance and mitigation

Table 6-1 outlines safeguards intended to avoid or reduce the impacts of the construction and operation of the proposed wind turbines on flora and ecological communities. Some of the safeguards have been adapted from measures recommended for the powerhouse project in the Planning Assessment Report (LHIB 2012b).

Table 6-1 Safeguards to avoid and mitigate flora and ecological community impacts

Safeguard	Phase
Training and induction	
The induction of project staff should emphasise the ecological sensitivity of the site. Staff should be made aware of significant vegetation features, potential environmental risks, environmental protection measures (including travelling to and from the site), and emergency response protocols and equipment.	Construction
Site protection	
The clearing of native vegetation at the access track site should be the minimum required to allow access for construction vehicles and machinery. The extent of clearing should be marked with tape or pegs to ensure no overclearing.	Construction
Where practicable and adequate for construction access, native shrubs and vines should be trimmed and retained on the road verge rather than cleared to encourage regeneration and reduce the vigour of exotic grasses and weeds at the edge of the forest.	Construction
Vehicle access and parking and materials and equipment laydown should be confined to disturbed pasture areas dominated by exotic grasses. These activities should not be undertaken within the dripline of forest trees at the site.	Construction
Stockpiles of soil, gravel or other materials should be protected from runoff and contained using sediment fencing to prevent sedimentation of adjacent native vegetation and habitat areas.	Construction
All sediment control must use clean sediment fencing, rather than haybales to prevent the importation of weeds and exotic insects.	Construction
Native vegetation to be retained at the access track site, and native dune vegetation either side of the Waste Management Facility barge landing ramp and track, should be fenced or otherwise clearly marked during the construction period to prevent peripheral or accidental impacts.	Construction
Biosecurity and weed control	
Excavated materials imported for the project should be certified Virgin Excavated Natural Material to minimise weed risks.	Construction
The noxious weeds Ground Asparagus, Sweet Pittosporum and Cherry Guava should be controlled at the subject site prior to the works to assist the recovery of native species. The occurrence of these and other noxious and invasive weeds should be monitored and controlled at the site for at least one year following the works.	Pre-construction Construction
All earthmoving equipment, tools and any prefabricated barrier fencing etc imported to the island for construction should be cleaned of any soil, insects and pathogens and certified as clean prior to their departure. To prevent the spread of Phytopthora and Myrtle Rust all tools etc that have been exposed to soil must be cleaned with Phyto-clean prior to importation. Equipment and materials should remain in quarantine at the LHI jetty or point of arrival until cleared by the LHI MEWH.	Construction

Safeguard	Phase
The National Best Practice Guidelines for managing *Phytophthora cinnamomi* for biodiversity conservation (Gara *et al.* 2005), the Arrive Clean, Leave Clean guidelines (DOE 2015) and the Lord Howe Island Board Biosecurity Strategy (AECOM 2016) should be applied to prevent the introduction and spread of pests and diseases at the site.	Construction
Rehabilitation and restoration	
Soils excavated from trenches should be reinstated by restoring the original soil profile to retain the seed bank and site productivity.	Construction
Any topsoil stripped from parts of the site carrying native vegetation should be stored and reused in revegetation at the site to encourage regeneration from soil-borne propagules.	Construction
Vegetation cleared from the site should be chipped and spread on bare areas, or used as mulch for restoration planting at the offset site.	Construction
Subject to continued accessibility for maintenance of the turbines, consideration should be given to revegetating disturbed areas beside the upgraded access track to reduce vegetation loss and fragmentation impacts. Any restoration work should follow the guidelines in the Lord Howe Island Vegetation Rehabilitation Plan 2002-2007 (LHIB 2002).	Operation
If practicable, the tree canopy either side of the access track should be allowed to grow back over the track corridor following the construction phase to reduce fragmentation impacts and improve resilience against weeds.	Construction Operation
The loss of native vegetation should be offset with restoration planting and site protection consistent with the proposed biodiversity offset described in Appendix E.	Construction Operation

6.2 FAUNA

6.2.1 Construction impacts

Fauna impacts during the construction phase relate to habitat loss as a result of clearing for the access track, the potential for interference to habitat utilisation caused by construction noise and activity, and risks to wildlife from construction traffic.

Up to 200m^2 of disturbed Greybark-Blackbutt (*Drypetes deplanchei–Cryptocarya triplinervis*) Closed Forest would be removed to enable widening of the access track at the western end of the subject site. This vegetation is locally common and dominant in the settlement area, and the habitat loss is not expected to significantly affect local fauna populations.

The widening of the access track from a corridor 5 to 6 metres wide to 9 metres wide would marginally increase fragmentation impacts. Volant species (birds, bats and insects) would not be affected. Species with poor dispersal capacity or an inability to cross open areas may be selectively affected by the increased road width and surface sealing. The clearing may also increase the exposure of some species to predation. The tree canopy and understorey either side of the road are expected to regenerate and reduce the barrier effects of the clearing over time. The works are not expected to result in significantly greater barrier effects for fauna than currently exist at the site (refer also section 6.2.3 and Appendix F).

Intermittent noise, vibration and activity during the 3 month construction period may cause localised disturbance to fauna (refer also section 6.2.3). Work would not occur at night. These impacts would be temporary and are not likely to affect local fauna populations over the medium-long term.

Large Forest Bat

Two dead Scalybark trees at the southern end of the access track may require removal. The southern (upslope) tree is hollow-bearing, and provides potential habitat for hollow-dependent fauna such as the Large Forest Bat (Figure 5-7). This species is colonial, with up to 80 individuals occupying a roost site. Disturbance to a maternity colony may disrupt the breeding cycle and during the winter torpor period may use up critical energy reserves.

If possible, the hollow-bearing tree should be retained and fenced during the works to avoid accidental damage. Clearing protocols are provided in Table 6-2 below if this tree cannot be retained, including pre-works inspections and clearing outside the Large Forest Bat September – March breeding and winter hibernation periods. Removal of dead wood and trees is also likely to have had a negative impact on invertebrates on the island (DECC 2007). This activity is listed as a Key Threatening Process under the TSC Act. The other (lower) dead Scalybark would be removed, sectioned and placed as log habitat in adjacent forest.

Seabirds

The increase in traffic during the construction phase has potential to increase risks to fauna from vehicle collisions (refer also section 6.2.3). Most construction would occur outside the seabird breeding period, reducing risks to seabirds. Construction traffic associated with the project would be restricted to daylight hours and speed limited on Anderson Road to protect birds on roads.

6.2.2 Operational impacts

The principal operational impacts of the proposed wind farm are associated with bladestrike risks to birds and bats. Bats are also susceptible to mortality from barotrauma when passing close to spinning turbine blades. Other potential impacts include collision with standing obstacles such as guy wires and the disruptive effects of turbine lighting and alienation of habitat.

The operation of the turbines would not change staff numbers at the power house and any increase in traffic and collision risk associated with the operation of the turbines would be negligible. The proposal may enable the use of electric vehicles for general transport on the island. This has the potential to reduce collision risks to birds because these vehicles would be speed-limited and potentially offer improved visibility.

Bird impacts

SURVEY RESULTS

The potential bladestrike impacts on threatened, endemic and migratory bird species have been identified in the specialist bird impact assessment undertaken by O'Neill and Carlile (2016) and Ambrose Ecological Services (2016), provided in Appendix B. A summary of the key findings of these reports are included in the assessment below.

The proposed development has the potential to affect 7 seabird species that fly over the subject site (Flesh-footed Shearwater, Little Shearwater, Black-winged Petrel, Red-tailed Tropicbird, Black Noddy, Sooty Tern and White Tern), 7 terrestrial bird species and their habitats (White-throated Needletail, Welcome

Swallow, Australian Kestrel, Magpie-lark, Lord Howe Pied Currawong, Lord Howe Silvereye and Lord Howe Woodhen), 2 migratory shorebirds (Whimbrel and Pacific Golden Plover) and one heron species (White-faced Heron).

Based on the bird survey results, the proposed Vergnet turbine at WTG2 (refer Figure 2-2) would have the lowest collision risk of the turbine options. No birds were observed flying through the blade area at this turbine location. Two Red-tailed Tropicbird flight events were recorded at WTG1, representing 12.5% of observed Red-tailed Tropicbird flights over the subject site, but only 0.08% of observed flights of all bird species over the site.

The XANT turbines would have a greater impact on birds. Flight paths of 6 species were observed that would have intersected with the blade areas of the 31.8m 100 kW XANT turbines at WTG1 and WTG2. Four species (Red-tailed Tropicbird, Lord Howe Pied Currawong, Sooty Tern and White Tern) are listed as threatened, and two (Whimbrel and Red-tailed Tropicbird) are listed migratory species. In terms of numbers of flights, the Red-tailed Tropicbird (four flights over WTG1 and six flights over WTG2) would have been most at risk of colliding with turbines. In terms of proportions of observed flights over the subject site, the White Tern (60.0% at WTG1) and Red-tailed Tropicbird (25.0% at WTG1; 37.5% at WTG2) would have been most at risk. Overall, 1.1% of all observed bird flights would have intersected with the rotational area of the blades.

The 2016 surveys by Ambrose Ecological Services did not record observations of the Flesh-footed Shearwater, which was the subject of an earlier survey conducted by O'Neill and Carlile (2016). O'Neill and Carlile (2016) observed this species using the airspace where WTG1 and WTG2 are proposed.

The surveys conducted by Ambrose Ecological Services Pty Ltd in February and March 2016 were late in the breeding season of most diurnal seabird species that were observed flying over or near the subject site. The assessment report recommends further surveys of flight patterns of diurnal birds, especially seabirds, early in the breeding season (September-December). The conclusions of the assessment should be reviewed following completion of these surveys.

OTHER STUDIES

Known fauna fatalities from turbine collisions at south-eastern Australian wind farms are summarised and discussed by Smales (2015 in Ambrose Ecological Services 2016). Australian Magpies account for almost one quarter of all detected fatalities and slightly more than one quarter were comprised of two small raptors (Australian Kestrel and Brown Falcon). Two bird species (Swamp Harrier and Wedge-tailed Eagle) each represented between 6 and 8% of the total detected deaths. Each of the other species represented 1–2% of all fatalities and 16 of these were represented by a single individual. Bird species from a broad range of ecological niches have collided with turbine blades, but the majority of bird collisions involved a small number of bird species, and the incidence of collisions is very low for the majority of species.

BLADESTRIKE RISK FACTORS

Vulnerable groups

The vulnerability to bladestrike and ability to habituate to the presence of turbines varies between bird groups and species. The fauna groups considered to be most at risk from bladestrike include:

- waterbirds that are listed threatened or migratory species
- seabirds that are listed threatened or migratory species
- listed migratory species and threatened species that migrate within Australia
- species at risk of extinction (listed as endangered or critically endangered) (DEWHA 2009).

Northern hemisphere studies point to three bird groups which are most vulnerable to bladestrike; gulls, raptors and migrant songbirds (Airiola 1987, cited in Bird Studies Canada 2001). Species-specific behaviours such as hovering, circling, vertical and horizontal flights, movement frequency within the bladeswept zone, territorial and mating interactions and capacity for turbine avoidance also affect bladestrike risk. Martin (2011) also speculates that the visual acuity of birds varies considerably between species, affecting their ability to avoid collisions.

Species which are rare or declining, or which are naturally distributed at low density in the landscape (such as top order raptors) may be at greater risk because, while collision rates may be low, each mortality has a higher significance. Similarly, species with low reproductive rates, or poor capacity to disperse and recolonise habitats may be at greater risk at the population scale.

At some overseas wind farms, raptors have been disproportionately affected by bladestrike (Anderson *et al*. 1999, Thelander *et al*. 2003). Approximately 20 Australian Kestrels have been killed from bladestrike by small to mid-sized turbines at Coral Bay, Western Australia over 8 years of operation (Jacobs 2016a). The Australian Kestrel has bred on Lord Howe Island since 1944, colonising from the mainland to take advantage of altered environmental conditions since settlement. It is abundant on the mainland and has benefited from widespread forest clearing. Other raptor species on Lord Howe Island are listed as rare/accidental occurrences, including the Black-shouldered Kite, Swamp Harrier, White-bellied Sea Eagle and Brown Falcon (Avibase 2016).

Hull *et al*. (2013a in Ambrose Ecological Services 2016) and Smales (ibid) also report that there are many species that regularly fly within the rotational height ranges of turbine blades, but are rarely or never involved in collisions. Hull *et al.* (2013b in Ambrose Ecological Services 2016) and Hull and Muir (2013 in Ambrose Ecological Services 2016) showed that Wedge-tailed Eagles learned quickly to avoid collisions with turbines at a wind farm in Tasmania, suggesting that bird populations can adapt to turbines.

During the 2016 Lord Howe Island survey, the individual in front of a flock of 4 Black-winged Petrels collided with the guy wires of the weather monitoring mast, before continuing its flight; the other three individuals altered their course to avoid colliding with the wires. Moreover, O'Neill and Carlile (2016) observed a number of Flesh-footed Shearwater guy wire collisions, although none resulted in the bird losing flight control or falling to the ground. However, no such collisions were observed in the subsequent February and March 2016 survey, suggesting that Flesh-footed Shearwaters may have learned to avoid collisions.

Site conditions, weather and seasonal factors

The location of turbines in relation to migration routes, important nesting and feeding habitat areas and congregation sites increase risks to affected bird species. Site weather patterns are also a factor in collision risk. Poor siting of wind farms overseas has led to at least local population level bladestrike effects on raptors (Barrios and Rodríguez 2007, Smallwood and Thelander 2008) and seabirds (Everaert and Stienen 2007). The cleared turbine paddock is surrounded by habitat areas for forest birds, including threatened and endemic species (refer section 6.2.3 below), and adjacent to a large Flesh-footed Shearwater nesting ground.

Many studies have shown that poor weather conditions increase the occurrence of turbine collisions (Bird Studies Canada 2001). Weather conditions such as strong winds, fog, sea mist and low cloud can reduce the ability of birds to perceive the turbine blades or avoid collisions. Wind speeds exceeding 40 km/h are common in winter (when migratory seabirds are absent from the island). Gales, with winds in excess of 63 km/h, can be expected on an average of 3 days per month during winter. Other strong winds occur, on average, between 4 and 7 days per month throughout the year (Lord Howe Island Board 1985 in

Commonwealth of Australia 2002). The proposed turbines would automatically shut down when wind speeds reach 25 m/s (Vergnet) or 20 m/s (XANT), reducing collision risks caused by strong winds.

Low cloud below 659 metres is relatively rare on Lord Howe Island, observed around 12 days per year on average. Fog and mist are very rare, on average occurring less than once per year (Bureau of Meteorology 2014). Heightened bladestrike risk from low visibility caused by weather conditions is therefore likely to be infrequent at the subject site. It is likely that such events would occur primarily during periods of low wind, when the turbines are not likely to be operating (the turbines automatically shut down when wind speeds fall below 3-3.5 m/s).

Flesh-footed Shearwater bird surveys at the proposed turbine site were conducted from November to April occurred during warm, sparse low-cover and low wind conditions. Land-birds area are more at risk of turbine collision when inclement weather forces them to fly at lower altitudes, whereas sea birds generally showed a high degree of avoidance of wind farms at these times because they spend more time at sea (Skov and Heinänen 2015). Winter bird surveys were undertaken at the subject site during high wind conditions. Very few seabirds were observed at the site; Providence Petrels were recorded on one occasion. There were similarly fewer land bird movements across the site during the winter survey, the majority being Welcome Swallows (80% of flights) foraging on insects less than 2 metres above the gound. Based on the survey results, the impacts of the turbines on birds are likely to be less in winter.

Infrastructure factors

Biosis Research (2007) compared the potential collision risks to birds on Flinders Island posed by four different wind turbines, of varying sizes. The study suggests that small machines with rotors set higher above the ground present the lowest collision risk. This is because more flights by a greater range of bird species occur relatively lower, rather than higher above the ground (Biosis Research 2007).

Structural characteristics of the development, such as the presence of guy lines (Erickson *et al*. 2001), aerial cabling and perching opportunities may also affect the frequency of bird and bat collision. Lattice structures in particular attract perching species such as raptors (Bird Studies Canada 2001). The proposed turbines would be tubular structures providing minimal perching opportunities. The turbines would be supported by guy wires but would not use aerial electrical cabling.

During surveys undertaken for the monitoring mast at the subject site (O'Neill and Carlile 2016), a few bird collisions with the mast cables were heard and observed during dusk, although none resulted in the bird losing flight control or falling to the ground. No birds were found injured or dead despite searches immediately after these incidents. Independently of these searches, two birds were found dead in the monitoring mast paddock, one likely to have died prior to the erection of the mast and one more likely to have died from collision with wooden fence at the site than with a cable. Based on monitoring results and experience at other wind farms, the guy wires may lead to collision injuries and mortalities but numbers are likely to be low and unlikely to be significant at the population level.

BEHAVIOURAL DISRUPTION CAUSED BY LIGHTING

Turbine lighting has potential to affect night-flying birds and insects. Nocturnally active seabirds are known to be attracted to, and disoriented by, artificial lighting, particularly petrels, shearwaters and albatrosses (BirdLife International 2012, Rodríguez *et al.* 2014). The aviation assessment conducted for the project concluded that the turbines should be lit using a medium intensity light (Airport Group 2015). A single steady red light (one on each turbine) would be used. Red and yellow lighting has been found to be less attractive than green and blue lighting for Audubon's Shearwater (*Puffinus lherminieri*) (Salamolard *et al.* 2007). Kerlinger and Kerns (2003) found that red flashing lights did not attract night migrating birds. Red

strobe or strobe-like lights recommended for use in the United States do not appear to influence bat and songbird fatalities (NWCC 2010).

The proposed turbine lights would be remotely activated only when the airport is used at night, such as during a medical emergency or for RAAF purposes. These are rare events and have not occurred in at least the past 3 years (A Logan pers comm). Turbine lighting is therefore considered to represent a minor risk to birds on the island. The turbine light would only be visible from viewpoints at the same elevation or higher than the turbine. The impact of existing lighting on the Flesh-footed Shearwater on the island is low because external lighting is minimal (Priddel *et al.* 2006).

HABITAT ALIENATION AND DISPLACEMENT

The proposed turbines would be constructed within a cleared, grazed paddock dominated by exotic pasture grasses, and are not expected to result in the loss or alienation of bird habitat. The impact of the turbines on the neighbouring Flesh-footed Shearwater breeding colony has been assessed in Appendix B; the assessment concludes that, subject to the identified mitigation measures (including evening shutdown and construction outside the breeding period), the proposal would not significantly affect the breeding and foraging behaviour of this species. Because of the limited number and distribution of turbines, the proposal is not expected to create significant barrier effects for birds. The habitat utilisation impacts of the proposal should be monitored (refer section 6.2.4).

Microbat impacts

Microbats flying close to turbines may be killed by bladestrike or barotrauma (lung damage caused by rapid changes in air pressure). There is little information on the extent and significance of barotrauma and the degree to which it contributes to turbine related deaths is currently uncertain (Grodsky *et al* 2011; Rollins *et al* 2012 in Fly By Night Bat Surveys 2016). Bat collisions have been shown to be overwhelmingly correlated with migration and seasonal dispersal, and acclimatisation allows resident bats to forage and breed around the turbines (Erickson *et al*. 2002).

The only bat species (and the only native breeding mammal) on Lord Howe Island is the Large Forest Bat (*Vespadelus darlingtoni*), which is also found widely in south eastern Australia (DECC 2007). This colonial tree-roosting species forages at and below forest canopy level. At least one carcass that is likely to be *Vespadelus darlingtoni* has been found during searches at two wind farms in Tasmania (Fly By Night Bat Surveys 2016).

Bat surveys have confirmed the presence of this species in the lower elevated parts of the island including the subject site. A population of approximately 500 breeding females exists north of the airstrip, with a second smaller population in the southern mountains (Fly By Night Bat Surveys 2010-2014). The potential impact of the wind turbines on this species was assessed in a specialist study (Fly By Night Bat Surveys 2016); the assessment report is at Appendix C.

The bat survey found that activity levels in the turbine paddock were very low when compared with activity in adjacent forest. Within the paddock, activity was highest near ground level and was an order of magnitude lower at 20 metres height. Activity at ground level at the existing mast varied from no or little activity on some nights to over 50 passes per night on a few occasions. While activity was low even at 2 metres, activity at 20 metres height was negligible. No activity was recorded at 40 metres height (refer Figure 6-2).

These results indicate that the Large Forest Bat does not currently forage in or commute through the turbine paddock area to a substantial extent. The results suggest that the small number of bats passing

over the pasture do so close to ground level. The likelihood of the Large Forest Bat passing through the swept rotor area of the proposed turbines is low.

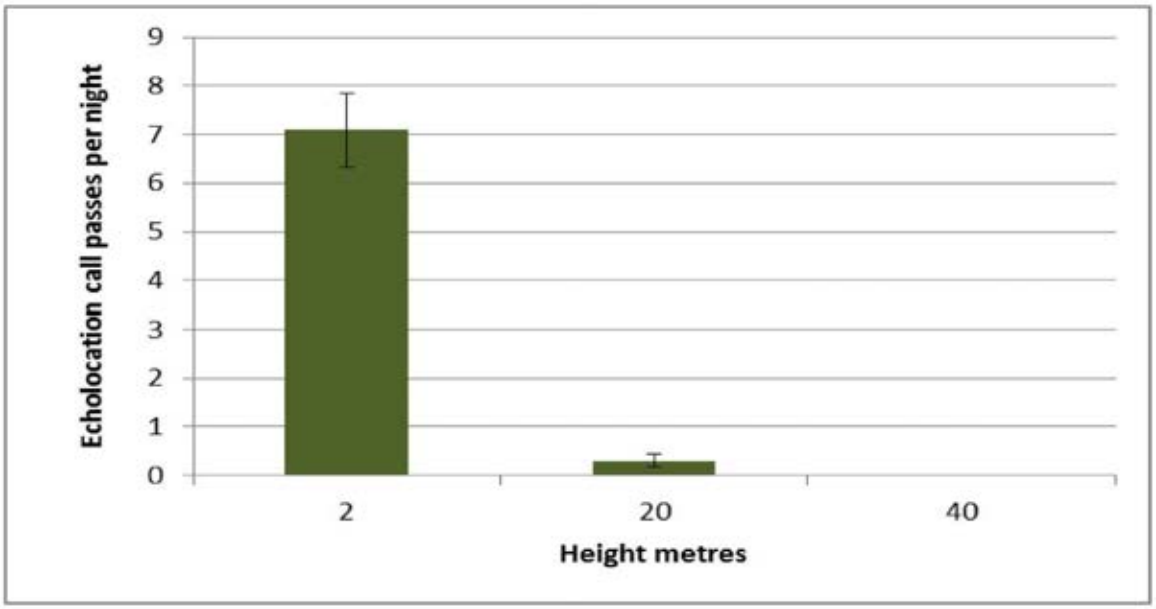

Figure 6-2 Bat activity levels at different heights at the monitoring mast location (from Fly By Night Surveys 2016)

Activity was highly seasonal with peak activity between October and March and little to no activity in winter. No evidence of mortality from guy wire or monitoring mast collisions was recorded during visits to the island from November 2014 until November 2015, although carcass detection would have been difficult.

Based on these results, the turbines and guy wires are likely to pose a low bladestrike and collision risk to the Large Forest Bat from random interactions. There is the possibility however that mortalities may result from the bats being attracted to the turbines as potential roosting sites or for other reasons. Jameson and Willis (2014 in Fly By Night Bat Surveys 2016) found that microbats were attracted to large structures. The bat assessment report recommends operation phase echolocation call monitoring and seasonal carcass searches for the first year, and other mitigation measures (refer section 6.2.4).

6.2.3 Threatened and migratory fauna

Construction impacts on the Lord Howe Placostylus

The specific impacts of forest clearing and fragmentation on the Lord Howe Placostylus have been assessed in the Assessments of Significance in Appendix F. The Assessments of Significance conclude that the works would not be likely to significantly affect this species, subject to specific mitigation measures identified in this Biodiversity Assessment. Measures cover pre-works survey, collection and redistribution of litter, restrictions on clearing, track surfacing, post-works management of the access track site and habitat restoration in the proposed offset area (refer section 6.2.4).

Construction impacts on threatened and migratory birds

Intermittent noise, vibration and activity during the 3 month construction period may cause localised disturbance to threatened and migratory birds. These impacts would be temporary and are not likely to affect local populations over the medium-long term.

The Ambrose Ecological Services (2016) bird assessment report notes that it is preferable for construction of the turbines and foundations to occur outside the Flesh-footed Shearwater breeding season (November to April) to avoid disturbance to the colony. Any blasting associated with the construction of the turbines on the subject site, including the concrete pads, would occur outside the Flesh-footed Shearwater breeding season (refer section 6.2.4). The Flesh-footed Shearwater nests in close proximity to residences and roads on the island and is likely to be tolerant of some level of daytime disturbance including routine maintenance and minor civil works.

The increase in traffic during the construction phase has potential to increase risks to threatened and migratory birds from vehicle collisions. Seabirds which breed close to the subject site include the Black-winged Petrel (Joys Hill, Middle Beach Road, November-May) and Flesh-footed Shearwater (Clear Place, September-May) are at particular risk during the breeding season. Young birds are at risk on roads during April-May before fledging and after the adults have left the island. Up to 185 Flesh-footed Shearwaters are estimated to be killed by cars each year (Reid 2010). Most construction would occur outside the seabird breeding period, reducing risks to seabirds. Construction traffic associated with the project would be restricted to daylight hours and speed limited on Anderson Road to protect birds on roads.

Operation impacts on threatened and listed migratory bird species

10 threatened bird species were observed flying across the cleared paddock during the bird survey periods (O'Neill and Carlile 2016, Ambrose Ecological Services 2016). An additional 4 threatened species have the potential to fly low over the subject site, but were not observed during the bird survey periods. The flightless Lord Howe Woodhen also has the potential to use the small area of forest that would be cleared for widening the access track to the subject site.

7 listed migratory bird species were observed in or flying across the cleared paddock during the bird survey periods. An additional 14 migratory species have the potential to occur on or above the subject site, but were not observed during the bird surveys.

Seven-part tests of significance for NSW threatened species and Assessments of Significance for threatened and nationally-listed migratory species (Appendix B) conclude that the proposed development would not significantly impact on the status of listed terrestrial birds, seabirds, shorebirds and other coastal birds, subject to the implementation of recommendations in the bird assessment (included in section 6.2.4 below). A Species Impact Statement is not required for these species.

The Ambrose Ecological Services (2016) bird assessment report notes that the XANT turbine option has greater potential for impact on threatened and migratory bird species as a result of individuals flying over the subject site. While XANT turbines are unlikely to lead to the extinction of locally viable populations of threatened bird species or affect their conservation status, there is a risk of significant bird mortality, particularly among seabirds, shorebirds, endemic flying land bird species and White-throated Needletails. The bird assessment report recommends the adoption of one of the Vergnet turbine options to minimise risks to threatened birds. The Ambrose Ecological Services (2016) report also recommends that the turbines should be shut down during the peak daily Flesh-footed Shearwater return period, from 30 minutes before dusk to 3 hours after dusk during the October – April breeding season.

Further surveys of flight patterns of diurnal birds, especially seabirds, early in the breeding season (September-December) are recommended (Ambrose Ecological Services 2016). The conclusions of the bird assessments should be reviewed following completion of these surveys.

FLESH-FOOTED SHEARWATER

The Flesh-footed Shearwater has an important nesting ground adjacent to the site and has been the subject of specific survey and assessment (O'Neill and Carlile 2016). This study considered that the bladestrike risks from the proposed turbines could threaten the safety of the local Flesh-footed Shearwater sub-colony. Infrequent but large aggregations of birds within the turbine airspace creates the risk of a mass bird strike.

The report recommends a series of mitigation measures to reduce bladestrike risks to the Flesh-footed Shearwater. Mitigation measures identified in the report and incorporated in the safeguards and contingency measures in Table 6-2 include:

- turbine shutdown from 15 minutes prior to sunset until two hours after sunset for the duration of the breeding season (15 September to 15 May)
- regeneration of habitat on and around the walking track from Middle Beach to The Clear Place, including the Valley of the Shadows
- an adaptive management plan prepared prior to installation in consultation with experts, with specific triggers for temporary or longer-term turbine shutdown
- ongoing monitoring of bird interactions with feedback to the adaptive management plan
- long-term monitoring of the breeding success and range of the sub-colony immediately adjacent to the turbine area, in other sub-colonies on the island, and in the habitat regeneration area (if applicable).

The report notes that even with a dusk shutdown, collision risk would still remain for birds accessing the colony over the paddock since a proportion of returning birds arrive after the dusk shutdown period. In a 2005 study (Thulmann 2005 in O'Neill and Carlile 2016), the first 2 hours after sunset accounted for 71.5% of all returning birds. Non-breeding birds may be at greater risk of collision as they may spend more time circling in the air over the paddock than breeding birds, and during different times of night.

The report identifies a dusk to dawn shutdown throughout the entire breeding season as a last resort measure that would ensure the proposal would not significantly impact the Flesh-footed Shearwater, which is largely nocturnal when on and over land.

The Ambrose Ecological Services (2016) report also identifies the provision of artificial nest boxes in other locations to extend the breeding colony as a further offsetting measure to offset the impacts of low level bladestrike mortality. Flesh-footed Shearwaters readily adopt artificial burrows for nesting (Ambrose Ecological Services 2016). This option has also been included among the contingency measures in the proposed Adaptive Management Plan.

6.2.4 Avoidance and mitigation

Table 6-2 outlines safeguards intended to avoid or reduce the fauna impacts of the construction and operation of the proposed wind turbines. Some of the safeguards have been adapted from measures recommended for the powerhouse project in the Planning Assessment Report (LHIB 2012b).

Table 6-2 Safeguards to avoid and mitigate fauna impacts

Safeguard	Phase
Turbine selection and design	
Of the turbine options, the 200 kW Vergnet wind turbines at locations WTG1 and/or WTG2 are recommended to minimise bird impacts.	Planning Construction

Safeguard	Phase
Any navigation lights on the turbine towers used for scheduled or emergency night flights would be remotely activated, **red in colour** and solid (ie. not flashing)**. If any white light is used, the turbines should be shut down while the lights are on, in case the FFSW are attracted to the light.**	Planning Construction Operation
Pre-construction bird surveys	
Surveys should be conducted recording the flight patterns of diurnal birds, especially seabirds, early in their breeding season (September-December) to further assess potential impacts of the turbines on the status of Lord Howe Island's bird populations. These surveys should be conducted monthly, over three consecutive days per month. The conclusions of the assessment should be reviewed following the completion of these surveys.	Pre-construction
Tree clearing	
If possible, the dead hollow-bearing Scalybark tree at the southern end of the access track site should be retained, and fenced during the works to avoid accidental damage. If the tree needs to be removed, the following protocol should be followed: • if practicable, clearing should avoid the September-February breeding period and the winter hibernation period of the Large Forest Bat (ie clear during autumn) • hollows present in the tree should be inspected well before the clearing, and again immediately prior to clearing • a potential translocation site should be identified prior to the works. Note that the Large Forest Bat is a colonial species and there may be many individuals to relocate • the MEWH, an ecologist or wildlife carer should be present during tree felling to inspect the tree before and after felling • where practicable hollow-bearing trees should be removed in a manner which causes least disturbance to resident fauna.	Construction
Any dead Scalybark trees which require removal should be used as log habitat in adjacent forest.	Construction
Threatened species protection	
The proposed access road clearing area and a 5 metre wide buffer should be searched for Lord Howe Placostylus individuals and shells prior to the works. If shells or live snails are found, consideration should be given to additional measures to reduce habitat loss and barrier impacts including: • relocating any live individuals into adjacent habitat areas • redistributing litter on the track verges and adjacent areas • if possible, retaining an unsealed 3 metre wide track, with a vegetated ground surface and gravelled traction strips for vehicle access as required • minimising shrub and tree clearing • following construction, using fencing and planting to reduce track corridor width to the minimum necessary for ongoing operation of the turbines • excluding cattle grazing in the track section passing through potential Placostylus habitat to protect snails and assist the restoration of vegetation cover • allowing the adjacent tree canopy to grow over the track corridor	Pre-works Construction Operation

Safeguard	Phase
• undertaking follow-up control of Ground Asparagus and other weeds at the site • intensifying and expanding local rat baiting if required.	
Turbine operation should be curtailed during the peak daily return period of Flesh-footed Shearwaters to the nesting and roosting colony i.e. from 15 minutes before dusk to 2 hours after dusk during the Flesh-footed Shearwater breeding season (15 September to 15 May).	Operation
In the infrequent event that the turbines are covered in low cloud, mist or fog and the prevailing wind speed is above the turbine cut-in speed (3-3.5 m/s), the turbines would be shut down to avoid bladestrike risks to birds.	Operation
The maximum extent of works should be fenced or clearly marked on the north-eastern side of the turbine paddock to avoid peripheral impacts to the Flesh-footed Shearwater colony.	Construction
Fencing around turbine guy anchors should not use barbed wire and should not create an entrapment hazard for the Flesh-footed Shearwater. A minimum 200mm gap should be left between the ground and lower fence wire. Grass should be kept low under the fences.	Construction
To avoid significant disturbances to brooding adults and chicks, no blasting associated with the construction of the turbine foundations would occur during Flesh-footed Shearwater breeding season of the (15 September to 15 May).	Construction
Measures to minimise traffic impacts on seabirds and the Lord Howe Island Woodhen should include: • construction traffic should be restricted to daylight hours (except for emergencies) • construction traffic between September and May should be subject to a speed limit of 15 km/hr on Anderson Road between Middle Beach Road and the subject site • staff induction should cover traffic restrictions and species at risk from vehicle collisions • construction works should be organised to minimise vehicle movements.	Construction
If practicable, trenches for underground cabling should be covered or filled overnight. Where this is not possible, trenches should be inspected each morning and any trapped native wildlife released into nearby suitable habitat. The Board's Manager Environment/World Heritage should be notified immediately if any threatened species (Placostylus, Lord Howe Skink, Lord Howe Gecko) are detected in the excavations.	Construction
Biosecurity	
Any materials transferred to the site from elsewhere on the island should be inspected for African Big-headed Ants, rodents and other introduced pest species prior to movement.	Construction
Monitoring, response and adaptive management	
An Adaptive Management Plan (AMP) should be developed which details management responses to unexpectedly high mortalities of threatened and migratory bird species, or significant changes in habitat utilisation.	Planning Operation

Safeguard	Phase
The AMP should detail management responses to unexpectedly high mortalities of threatened and migratory bird species, or significant changes in breeding success or habitat utilisation. The following contingency responses should be included: • **A Flesh-footed Shearwater nesting habitat restoration program involving construction of a raised walkway over part of the Middle Beach – Valley of the Shadows - Clear Place walking track implemented to offset potential mortalities caused by the project.** • **Artificial burrows provided for the Flesh-footed Shearwater in suitable habitat areas away from the turbine site as a biodiversity offset. The size of the biodiversity offset and the number of artificial burrows required would need to be calculated by an accredited biodiversity offset specialist in consultation with an expert in seabird ecology. The nests would need to be monitored regularly throughout the breeding season for at least three years, and assessed against turbine mortalities and breeding success in the existing colony adjacent to the turbine site, to determine the effectiveness of compensation.** • **Turbine operation curtailed each night of the Flesh-footed Shearwater breeding season (15 September to 15 May), from 30 minutes before dusk until at least 60 minutes after dawn.**	Planning Operation
Depending on the circumstances of the bladestrikes, additional mitigation actions may include extending or altering the timing of the turbine shutdown, shutting down during certain conditions (wind speed, wind direction, low visibility) or investigating technical options such as ornithological radar.	Operation
The AMP and effectiveness of measures for avoiding, reducing and offsetting bird fatalities from turbine collisions should be reviewed and, if necessary revised, at least annually, or more frequently in circumstances of high bird mortality.	Operation
The impact of the operating turbines on Flesh-footed Shearwater breeding success and range of the colony should be monitored for three years after the commissioning of the turbines, then twice more at three year intervals. After this period, the monitoring program should be reviewed. Monitoring should be undertaken in the sub-colony close to and distant from the turbines, in other sub-colonies on the island, and in the Middle Beach - Valley of the Shadows - The Clear Place habitat regeneration area (if applicable).	Operation
Commencing during installation, the subject site and adjacent areas should be inspected daily **for dead bird and bat carcasses throughout the first breeding season post-construction. Any birds or bats found dead must be sent for autopsy as soon as possible, and injured animals should be handled humanely. Any deaths or injuries should be recorded. The duration and frequency of these inspections over subsequent breeding seasons should be determined as part of the AMP, considering data from the first season. Grass around the turbines should be kept short (<10cm) using grazing. Microbat echolocation call monitoring should also be undertaken for the first year following commissioning.**	Construction Operation
The nocturnal behaviour and movements of Flesh-footed Shearwaters in the air space above and adjacent to the site should be monitored monthly, sampling over at least three successive nights each month of the breeding cycle (October-April) for the first year of operation to determine if there are any collisions with the turbines or guy cables.	Operation

Safeguard	Phase
The Adaptive Management Plan, the results of monitoring and the implementation of any additional mitigation measures under the plan should be published on the Board website. The results of collision and nest site monitoring should be made available at least annually to the Office of Environment and Heritage.	Operation
Measures for reducing or avoiding bird fatalities from turbine collisions should be reviewed and, if necessary revised at least annually, or more frequently in the unlikely circumstances of high bird mortality.	Operation

6.3 REGIONAL AND CUMULATIVE IMPACTS

The proposed turbine development would add to the existing obstacle and collision hazards for birds and bats at the subject site, which include the monitoring mast and fencing (Figure 5-8). The turbulence produced by the turbines may increase the risks of collision with standing obstacles for some species. No other wind turbines are currently operating on the island. The impact assessment for affected species in this report has taken the total cumulative impact of existing and proposed infrastructure into account. Subject to the identified safeguards, the proposal is not considered likely to significantly affect bird and bat species at the population level.

The proposal would contribute to the history of vegetation clearing for human development in the lowland part of the island. About 15% of the island forest has been cleared, mostly Greybark-Blackbutt closed forest (Pickard 1983 in Auld and Hutton 2004). The impacts of clearing have been extended by the dieback effects of the strong, salt laden winds that blow across the island, particularly during winter (Pickard 1983). Exposure dieback has been exacerbated by the invasion of exotic pasture grasses (DECC 2007).

The clearing impacts would be minor (up to 200m^2), extending the width of an existing track corridor over a road length of 35 metres. The proposal would marginally add to existing fragmentation of habitats on the island. The clearing is not expected to significantly affect threatened or endemic flora and fauna species in terms of habitat loss or fragmentation. The loss of Greybark-Blackbutt closed forest would be offset by restoration works undertaken at the southern end of the turbine paddock (refer Appendix G).

The subject site, and the island, are located in the IBRA7 Pacific Subtropical Islands Bioregion, which occupies 5,817 hectares. The biodiversity on the island is regionally significant because of the high levels of endemism. The site is located in the 'Tropical and subtropical moist broadleaf forests ecoregion', under the global classification system developed by WWF comprising 14 ecoregions based on climate and vegetation. The forests in this ecoregion in Australia are generally small and scattered in Queensland, relict from more widespread forests that covered most of Australia and Antarctica, approximately 15 million years ago. The subtropical moist forests on Lord Howe Island and Norfolk Island have high levels of plant and bird endemism. The impacts of the proposal would not be significant at the region scale.

6.4 KEY THREATENING PROCESSES

Key Threatening Processes are listed in NSW under the TSC Act and at the Commonwealth level under the EPBC Act.

KTPs of direct relevance to the current proposal include:

- Clearing of native vegetation (NSW and Commonwealth)

- Invasion of native plant communities by exotic perennial grasses (NSW)
- Loss of hollow-bearing trees (NSW)
- Removal of dead wood and dead trees (NSW).

KTPs which represent particular environmental risks to be managed during the construction phase of the project include:

- Infection of native plants by *Phytophthora cinnamomi* (NSW and Commonwealth)
- Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae (NSW)
- Importation of red imported fire ants (*Solenopsis invicta*) (NSW and Commonwealth)
- Invasion of the yellow crazy ant (*Anoplolepis gracilipes*) (NSW)
- Predation by the ship rat (*Rattus rattus*) on Lord Howe Island (NSW and Commonwealth)
- Invasion, establishment and spread of *Lantana camara* (NSW)
- Invasion of native plant communities by *Chrysanthemoides monilifera* (Bitou Bush and Boneseed) (NSW).

National threat abatement plans have been developed for *Phytophthora cinnamomi* and exotic rodents on Australian offshore islands. A NSW threat abatement plan has been finalised for Bitou Bush and Boneseed.

The assessment and mitigation of these threats have been incorporated into the impact assessment in this report. KTPs are further discussed in the Assessments of Significance (Appendix F).

7 SUMMARY AND CONCLUSIONS

7.1 GENERAL IMPACT

7.1.1 Flora and ecological communities

The construction of the wind turbines would result in temporary disturbance to and permanent loss of exotic pasture with little flora conservation value. The widening of an existing unsealed track section in the north-west of the subject site would result in the removal of up to 200 m^2 of Greybark-Blackbutt (*Drypetes deplanchei–Cryptocarya triplinervis*) Closed Forest. This forest community is the dominant lowland forest association on Lord Howe Island (DECC 2007). A small number of individuals of endemic plant species would be removed by the proposed clearing; these species are locally common. The vegetation clearing would be offset by restoration works located close to the subject site. The risks from weeds, pests and diseases associated with the proposal are manageable using current best practice guidelines and policies.

7.1.2 Fauna

The proposal has the potential to affect fauna through habitat loss, alienation and fragmentation, and bladestrike impacts on birds and bats. The small area of habitat to be cleared is locally common and the works would not significantly affect fauna populations at the local scale, or significantly add to existing habitat fragmentation in the study area.

The principal operational impacts of the proposed wind farm are associated with bladestrike risks to birds and bats. The proposal has the potential to affect 7 seabird species, 7 terrestrial bird species and their habitats, 2 migratory shorebirds, one heron species and one microbat species. Based on the bird survey results, the proposed Vergnet turbines have the lowest collision risk of the three turbine options. Forest birds and the Large Forest Bat are unlikely to be significantly impacted because of the turbine height. Seabirds have potential to be affected and a range of mitigation measures would be implemented to ensure that bladestrike or habitat utilisation impacts do not significantly affect local populations.

7.2 IMPACT ON THREATENED FLORA, FAUNA AND ECOLOGICAL COMMUNITIES

No threatened flora species or ecological community would be affected by the proposal. The operating turbines may affect local bird and bat populations through bladestrike and collision risks. 10 threatened bird species and 7 listed migratory bird species were observed flying across the cleared paddock during the February and March 2016 bird survey periods. An additional 4 threatened species and 14 migratory species have the potential to fly low over the subject site, but were not observed during the surveys.

Seven-part tests of significance for NSW threatened species and Assessments of Significance for nationally-threatened and listed migratory species conclude that the proposal would not result in significant impact to these species, subject to the implementation of avoidance and mitigation measures identified in this report. A Species Impact Statement is not required for the project. While neither the Vergnet nor XANT turbine options are likely to lead to the extinction of locally viable bird populations or affect their conservation status, the XANT turbine has greater potential for impact because of the lower rotor height. The adoption of one of the Vergnet turbine options is recommended to minimise risks to threatened and migratory birds.

7.3 ECOLOGICALLY SUSTAINABLE DEVELOPMENT

Ecologically sustainable development (ESD) involves the effective integration of social, economic and environmental considerations in decision-making processes. In NSW, the concept has been incorporated into legislation including the *Environmental Planning and Assessment Act 1979* and Regulation and the *Protection of the Environment Administration Act 1991*. Schedule 3 of the Lord Howe Island LEP requires an Environmental Report to justify the development in terms of the principles of ecologically sustainable development. The principles and their relationship to the biodiversity aspects of the proposal are identified below.

(a) 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. In the application of the precautionary principle, public and private decisions should be guided by:

(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and

(ii) an assessment of the risk-weighted consequences of various options

The impact and significance of the construction of the wind turbines at the subject site are reasonably predictable and carry low levels of uncertainty and risk. Some uncertainty exists regarding the population scale response of seabirds and, to a lesser extent, forest birds, to the operation of the proposed turbines. A precautionary approach has been adopted incorporating detailed assessment of risks and potential impacts, impact modelling, monitoring and adaptive management to ensure that any unexpected or unacceptable impacts are met with effective and timely responses. A range of adaptive measures have been identified to respond to unforeseen wildlife, noise and visual impacts in particular, to be implemented through an Adaptive Management Plan. The turbine development would have an operational life of around 20 years and would be highly reversible.

(b) inter-generational equity—namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations

The proposal would not diminish long term ecological or agricultural productivity, biological resources or future land use options at the subject site. The proposal is also considered unlikely to reduce the ecological health and biological diversity of the site and study area (refer below). The project would provide a significant environmental benefit by producing sustainable energy, reducing the reliance on fossil fuels which threatens the well-being of current and future generations through climate change.

(c) conservation of biological diversity and ecological integrity— namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration

The environmental safeguards in the biodiversity assessment are intended to avoid any impacts which would damage the long term viability of populations of all native species at and around the subject site, particularly threatened and migratory species. The specialist bird studies and Assessments of Significance have concluded that the project would not be likely to significantly affect local populations of listed threatened and migratory species. Monitoring and adaptive measures and acceptable impact thresholds would be implemented through an Adaptive Management Plan to respond to unexpected or unacceptable impacts.

(d) improved valuation, pricing and incentive mechanisms— namely, that environmental factors should be included in the valuation of assets and services, such as:

(i) polluter pays—that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement, and

(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste, and

(iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

The electricity supply on Lord Howe Island is provided by a public authority and subsidised as an essential public good. The project includes considerable public expenditure on environmental assessment and management, including the active protection of threatened and migratory bird species.

To date the environmental and social costs of electricity generation on the island have not been incorporated into wholesale or retail pricing. Jacobs (2016c) was engaged to identify the external costs of using diesel fuel for electricity generation on the island.

The study estimated monetary costs (expressed in cents per litre) for:

- CO2, SOx and NOx emissions
- the risk of a diesel fuel spill, including spill clean-up costs and the effect of a serious spill on the economy (especially tourism).

The study found that the most significant costs relate to greenhouse gas emissions, NOx emissions and the economic impact of a diesel spill arising from the resupply ship running aground on the reef. Based on the analysis, a value of 27.5 cents per litre can be added to the current base price of diesel fuel to reflect these externalities. This information has been used to model the optimal HREP design and evaluate the costs and benefits of the proposal.

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APPENDIX A FLORA SPECIES LISTS

Note that these lists are based on field observations made during the NGH Environmental site visit on 20 January 2016. The lists are indicative of general species composition and are not exhaustive. Scientific names are based on the Royal Botanic Gardens' PlantNet website.

Introduced species are indicated with an asterisk.

Noxious weeds are indicated with two asterisks.

+ indicates an endemic taxon.

1. Turbine development site

Scientific name	Common name
Trees	
***Psidium cattleyanum* (seedlings)	Cherry Guava
Forbs	
**Aster subulatus*	Wild Aster
**Cerastium fontanum*	Mouse-ear Chickweed
**Cirsium vulgare*	Spear Thistle
Commelina cyanea	Scurvy Weed
**Conyza sumatrensis*	Tall Fleabane
**Cyclospermum leptophyllum*	Slender Celery
**Euphorbia peplus*	Petty Spurge
**Gamochaeta coarctata*	Cudweed
**Hypochaeris radicata*	Flatweed
Oxalis sp	
**Plantago major*	Large Plantain
**Plantago lanceolata*	Lamb's Tongues, Ribwort Plantain
**Portulaca oleracea*	Pigweed
**Potentilla indica*	Indian Strawberry
**Sida rhombifolia*	Paddy's Lucerne
**Taraxacum officinale*	Dandelion
**Trifolium repens*	White Clover
**Trifolium* sp	a clover
Graminoids	
**Axonopus fissifolius*	Narrow-leaved Carpet Grass
**Briza minor*	Shivery Grass
**Cenchrus clandestinus*	Kikuyu
**Paspalum dilatatum*	Paspalum
**Sporobolus africanus*	Parramatta Grass
**Stenotaphrum secundatum*	Buffalo Grass

2. Access track clearing area

Scientific name	Common name
Trees	
Baloghia inophylla	Bloodwood
+ *Celtis conferta* ssp *amblyphylla*	Cotton Wood
Cryptocarya triplinervis	Blackbutt
Drypetes deplanchei	Greybark
+ *Howea belmoreana*	Curly Palm
Olea paniculata	Maulwood
***Pittosporum undulatum* (seedlings)	Sweet Pittosporum
Planchonella reticulata	Axe-handle Wood
***Psidium cattleyanum*	Cherry Guava
+ *Sophora howinsula*	Lignum Vitae
+ *Syzygium fullagarii* (dead)	Scalybark
+ *Xylosma maidenii*	
Shrubs	
Alyxia ruscifolia	Christmas Bush
***Asparagus aethiopicus*	Ground Asparagus
+ *Cassinia tenuifolia*	Bullybush
Myoporum insulare	Boobialla
Vines	
Muehlenbeckia complexa	Wire Vine
+ *Parsonsia howeana*	Silkpod
+ *Trophis scandens* ssp *megacarpa*	Burny Vine
Forbs	
**Bidens pilosa*	Cobbler's Pegs
Commelina cyanea	Scurvy Weed
**Conyza sumatrensis*	Tall Fleabane
**Plantago major*	Large Plantain
**Potentilla indica*	Indian Strawberry
**Gamochaeta coarctata*	Cudweed
Graminoids	
Carex brunnea	Greater Brown Sedge
**Cenchrus clandestinus*	Kikuyu

APPENDIX B BIRD IMPACT ASSESSMENTS

APPENDIX C MICROBAT IMPACT ASSESSMENT

APPENDIX D DATABASE SEARCH RESULTS

APPENDIX E THREATENED SPECIES EVALUATIONS

The tables in this attachment present the habitat evaluation for threatened species, ecological communities and endangered populations listed in the Atlas of NSW Wildlife Bionet[1] database (Lord Howe Island LGA search area) and the Commonwealth EPBC *Protected Matters Search Tool*[2] (within a 10 kilometre radius of the site).

The likelihood of occurrence is based on presence of habitat, proximity of nearest records and mobility of the species (where relevant). The assessment of potential impact is based on the nature of the proposal, the ecology of the species and its likelihood of occurrence. The following categories and terms are used:

Presence of habitat:

Present: Potential or known habitat is present within the study area

Absent: No potential or known habitat is present within the study area

Likelihood of occurrence

Unlikely: Species known or predicted within the locality but unlikely to occur in the study area

Possible: Species could occur in the study area

Present: Species was recorded during the field investigations

Possible to be impacted

No: The proposal would not impact this species or its habitats. No Assessment of Significance (AoS) is necessary for this species or communities

Yes: The proposal could impact this species or its habitats. An AOS may be required for these species or communities.

The distribution and habitat information used in the evaluation has been sourced from species profiles in The LHI Biodiversity Management Plan (DECC 2007), OEH threatened species database or the Commonwealth Species Profiles and Threats database (SPRAT) unless otherwise stated.

OEH threatened species database: http://www.threatenedspecies.environment.nsw.gov.au/index.aspx
Commonwealth SPRAT: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

[1] The *Atlas of NSW Wildlife* is administered by the NSW Office of Environment and Heritage (OEH) and is an online database of fauna and flora records that contains over four million recorded sightings.

[2] This online tool is designed for the public to search for matters protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

E.1 EVALUATION OF THE LIKELIHOOD AND EXTENT OF IMPACT ON THREATENED FLORA SPECIES

Species	Description of habitat	Presence of habitat	Likelihood of occurrence	Possible impact?
Trees				
Coast Euodia *Melicope vitiflora* E TSC	A small tree with compound leaves in 3 leaflets growing in small populations in subtropical and littoral rainforest. Only LHI record in NSW Wildlife Atlas is on Roach Island. The species is not included in the census in Rodd and Pickard (1983) or in more recent literature.	Absent (based on known distribution)	Unlikely	No
Shrubs				
Knicker Nut *Caesalpinia bonduc* E TSC	A low, woody, scrambling shrub with sharp, recurved hooks on leaf stems and large pinnate leaves, growing on sandy, coral-derived soil close to the shoreline, in coastal scrub vegetation. Only found in the northern part of Lord Howe Island, in the vicinity of Ned's Beach and near Old Settlement Beach.	Absent	Unlikely	No
Lord Howe Island Broom *Carmichaelia exsul* E TSC	An endemic broom-like shrub, with leafless, flattened, ridged branches known from less than 20 locations in the southern mountains.Occurs between 300 - 500 m, often found at the base of cliffs, with Mountain Rose - Fitzgeraldii forest, Mountain Palm forest and mixed fern and herb vegetation.	Absent	Unlikely	No
Small-leaved Currant Bush *Coprosma inopinata* E TSC	A compact endemic shrub to 50 cm, with small, pointed leaves. Largely restricted to the narrow, exposed south-westerly or south-easterly ridges of Mounts Lidgbird and Gower, and nearby more sheltered pockets. All populations are reserved within the Permanent Park Preserve Only found in the southern mountains of Lord Howe Island.	Absent	Unlikely	No

Species	Description of habitat	Presence of habitat	Likelihood of occurrence	Possible impact?
Hutton's Geniostoma *Geniostoma huttonii* E TSC E EPBC	Scrambling shrub to 1 m with paired glossy leaves. Grows in rainforest, Curly Palm forest and scrub, on south and east-facing shaded cliffs amongst open, stunted shrubs. Dominant associates include Blue Plum (*Chionanthus quadristamineus*), Mountain Rose (*Metrosideros nervulosa*) and Fitzgeraldii (*Dracophyllum fitzgeraldii*). Mainly found on remote ridges of Mount Gower and Mount Lidgbird in the southern mountains.	Absent	Unlikely	No
Little Mountain Palm *Lepidorrhachis mooreana* CE TSC CE EPBC	A short endemic palm with a sturdy trunk to 2 m tall. Occurs above approximately 740 m, and restricted to the cloud forest vegetation at the summits of Mt Gower and Mt Lidgbird.	Absent	Unlikely	No
Mountain Xylosma *Xylosma parvifolia* E TSC E EPBC	An upright endemic shrub with small, toothed leaves. Only found in the Permanent Park Preserve on exposed, remote parts of the southern mountains. Grows mostly in very steep and exposed terrain amongst dense, stunted vegetation on cliffs and ridges, and also in low numbers in Cloud Forest on Mts Lidgbird and Gower. Dominant associates include Mountain Rose (*Metrosideros nervulosa*), *Melicope polybotrya, Alyxia squamulosa, Olearia elliptica* and *Guioa coriacea*.	Absent	Unlikely	No
Herbs				
Lord Howe Island Morning Glory *Calystegia affinis* CE TSC CE EPBC	A thin-stemmed twiner with arrow head-shaped leaves. Occurs in two different habitats on LHI, in lowland areas in the north of the island on the lower slopes of Dawsons Ridge, and high in the southern mountains on Mt Lidgbird. The mountain habitat is an open, sunny, moist area near semi-permanent water flows. The lowland habitat is on a south facing slope in Blackbutt-Greybark forest, beside the Max Nicholls track with an introduced grass understorey (buffalo grass). Both habitats are on basalt.	Marginal	Unlikely (based on known distribution)	No

Species	Description of habitat	Presence of habitat	Likelihood of occurrence	Possible impact?
Sand Spurge *Chamaesyce psammogeton* E TSC	A mat-forming herb growing on foredunes, pebbly strandlines and exposed headlands, often with Spinifex (*Spinifex sericeus*) and Prickly Couch (*Zoysia macrantha*). Restricted to Blinkie Beach dune on Lord Howe Island. The proposed barge landing access passes through marginal Coral Sand Beach and Dune community habitat.	Marginal	Unlikely (based on distributed and habitat quality)	No
Phillip Island Wheat Grass *Elymus multiflorus* subsp. *kingianus* CE TSC CE EPBC	A tufted perennial grass 30-100 cm in height, with narrow glaucous leaves 3-5 mm wide. On LHI it occurs at the intergrade between exposed basalt-derived rocky cliffs and a shrub zone that merges into littoral rainforest. Associates include *Dichelachne crinita, Poa poiformis, Senecio howeanus, Sporobolus virginicus, Tetragonia tetragonioides, Cassinia tenuifolia, Dodonaea viscosa, Leucopogon parviflorus, Melaleuca howeana* and *Melanthera biflora*. Restricted to two locations with an estimated mature population size of less than 50 plants.	Absent	Unlikely	No
Ferns				
Rock Shield Fern *Polystichum moorei* E TSC E EPBC	A small, hardy fern that grows on rocks, only found in the southern part of LHI. Grows on rocks in overhanging caves on basalt cliffs and on coral-derived sedimentary rock, mostly in the mountains, with one population close to the beach. Fewer than 30 mature plants are known from five locations.	Absent	Unlikely	No
EECs				
Gnarled Mossy Cloud Forest on Lord Howe Island CE TSC	An endemic forest 2-8 m tall, restricted to the summit plateau of Mt Gower and on the narrow summit ridge of Mt Lidgbird. On Mt Gower, the dominant species are *Zygogynum howeanum* and *Dracophyllum fitzgeraldii*. On Mt Lidgbird, the canopy is *Hedyscepe canterburyana, Cryptocarya gregsonii, Dysoxylum pachyphyllum, Negria rabdothamnoides, Pittopsorum erioloma* and *Cyathea macarthurii.*	Absent	Unlikely	No

Species	Description of habitat	Presence of habitat	Likelihood of occurrence	Possible impact?
Lagunaria Swamp Forest on Lord Howe Island CE TSC	'Sallywood Swamp Forest' is dominated by Sallywood (*Lagunaria Patersonia*), sometimes growing with *Hibiscus tileaceus* and *Myoporum insulare*, sparse shrubs including *Aegiceras corniculatum, Cryptocarya triplinervis* and *Celtis conferta* subsp. *Amblyphylla,* and groundcover species *Cyperus brevifolius, Cyperus lucidus, Commelina cyanea* and *Hydrocotyle hirta*. Restricted to low-lying swampy areas at altitudes below 20 m. Originally restricted to five small patches in the mid island lowlands, some patches have since been destroyed. None are in the Permanent Park Preserve. Scattered individual *Lagunaria patersonia* plants do not form part of the community.	Absent	Unlikely	No

V TSC - listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995*

E TSC - listed as Endangered under the NSW *Threatened Species Conservation Act 1995*

CE TSC - listed as Critically Endangered under the NSW *Threatened Species Conservation Act 1995*

V EPBC - listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

E EPBC - listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

CE EPBC - listed as Critically Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

E.2 EVALUATION OF THE LIKELIHOOD AND EXTENT OF IMPACT ON THREATENED FAUNA

Species and Status	Description of habitat	Presence of habitat	Likelihood of occurrence	Potential for impact?
Birds				
Refer to the bird assessment (Ambrose Ecological Services 2016) in Appendix B for seabird and land bird evaluations.				
Reptiles				
Lord Howe Skink *Cyclodina (Oligosoma) lichenigera* V TSC V EPBC	Endemic skink found in a range of habitats including lowland rainforest, montane rainforest and *Poa poiformis* grassland. Requires rocks for shelter, and prefers sandy substrate. Nocturnal, shelters under under rocks, in rock cavities or tree crevices during the day and forages for arthropods in litter at night. The closest recent record to the subject site is on the lagoon foreshore at the Pinetrees boathouse (R. Bray unpub PhD research), 600 metres from the site.	Present (marginal)	Unlikely	No
Lord Howe Gecko *Christinus guentheri* V TSC V EPBC	Possibly an endemic species, distinct from Norfolk Island taxon (R. Bray, unpub PhD research). Inhabits a wide range of forest types from lowland rainforest to montane rainforest to *Poa poiformis* grassland. Nocturnal, shelters under under rocks, in rock cavities or tree crevices during the day and at night forages for arthropods in litter and in tree branches (where it is known to feed on Sallywood nectar). Occurs in Kentia Palm Closed Sclerophyll Forest and Lowland Mixed Closed Forest north and east of the subject site.	Present (marginal)	Unlikely	No
Invertebrates				
Lord Howe Wood-feeding Cockroach *Panesthia lata* E TSC	Endemic species locally extinct on the main island and are now confined to offshore islands.	Absent	Unlikely	No

Species and Status	Description of habitat	Presence of habitat	Likelihood of occurrence	Potential for impact?
Lord Howe Phasmid *Drycocelus australis* CE TSC CE EPBC	Endemic species locally extinct on the main island and are now confined to offshore islands.	Absent	Unlikely	No
Lord Howe Earthworm *Pericryptodrilus nanus* E TSC	Endemic species restricted to the northern ridge on Mount Gower.	Absent	Unlikely	No
Magnificent Helicarionid Land Snail *Gudeoconcha sophiae magnifica* CE TSC CE EPBC	Little known about the biology and ecology of this species. Early records indicatepreferred habitat is forest with dead timber, bark and fallen palm leaves, on soil formed of the decomposed coral sand rock (Etheridge 1889). Geographic distribution is confined to the southern half of the island extending from the foothills west of Intermediate Hill in the centre of the island to the south of the summit of Mount Gower.	Absent	Unlikely	No
Whitelegge's Land Snail *Pseudocharopa whiteleggei* CE TSC CE EPBC	Little known about biology and ecology of this species; recorded living under and inside logs and in moss. Recent surveys suggest the species has disappeared from Mount Lidgbird and is now confined to Mount Gower.	Absent	Unlikely	No
Mount Lidgbird Charopid Land Snail *Pseudocharopa ledgbirdi* CE TSC CE EPBC	Little known about biology and ecology; recorded living on wet rock surfaces on the Mount Lidgbird summit. While the pre 1945 distribution of this species included Mount Gower, Mount Lidgbird and the Erskine Valley, it now appears confined to Mount Gower.	Absent	Unlikely	No
Lord Howe Flax Snail, Lord Howe Placostylus *Placostylus bivaricosus* E TSC	A large endemic land snail with 3 subspecies, inhabiting leaf litter under forest canopy cover, usually in damp shady locations, less common at higher elevations and avoiding open areas. Ponder and Chapman (1999) found live individuals sheltering	Marginal	Unlikely	Yes

Species and Status	Description of habitat	Presence of habitat	Likelihood of occurrence	Potential for impact?
E EPBC	under well-developed moisture-retaining leaf litter in forest, often but not exclusively in the vicinity of Banyan trees and mostly on calcarenite-derived soils and sandy soils. Recent records are either Kentia Palm forest or Greybark– Blackbutt closed forest. Distribution is currently restricted to the northern, lower end of the island, from immediately south-east of the airport to North Bay (although small populations may survive in the southern Mountains). Board habitat modelling maps show potential Placostylus habitat (High Quality B) in forest at and adjacent to the subject site.			
Masters' Charopid Land Snail *Mystivagor mastersi* CE TSC CE EPBC	Little known about biology and ecology. Recorded from only a few sites on LHI, including the summit of Mount Lidgbird, Mt Gower, Blinky Beach and Boat Harbour. Now suspected to be restricted to Mount Lidgbird and Mount Gower.	Absent	Unlikely	No

V TSC - listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995*

E TSC - listed as Endangered under the NSW *Threatened Species Conservation Act 1995*

CE TSC - listed as Critically Endangered under the NSW *Threatened Species Conservation Act 1995*

V EPBC - listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

E EPBC - listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

CE EPBC - listed as Critically Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

C - CAMBA, J-= JAMBA, K - ROKAMBA (migratory bird agreements)

APPENDIX F ASSESSMENTS OF SIGNIFICANCE

F.1 THREATENED SPECIES CONSERVATION ACT SEVEN-PART TEST

Section 5A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) specifies seven factors to be taken into account in deciding whether a development is likely to significantly affect threatened species, populations or ecological communities, or their habitats, listed at the state level under the *Threatened Species Conservation Act 1995*.

Threatened bird assessments have been undertaken by Ambrose Ecological Services (2016); refer Appendix B.

Lord Howe Placostylus

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The diet of the Lord Howe Placostylus is thought to be the fallen dead leaves of broadleaf trees. In suitable habitat the Lord Howe Placostylus occurs at an average density of one live adult per 4.17 m^2 and one live juvenile per 3.03 m^2, with localised densities of up to two live animals per square metre in appropriate microhabitat patches within these areas. Accumulated shells of dead Lord Howe Placostylus have been recorded at densities of up to 30 shells per square metre (Ponder and Chapman 1999 in NPWS 2001).

Related Placostylus species in New Zealand (*Placostylus hongii* and *P. ambagiosus*) reach maturity at 3-5 years and may live for 20 years or more (Parrish *et al*. 1995). Mating in these species appears to be triggered by climatic conditions (e.g. rainfall) and probably occurs every year except in periods of drought. The Lord Howe Placostylus lays small clutches of eggs in the soil beneath leaf litter, probably during the warmer months. Hatchling and juvenile mortality is high (Ponder and Chapman ibid.). Egg-laying in a captive Lord Howe Placostylus breeding colony on the island was recorded in the month of August (Hutton 2010).

Giant Land Snails may be particularly vulnerable to predation during mating and egg-laying. New Zealand Placostylus hatchlings may spend an unknown period living in trees and shrubs up to 6 metres above the ground (Parrish *et al*. 1995).

The total population of the Lord Howe Placostylus is estimated to be less than 1000 mature individuals (DOE 2016). The species is restricted to two fragmented locations (comprising a total of 26 sites) in the settlement area and around North Bay (Ponder and Chapman ibid.).

Habitat at the proposed access track site appears to be marginal for this species (refer d) below) and the potential for significant life cycle impacts is therefore likely to be low. Fragmentation and barrier impacts are assessed in d) below. Potential life cycle impacts caused by habitat loss or fragmentation would be mitigated and offset by specific measures identified in this Biodiversity Assessment, including pre-works survey, redistribution of leaf litter, restrictions on clearing, track surfacing, post-works management of the access track site and habitat restoration in the proposed offset area (Appendix F).

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable.

d) In relation to the habitat of a threatened species, population or ecological community:

i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

i. The Lord Howe Placostylus is restricted to two fragmented locations (comprising a total of 26 sites) in the settlement area and around North Bay (Ponder and Chapman ibid.). The concentration of clearing in the settlement area is likely to have had an adverse impact on the species, whose preferred habitat coincides with this area (DECC 2007). Nearly 50% of high quality potential habitat for the species has been cleared since settlement (DOE 2016). The extent of occurrence is less than 15.2km^2 and the current area of occupancy is approximately 7.95km^2 (DOE 2016).

   Based on current knowledge regarding habitat preferences and distribution (refer iii. below), the limited clearing of up to 200m^2 of marginal forest habitat for the widening of the proposed access track is not expected to result in a significant loss of Placostylus habitat in areal terms. A series of precautionary and contingency measures are included in the Biodiversity Assessment to account for the possible presence of the species at the site and offset habitat loss impacts.

ii. The Lord Howe Placostylus was formerly widespread over Lord Howe Island but is now apparently restricted to two fragmented locations. Many of the populations of this species may already be effectively isolated from others, except where they exist within the same forest remnant or similar immediately adjacent locations (NPWS 2001).

   Placostylus has been recorded 120 metres to the south and 190 metres to the north of the access track site on calcarenite substrate. Live Placostylus snails were recorded near Transit Hill in June 2000 (E. Brown RBG pers. comm. in NPWS 2001) and are known to be present at Pine Trees to the west of the site (Hutton 2010). The *Howea forsteriana* closed forest on calcarenite to the north-east of the subject site is likely to be unsuitable habitat because of seasonal disturbance from Flesh-footed Shearwater nesting. If Placostylus disperse through suboptimal habitat (disturbed forest on basalt), the strip of vegetation at the access track site may provide opportunities for genetic exchange between populations north and south of the site (although the speciation within *P. bivaricosus* suggests low rates of gene flow between habitat areas).

   The existing 5-9 metre wide track corridor passes through a narrow strip of Greybark-Blackbutt Closed Forest over a distance of approximately 50 metres. Sealed and unsealed roads and tracks have been found to impede dispersal in other land snail species (Baur and Baur 1990). The Placostylus Recovery Plan recommends that, because little is know about dispersal ability, any development which will result in the fragmentation of evergreen closed forest habitat areas should be considered as likely to isolate Placostylus populations (NPWS 2001). The existing track corridor may already represent a dispersal barrier for Placostylus, if the species is present at the site.

   The track corridor would be widened to provide a uniform 9 metre wide corridor to enable construction access for the project. In view of the low probability of the Placostylus being present at the site, and the presence of the existing track corridor, the proposed works are considered unlikely to significantly exacerbate existing fragmentation impacts for the Placostylus in the study area. Precautionary measures are included in the Biodiversity Assessment to account for the possible presence of the species at the site and knowledge gaps regarding the dispersal ability of the species.

iii. The preferred habitat of the Lord Howe Placostylus is described as the *Drypetes deplanchei–Cryptocarya triplinervis* association and *Howea forsteriana* association on calcarenite (Hunter 2002, DECC 2007), in damp shaded locations with a closed canopy (DECC 2007). The vegetation at all recent sites is either *Howea forsteriana* closed forest or *Drypetes deplanchei-Cryptocarya triplinervis* closed forest or a combination of the two (Curtis 1998; Pickard 1983; Ponder and Chapman ibid.). NPWS

(2001) and Hunter (2002) note that Placostylus distribution is confined largely, but not totally, to calcarenite or sandy substrates. Ponder and Chapman (ibid.) found the species sheltering under leaf litter in forest often, but not exclusively, in the vicinity of Banyan trees and mostly on calcarenite-derived soils and sandy soils.

The Recovery Plan for the species recommends that any area supporting evergreen closed forest on calcarenite-derived soils or sandy soils should be considered as potential habitat, no matter how degraded, especially if a leaf litter layer is present (NPWS 2001).

The Lord Howe Placostylus appears to avoid open areas (Brazier 1889 in NPWS 2001). Placostylus species do not seal the shell aperture with mucous and are therefore prone to desiccation (Sherley 1994 in NPWS 2001). Ponder and Chapman (ibid.) noted freshly dead shells in areas where the forest canopy had been damaged by drought or storms (NPWS 2001).

Ponder and Chapman (ibid.) also suggested that disturbance of the leaf litter layer by nesting seabirds may adversely affect the species and noted many dead shells but few fresh specimens and no live specimens in active nesting areas. There are no Placostylus records from Flesh-footed Shearwater nesting area to the north-east of the subject site. Ponder and Chapman (ibid) further suggested that the Placostylus is impacted by trampling by domestic cattle.

Prime habitat elements for this species are likely to be a lowland position, overstorey tree canopy cover providing shade and high humidity, a shrub - small tree midstorey (refer a) above), a well-developed litter layer, and possibly sandy or calcarenite substrate. Negative features include exposed sites, possibly basalt substrates, nesting seabirds, grazing cattle and the presence of predators such as the Ship Rat, Blackbird, Song Thrush and domestic chickens.

The vegetation affected by the proposal at the access track site is *Drypetes deplanchei-Cryptocarya triplinervis* closed forest on basalt, with a disturbed understorey and low broken canopy and a patchy litter layer. The forest appears to be regrowth with no large trees. Based on current knowledge, the access track site appears to provide unlikely habitat for the Placostylus, and the proposed clearing of up to 200m^2 of forest is not expected to result in a significant loss of habitat. Precautionary measures are included in the Biodiversity Assessment to account for the possible presence of the species at the site and to offset habitat impacts.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not applicable.

f) Whether the action proposed is consistent with the objectives or actions of a Recovery Plan or Threat Abatement Plan.

The approved recovery plan for the Lord Howe Placostylus (NPWS 2001) outlines the distribution, habitat and ecology of the snail, key threats and recovery actions. The overall objective of the plan is to protect and recover the species in the wild in the long term. Specific objectives include to identify habitat and populations, to identify and ameliorate current threats, to support and coordinate relevant and to encourage community awareness and involvement.

Recovery actions cover survey and research, protection of extant populations and habitat (including rat baiting, habitat mapping and application of assessment guidelines), Commonwealth listing, community information and publicity, *ex situ* conservation measures (captive breeding and habitat regeneration on Blackburn Island), and the formation of a Lord Howe Island recovery team with representatives from the Board and Lord Howe Island community, OEH and the Australian Museum.

Habitat mapping under the plan is to incorporate the occurrence of calcarenite-derived and sandy soils, occurrence of *Howea forsteriana* evergreen closed forest and *Drypetes-Cryptocarya* evergreen closed forest, and recent and historical Placostylus records.

Appendix 2 of the plan provides Environmental Impact Assessment Guidelines to ensure that potential impacts to the Placostylus and its habitat are considered in development assessment processes.

The plan notes that the causes of the decline of the Lord Howe Placostylus are likely to include habitat clearing and modification, predation and habitat disturbance by exotic fauna species, and possibly herbicide and pesticide use. The Ship Rat is considered to be a major predator and a significant threat.

Other threats include predation by Song Thrush, Blackbird and domestic chickens, cattle trampling, habitat disturbance from nesting seabirds and weeds such as Ground Asparagus and Guava.

The proposed works would not interfere with the objectives or actions contained in the recovery plan. Mitigation and offsetting measures associated with the proposal are consistent with recovery actions in the plan.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Key Threatening Processes are listed in NSW under the TSC Act and at the Commonwealth level under the EPBC Act. KTPs of direct relevance to the current proposal include:

- Clearing of native vegetation (NSW and Commonwealth)
- Invasion of native plant communities by exotic perennial grasses (NSW)
- Loss of hollow-bearing trees (NSW)
- Removal of dead wood and dead trees (NSW).

KTPs which represent particular environmental risks to be managed during the construction phase of the project include:

- Infection of native plants by *Phytophthora cinnamomi* (NSW and Commonwealth)
- Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae (NSW)
- Importation of red imported fire ants (*Solenopsis invicta*) (NSW and Commonwealth)
- Invasion of the yellow crazy ant (*Anoplolepis gracilipes*) (NSW)
- Predation by the ship rat (*Rattus rattus*) on Lord Howe Island (NSW and Commonwealth)
- Invasion, establishment and spread of *Lantana camara* (NSW)
- Invasion of native plant communities by *Chrysanthemoides monilifera* (Bitou Bush and Boneseed) (NSW).

The assessment and mitigation of these threats have been incorporated into the impact assessment in this report. The safeguards for the proposal contain specific control measures for rat predation and environmental weeds, which are two significant threatening processes currently operating at the site. In the context of impacts to identified biodiversity values and proposed avoidance and mitigation measures, the proposal is not considered likely to significantly exacerbate the operation of, or increase the impact of, a key threatening process.

Conclusion

The limited forest clearing associated with the wind turbine proposal is unlikely to significantly affect the Lord Howe Placostylus or its habitat. A series of mitigation measures are included in the Biodiversity Assessment to account for the possible presence of the species at the site and to offset habitat impacts (refer section 6.2.4).

F.2 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT ASSESSMENT OF SIGNIFICANCE

The Commonwealth Significant Impact Guidelines 1.1 provide assessment criteria for the assessment of significance of impacts to MNES. The criteria are used to determine whether a proposal is likely to have a significant impact and requires referral to the Commonwealth Government for approval under the EPBC Act.

For the purposes of this assessment, an 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species' range (Commonwealth of Australia 2013).

Threatened bird assessments have been undertaken by Ambrose Ecological Services (2016); refer Appendix B.

Lord Howe Placostylus

a) Will the action lead to a long-term decrease in the size of an important population of a species?

The preferred habitat of the Lord Howe Placostylus is described as the D*rypetes deplanchei–Cryptocarya triplinervis* association and *Howea forsteriana* association on calcarenite (Hunter 2002, DECC 2007), in damp shaded locations with a closed canopy (DECC 2007). The vegetation at all recent sites is either *Howea forsteriana* closed forest or *Drypetes deplanchei-Cryptocarya triplinervis* closed forest or a combination of the two (Curtis 1998; Pickard 1983; Ponder and Chapman 1999 in NPWS 2001). NPWS (2001) and Hunter (2002) note that Placostylus distribution is confined largely, but not totally, to calcarenite or sandy substrates. Ponder and Chapman (ibid.) found the species sheltering under leaf litter in forest often, but not exclusively, in the vicinity of Banyan trees and mostly on calcarenite-derived soils and sandy soils.

The Recovery Plan for the species recommends that any area supporting evergreen closed forest on calcarenite-derived soils or sandy soils should be considered as potential habitat, no matter how degraded, especially if a leaf litter layer is present (NPWS 2001).

Ponder and Chapman ((ibid.) also suggested that disturbance of the leaf litter layer by nesting seabirds may adversely affect the species and noted many dead shells but few fresh specimens and no live specimens in active nesting areas. There are no Placostylus records from Flesh-footed Shearwater nesting area to the north-east of the subject site. Ponder and Chapman (ibid) further suggested that the Placostylus is impacted by trampling by domestic cattle.

Prime habitat elements for this species are likely to be a lowland position, overstorey tree canopy cover providing shade and high humidity, a shrub - small tree midstorey (refer a) above), a well-developed litter layer, and possibly sandy or calcarenite substrate. Negative features include exposed sites, possibly basalt substrates, nesting seabirds, grazing cattle and the presence of predators such as the Ship Rat, Blackbird, Song Thrush and domestic chickens.

The vegetation affected by the proposal at the access track site is *Drypetes deplanchei-Cryptocarya triplinervis* closed forest on basalt, with a disturbed understorey and low broken canopy and a patchy litter layer. The forest appears to be regrowth with no large trees. Based on current knowledge, the access track site appears to provide unlikely habitat for the Placostylus, and is unlikely to support an important population. The proposed clearing of up to 200m^2 of forest is not expected to result in a long-term decrease in the size of a Placostyuls population. Precautionary measures are included in the Biodiversity Assessment to account for the possible presence of the species at the site and offset population and habitat impacts.

b) Will the action reduce the area of occupancy of the an important population?

The Lord Howe Placostylus occurs at two locations on Lord Howe Island; the settlement area and North Bay. The extent of occurrence is less than 15.2km^2 and the current area of occupancy is approximately 7.95km^2 (DOE 2016).

Based on current knowledge, the access track site appears to provide unlikely habitat for the Placostylus (refer a) above) and is unlikely to support an important population. The proposed clearing of up to 200m^2 of forest is not expected to result in a reduction in the area of occupancy of the Placostylus. Precautionary and contingency measures are included in the Biodiversity Assessment to account for the possible presence of the species at the site and offset habitat impacts.

c) Will the action fragment and existing population into two or more populations?

The Lord Howe Placostylus was formerly widespread over Lord Howe Island but is now apparently restricted to the northern, lower end of the Island, with the majority of records in the settlement area. Many of the populations of this species may already be effectively isolated from others, except where they exist within the same forest remnant or similar immediately adjacent locations (NPWS 2001).

Placostylus has been recorded 120 metres to the south and 190 metres to the north of the access track site on calcarenite substrate. Live Placostylus snails were recorded near Transit Hill in June 2000 (E. Brown RBG pers. comm. in NPWS 2001) and are known to be present at Pine Trees to the west of the site (Hutton 2010). The *Howea forsteriana* closed forest on calcarenite to the north-east of the subject site is likely to be unsuitable habitat because of seasonal disturbance from Flesh-footed Shearwater nesting. If Placostylus disperse through suboptimal habitat (disturbed forest on basalt), the strip of vegetation at the access track site may provide opportunities for genetic exchange between populations north and south of the site (although the speciation within *Placostylus bivaricosus* suggests low rates of gene flow between habitat areas).

The existing 5-9 metre wide track corridor passes through a narrow strip of Greybark-Blackbutt Closed Forest over a distance of approximately 50 metres. Sealed and unsealed roads and tracks have been found to impede dispersal in other land snail species (Baur and Baur 1990). The Placostylus Recovery Plan recommends that, because little is know about dispersal ability, any development which will result in the fragmentation of evergreen closed forest habitat areas should be considered as likely to isolate Placostylus populations (NPWS 2001). The existing track corridor may already represent a dispersal barrier for Placostylus, if the species is present at the site.

The track corridor would be widened to provide a uniform 9 metre wide corridor to enable construction access for the project. In view of the low probability of the Placostylus being present at the site, and the presence of the existing track corridor, the proposed works are considered unlikely to significantly exacerbate existing fragmentation impacts for the Placostylus in the study area. Precautionary measures are included in the Biodiversity Assessment to account for the possible presence of the species at the site and knowledge gaps regarding the dispersal ability of the species.

d) Will the action adversely affect habitat critical to the survival of a species?

As indicated under a) above, the disturbed forest at the proposed access track site is considered unlikely to provide habitat for the Placostylus. Precautionary measures are included in the Biodiversity Assessment to account for the possible presence of the species at the site and and offset any habitat impacts.

e) Will the action disrupt the breeding cycle of an important population?

Related Placostylus species in New Zealand (*Placostylus hongii* and *P. ambagiosus*) reach maturity at 3-5 years and may live for 20 years or more (Parrish *et al*. 1995). Mating in these species appears to be triggered by climatic conditions (e.g. rainfall) and probably occurs every year except in periods of drought. The Lord Howe Placostylus lays small clutches of eggs in the soil beneath leaf litter, probably during the warmer months. Hatchling and juvenile mortality is high (Ponder and Chapman ibid.). Egg-laying in a captive Lord Howe Placostylus breeding colony on the island was recorded in July and August (Hutton 2010).

Giant Land Snails may be particularly vulnerable to predation during mating and egg-laying. New Zealand Placostylus hatchlings may spend an unknown period living in trees and shrubs up to 6 metres above the ground (Parrish *et al*. 1995).

As indicated under a) above, the disturbed forest at the proposed access track site is considered unlikely to provide habitat for an important Placostylus poplation and the potential for breeding impacts is therefore

likely to be low. The precautionary mitigation measures included in the Biodiversity Assessment provide for the protection and restoration of habitat elements important for Placostylus breeding.

f) Will the action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

As indicated under a) above, the disturbed forest at the proposed access track site is considered unlikely to provide habitat for the Placostylus. The loss of up to 200 m^2 of this forest is unlikely to result in or exacerbate the decline of the species. Precautionary measures are included in the Biodiversity Assessment to account for the possible presence of the species at the site and and offset any habitat impacts.

g) Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

The proposed works are unlikely to result in the introduction or spread of invasive plant or animal species at the site. Measures to exclude and control pest species included in the Biodiversity Assessment include stringent biosecurity in relation to materials imported to the island and weed control before and after the works.

h) Will the action introduce disease that may cause the species to decline?

The proposed works are unlikely to result in the introduction or spread of pathogens at the site. Stringent biosecurity and site hygiene measures are included in the Biodiversity Assessment.

i) Will the action interfere with substantially with the recovery of the species?

The NSW recovery plan for the Lord Howe Placostylus (NPWS 2001) outlines the distribution, habitat and ecology of the snail, key threats and recovery actions. The overall objective of the plan is to protect and recover the species in the wild in the long term. Specific objectives include to identify habitat and populations, to identify and ameliorate current threats, to support and coordinate relevant and to encourage community awareness and involvement.

Recovery actions cover survey and research, protection of extant populations and habitat (including rat baiting, habitat mapping and application of assessment guidelines), Commonwealth listing, community information and publicity, *ex situ* conservation measures (captive breeding and habitat regeneration on Blackburn Island), and the formation of a Lord Howe Island recovery team with representatives from the Board and Lord Howe Island community, OEH and the Australian Museum.

Habitat mapping under the plan is to incorporate the occurrence of calcarenite-derived and sandy soils, occurrence of *Howea forsteriana* evergreen closed forest and *Drypetes-Cryptocarya* evergreen closed forest, and recent and historical Placostylus records.

Appendix 2 of the plan provides Environmental Impact Assessment Guidelines to ensure that potential impacts to the Placostylus and its habitat are considered in development assessment processes.

The plan notes that the causes of the decline of the Lord Howe Placostylus are likely to include habitat clearing and modification, predation and habitat disturbance by exotic fauna species, and possibly herbicide and pesticide use. The Ship Rat is considered to be a major predator and a significant threat. Other threats include predation by Song Thrush, Blackbird and domestic chickens, cattle trampling, habitat disturbance from nesting seabirds and weeds such as Ground Asparagus and Guava.

The proposed works would not interfere with the objectives or actions contained in the recovery plan. Mitigation and offsetting measures associated with the proposal are consistent with recovery actions in the plan. The safeguards for the proposal contain specific control measures for rat predation and environmental weeds, which are two significant threatening processes currently operating at the site.

Key Threatening Processes relevant to the proposal are discussed in section 6.4.

Conclusion

The limited forest clearing associated with the wind turbine proposal is unlikely to significantly affect the Lord Howe Placostylus or its habitat. A series of mitigation measures are included in the Biodiversity Assessment to account for the possible presence of the species at the site and to offset habitat impacts (refer section 6.2.4 and Appendix G).

APPENDIX G BIODIVERSITY OFFSET

1. Introduction

Biodiversity offsets are measures that are used to compensate for the adverse impacts of development. Offsets are applied to the residual impacts of proposals, after all reasonable avoidance and mitigation measures have been undertaken. Direct offsets are areas of land similar and generally close to the area impacted by a proposal which are set aside permanently and managed for conservation to compensate for specific biodiversity impacts.

This section outlines the biodiversity impacts of the wind turbine project to be offset and the vegetation restoration actions proposed to directly offset the impacts.

It is noted that the scale of impact to native vegetation at the site is small and that the affected vegetation community and habitat are abundant on Lord Howe Island. The proposed offset arrangements are considered proportionate to the significance of the affected vegetation and the scale of the impact.

The proposed offset is consistent with the OEH principles for the use of biodiversity offsets in NSW and the Commonwealth EPBC Act environmental offsets policy.

2. Impacts to be offset

The upgrading of the access track to the proposed turbine site would require the removal of up to 170 m^2 of Greybark-Blackbutt (*Drypetes deplanchei–Cryptocarya triplinervis*) Closed Forest (refer section 6.1.4, and Figure E2.1). In addition, dead trees, palms and shrubs over a disturbed groundlayer would also be removed on the south-western verge of the existing track (up to 30 m^2). The total area of vegetation cleared would not exceed 200 m^2.

Figure E2.1 Vegetation clearing required for access track widening (red). Image: Google Earth

3. Offset site selection

The selected offset site is located at the southern end of the cleared paddock on Portion 101. The site is zoned Environmental Protection under the LEP. The offset site would occupy approximately 1700m^2 (0.17 hectares), offering an offset multiple of 8.5 times the clearing area.

The selected offset site meets or contributes to the following criteria for high priority rehabilitation sites in the LHI Vegetation Rehabilitation Plan 2002-2007:

- Sites inside or bordering the Permanent Park Preserve with the object of preventing dieback of native vegetation
- Sites where there is natural resilience (ie. remnant trees in a paddock)
- Vegetation corridor linking the northern and southern sections of the Permanent Park Preserve.

In addition, the proposed offset would revegetate a cleared island within the area of Significant Native Vegetation mapped under the LEP (refer Figure 3-2). The proposed offset site appears to be the same vegetation community on the same shallow basalt soil as the vegetation affected by the wind turbine project clearing. The site is located adjacent to the turbine paddock, intruding into the large forest patch occupying the central hills area of the island (refer Figure E3.1).

Revegetating the offset site provides an efficient use of resources by building on existing regeneration and eliminating a lot of edge. Windshear at forest edges is one of the processes threatening the Greybark-Blackbutt community on the island (DECC 2007). The offset restoration area is shown on Figure E3.2.

Figure E3.1 Location of the proposed turbine site (red) and the offset area (yellow). Image: Google Earth

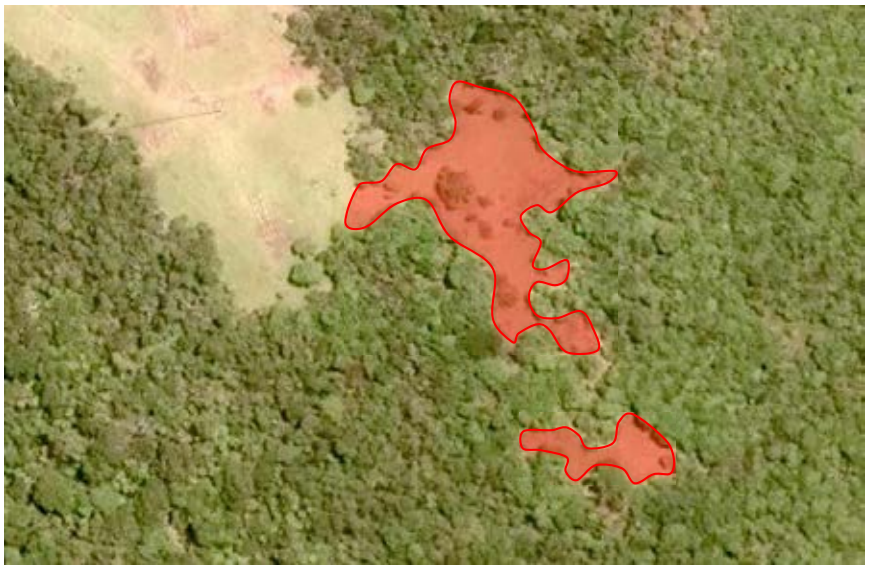

Figure E3.2 Proposed offset site adjacent to the turbine paddock (shaded red). Image: Google Earth

3. Restoration objectives and actions

The objective of restoration works at the offset site is to restore the vegetation community to a resilient, self-sustaining state using grazing exclusion, native species planting and weed control.

Under the Lord Howe Island LEP, vegetation restoration means the maintenance or rehabilitation of natural areas, including by weed eradication and erosion control and by revegetation of corridors and other areas with species of plants that are native to the Island and common in the locality.

The restoration works would be consistent with the techniques and guidelines in the LHI Vegetation Rehabilitation Plan. Specific restoration actions would involve:

- Preliminary survey to determine suitable species and abundances for planting
- Fencing to exclude cattle grazing
- Herbicide (glyphosate) treatment of existing pasture grasses
- Planting and protection of native canopy trees and pioneer species
- Monitoring and maintenance until a closed canopy is established.

The offset site would be surveyed to determine the natural dominants and pioneer species for use in revegetation planting. The LHI Vegetation Rehabilitation Plan identifies the following species which are suitable for revegetation projects, which would be affected by the proposed clearing and which may be suitable for inclusion in the offset plantings:

Canopy species

- *Cryptocarya triplinervis* (dominant)
- *Drypetes deplanchei*
- *Olea paniculata*
- *Celtis conferta.*

Pioneer species

- *Parsonsia howeana*
- *Stephania japonica*

- *Jasminum didymum*
- *Geitonoplesium cymosum*.

The proposed clearing would result in the loss of a small number of individuals of the endemic species *Howea belmoreana, Sophora howinsula, Xylosma maidenii, Cassinia tenuifolia* and *Trophis scandens* ssp *megacarpa.* Subject to the survey of the offset site and their suitability for revegetation, these species would also be included in the offset planting program.

The offset site is mapped as lower quality potential habitat for the threatened land snail *Placostylus bivaricosus*. Searches for this species would be undertaken at and around the offset site prior to the general use of herbicide.

4. Managing the offset site

The offset site would be effectively managed by the Board for conservation as part of the Permanent Park Preserve. Permanent fencing would be erected to exclude cattle grazing at the site. The maintenance of the revegetation plantings and weed control at the site would continue until the regenerating forest is self-sustaining. The offset site would be protected into the future through a subdivision plan (refer Environmental Report section 2.3.3).