



APPENDIX D BIODIVERSITY DEVELOPMENT ASSESSMENT REPORT

Wind Energy Partners
Hills of Gold Wind Farm
Biodiversity Development
Assessment Report

270335-00-REP-001

03 | 10 November 2020

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 270335-00

Arup Pty Ltd ABN 18 000 966 165

Arup
Level 4, 108 Wickham Street
Fortitude Valley
QLD 4006
GPO Box 685 Brisbane QLD 4001
Australia
www.arup.com

ARUP

Contents

	Page
Executive Summary	1
Environmental assessment requirements	1
Abbreviations and glossary	1
1 Introduction	2
1.1 Project description	2
1.2 Project location	6
1.3 Study area	6
1.4 Development footprint	6
1.5 Report purpose	9
1.6 Sources of information	9
1.7 Report structure	10
2 Statutory considerations	12
2.1 NSW legislation and policies	12
2.2 Commonwealth legislation	12
3 Landscape features	14
3.1 Identified features	14
3.2 Site context	47
4 Native vegetation	73
4.1 Methodology	73
4.2 Vegetation communities	78
4.3 Threatened ecological communities	116
4.4 Groundwater dependent ecosystems	123
5 Threatened species and habitat	125
5.1 General habitat types and features	125
5.2 Identifying habitat suitability for threatened species	129
5.3 Candidate threatened species and targeted survey methods	144
5.4 Threatened species results	170
5.5 Threatened fauna habitat	185
6 Matters of National Environmental Significance	221
6.1 Commonwealth determination and controlling provisions	221
6.2 Significant impact assessment	222
7 Avoid and minimise impacts	224
7.1 Wind farm layout	224

7.2	Microbat breeding and foraging habitat	225
7.3	Transmission line route selection	240
7.4	Access roads – construction and operation	241
8	Assessment of Impacts	242
8.1	Impact summary	242
8.2	Direct impacts	244
8.3	Indirect impacts	249
8.4	Waterway crossings	251
8.5	Cumulative impacts	255
8.6	MNES Significant impact assessment	257
8.7	Mitigating and managing impacts	276
9	Impact summary and biodiversity credit report	284
10	References	289

Figures

Figure 1: Wind farm and transmission line infrastructure project overview

Figure 2: Haul route project overview

Figure 3: Site map and location map features

Figure 4: Location map native vegetation cover

Figure 5: Native vegetation

Figure 6: Threatened ecological communities

Figure 7: Threatened flora survey tracks

Figure 8: Schematic diagram of installation of acoustic bat detectors on meteorological masts.

Figure 9: Threatened fauna survey locations

Figure 10: Threatened flora recorded during field surveys

Figure 11: Average flight height for bird species recorded flying within rotor swept height.

Figure 12: Threatened fauna recorded during field surveys

Figure 13: Cave bat habitat polygons

Figure 14: Southern Myotis habitat polygons

Figure 15: Arboreal mammals habitat polygons

Figure 16: Booroolong Frog and Border Thick-tailed Gecko habitat polygons

Figure 17: Potential cave-dwelling bat habitats, with design and 100m buffer

Figure 18: Extract from Technical Information Note TIN051 Bats and onshore wind turbines, showing how buffer distance is determined from top of canopy to blade tip.

Figure 19: Waterway crossing locations and stream order

Appendices

Appendix A

Haul route desktop study

Appendix B

Detailed PCT descriptions

Appendix C

Threatened species habitat suitability assessment

Appendix D

Collision Risk Model Report

Appendix E

Offset credit summary reports

Executive Summary

Wind Energy Partners (WEP or the Proponent) proposes to develop a wind farm on the ridgeline between Hanging Rock and Crawney Pass, approximately 60 km southeast of Tamworth.

The project is classified as ‘State Significant Development’ and will be assessed under Part 4 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act). A referral under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) has been submitted to the Commonwealth Department of Agriculture, Water and the Environment (DAWE) and the project was determined to be a ‘controlled action’. The project is being assessed under the EPBC Act in accordance with the *NSW Bilateral Agreement relating to environmental assessment 2015*.

The proposed Hills of Gold Wind Farm would have a capacity of approximately 420 MW and would supply electricity to the national electricity grid.

The project will consist of the following:

- up to 70 WTGs, each with:
 - a generating capacity of approximately 6 MW;
 - three blades mounted to a rotor hub on a tubular steel tower, with a combined height of blade and tower limited to a maximum tip height of 230 m AGL;
 - a gearbox and generator assembly housed in a nacelle;
 - adjacent hardstands for use as crane pads and assembly and laydown areas;
- decommissioning of three current monitoring masts and installation of up to five new monitoring masts for power testing. The up to five new monitoring masts will be located close to a WTG location and will have a maximum height of approximately 150 m AGL, equivalent to the hub height of the installed WTGs. The exact number and location will be defined at the detailed design stage;
- a centrally located 330kV electrical substation, including transformers, insulators, switchyard and other ancillary equipment;
- an operations and maintenance facility;
- a battery energy storage system of 100 to 400Mwh;
- aboveground and underground 33kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substation (following site access tracks where practicable);
- a 330kV overhead transmission line to connect the onsite substation to the existing 330kV TransGrid Liddell to Tamworth overhead transmission line network, located approximately 21 km west of the substation.
- A switching station to connect the Project to the 330kV TransGrid Liddell to Tamworth line;

- an internal private access road network (up to a combined total length of approximately 48.65 km) connecting the WTGs and other Project infrastructure to the public road network; and
- upgrades to local roads and waterway crossings, as required for the delivery, installation and maintenance of WTG components and other associated materials and structures.

The final concept design layout that was used to prepare a development footprint was developed in consultation with project ecologists and the proponent who undertook redesign of the project infrastructure to respond to consultation outcomes and to minimise impacts on biodiversity values. The iterative design process and the changes made in light of identified constraints and stakeholder consultation outcomes are summarised in detail in chapter 5.5 of the EIS. In summary, these included:

- A reduction in the total number of turbines proposed by 27 turbines, from the originally proposed up to 97 turbines to the now proposed up to 70 turbines
- Optimisation based on additional surveys and improved biodiversity mapping of highly ecologically sensitive areas
- Identification of optimised construction methods and increased civil design scope to identify impact mitigation opportunities where cut and fill requirements were significant. This resulted in:
 - 19 turbine hardstands being proposed as “just in time” pads to remove temporary blade storage and relocate to less sensitive areas
 - Reorientation and/or reallocation of 8 turbines
- Mapping of existing access tracks as priority construction and operational access tracks for access to the transmission line easement
- Identification and biodiversity assessment of 7 transmission options in 2018 to determine lowest ecological value route options for landowner consultation. Following this:
 - In 2019, priority routes were investigated through field surveys and a preferred option was selected.
 - In 2020 final surveys were completed to finalise the transmission line route.

This Biodiversity Development Assessment Report (BDAR) has been prepared in accordance with the requirements of the *Biodiversity Conservation Act 2016 (NSW)* (BC Act). The NSW Biodiversity Assessment Method (BAM) (OEH 2017) continues to apply to the Project under the transitional provisions in clause 6.31 of the *Biodiversity Conservation Regulation 2017 (NSW)*. Prior to the commencement of this biodiversity assessment, consultation was completed with the Biodiversity Conservation Division (BCD) of DPIE and NSW Parks and Wildlife Service.

For the purpose of assessing impacts to biodiversity, a single development footprint has been assessed covering the five project elements that comprise the overall project infrastructure, including wind farm infrastructure, internal roads,

transmission line, access tracks and transport haul route. The development footprint has included areas of both permanent and temporary impacts associated with the construction and operation of the Project. For the purpose of the landscape assessment required under the BAM, a wider study area has been assessed that consists of a 1,500m buffer around the development footprint.

The assessment reveals that the combined development footprint for the project contains the following features and biodiversity values:

- The study area's topography includes a range of plateaus, ridgelines and escarpments. The ridgetop that the wind turbines follow within the development corridor is relatively flat;
- The majority (58% or 279.75 hectares) of the mapped vegetation within the development footprint is composed of exotic grassland or planted/urban vegetation, with only 42% or 206.7 hectares of the mapped vegetation in the development footprint being classified as native vegetation;
- The 206.70 hectares of native vegetation which is contained in the development footprint represents 0.95% of the approximately 21,540 ha of native vegetation contained within the study area;
- Of the native vegetation mapped within the development footprint, 64.88ha, or only 31% of the native vegetation extent, has been mapped as being in high condition with remnant trees and good habitat values for native fauna.
- A total of 22 Plant Community Types (PCTs) were identified and mapped within the development footprint.
- A total of 2 Endangered Ecological Communities (EECs) listed under the NSW Biodiversity Conservation Act 2016 (BC Act) were identified and mapped within the development footprint. These were identified as White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Ribbon Gum-Mountain Gum-Snow Gum Grassy Woodland or open forest.
- A total of 1 Threatened Ecological Communities (TECs) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) identified and mapped within the development footprint being White Box-Yellow Box-Blakely's Red Gum Grassy Woodland.
- A total of 10 species protected by credit requirements under the BC Act (which are associated with PCTs in the study area) were determined to be present, including 8 mammals, 1 amphibian and 1 reptile;
- Four fauna species listed as threatened under the EPBC Act were identified as occurring or highly likely to occur within the study area, including the Koala, Large-eared Pied Bat, Greater Glider and Spotted-tailed Quoll;
- No flightpaths or routes were observed or mapped for migratory fauna within the study area;
- Raptors were confirmed to be present within the study area being the Nankeen Kestrel, Brown Goshawk and Wedge-tailed Eagle, all not listed under the BC Act and EPBC Act

The potential impacts to biodiversity as a result of the project have been avoided and minimised as much as practicable, through design phase refinements. Further mitigation measures are outlined and proposed to be adopted to minimise biodiversity impacts during the construction and operational phases and include the provisions of biodiversity offsets, management measures and monitoring and adaptive management measures.

The assessment confirms that there are no serious and irreversible impacts from the project. In particular:

- There is sufficient habitat availability in the wider landscape and study area to continue to support threatened species known to occur within the development footprint;
- The Project design has been refined so that the majority of vegetation impacts occur on areas that contain exotic grassland;
- The Project design avoids areas of breeding habitat for threatened microbats, by locating all infrastructure outside of the mapped cliffs and steep areas;
- Impacts to high quality vegetation communities, containing higher quality fauna habitat has been minimised through the location of infrastructure; and
- Residual impacts associated with the project will be offset in accordance with the NSW Biodiversity Offset Scheme and the EPBC Act Offsets Policy. Once these offsets are applied, no net loss to biodiversity is expected to be achieved.

Environmental assessment requirements

The below table lists the Secretary's environmental assessment requirements (SEARs) relevant to biodiversity and where they are addressed in this report.

Table 1: SEARs relevant to biodiversity

SEARs No.	Secretary's requirement	Where addressed
Key issues – Biodiversity (1)	The EIS must assess biodiversity values and the likely biodiversity impacts of the development including impacts associated with transport route road upgrades in accordance with the <i>Biodiversity Conservation Act 2016</i> (NSW), including a detailed description of the proposed regime for minimising, managing and reporting on the biodiversity impacts of the development over time, and a strategy to offset any residual impacts of the development in accordance with the <i>Biodiversity Conservation Act 2016</i> (NSW).	All sections of this BDAR
Key issues – Biodiversity (2)	The EIS must assess the impact of the development on the National Estate in accordance with the Guidelines for Development Adjoining Land and Water Managed by DECCW (OEH, 2010).	Section 4, 5, 7 and 8 of this BDAR
Key issues – Biodiversity (3)	The EIS must assess the impact of the project on birds and bats from blade strikes, low air pressure zones at the blade tips (barotrauma), and alteration to movement patterns resulting from the turbines and considering cumulative effects of other wind farms in the vicinity.	Section 4, 5, 7 and 8 of this BDAR

Relevant agency SEARs requirements are also provided in Table 2.

Table 2: Agency SEARs requirements relevant to the project

Agency	Assessment requirements	How addressed
DPI- Fisheries	Assess the impact of the design, construction and operation of waterway crossings on access roads across the site in accordance with NSW Fisheries (2013) Fisheries Policy and Guidelines Fish Habitat Conservation and Management (2013 update) and Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings.	Section 8.4 of the BDAR
Department of Planning and Environment	Biodiversity impacts related to the proposed development are to be assessed in accordance with Section 7.9 of the Biodiversity Conservation Act 2017 the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the Biodiversity Conservation Act 2016 (s6.12), Biodiversity Conservation Regulation 2017 (s6.8) and Biodiversity Assessment Method, unless OEH and DPE determine that the proposed development is not likely to have any significant impacts on biodiversity values.	Addressed throughout this document.
	The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the Biodiversity Assessment Method.	Section 7, 8 and 9 of this BDAR
	The BDAR must include details of the measures proposed to address the offset obligation as follows; <ul style="list-style-type: none"> • The total number and classes of biodiversity credits required to be retired for the development/project; • The number and classes of like-for-like biodiversity credits proposed to be retired; • The number and classes of biodiversity credits proposed to be retired in accordance with the • variation rules; 	Section 9 of this BDAR

Agency	Assessment requirements	How addressed
	<ul style="list-style-type: none"> • Any proposal to fund a biodiversity conservation action; • Any proposal to conduct ecological rehabilitation (if a mining project); • Any proposal to make a payment to the Biodiversity Conservation Fund. <p>If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits.</p>	
	The BDAR must be submitted with all spatial data associated with the survey and assessment as per Appendix 11 of the BAM.	All data will be provided upon submission to DPIE
	The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under s6.10 of the Biodiversity Conservation Act 2016.	Section 1 of this BDAR
	<p>The EIS must map the following features relevant to water and soils including:</p> <ul style="list-style-type: none"> • Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method). • Wetlands as described in s4.2 of the Biodiversity Assessment Method. 	Section 3 of this BDAR.
	Fauna survey is to be conducted in native vegetation adjacent to the development site, including Ben Halls Gap Nature Reserve and Ben Halls Gap State Forest.	Section 4 and 5 of this BDAR
	Assessment of impact is to include all components of the proposal, including any road/track widening to enable transport of turbines to the site.	Section 1.3 and Sections 4, 5, 7 and 8 of this BDAR
	Hollow-bearing trees are to be quantified on the development site and in adjacent native vegetation.	Section 4 and 5 of this BDAR
	A candidate list of species that may use the development site as a flyway or migration route must be included in the EIS, including: (a) resident threatened aerial species (b) resident	Section 5 and 7 of this BDAR Appendix D of this BDAR

Agency	Assessment requirements	How addressed
	raptor species (c) nomadic and migratory species that are likely to fly over the project area.	
	Bird and bat flight paths are to be identified and assessed. Maps of habitual flight paths for nomadic and migratory species likely to fly over the site and maps of likely habitat for threatened aerial species resident on the site are to be included in the EIS.	Section 5 and 7 of this BDAR Appendix D of this BDAR
	The cumulative effect of wind farms in the broader area should be considered in relation to migratory birds.	Section 8.5 of this BDAR
	Copies of all raw data sheets for flora and fauna studies are to be included in the EIS or provided to OEH.	To be provided
	ArcGIS compatible spatial data is to be provided including (but not limited to) vegetation mapping, plot locations, transect locations and the locations of turbines and other infrastructure.	To be provided

On the 23 December 2019, the Department of Agriculture, Water and Environment (DAWE) determined the project was a controlled action under section 75 of the EPBC Act. Controlling provisions for the proposed action are listed threatened species and communities (section 18 and 18A) and listed migratory species (section 20 and 20A). Table 3 details the specific assessment requirements identified by DAWE for these matters.

Table 3: Department of Agriculture, Water and Environment assessment requirements for the proposal

DAWE requirement	Assessment requirements	How addressed
General (5)	The Environmental Impact Statement (EIS) must address all matters outlined in Schedule 4 of the EPBC Regulations and all the matters outlined below in relation to the controlling provisions	This BDAR
General (10)(a)	The EIS must include an assessment of the relevant impacts of the action on the matters protected by the controlling provisions, including <ul style="list-style-type: none"> A description and detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including short term and long term relevant impacts. 	Section 6 of this BDAR

DAWE requirement	Assessment requirements	How addressed
General (10)(b)	<ul style="list-style-type: none"> A statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible. 	Section 6, 7 and 8 of this BDAR
General (10)(c)	<ul style="list-style-type: none"> Analysis of the significance of relevant impacts. 	Section 6 of this BDAR
General (10)(d)	<ul style="list-style-type: none"> Any technical data and other information used or needed to make a detailed assessment of the relevant impacts. 	To be provided
General (11)(a)	<p>For each of the relevant matters protected that are likely to be significantly impacted by the action, the EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action including:</p> <ul style="list-style-type: none"> A description and an assessment of the expected or predicted effectiveness of the mitigation measures. 	Section 6, 7 and 8 of this BDAR
General (11)(b)	<ul style="list-style-type: none"> Any statutory policy basis for the mitigation measures 	Section 6, 7 and 8 of this BDAR
General (11)(c)	<ul style="list-style-type: none"> The cost of the mitigation measures. 	Detailed costs to be prepared as part of future design phases
General (11)(d)	<ul style="list-style-type: none"> An outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing. 	Section 6, 7 and 8 of this BDAR
General (11)(e)	<ul style="list-style-type: none"> The name of the agency responsible for endorsing or approving each mitigation measures or monitoring program. 	NSW DPIE and DAWE
General (12)	<p>Where a significant residual adverse impact to a relevant protected matter is considered likely, the EIS must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy.</p>	Section 9 of this BDAR. Offsets to be delivered under the NSW BOS
General (13)	<p>For each of the relevant matters likely to be impacted by the action, the EIS must provide reference to and consideration of, relevant Commonwealth guidelines and policy statements including any:</p>	Section 6 of this BDAR

DAWE requirement	Assessment requirements	How addressed
	<ul style="list-style-type: none"> • Conservation advice or recovery plan for the species or community • Relevant threat abatement plan for a process that threatens the species or community • Wildlife conservation plan for the species • Any strategic assessment. 	
Key Issues – Biodiversity (1)	The EIS must identify each EPBC Act listed threatened species and community and migratory species likely to be impacted by the action. For any species and communities that are likely to be impacted, the proponent must provide a description of the nature, quantum and consequences of the impacts. For species and communities potentially located in the project area or in the vicinity that are not likely to be impacted, provide evidence why they are not likely to be impacted.	Section 5 and 6 of this BDAR
Key Issues – Biodiversity (2)(a)	For each of the EPBC Act listed threatened species and communities and migratory species likely to be impacted by the action, the EIS must provide a separate: <ul style="list-style-type: none"> • Description of the habitat (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of and reference to any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans. 	Section 5 and 6 of this BDAR
Key Issues – Biodiversity (2)(b)	<ul style="list-style-type: none"> • Details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements. 	Section 5 and 6 of this BDAR
Key Issues – Biodiversity (2)(c)	<ul style="list-style-type: none"> • Description of the specific proposed avoidance and mitigation measures to deal with relevant impacts of the action. 	Section 7 of this BDAR

DAWE requirement	Assessment requirements	How addressed
Key Issues – Biodiversity (2)(d)	<ul style="list-style-type: none"> Identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account. 	Section 6 of this BDAR
Key Issues – Biodiversity (2)(e)	<ul style="list-style-type: none"> Description of any offsets proposed to address residual adverse significant impacts and how these offsets will be established. 	Section 9 of this BDAR
Key Issues – Biodiversity (2)(f)	<ul style="list-style-type: none"> Details of how the current published NSW Biodiversity Assessment Methodology has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts. 	Section 4, 5, 6 and 7 of this BDAR
Key Issues – Biodiversity (2)(g)	<ul style="list-style-type: none"> Details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the action in accordance with the NSW biodiversity Assessment Methodology and/ or mapping and descriptions of the extent and condition of the relevant habitat and/ or threatened communities occur on proposed offset sites. <p>[Note: For the purposes of approval under the EPBC Act, it is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action and deliver an overall conservation outcome that improves or maintains the viability of the MNES i.e. ‘like for like’. Like-for-like includes protection of native vegetation that is the same ecological community or habitat being impacted (preferably in the same region where the impact occurs), or funding to provide a direct benefit to the matter being impacted e.g. threat abatement, breeding and propagation programs or other relevant conservation measures.]</p>	Section 9 of this BDAR
Key Issues – Biodiversity (2)(h)	<ul style="list-style-type: none"> Any significant residual impacts not addressed by the NSW Biodiversity Assessment Methodology may need to be addressed in accordance with the EPBC Act Environmental Offsets Policy. 	Section 9 of this BDAR

Abbreviations and glossary

Table 4: List of abbreviations and glossary of technical terms used in this BDAR.

Abbreviations and technical terms	
AGL	Above ground level
BAM	Biodiversity Assessment Method 2017
BC Act	<i>Biodiversity Conservation Act 2016</i>
BCD	Biodiversity Conservation Division
BDAR	Biodiversity Development Assessment Report
BoM	Bureau of Meteorology
BOS	Biodiversity Offsets Scheme
BVM	Biodiversity Values Map
EES	Environment, Energy and Science Group in the Department of Planning, Industry and Environment
Development footprint	The total area subject to direct and indirect impacts as a result of the Project.
DNG	Derived Native Grassland
DPIE	Department of Planning, Industry and Environment
EMS	Environmental Management Strategy
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
FM Act	<i>Fisheries Management Act 1994</i>
GDEs	Groundwater Dependent Ecosystems
IBRA	Interim Biogeographic Regionalisation for Australia
LGAs	Local Government Areas
OEH	Office of Environment and Heritage
PCT	Plant Community Type
SEAR's	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
Study area	The study area for the proposal includes the development footprint plus a 1500m buffer.
TEC	Threatened Ecological Community
WTG	Wind turbine generator

1 Introduction

1.1 Project description

The Project involves the construction, operation and commissioning of a wind farm with up to 70 wind turbine generators (WTG), together with associated and ancillary infrastructure.

The Project consists of the following key permanent components:

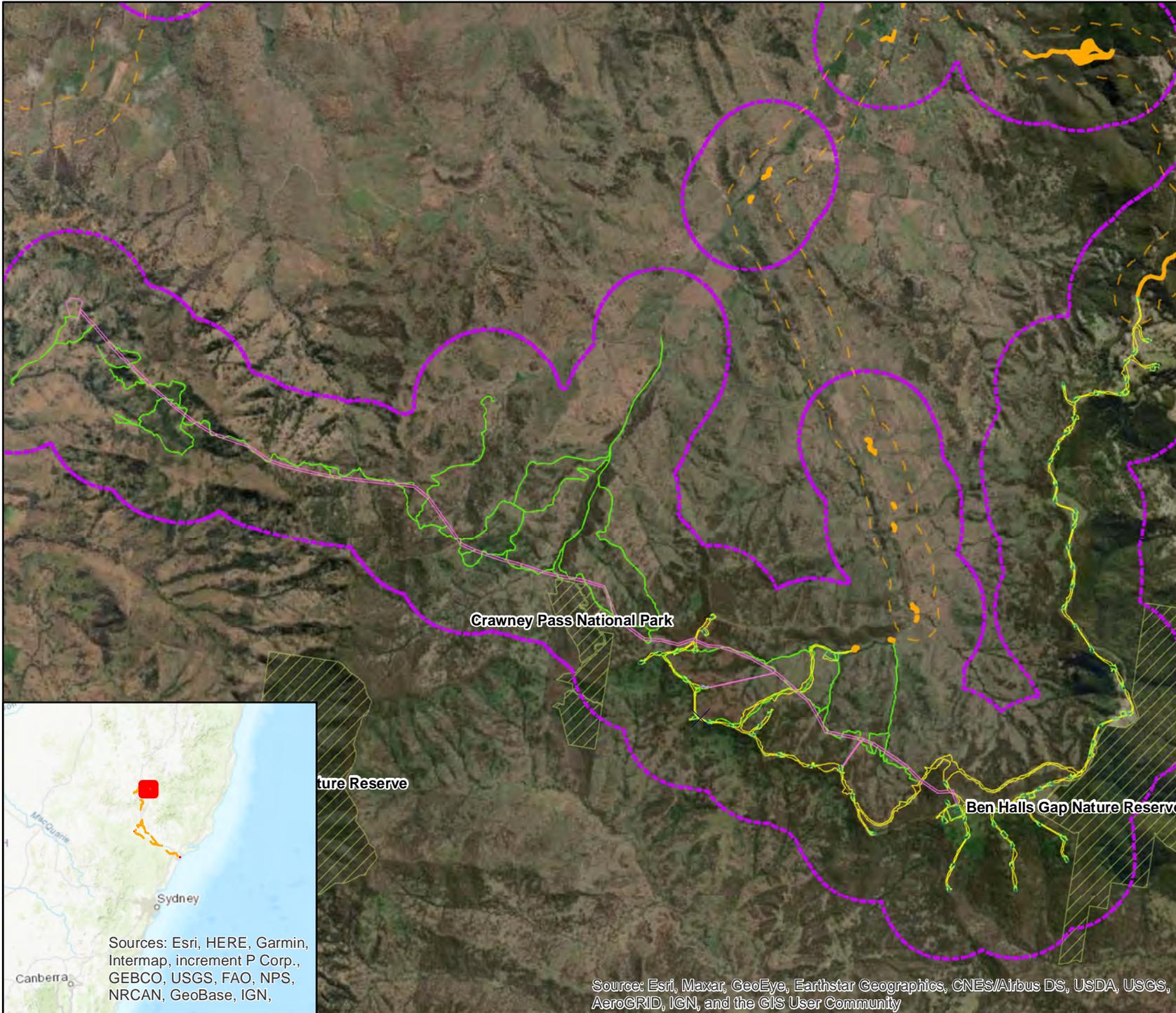
- up to 70 WTGs with a generating capacity of approximately 6 MW. Each WTC has:
 - three blades mounted to a rotor hub on a tubular steel tower, with a combined height of blade and tower limited to a maximum tip height of 230 m AGL;
 - a gearbox and generator assembly housed in a nacelle;
 - adjacent hardstands for use as crane pads and assembly and laydown areas;
- decommissioning of three current monitoring masts and installation of up to five new monitoring masts for power testing. The up to five new monitoring masts will be located close to a WTG location and will have a maximum height of approximately 150 m AGL, equivalent to the hub height of the installed WTGs. The exact number and location will be defined at the detailed design stage;
- a centrally located 330kV electrical substation, including transformers, insulators, switchyard and other ancillary equipment;
- an operations and maintenance facility;
- a battery energy storage system of 100 to 400Mwh;
- aboveground and underground 33kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substation (following site access tracks where practicable);
- a 330kV overhead transmission line to connect the onsite substation to the existing 330kV TransGrid Liddell to Tamworth overhead transmission line network, located approximately 21 km west of the substation;
- a switching station to connect the Project to the 330kV TransGrid Liddell to Tamworth line;
- an internal private access road network (up to a combined total length of approximately 48.65 km) connecting the WTGs and other Project infrastructure to the public road network; and
- upgrades to local roads and waterway crossings, as required for the delivery, installation and maintenance of WTG components and other associated materials and structures.

The following temporary elements will be required during construction of the Project:

- temporary site buildings and facilities for construction contractors / equipment, including site offices, car parking and amenities for the construction workforce;
- two temporary concrete batching plants to supply concrete for WTG footings and substation construction works;
- earthworks, including cut and fill, for constructing access roads, WTG platforms and foundations;
- potentially rock crushing facilities for the generation of suitable aggregates for concrete batching or sized rock for access road and hardstand construction; and
- up to seven additional hardstand laydown areas for the temporary storage of construction materials, plant, and equipment construction.

The indicative Project layout for the wind farm infrastructure, including the WTGs, internal access roads and supporting infrastructure are shown in **Figure 1, Page 1 to 3** and the biodiversity impacts have been assessed based on this development footprint. In order to facilitate refinement of the layout during the detailed design process, an allowance for micro-siting of WTGs and other components of the Project of up to 100 m radius from the locations identified in the EIS is proposed. **Figure 1, Page 1** shows the layout of all components, while **Figure 1, Page 2** provides more detail on the wind farm and internal roads layout and **Figure 1, Page 3** shows the transmission line corridor and construction access tracks.

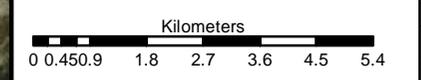
In addition to the wind farm infrastructure, the Project will require minor upgrades to the highway and local road network to facilitate haulage of the turbine components from Port of Newcastle to the development site (**Figure 2**). Some of these works will require modifications to the curve radii of intersections that will involve clearing of vegetation. Where clearing of vegetation is required, these areas along the haul route have also been subject to assessment in this BDAR and form part of the development footprint. This assessment included fieldwork to verify vegetation communities and habitat condition for suitability to support threatened species.



-  Transport route development footprint (port to site)
-  Wind farm infrastructure
-  Transmission line and switching
-  Internal roads
-  Transmission line access tracks
-  Transport haul route corridor
-  Landscape assessment buffer (study area)
-  NPWS reserve



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
Wind farm infrastructure project overview - Page 1

Scale at A4 1:119,967	Drawing Status Final
---------------------------------	--------------------------------

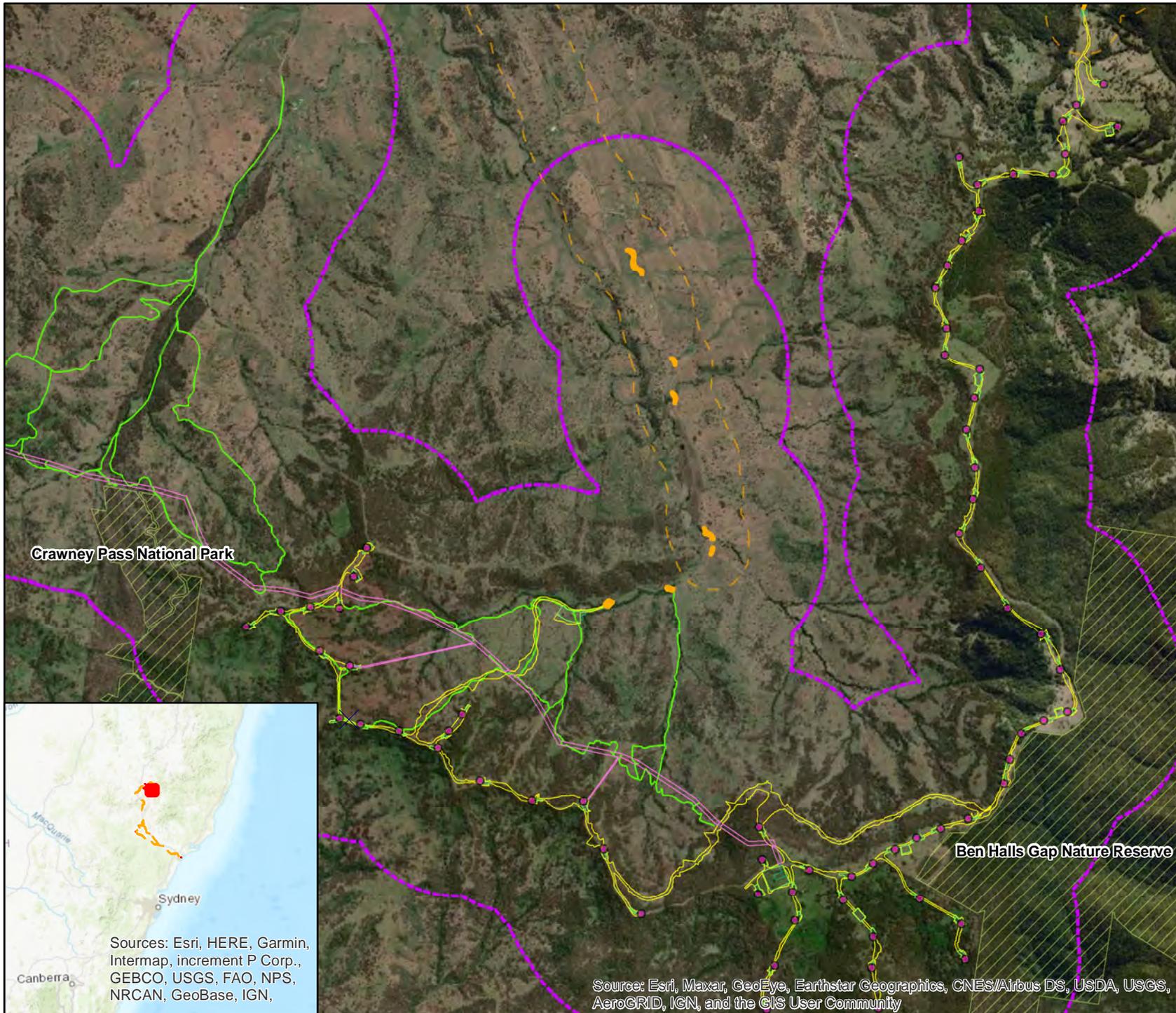
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 001
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN,

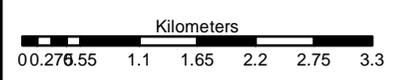
D:\270000\270335-00 Hills of Gold\Work\mama\05\signets\Figures\Draw\BDRAR_June2020\Draw\Figures_revised.mxd

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



- Wind turbine locations
- Transport route development footprint (port to site)
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks
- Transport haul route corridor
- Landscape assessment buffer (study area)
- NPWS reserve

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
Wind farm infrastructure project overview - Page 2

Scale at A4 1:71,182	Drawing Status Final
--------------------------------	--------------------------------

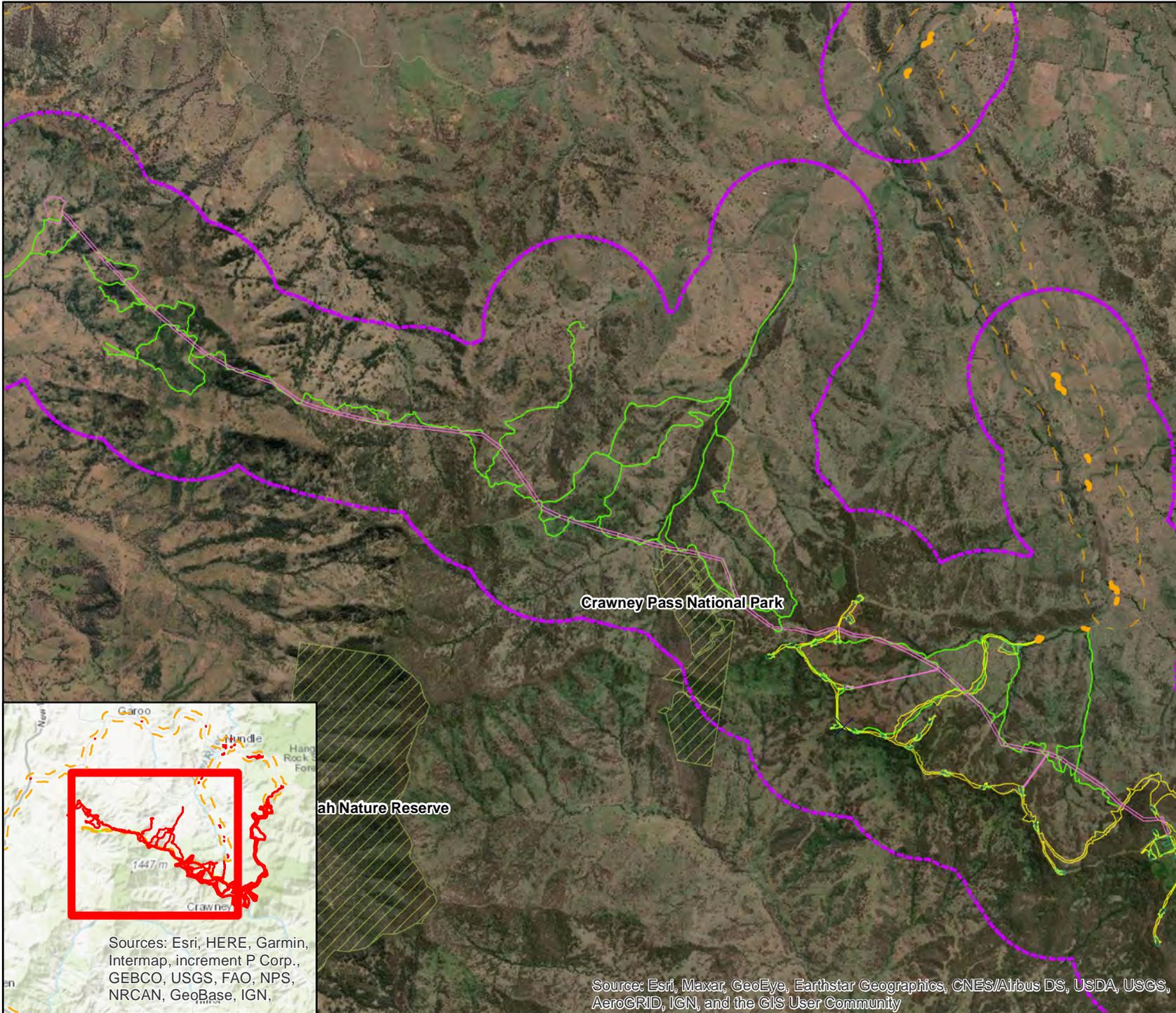
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 001
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

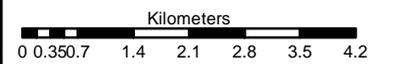
D:\270000\270335-00 Hills of Gold\Work\mema\05\mcs\figures\Draft\BDRAR_June2020\Draft_Figures_revised.mxd



-  Transport route development footprint (port to site)
-  Wind farm infrastructure
-  Transmission line and switching
-  Internal roads
-  Transmission line access tracks
-  Transport haul route corridor
-  Landscape assessment buffer (study area)
-  NPWS reserve



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
Wind farm infrastructure project overview - Page 3

Scale at A4 1:95,159	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 001
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN,

ah Nature Reserve

Crawney Pass National Park

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

D:\270000\270335-00 Hills of Gold\Work\mama\design\figures\Drawn\ARUP_270335-00\Drawn\Figures_revised.mxd



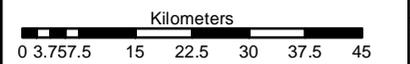
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

-  Transport route development footprint (port to site)
-  Transport haul route corridor
-  Wind farm site boundary



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
Haul route project overview

Scale at A4 1:1,000,000	Drawing Status Final
-----------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 002
----------------------------	--------------------------

D:\270000\270335-00 Hills of Gold\Work\main\0 esg\mcs\figures\Draft\BDRAR_June2020\Draft_Figures_revised.mxd

1.2 Project location

The project is located approximately 4 km south of Hanging Rock, 8 km south east of the Nundle and 60km south east of Tamworth, within the Tamworth Regional Local Government Area (LGA), Upper Hunter Shire LGA and Liverpool Plains LGA. The eastern boundary of the site is adjacent to Ben Halls Gap Nature Reserve. Crawney Pass National Park is situated to the west of the project.

The development footprint predominately supports agricultural land on flatter topographies that are dominated by exotic grasslands created as part of cattle grazing activities. There is a higher percentage of overstorey native vegetation within steeper terrain and situated adjacent to the development footprint associated with the wind farm infrastructure. The development footprint is primarily classified as primary production land zone and lies adjacent to forestry, National Parks and Nature Reserves zones.

1.3 Study area

The study area for this BDAR includes the development footprint, as defined in **Section 1.4** below, and a 1,500m buffer for the landscape assessment (**Figure 1** and **Figure 2**). This buffer has been applied in accordance with Section 4.2 of the BAM, which requires landscape attributes to be assessed for a 1,500m buffer around the development footprint.

1.4 Development footprint

For the purpose of assessing impacts to biodiversity, a single development footprint has been assessed covering the five project elements that comprise the overall project infrastructure described in **Section 1.4.1** and **Table 5**. This development footprint has been prepared based on the concept design developed to understand the maximum impacts associated with the construction and operation of the Project.

1.4.1 Project infrastructure

Lands within the development footprint will be subject to direct impacts as a result of the project. This includes the permanent and temporary elements outlined in **Table 5**, and includes:

1. Wind turbine infrastructure, consisting of wind turbine generators and hardstands for construction;
2. Ancillary infrastructure including operations and maintenance buildings, substation, battery energy storage system, switching station and parking/storage/laydown areas
3. Internal roads connecting wind farm infrastructure;
4. Transmission line and switching station;
5. Transmission line access tracks; and

6. Transport haul route from Port of Newcastle to the wind farm site.

Concept design work was completed to confirm a conservative maximum development footprint to be assessed in this BDAR. The concept design was developed by the project team, which included wind farm designers and civil designers, with input from ecologists and other specialists to minimise impacts as much as practicable.

The concept design has also considered temporary construction phase impacts associated with ancillary sites, access routes, hardstand and laydown areas, storage, stockpile and site office facilities. This development footprint is considered to be a maximum footprint based on the current level of concept design, with refinements and reductions expected during detailed design.

The development footprint for the assessment of biodiversity impacts has also considered a network of access tracks for the construction of the transmission line. As much as possible these tracks have been mapped using the existing farm track network to minimise impacts to areas of native vegetation. A 10m corridor on each of these tracks has been included in the development footprint to capture any potential vegetation clearing required to use these tracks. The intent of including these areas in the biodiversity impact assessment is to understand the potential maximum development footprint that will be subject to assessment under the BAM.

The majority of the impacted areas associated with the transport route upgrades are required to enable the over mass and oversize construction vehicles required to transport Project components are also included in Table 5 above. The majority of these areas are developed or modified areas that are not required to be assessed under the BAM. A detailed desktop assessment of all works areas along the haul route was carried out to identify areas that contain biodiversity features and required field survey to identify vegetation communities, condition and habitat suitability for threatened species (**Appendix A**).

From the desktop assessment, a total of 25 sites along the haul route were confirmed to have biodiversity values that required assessment under the BAM. These areas were included in the development footprint and ecological fieldwork was carried out to confirm Plant Community Type (PCT) and habitat value for threatened fauna.

Table 5: Wind farm infrastructure project elements for biodiversity assessment

Project Component	Permanent footprint (ha)	Temporary footprint (ha)	Total footprint (ha)
Wind Farm Infrastructure ¹ consisting of:			
WTGs including crane pad assembly areas and asset protection zones	57.15	0.00	57.15
Operations and maintenance building	1.09	0.00	1.09
Substation	0.36	0.00	0.36
Battery energy storage system	6.38	0.00	6.38
Parking, storage and laydown areas	0.00	10.60	10.6
Wind monitoring masts	0.002	0.00	0.002
Internal Roads ^{2, 3}	96.3	89.0 ⁷	185.3
Transmission line and Switching Station ⁴	17.4	119.1 ⁸	136.5
Transmission line Access Tracks ⁵	35.7	23.8	59.5
Transport route upgrades ⁶	28.10	28.10 ⁹	56.2
TOTAL	242.0	271.0	513.0

¹ Includes wind turbine generators, hardstands for construction and ancillary sites including operations and maintenance buildings, substation, battery energy storage station, internal switching station and parking/storage/laydown areas

² Calculation based on approximately 48km length of internal access roads with the assumption of 38.59m wide road corridor to accommodate all required drainage, internal 33 kV underground cabling, and cut & fill batters

³ Internal access road calculation includes internal roads between hardstands, the access track form Head of the Peel Road to the Project Area and transverse access track.

⁴ 330 kV transmission line is approximately 24 km long within a 60 m wide easement area. The 33 kV aboveground connection line is 2.46 km long within a 15 m wide easement area plus existing access tracks will be upgraded as required. The upgrade of existing tracks has included a 10m wide corridor to allow for clearing if required for these tracks.

⁵ Access tracks for the transmission line have been developed at a concept level only to provide for a worst-case scenario for biodiversity impacts. The concept alignment of these tracks have followed existing tracks as much as practicable. The development footprint for these existing tracks has included for a 10m wide corridor to allow for clearing if required for these tracks

⁶ Transport route upgrade areas have been determined as part of a haul route transport study to identify area that require upgrade to facilitate movement of long wind farm infrastructure. These sites were further refined by a desktop biodiversity assessment to identify sites that have the potential to support biodiversity features, as opposed to existing roads and highways. Those sites with a potential to result in biodiversity impacts were assessed in the field and included in the development footprint for assessment of biodiversity values.

⁷ Temporary areas to be rehabilitated include cut and fill, roads Asset Protection Zones (APZ) and buffer for underground cabling. Rehabilitation will include native grasses at a minimum and opportunities to use native shrubs and trees will be considered where appropriate.

⁸ It has been estimated that 90% of the 330kV easement can be rehabilitated using native grasses, at a minimum and detailed design will consider use of native shrubs and trees where safety and operational constraint permit.

⁹ It is estimated that 50% of the transport route upgrades will be rehabilitated with native grass within existing road verges, with opportunities for native shrub and tree plantings to be considered.

For all project elements, a maximum development footprint has been proposed for assessment in this BDAR and it is expected to be refined and reduced during detailed design phases.

1.5 Report purpose

This Biodiversity Development Assessment Report (BDAR) has been prepared in accordance with the requirements of the BC Act to address the Secretary's Environmental Assessment Requirements (SEARs) for the proposed Hills of Gold Wind Farm.

Specifically, this report assesses:

- Impacts to native vegetation, including threatened ecological communities listed under the BC Act and the EPBC Act
- Impacts to listed threatened species under the BC Act and the EPBC Act
- Impacts of blade strike on birds and bats, with specific focus on listed threatened bats and raptors observed
- Impacts associated with development near to National Parks or State Reserves, including the adjacent Ben Halls Gap Nature Reserve/
- Measures to manage identified impacts (including details of adaptive management protocols and ability to obtain achievable offsets); and
- Measures to avoid, mitigate and offset impacts, with the objective of achieving an overall 'improve or maintain' environmental outcome for the project.

1.6 Sources of information

The following information sources were used in the preparation of this BDAR:

- Project spatial information provided by WEP;
- Preliminary Environmental Assessment (PEA), Hills of Gold Wind Energy Project (NGH Environmental 2018);
- Hills of Gold Wind Farm Preliminary Biodiversity and EPBC Act Significant Impact Assessment ('EPBC Assessment') (Arup 2019);
- DAWE EPBC Protected Matters Search Tool (PMST);
- DAWE Species Profiles and Threats (SPRAT) database;
- DAWE Interim Biogeographic Regionalisation for Australia (IBRA) mapping;
- NSW Mitchell Landscapes mapping, version 3.1;
- DPI Key Fish Habitat mapping;
- OEHL BioNet Atlas of NSW database;
- OEHL Threatened Biodiversity Data Collection (formerly known as the Threatened Species Profiles database);

- State Vegetation Type Map: Border Rivers Gwydir / Namoi Region Version 2.0. VIS_ID 4467 (OEH, 2020a);
- State Vegetation Type Map: Upper Hunter Version 1.0. VIS_ID 4894 (OEH, 2020b);
- Greater Hunter Native Vegetation Mapping Version 4.0. VIS_ID 3855 (DPIE, 2015).
- OEH BioNet Vegetation Classification Database;
- OEH online BAM calculator
- Biodiversity Assessment Method (OEH, 2020);
- Groundwater Dependent Ecosystems Atlas (Bureau of Meteorology (BOM), 2020)
- LiDAR Survey data was used to assess areas of steep cliffs and rocky outcrops for cave-dwelling bat roost habitats.
- Relevant published literature on threatened biota (see References in Section 9).

1.7 Report structure

This BDAR addresses total estimated development footprint arising from the Project as outlined in **Table 5**. In accordance with the requirements of the BAM, the assessed development footprint includes the area of land that may be directly impacted by the project.

1.7.1 Interpretation of maps

Map sets presenting survey effort, survey results, and biodiversity constraints are provided for the total development footprint, in accordance with the requirements of the BAM. Each map set contains an overview map and a set of detailed maps. The overview map shows the order in which the detailed maps are referenced and their location within the study area.

When locations are referenced within the report, they are described using the infrastructure elements defined in **Section 1.4.1** and **Table 5**.

1.7.2 Relevant personnel

The BDAR has been prepared in accordance with the BAM by Arup and Biosis. The following accredited biodiversity assessors have prepared, provided input into and reviewed sections of this BDAR in accordance with the BAM:

- Chani Wheeler (BAAS 19077) – Arup (no longer employed at Arup)
- Matt Davis (BAAS 18090) - Arup
- Nicola Trulock (BAAS 19058) – Biosis
- Callan Wharfe (BAAS 18138) - Biosis

- Rebecca Dwyer (BAAS 17067) - Biosis

Additional personnel contributed to the field survey effort, data analysis, interpretation and mapping, including:

- Caroline Tan – Arup terrestrial ecologist
- Andrea McPherson – Arup aquatic ecologist
- Matthew Hyde – Biosis Zoologist
- Kayla Asplet - Biosis Zoologist (no longer employed at Biosis)
- Sarah Allison - Biosis Zoologist
- Adam Baus – Biosis Zoologist (Aquatic)
- Bianca Klein - Biosis Botanist
- Tobias Scheid - Biosis Botanist
- Byron Dale – Biosis Zoologist
- Heather Lee-Kiorgaard – Biosis Botanist

This report has been compiled and reviewed by Matt Davis (Accredited Assessor number BAAS 18090). To meet the certification requirements under Section 6.15 of the BC Act, this report has been prepared on the basis of the requirements of (and information provided under) the Biodiversity Assessment Method (DPIE, 19 October 2020), as current on the date this report was finalised on 28 October 2020.

2 Statutory considerations

2.1 NSW legislation and policies

2.1.1 *Environmental Planning and Assessment Act 1979 (EP&A Act)*

The Project is State Significant Development (SSD) and development consent is being sought under Section 4 of the NSW EP&A Act. An EIS is a requirement of the development assessment process

Environmental Assessment Report (now called Scoping Report) was prepared and submitted to the NSW Department of Planning and Environment (now Department of Planning, Industry and Environment (DPIE)) in October 2018. Secretary's Environmental Assessment Requirements (SEARs) were issued for the Project on 22 November 2018. The SEARs form the basis of the assessment criteria for the Project. Supplementary SEARs were issued on 18 February 2020 in relation to the determination of the Project as a Controlled Action under the Commonwealth EPBC Act

2.1.2 *Biodiversity Conservation Act 2016 (BC Act)*

The *Biodiversity Conservation Act 2016 (BC Act)* and *Biodiversity Conservation Regulation 2017 (BC Regulation)* provide a framework for the assessment of biodiversity and the implementation of the Biodiversity Offset Scheme (BOS) in NSW. The NSW Biodiversity Assessment Method (BAM) supports the implementation of the BOS and establishes a consistent approach to assessing biodiversity values on lands within NSW.

Under the BC Act, impacts to biodiversity, including those associated with land clearing and development, must be assessed by an accredited person to determine proposal requirements for entry into the BOS. Entry into the BOS may be triggered where areas of mapped biodiversity value will be impacted, where land clearing exceeds area thresholds or where impacts to threatened species or ecological communities are likely to be significant. A proposal may also be refused where it is likely to result in serious or irreversible impacts to biodiversity, as defined by the BC Act.

2.2 Commonwealth legislation

2.2.1 *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*

The project has also been referred under the EPBC Act (2019/8535) and determined to be a controlled action which is required to be assessed under the Bilateral Agreement made under section 45 of the EPBC Act relating to environmental assessment between the Commonwealth of Australia and the State of New South Wales. The bilateral agreement endorses the BAM and the NSW

Biodiversity Offsets Scheme as accredited processes. Guidelines for preparing the EIS under the Bilateral Agreement have been provided by DAWE (Supplementary SEARS). This BDAR has been prepared to address approval requirements under the EPBC Act as set out in the Supplementary SEARs

3 Landscape features

In accordance with Section 4.2 of the BAM, a landscape assessment was completed for the study area, as shown in **Figure 3, Pages 1 to 25**. This landscape assessment has been carried out for the 1,500m buffer around the development footprint, as required by Section 4.2 of the BAM. For the purpose of this BDAR the 1,500m landscape buffer around the development footprint is defined as the study area.

This study area includes a total 42,315.90 hectares of land comprising the development footprint and the 1,500m buffer around all parts of the development footprint. This section provides a summary of the wider landscape features of the study area, that contribute to the ecological values within the development footprint.

3.1 Identified features

Section 4.2 of the BAM lists the required identified features that need to be mapped in this BDAR. Relevant landscape features identified for the study area are shown in **Figure 3, Page 1 to 25**.

3.1.1 IBRA bioregions and subregions

The study area intersects four Interim Biogeographic Regionalisation for Australia (IBRA) subregions, as detailed in **Table 6** and shown in **Figure 3, Pages 1 to 25**. The Nandewar IBRA bioregion and Peel IBRA subregion dominates the study area. In accordance with Section 6.4.1.6 of the BAM, these have formed the basis for the habitat suitability assessment documented within this BDAR.

At the scale of the development footprint, the majority of the project is located within the Peel sub-region within the Nandewar bioregion.

Table 6: IBRA region and sub-regions in which the project site is located

IBRA Region	IBRA Sub-region	Extent (ha)	% study area
New England Tablelands	Walcha Plateau	6,06.29	14%
Nandewar	Peel	22,133.40	52%
NSW North Coast	Tomalla	3,359.60	8%
Sydney Basin	Hunter	10,524.70	25%

3.1.2 NSW landscape regions (Mitchell Landscapes)

The study area supports 19 NSW landscapes, as detailed in **Table 7**.

Table 7: NSW (Mitchell) Landscapes within the study area

Landscapes	Corresponding Ecosystem Meso Grouping	Extent (ha)	% study area
Mount Royal Tops	NNC Barrington - Gloucester	7,158.84	17%
Mount Royal Ridges	NNC Barrington - Gloucester	10,105.50	24%
Manning Great Escarpment Southern Aspects	NNC Barrington - Gloucester	145.91	<1%
Manning Great Escarpment Western Aspects	NNC Barrington - Gloucester	18.69	<1%
Nundle Hills	NAN Peel	10,167.2	24%
Peel Channels and Floodplain	NAN Peel	1,042.23	2%
Slippery Rock Range	NAN Peel	45.53	<1%
Tamworth- Keepit Slopes and Plains	NAN Peel	2,19.83	6%
Central Hunter Alluvial Plains	SB Hunter	168.01	<1%
Central Hunter Foothills	SB Hunter	4,892.32	12%
Lower Hunter Channels and Floodplains	SB Hunter	881.65	2%
Newcastle Coastal Ramp	SB Hunter	444.62	1%
Upper Hunter Channels and Floodplain	SB Hunter	2,559.14	6%
Gosford-Coorangbong Coastal Slopes	SB Wyong	591.75	1%
Moonbi-Walcha Granites	NET Granites	77.36	<1%
Niangala Plateau and Slopes	NET Walcha	465.57	1%
Nowendoc- Yarras Serpentine	NNC Ultramafics	95.51	<1%
Sydney- Newcastle Barriers and Beaches	SB Coastal Barriers	692.25	2%
Watagan Ranges	SB Watagan	4.59	<1%

3.1.3 Rivers and streams

There are several waterways and wetland/farm dams in the study area, with many being defined as first order streams as per Appendix 3 of the BAM.

Rivers and streams (classified by stream order and including riparian buffers) are shown on the Site Map and Location Map in **Figure 3, Pages 1 to 25**. The majority of the streams that occur within the study area are first-order watercourses, which is characteristic of the location of the project on a ridgeline. The majority of these flow north and west of the ridgeline into the Namoi catchment area. The southern portion of the development footprint for the wind farm and transmission line flows south to the Hunter catchment area. A small portion of the eastern portion of this development footprint flows east to the Manning Catchment Area.

There are fourteen named streams within the study area for the wind farm and transmission line (refer to Soil and Water chapter), including:

- Dead Eye Creek
- Limestone Oaky Creek
- McDivitts Creek
- Nundle Creek
- Pages Creek
- Peel River
- Perrys Creek
- Talbots Creek
- Whites Creek
- Woodleys Creek
- Back Creek
- Goonoo Goonoo Creek
- Ryan's Oaky Creek
- Wombramurra Creek

A desktop assessment of aquatic habitats impacted as a results of the development are discussed in Section 5, including identification of where works forming part of the development footprint are required within waterways, primarily for site access and transport haul route upgrades.

3.1.4 Wetlands

The study area supports 388.51ha of mapped NSW wetlands, as detailed in **Table 8**. However each of these are contained within the 1,500m study area around small areas of road upgrades and related works along the transport route and none will be impacted by the development footprint.

Mapped wetlands include the Hunter River, Southern Hunter River, Throsby Creek and the Kooragang Nature Reserve (refer to **Figure 3, Page 25**). As outlined above, none of these will be directly or indirectly impacted by the development footprint.

Approximately 34.82ha of coastal wetlands, mapped under the State Environmental Planning Policy (SEPP) (Coastal Management) 2018, also occur within the study area, but will not be subject to any direct or indirect impacts associated with the project. These are situated at Newcastle and include the Southern Hunter River and Throsby Creek.

Table 8: NSW wetlands within the study area

Wetland group	Extent within study area (ha)
Reservoir/ dam	26.36
Floodplain wetland	5.40
Estuarine wetland	351.89
Freshwater lake	4.86
Total	388.51

3.1.5 Connectivity features

The study area for the wind farm and transmission line is well connected to vegetation both within and outside of the 1,500 m buffer study area surrounding the development footprint, with biodiversity features conserved in reserves, steep slopes and watercourses.

In the development footprint and study area, there are extensive agricultural pastures along ridgelines and low-lying topography is used as grazing land, with existing access roads, tracks and fence lines. Scattered and intermittent tree cover is present within grazing land. There are also grassy woodlands on the undulating foothills and escarpments.

Forested mountain tops are dominated by dense, mature forests, most notably associated with Ben Halls Gap Nature Reserve to the east, Hanging Rock to the north and Crawney Pass National Park to the west. Adjacent land uses include predominantly cattle grazing, as well as areas of forestry present to the north.

As required under Section 4.2 of the BAM for connectivity features:

- The connectivity of different areas of habitat that may facilitate the movement of threatened species across their range are identified on the Location Map (**Figure 3, Pages 2 to 13**); and
- No flyways for migratory species have been identified within the study area during desktop assessments, including extracts from the Bionet records and field assessments completed for this BDAR. As part of the Collision Risk Model (CRM) validation three seasons of bird utilisation surveys were completed. In addition, targeted surveys for threatened and migratory bird species surveys were undertaken in winter, spring and summer 2019 and autumn/winter 2020 and not flyways or substantial numbers of migratory species were observed.

The biodiversity corridors that facilitate the movement of threatened species across their range for this project can broadly be classified into two types. The first corridor provides for the maintenance of movement across the vegetated ridgelines and the second provides for movement of altitudinal migrants between the Mount Royal and Liverpool Ranges (**Figure 3, Pages 2 to 13**). The ridgeline corridors are associated with vegetation retained on upper ridgelines and steep slopes, with previous grazing land uses removing vegetation on more gentler slopes and foothills. Corridors extend from the range and escarpment, largely following vegetated watercourses where thin strips of riparian vegetation have been retained.

There is also a network of protected areas in the wider landscape associated with Ben Halls Gap Nature Reserve, Wallabadah Nature Reserve and Crawney Pass National Park. The biodiversity corridors within the study area, particularly along the ridgelines, provide important connectivity between these conservation areas.

The majority of these mapped corridors occur outside the development footprint and will not be directly or indirectly impacted by the project. The corridor that runs along the ridgeline connecting Ben Halls Gap to areas of native vegetation to the north and to Crawney Pass National Park intersects and adjoins part of the development footprint. This corridor will be maintained, as the spatial distribution of vegetation on the ridgeline where wind farm infrastructure and internal roads are proposed is fragmented and patchy. The larger patches of contiguous vegetation and habitat are located to the south and north of the ridgeline, within protected area reserves and steeper terrain and are not impacted by the development footprint.

3.1.6 Areas of geological significance and soil hazard features

Habitat features including karsts, caves, crevices and cliffs or other areas of geological significance are likely to occur within and adjacent to the study area. Field surveys have identified a number of areas of steep, rocky crevices on either side of the escarpment that provide potential roosting habitat for microbats. The location of steep cliff lines on the edge of the escarpments in the study area were mapped. The GIS desktop analysis was undertaken as follows:

- A 5 m Digital Elevation Model (DEM) was created from a LiDAR bare earth point cloud.

- Focal statistics were run on the DEM to create a surface representing the range of elevation in a 2x2m cell neighbourhood around each input cell (roughly a 10m buffer).
- Focal range surface was reclassified to remove areas with a range less than 3m between highest and lowest points in the neighbourhood.
- The resulting clifflines layer was symbolised to show areas of potential clifflines based on where the range was 3, 4, 5, 6, 7 or >7 metres within the 2x2 neighbourhood.

These areas of steep clifflines were used to identify all potential areas where cave-dwelling microbats could establish breeding or overnight roosts. These areas have been mapped in more detail in Section 4.3 of this BDAR.

In the wider landscape, outside of the study area defined by the BAM, there are known caves that support threatened cave bats.

- The presence of a known important winter roost site for Large Bent-winged Bat *Miniopterus schreibersii* subsp. *oceanensis* at Timor Caves, approximately 5 kilometres south-west of the study area.
- Four other known karst systems (caves) within 50 kilometres that support potential habitat for roosting and/or breeding microbats.
- The location of the development site is approximately 150 – 280 kilometres away from four known important maternity roost sites for Large-eared Pied Bat *Chalinolobus dwyerii* which are located to the the south and east of the development site, on the same side of the dividing range. This species is known to disperse around 200 kilometres to/from these maternity roosts, so there is a potential that some members of this species could utilise the development site for foraging and roosting.

Due to the presence of cliffs within and directly adjacent to the development site, and caves and karst landscapes in the wider locality, a detailed assessment of the presence and relative abundance of cave-dwelling bats was carried out and is reported on in subsequent sections of this BDAR.

There are no known significant soil hazard features at the time of preparing this BDAR.

A search of the ASC Soil Type Map of NSW (OEH, 2019) reveals that the Ferrosols soil type dominates the Project Area. Ferrosols are characterised by their deep red friable soils that lack strong texture contrast, which are high in free iron oxide and generally have a high clay content. Soils appeared generally stable during the field surveys, with a reasonable cover of exotic grasses or native vegetation in areas. There was some minor erosion associated with waterways observed during the field survey. This is likely due to the removal of riparian vegetation through historical clearing associated with agricultural land uses.

A search of the NSW EPA Contaminated Sites Register, identified the closest sites recorded to the project area are two sites within the Tamworth LGA and two sites within the Upper Hunter Shire LGA, located within Tamworth and Scone (over 50km away from the study area). As such it was determined that the project

location does not appear on the list of NSW contaminated sites. It was considered unlikely that contamination is present.

3.1.7 Biodiversity Values Map

The NSW Biodiversity Values Map identifies land with high biodiversity value that is particularly sensitive to impacts from development and clearing. The map forms part of the Biodiversity Offsets Scheme Threshold which is one of the triggers for determining whether the Biodiversity Offset Scheme (BOS) applies to a clearing or development proposal.

Based on a search of the NSW Biodiversity Values Map, there are areas of mapped high biodiversity value located within the study area as shown in **Figure 3, Pages 2 to 25**). The majority of the areas mapped in the Biodiversity Values Map are located outside of the development footprint and are associated with adjacent nature reserves, national park and higher order streams in the wind farm and transmission line corridor section of the project. There are only very small areas mapped in the Biodiversity Values Map within the development footprint in these areas (**Figure 3, Pages 2 to 12**).

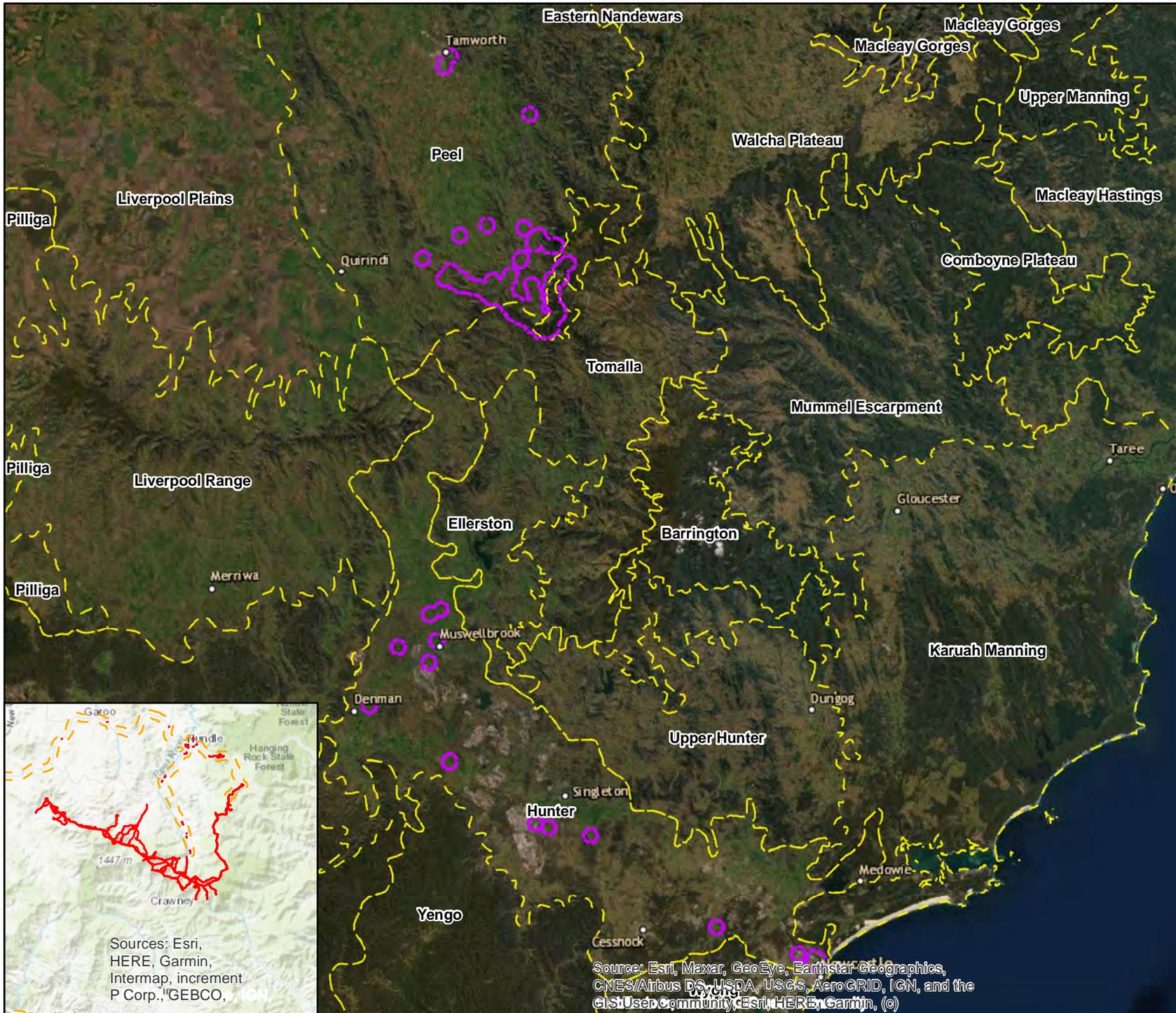
For the development footprint associated with the transport haul route there are no areas mapped in the Biodiversity Values Map (**Figure 3, Pages 13 to 25**).

3.1.8 Protected areas

Within the study area, but outside the development footprint there are two conservation areas protected by NSW legislation, which have been considered as part of the collection of baseline information on the ecological values of the study area and as part of the impact assessment.

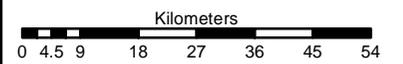
Ben Halls Gap Nature Reserve is located directly adjacent to the development area and in close proximity to the certain infrastructure and internal roads elements of the development footprint. This reserve covers over 2,500 hectares of tall, old growth eucalypt forest, with a mix of grassy eucalypt woodland, tall moist eucalypt forest and rainforest (NPWS, 2002). It contains important fauna habitat for a number of threatened species, including Koala *Phascolarctos cinereus*, Spotted-tailed Quoll *Dasyurus maculatus*, forest owls and microbats. Given the proximity of the Ben Halls Gap Nature Reserve to the development footprint additional field surveys were carried out to ground-truth the vegetation communities, condition and habitat features 100m into those parts of the reserve which adjoin the development footprint.

At its closest point, Crawney Pass National Park is located 50m from parts of the development footprint for the transmission line corridor. In most sections, there is an approximately 300m buffer from the national park boundary to the development footprint. The national park is just over 310ha in size and contains mostly grassy open eucalypt forests and woodlands, with some smaller patches of rainforest on lower slopes on major creeklines on the southern side of the park (NPWS, 2019). There are no known populations of threatened plants in the National Park however, it does provide habitat for Koala, forest owls, gliders and microbats.



 Landscape assessment buffer (study area)
 IBRA subregion

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

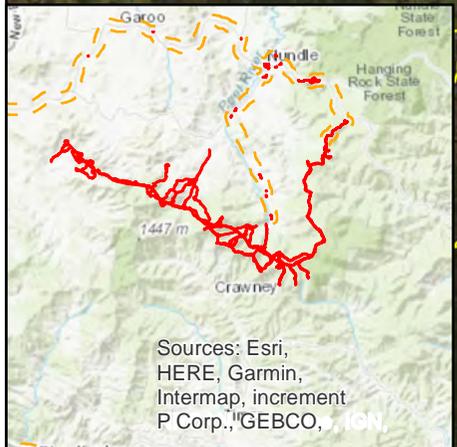
Job Title
Hills of Gold Wind Farm

Drawing Title
**Site map and location map
 Page 1**

Scale at A4	Drawing Status
1:1,168,611	Final

Coordinate System
GDA 1994 MGA Zone 56

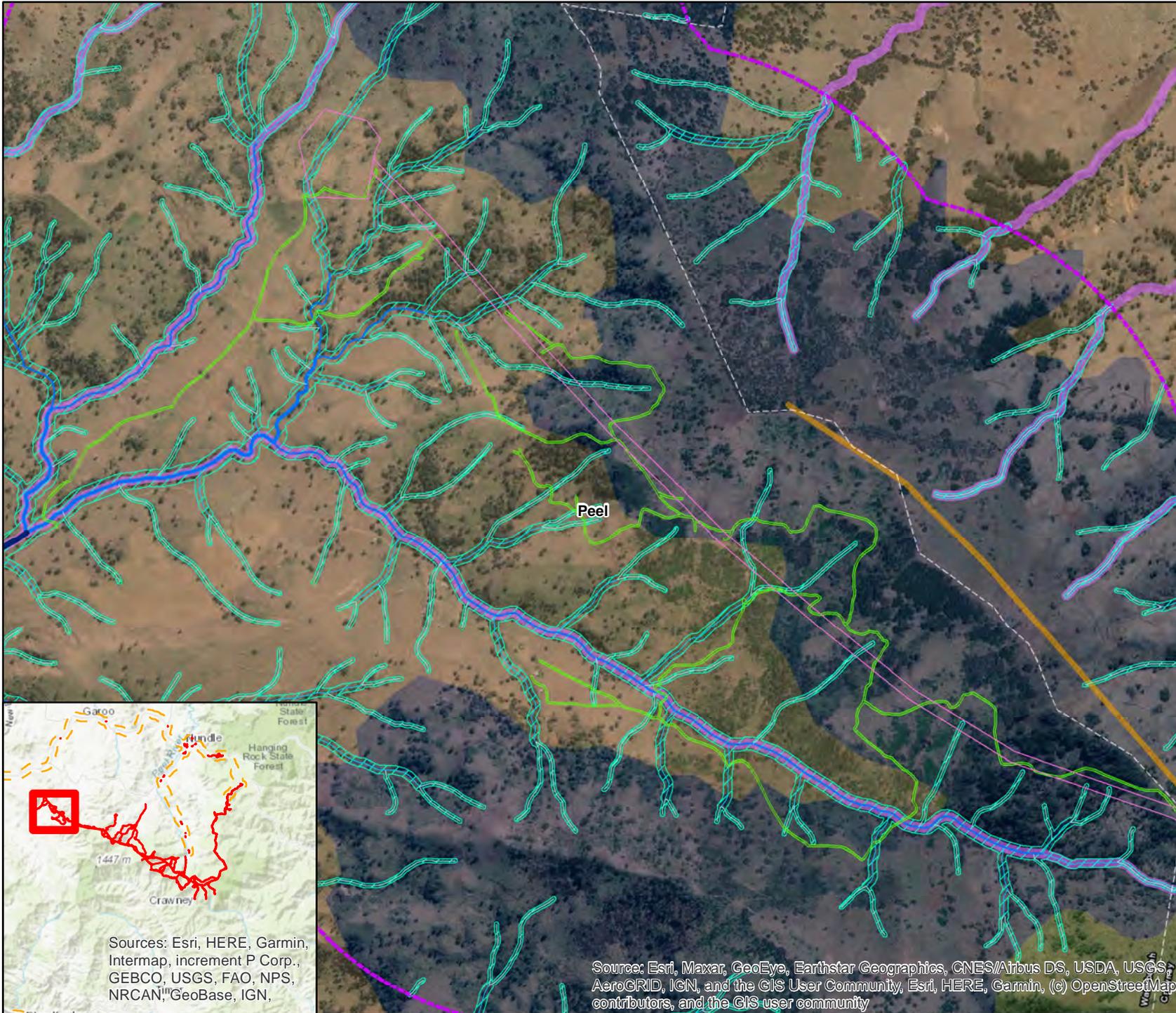
Job No	Drawing No
270335-00	003



Sources: Esri,
 HERE, Garmin,
 Intermap, increment
 P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics,
 CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the
 GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\marmal\Design\GIS\Figures\Site\Figures_Draft\BOAR_CJune2020\Draft\Figures_revised.mxd



Transmission line and switching
 Transmission line access tracks

Streams

Strahler stream order

- 1
- 2
- 3
- 4
- 5

Landscape assessment buffer (study area)

Biodiversity corridors (site mapped)

Type

- Ridgeline
- IBRA subregion
- Riparian lands (1500m buffer)
- Biodiversity Values Map (DPIE, 2020)

Mitchell Landscapes

landscapeN

- Mount Royal Ridges
- Mount Royal Tops
- Nundle Hills

D1	28/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers
 0.0 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

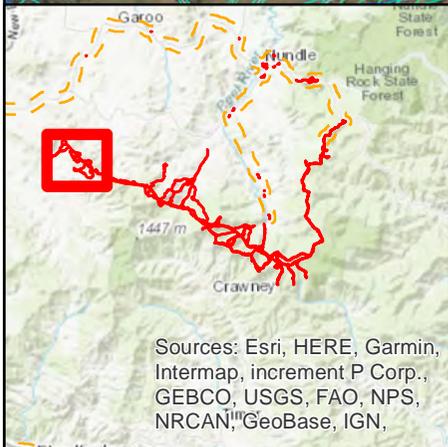
**Site map and location map
Page 2**

Scale at A4	Drawing Status
1:25,000	Final

Coordinate System

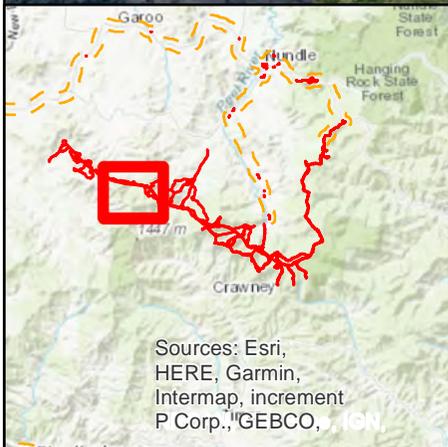
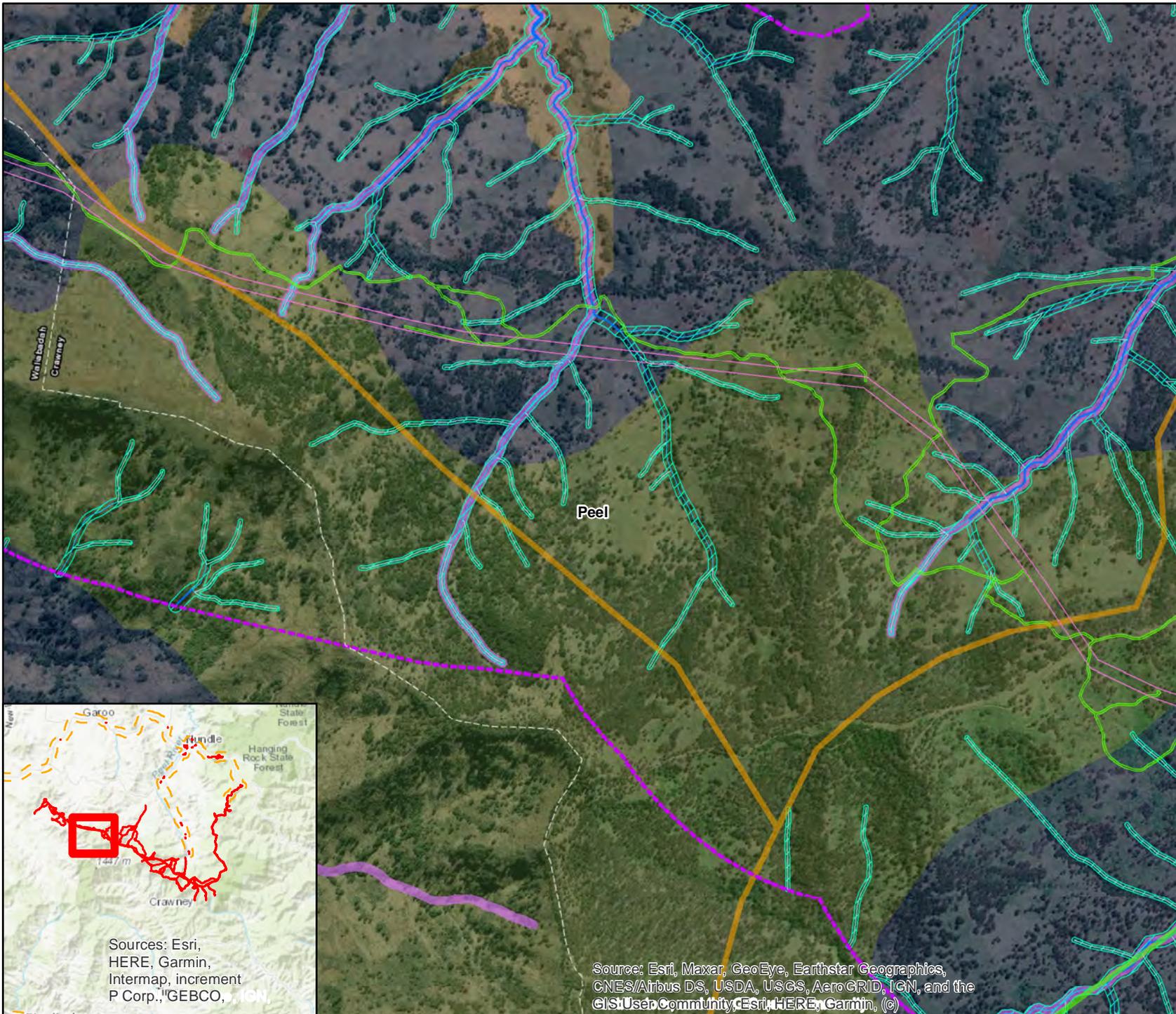
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	003



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

D:\270000\270335-00 Hills of Gold\Work\mmap\0 esg\mcs\figures\Drawn\ARUP June2020\Draw\Figures_revised_2.mxd



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

Transmission line and switching
 Transmission line access tracks
 Landscape assessment buffer (study area)

Biodiversity corridors (site mapped)

Type

- Altitudinal
- Ridgeline
- IBRA subregion

Streams

Strahler stream order

- 1
- 2
- 3
- 4

- Riparian lands (1500m buffer)
- Biodiversity Values Map (DPIE, 2020)

Mitchell Landscapes

landscapeN

- Mount Royal Ridges
- Mount Royal Tops
- Nundle Hills

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers
 0.0 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

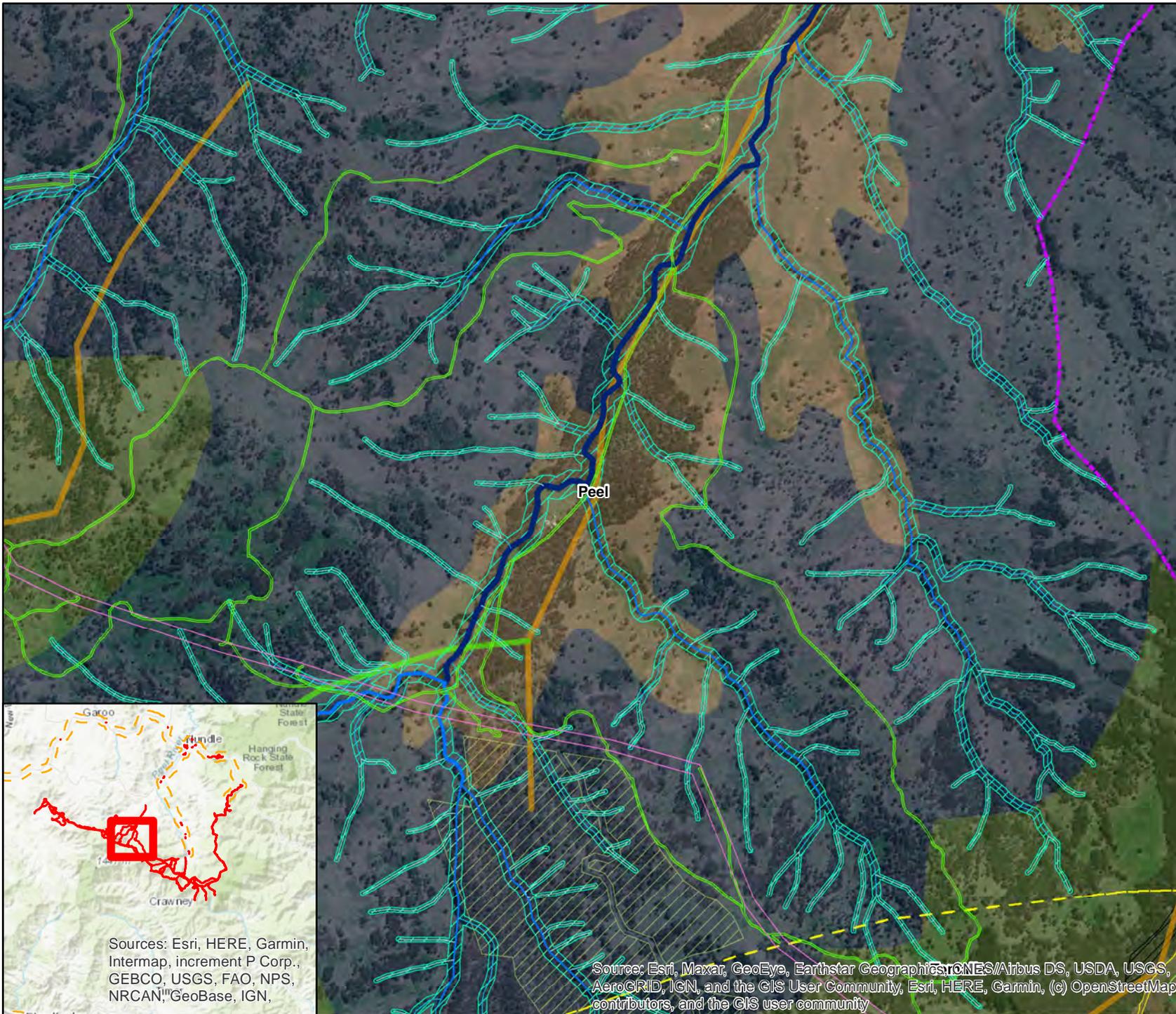
**Site map and location map
Page 3**

Scale at A4	Drawing Status
1:25,000	Final

Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	003



Wind farm infrastructure
 Transmission line and switching
 Internal roads
 Transmission line access tracks

Streams
 Strahler stream order
 1
 2
 3
 4
 5

Landscape assessment buffer (study area)

Biodiversity corridors (site mapped)
 Type
 Altitudinal
 Ridgeline
 Steep land (site mapped)
 IBRA subregion
 NPWS reserve
 Riparian lands (1500m buffer)

Mitchell Landscapes
 landscapeN
 Mount Royal Ridges
 Mount Royal Tops
 Nundle Hills

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers
 0.0 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

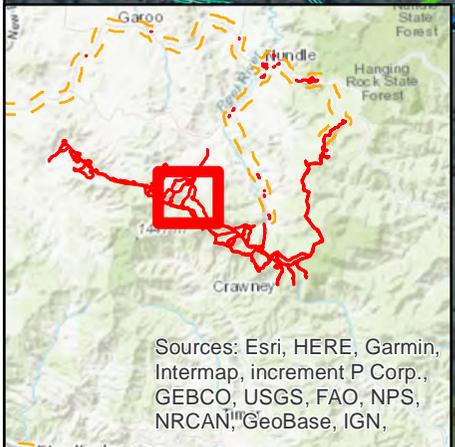
Job Title
Hills of Gold Wind Farm

Drawing Title
**Site map and location map
 Page 4**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

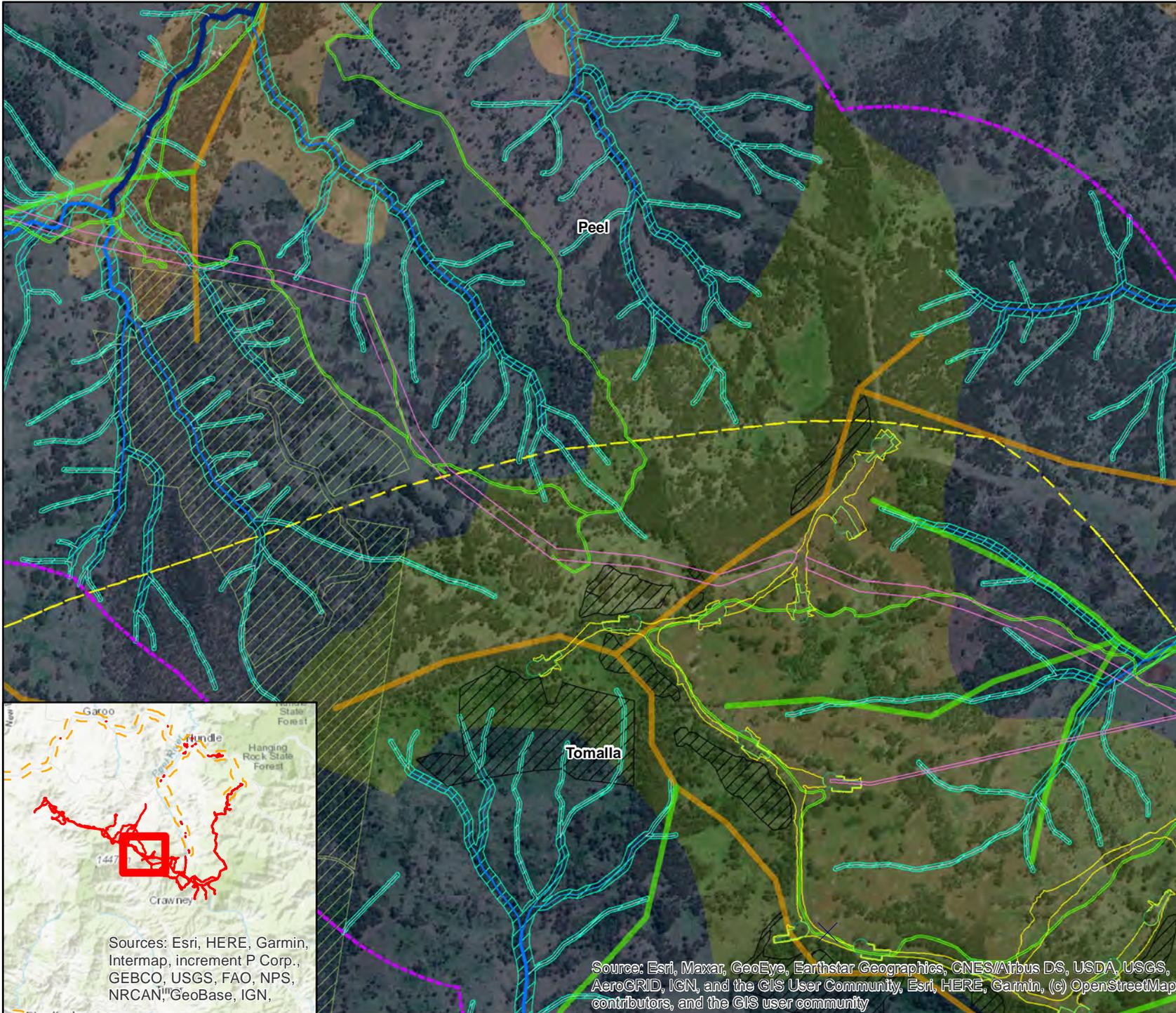
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 003
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

J:\270000\270335-00 Hills of Gold\Work\mmap\05esigns\Figures\Drawn\ARUP June2020\Draw\Figures_revised.mxd



	Wind farm infrastructure
	Transmission line and switching
	Internal roads
	Transmission line access tracks

Streams

Strahler stream order

	1
	2
	3
	4
	5

Landscape assessment buffer (study area)

Biodiversity corridors (site mapped)

Type

	Altitudinal
	Ridgeline
	Steep land (site mapped)
	IBRA subregion
	NPWS reserve
	Riparian lands (1500m buffer)

Mitchell Landscapes

landscapeN

	Manning Great Escarpment Western Aspects
	Mount Royal Ridges
	Mount Royal Tops
	Nundle Hills

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers
0.0 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

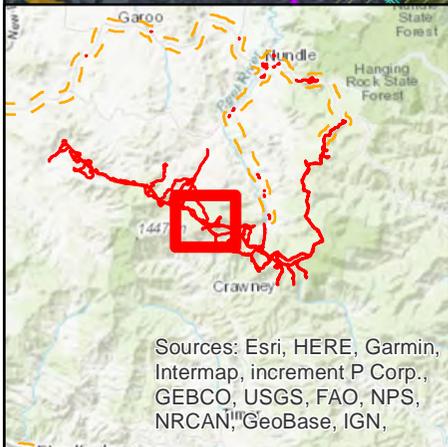
Job Title
Hills of Gold Wind Farm

Drawing Title
**Site map and location map
Page 6**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

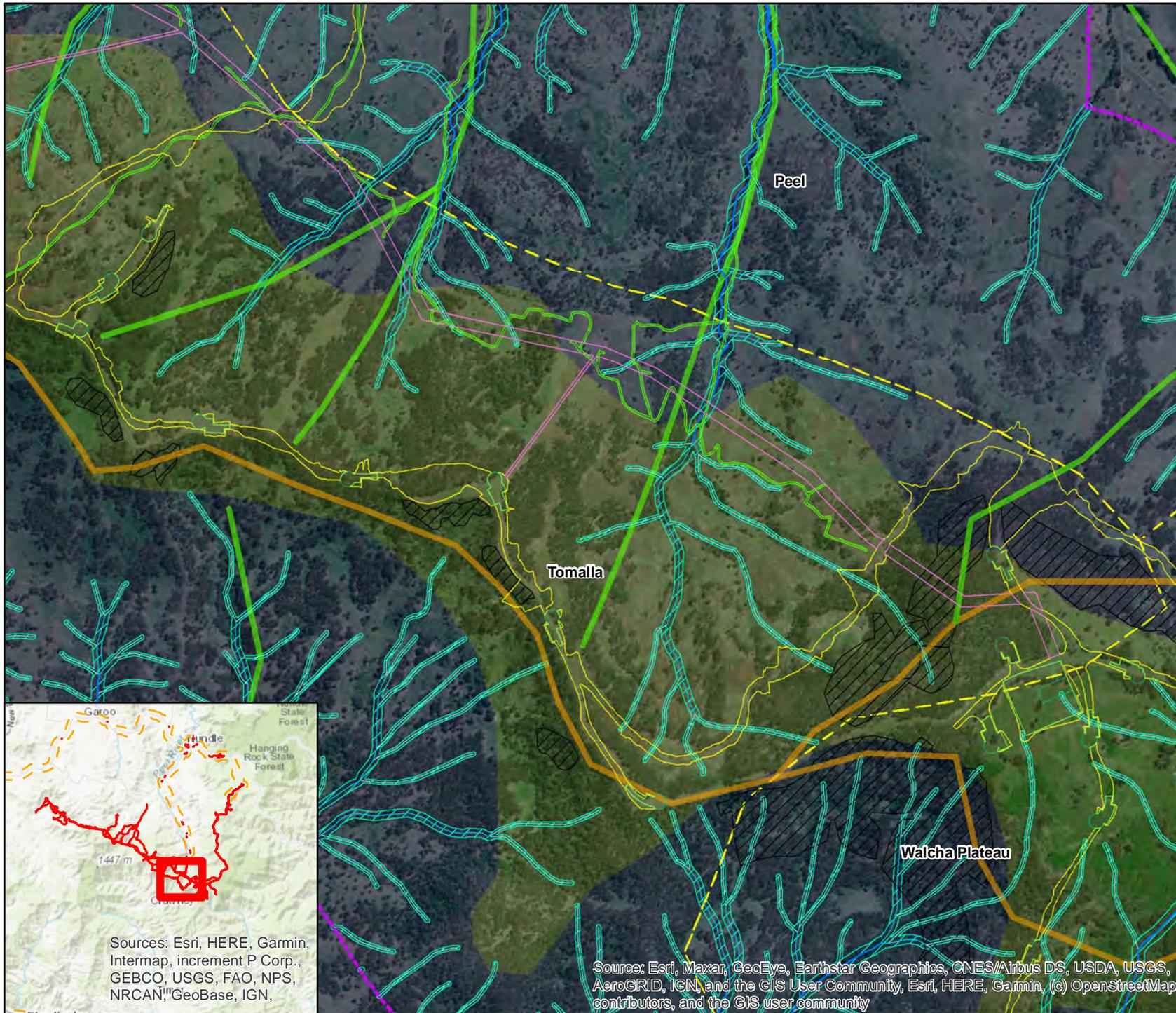
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 003
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

D:\270000\270335-00 Hills of Gold\Work\mama\design\cs\figures\Drawn\ARUP June 2020\Draw\Figures_revised.mxd



— Wind farm infrastructure
— Transmission line and switching
— Internal roads
— Transmission line access tracks

Streams

Strahler stream order

— 1
— 2
— 3
— 4

Landscape assessment buffer (study area)

Biodiversity corridors (site mapped)

Type

— Altitudinal
— Ridgeline
 Steep land (site mapped)
 IBRA subregion
 Riparian lands (1500m buffer)

Mitchell Landscapes

landscapeN

Manning Great Escarpment Western Aspects
 Mount Royal Ridges
 Mount Royal Tops

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers
 0.0 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

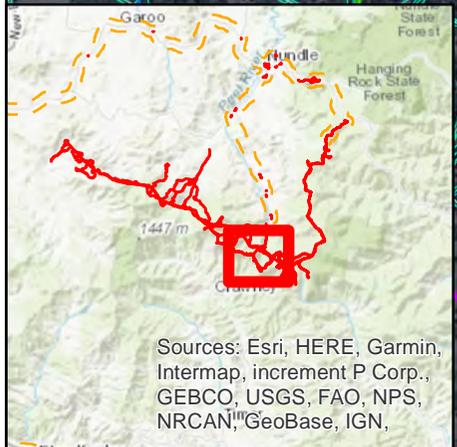
**Site map and location map
Page 7**

Scale at A4	Drawing Status
1:25,000	Final

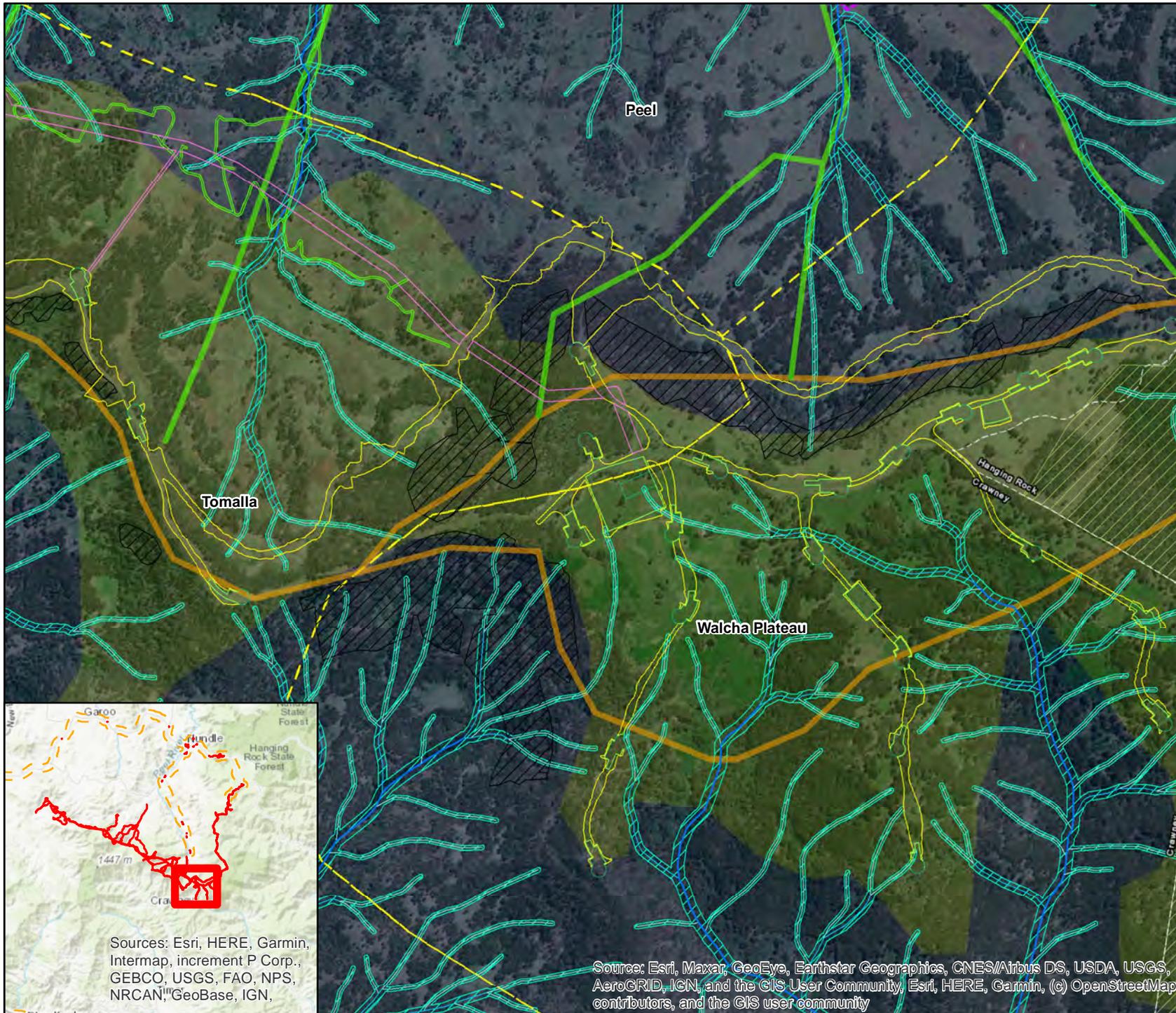
Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	003



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community



 Wind farm infrastructure
 Transmission line and switching
 Internal roads
 Transmission line access tracks

Streams

Strahler stream order

- 1
- 2
- 3
- 4

 Landscape assessment buffer (study area)

Biodiversity corridors (site mapped)

Type

- Altitudinal
- Ridgeline
- Steep land (site mapped)
- IBRA subregion
- NPWS reserve
- Riparian lands (1500m buffer)

Mitchell Landscapes

landscapeN

- Manning Great Escarpment Western Aspects
- Mount Royal Ridges
- Mount Royal Tops

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

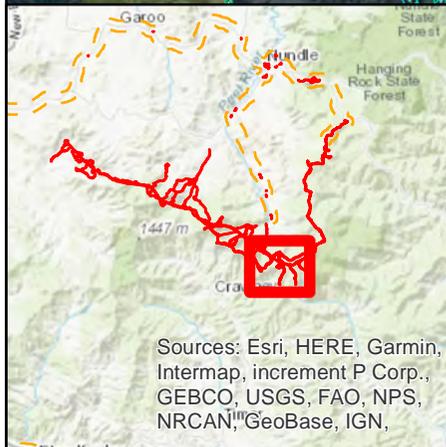
**Site map and location map
Page 9**

Scale at A4	Drawing Status
1:25,000	Final

Coordinate System

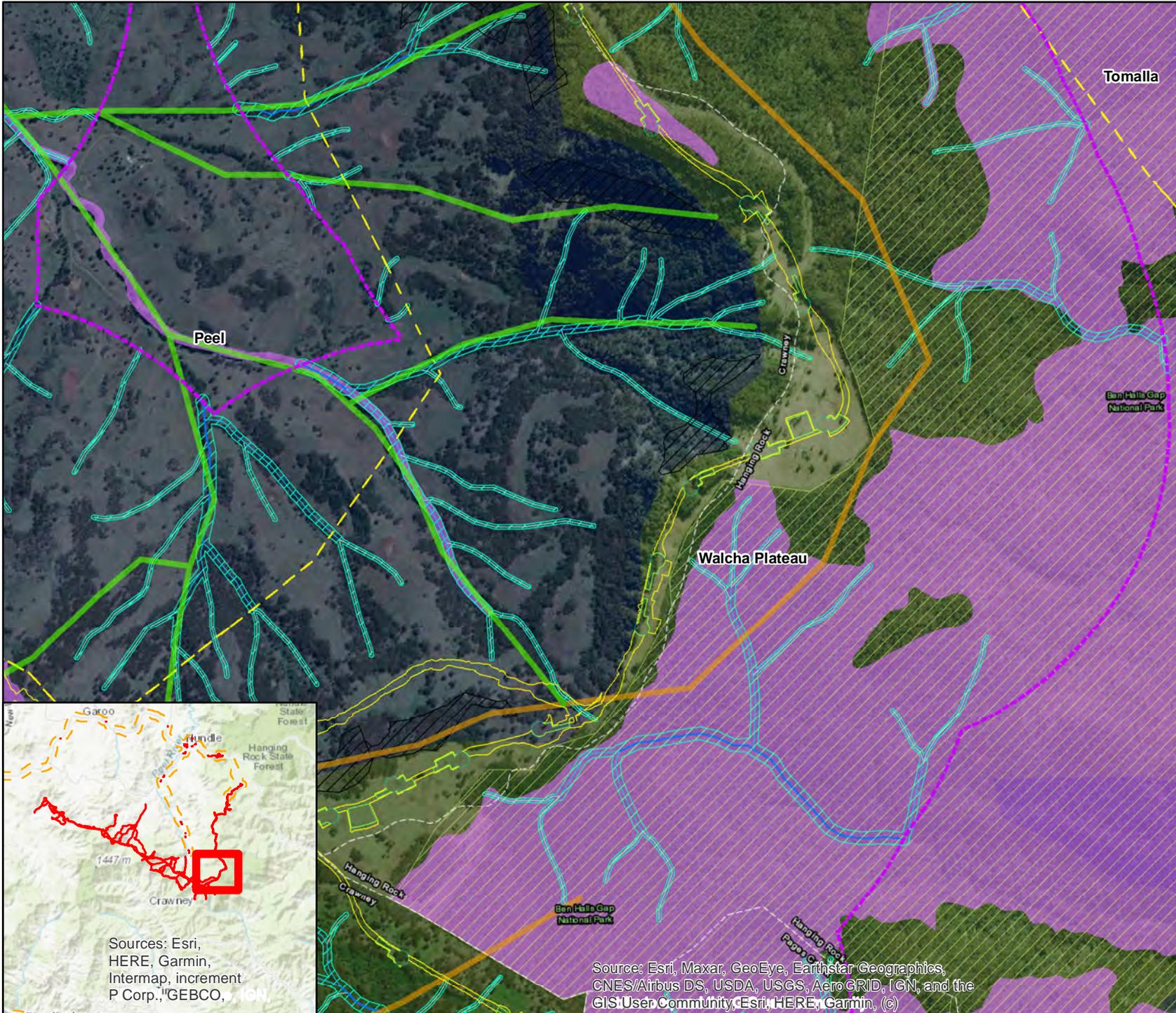
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	003



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

D:\270000\270335-00 Hills of Gold\Work\mama\05\mgs\cs\figures\Drawn\ARUP June2020\Draw\Figures_revised.mxd



Wind farm infrastructure
 Transmission line and switching
 Internal roads
 Landscape assessment buffer (study area)

Biodiversity corridors (site mapped)

Type

- Altitudinal
- Ridgeline
- Steep land (site mapped)
- IBRA subregion
- NPWS reserve

Streams

Strahler stream order

- 1
- 2
- 3

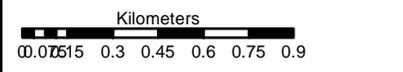
- Riparian lands (1500m buffer)
- Biodiversity Values Map (DPIE, 2020)

Mitchell Landscapes

landscapeN

- Mount Royal Ridges
- Mount Royal Tops

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

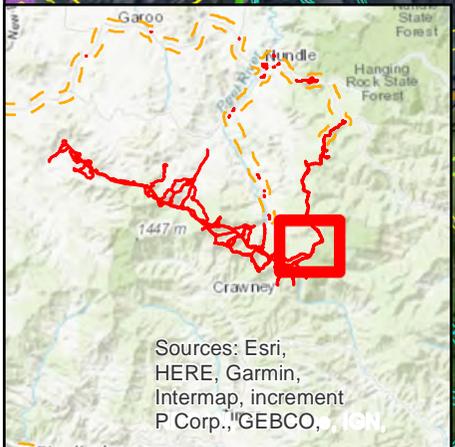
Job Title
Hills of Gold Wind Farm

Drawing Title
**Site map and location map
 Page 10**

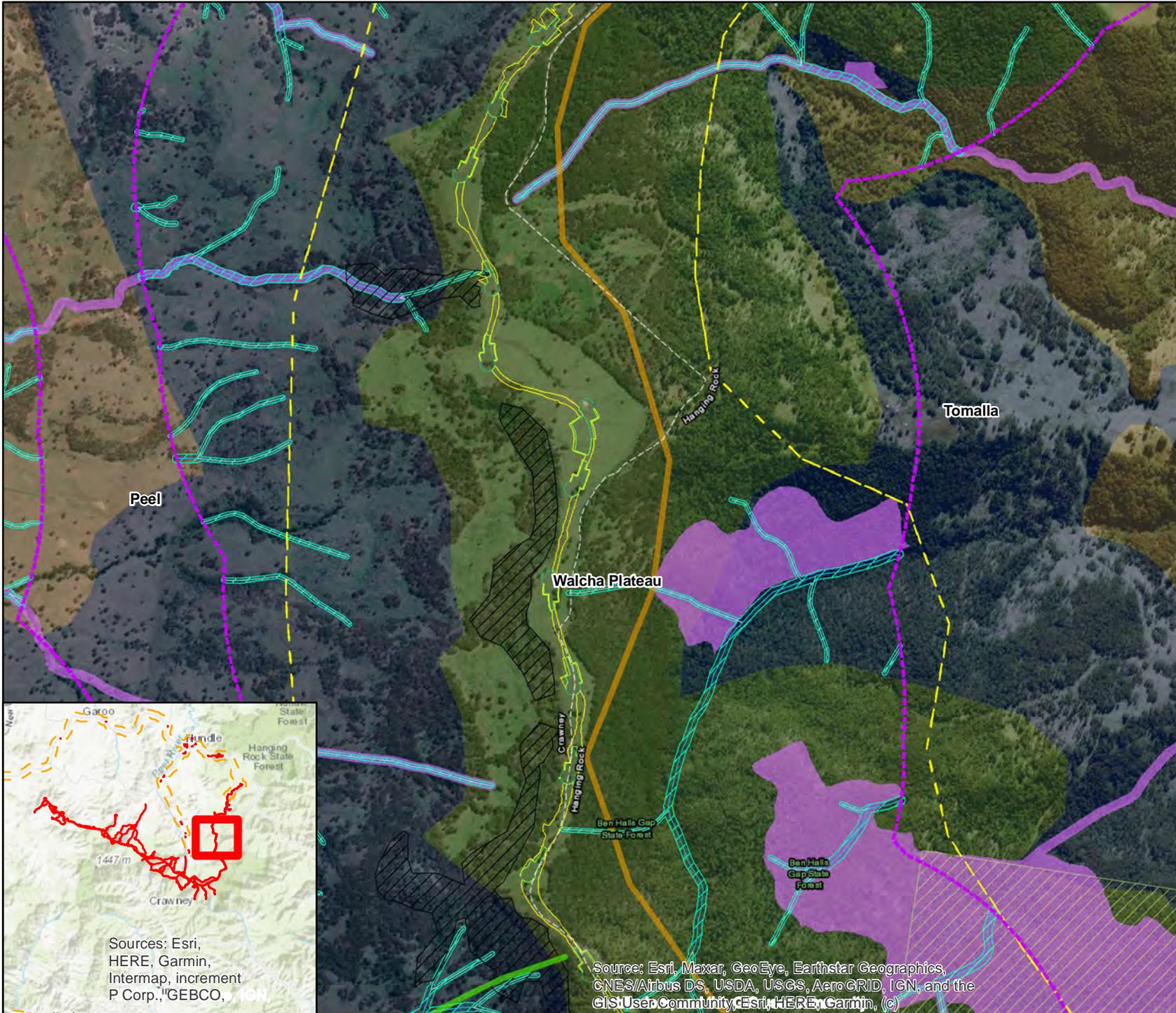
Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 003
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



 Wind farm infrastructure
 Internal roads
 Landscape assessment buffer (study area)

Biodiversity corridors (site mapped)

Type

- Altitudinal
- Ridgeline
- Steep land (site mapped)
- IBRA subregion
- NPWS reserve

Streams

Strahler stream order

- 1
- 2
- 3

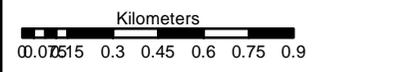
- Riparian lands (1500m buffer)
- Biodiversity Values Map (DPIE, 2020)

Mitchell Landscapes

landscapeN

- Manning Great Escarpment Southern Aspects
- Mount Royal Ridges
- Mount Royal Tops
- Nundle Hills

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

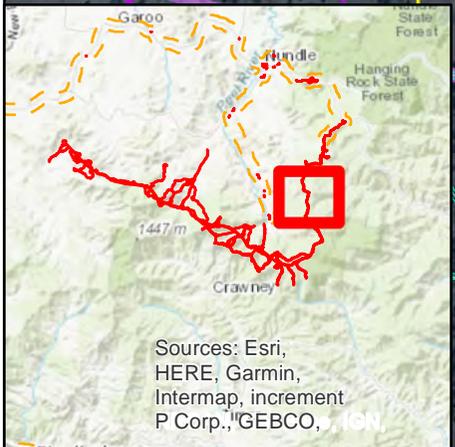
Job Title
Hills of Gold Wind Farm

Drawing Title
**Site map and location map
 Page 11**

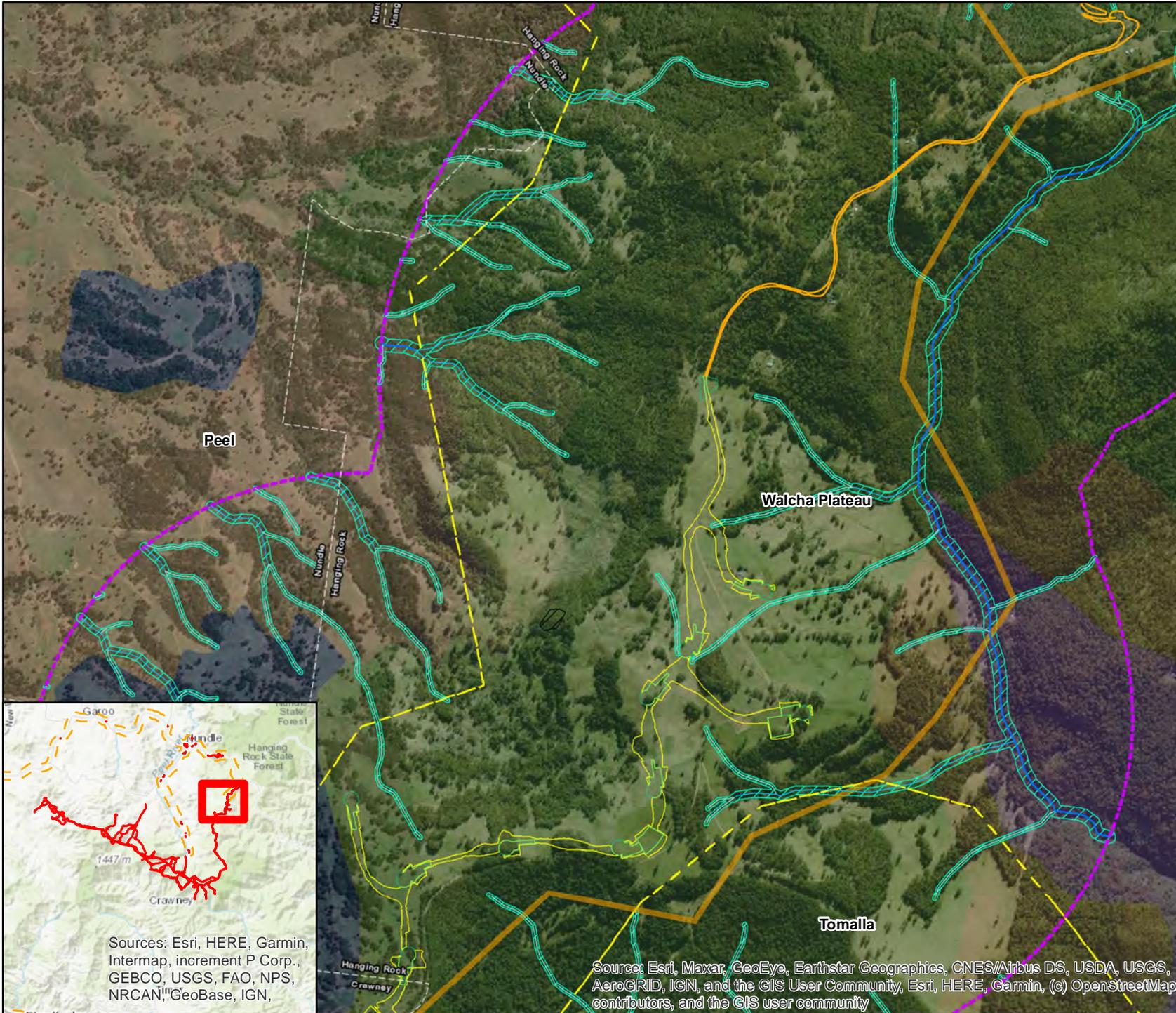
Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 003
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



— Transport route development footprint (port to site)
— Wind farm infrastructure
— Internal roads

Streams

Strahler stream order

— 1
— 2
— 3

- - - Landscape assessment buffer (study area)

Biodiversity corridors (site mapped)

Type

— Ridgeline
 Steep land (site mapped)
 IBRA subregion
 Riparian lands (1500m buffer)

Mitchell Landscapes

landscapeN

Manning Great Escarpment Southern Aspects
 Moonbi - Walcha Granites
 Mount Royal Ridges
 Mount Royal Tops
 Nowendoc - Yarras Serpentine
 Nundie Hills

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers
 0.0 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Site map and location map
Page 12**

Scale at A4	Drawing Status
1:25,000	Final

Coordinate System

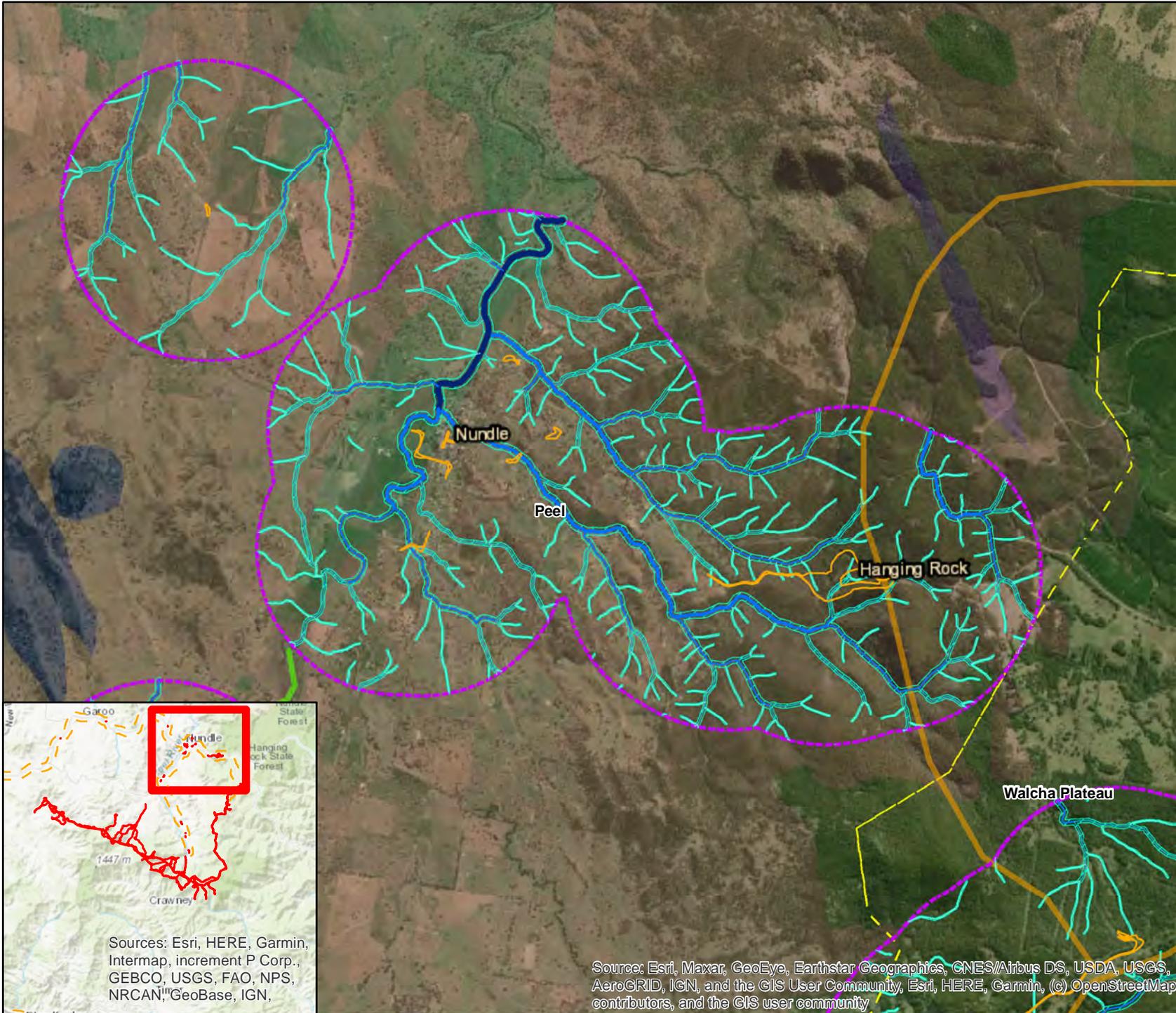
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	003

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

I:\270000\270335-00 Hills of Gold\Work\main\05\mains\figures\Drawings\Drawings\June2020\Draw\Figures_revised.mxd



Transport route development footprint (port to site)

Streams
 Strahler stream order
 1
 2
 3
 4
 5
 Landscape assessment buffer (study area)

Biodiversity corridors (site mapped)
 Type
 Altitudinal
 Ridgeline
 IBRA subregion
 Riparian lands (1500m buffer)

Mitchell Landscapes
 landscapeN
 Moonbi - Walcha Granites
 Mount Royal Ridges
 Mount Royal Tops
 Nowendoc - Yarras Serpentine
 Nundle Hills
 Tamworth - Keepit Slopes and Plains

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers
 0 0.2 0.4 0.8 1.2 1.6 2 2.4

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

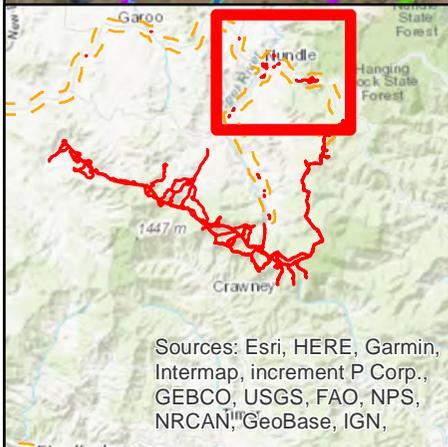
Job Title
Hills of Gold Wind Farm

Drawing Title
**Site map and location map
 Page 13**

Scale at A4 1:55,885	Drawing Status Final
--------------------------------	--------------------------------

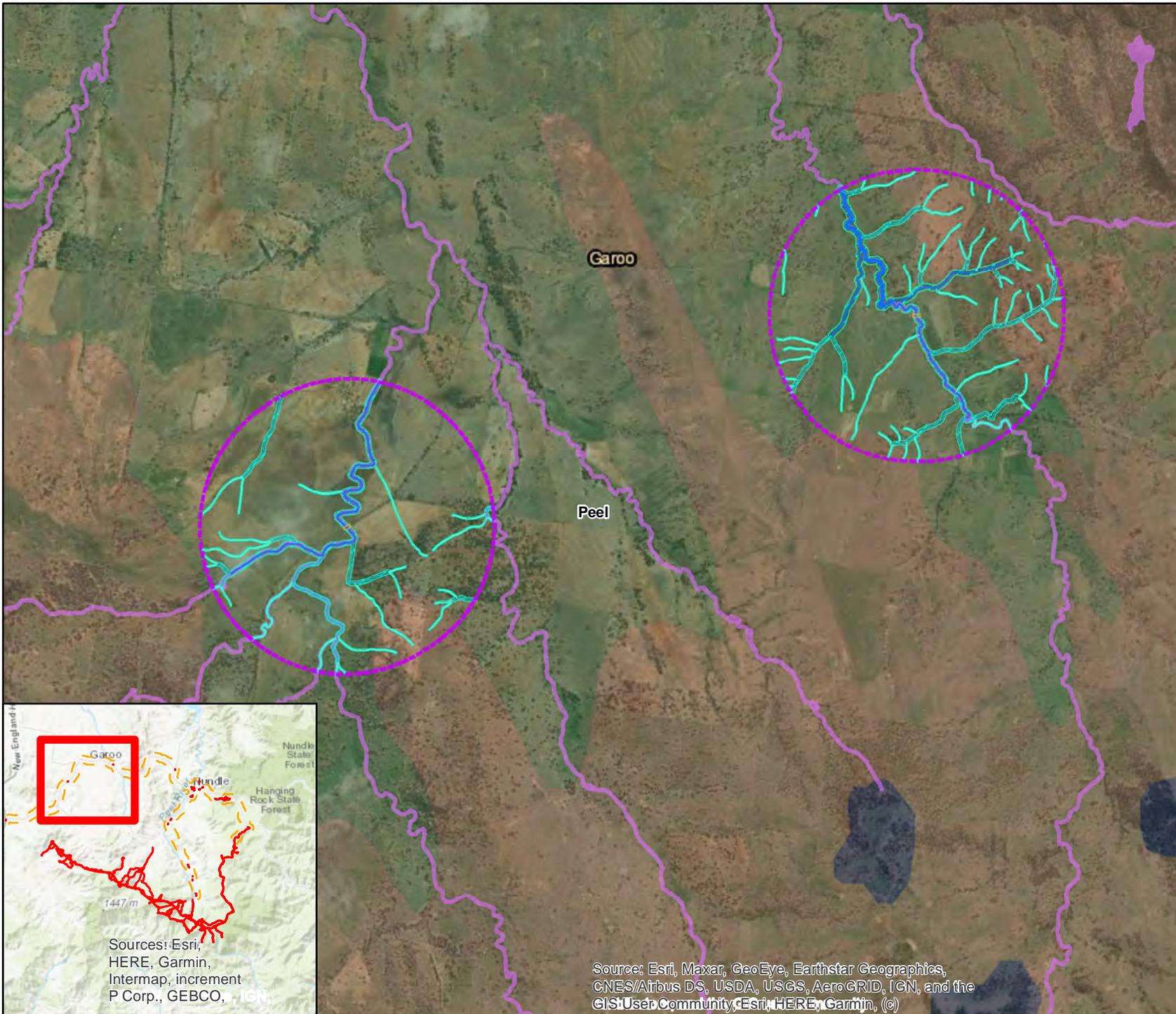
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 003
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

D:\270000\270335-00 Hills of Gold\Work\mmap\05sign\cs1\figures\Drawn\ARUP_270335-00\Drawn\Figures_revised.mxd



-  Transport route (port to site)
-  Landscape assessment buffer (study area)
-  IBRA subregion

Streams

Strahler stream order

-  1
-  2
-  3
-  4

 Riparian lands (1500m buffer)

 Biodiversity Values Map (DPIE, 2020)

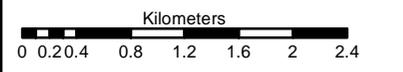
Mitchell Landscapes

landscapeN

-  Mount Royal Ridges
-  Nundle Hills
-  Tamworth - Keepit Slopes and Plains



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Site map and location map
Page 14**

Scale at A4

1:55,753

Drawing Status

Final

Coordinate System

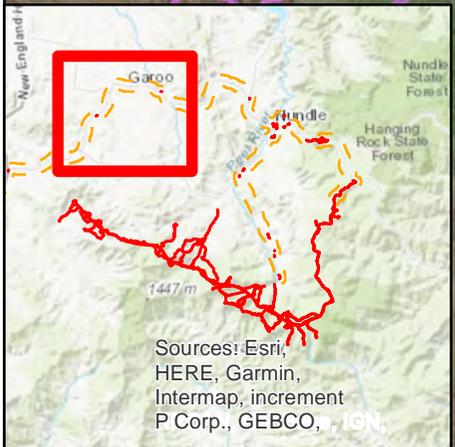
GDA 1994 MGA Zone 56

Job No

270335-00

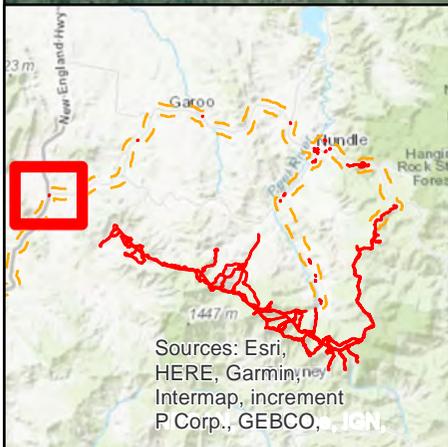
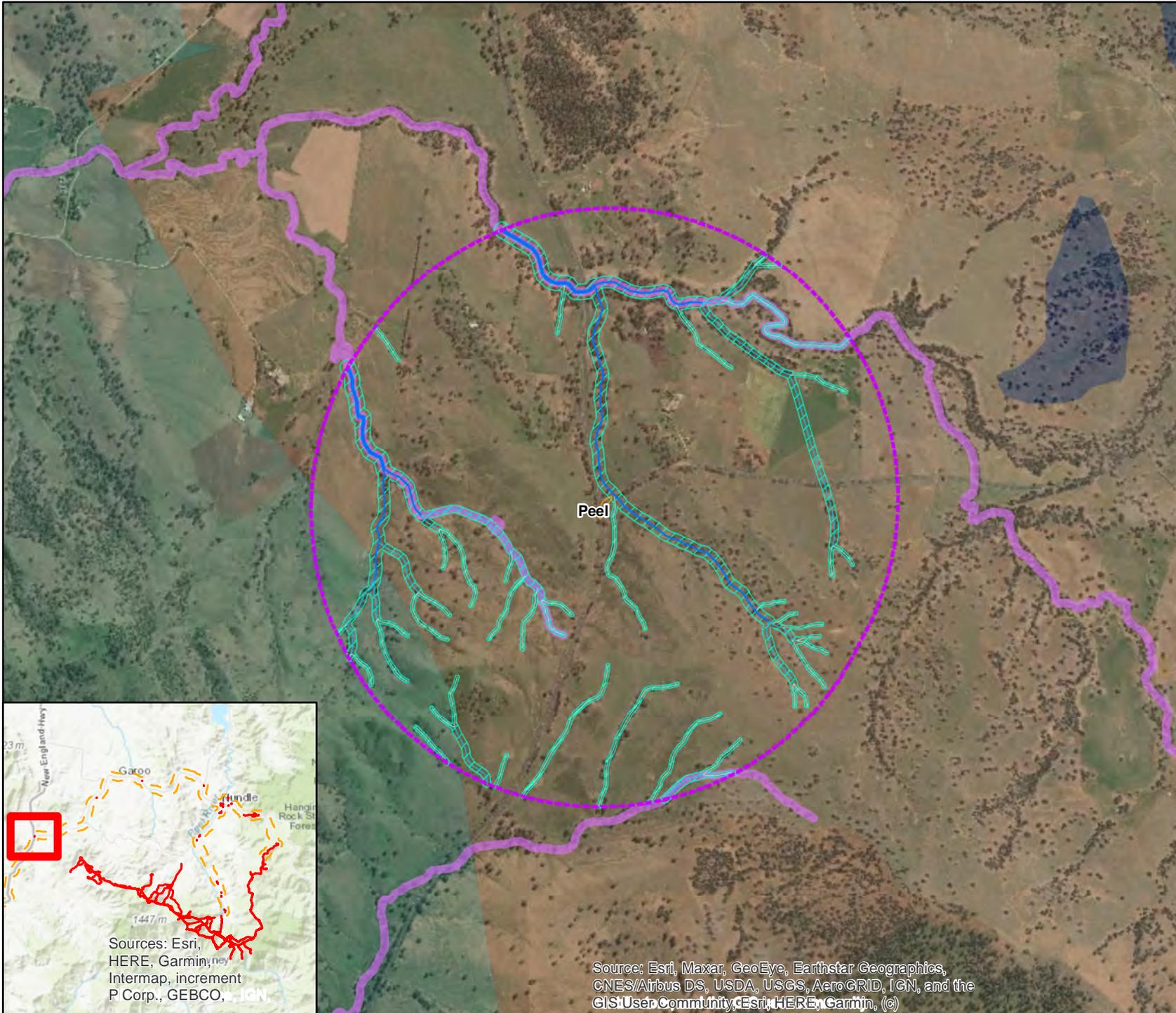
Drawing No

003



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

- Transport route (port to site)
- Landscape assessment buffer (study area)
- IBRA subregion

Streams

Strahler stream order

- 1
- 2
- 3
- 4

Riparian lands (1500m buffer)

Biodiversity Values Map (DPIE, 2020)

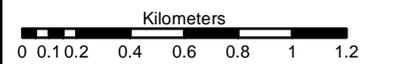
Mitchell Landscapes

landscapeN

- Mount Royal Ridges
- Nundle Hills
- Slippery Rock Range



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Site map and location map
Page 15**

Scale at A4

1:27,942

Drawing Status

Final

Coordinate System

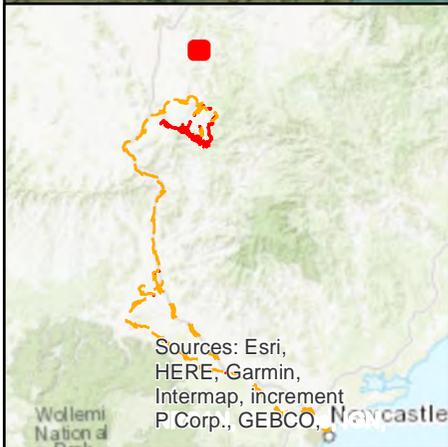
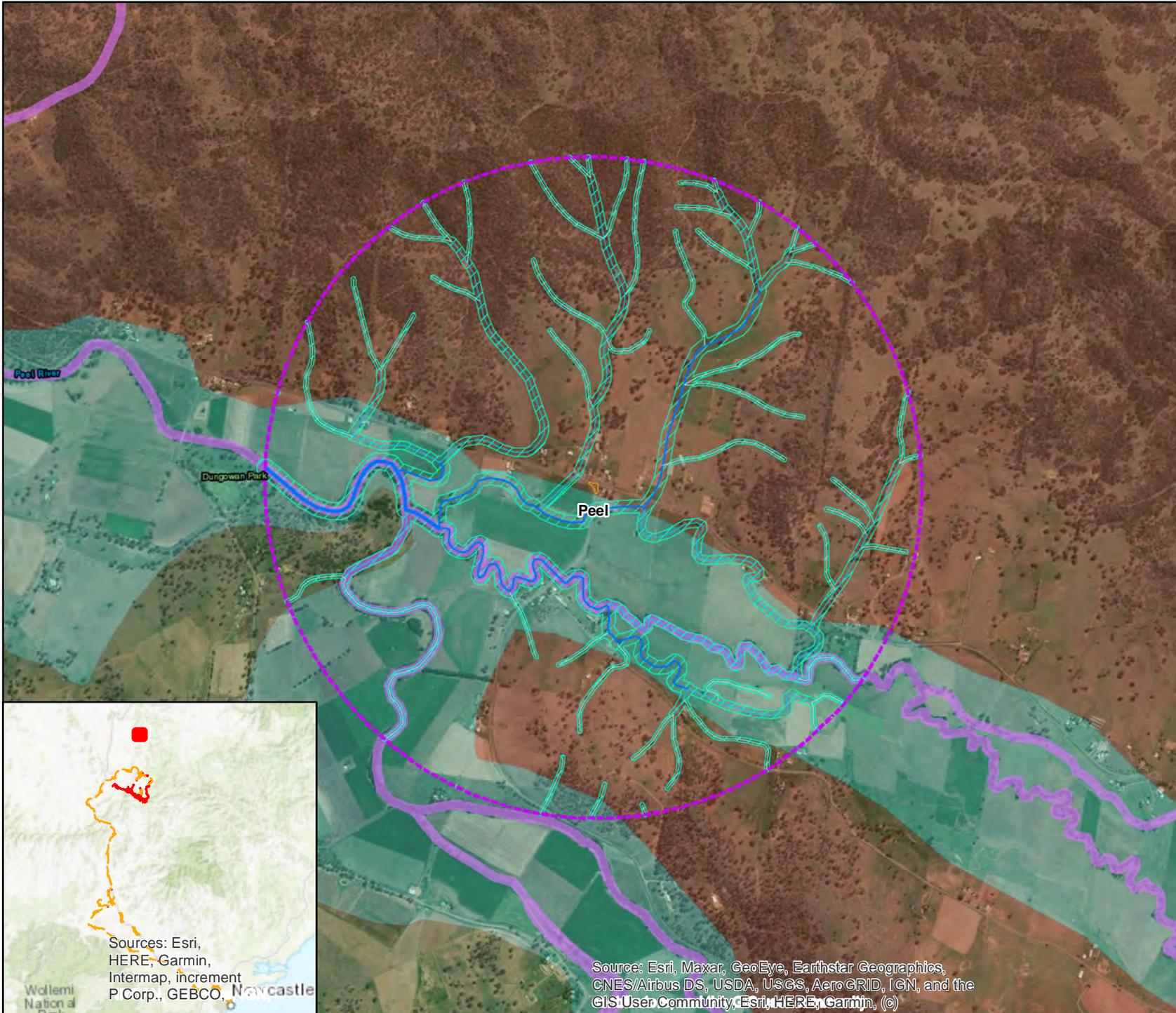
GDA 1994 MGA Zone 56

Job No

270335-00

Drawing No

003



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

	Transport route (port to site)
	Development footprint
	Landscape assessment buffer (study area)
	IBRA subregion

Streams

Strahler stream order

	1
	2
	3
	4

Riparian lands (1500m buffer)

Biodiversity Values Map (DPIE, 2020)

Mitchell Landscapes

landscapeN

	Niangala Plateau and Slopes
	Peel Channels and Floodplain
	Tamworth - Keppit Slopes and Plains

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

0.0 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Site map and location map
Page 16**

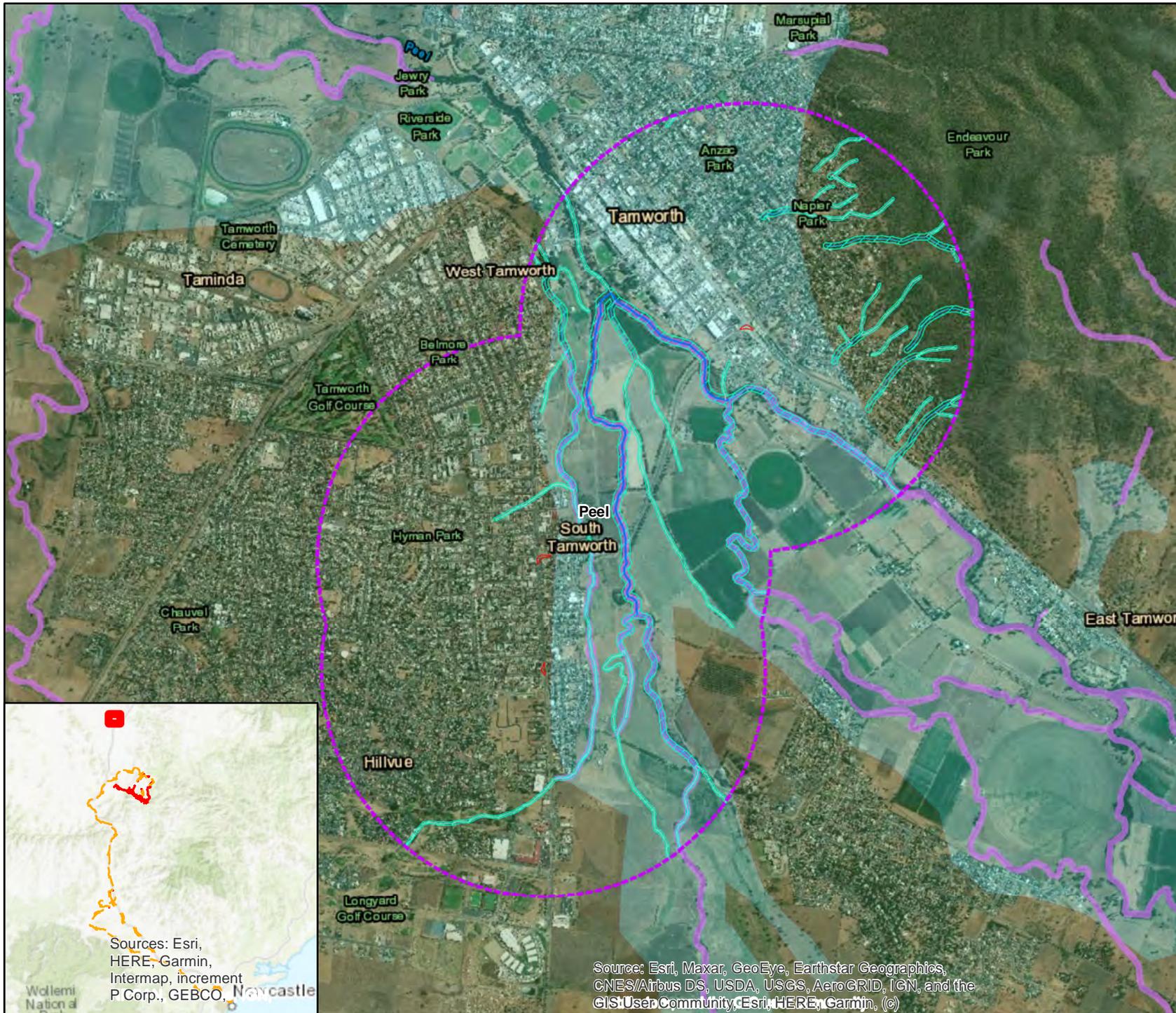
Scale at A4	Drawing Status
1:24,718	Final

Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	003

© Arup



Development footprint
 Landscape assessment buffer (study area)
 IBRA subregion

Streams

Strahler stream order

1
 2
 3

Riparian lands (1500m buffer)
 Biodiversity Values Map (DPIE, 2020)

Mitchell Landscapes

landscapeN

Peel Channels and Floodplain
 Tamworth - Keepit Slopes and Plains

↑

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

00.125 0.25 0.5 0.75 1 1.25 1.5

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Site map and location map
Page 17**

Scale at A4	Drawing Status
1:36,327	Final

Coordinate System

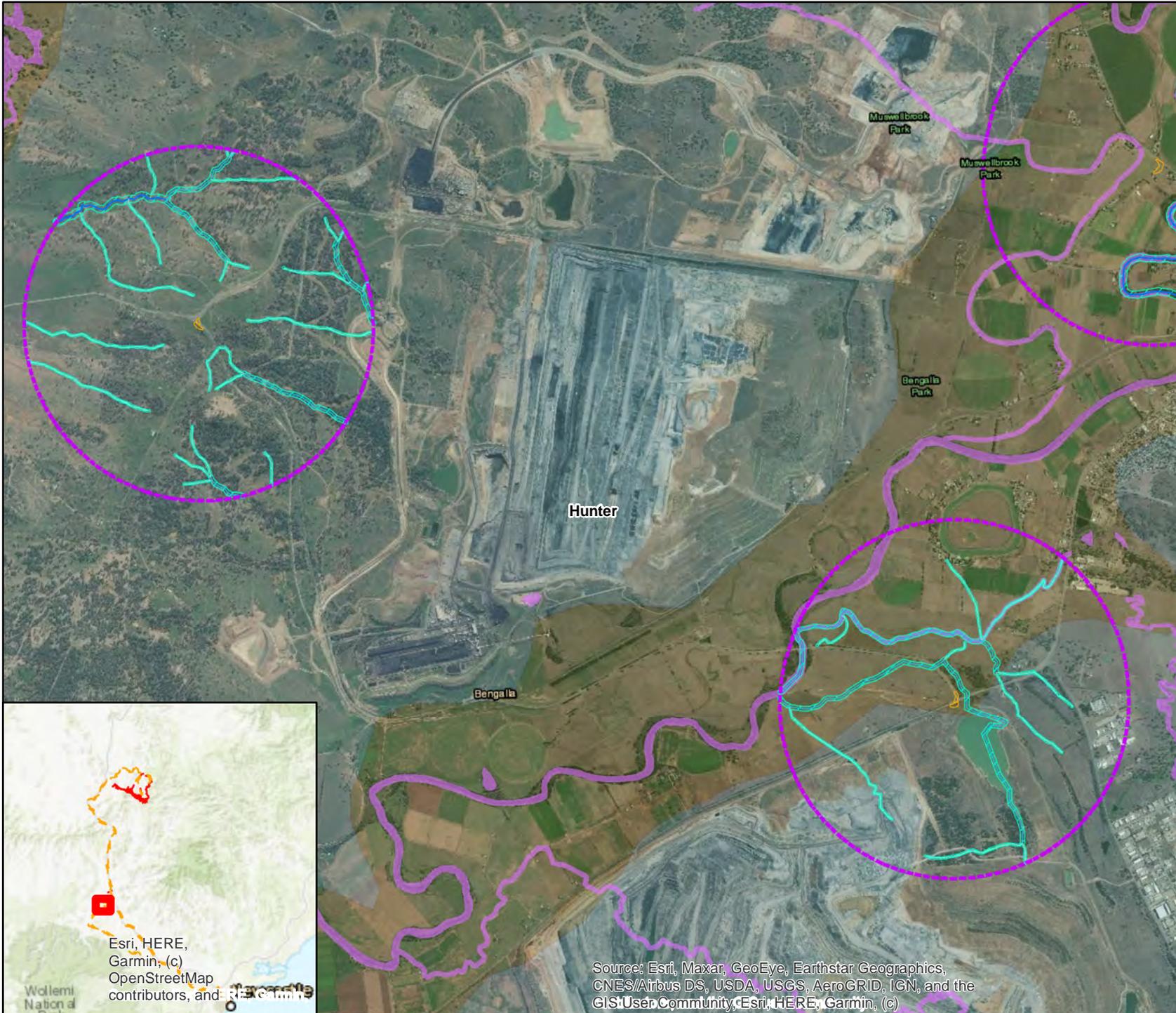
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	003



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Site\Figures\Drawn\ARUP_June2020\Drawn\Figures_revised.mxd



- Transport route (port to site)
- Landscape assessment buffer (study area)
- IBRA subregion

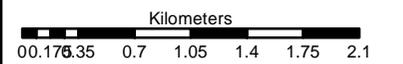
Streams

- Strahler stream order**
- 1
 - 2
 - 3
- Riparian lands (1500m buffer)
 - Biodiversity Values Map (DPIE, 2020)

Mitchell Landscapes

- landscapeN**
- Central Hunter Foothills
 - Upper Hunter Channels and Floodplain

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Site map and location map
Page 19**

Scale at A4 1:46,989	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

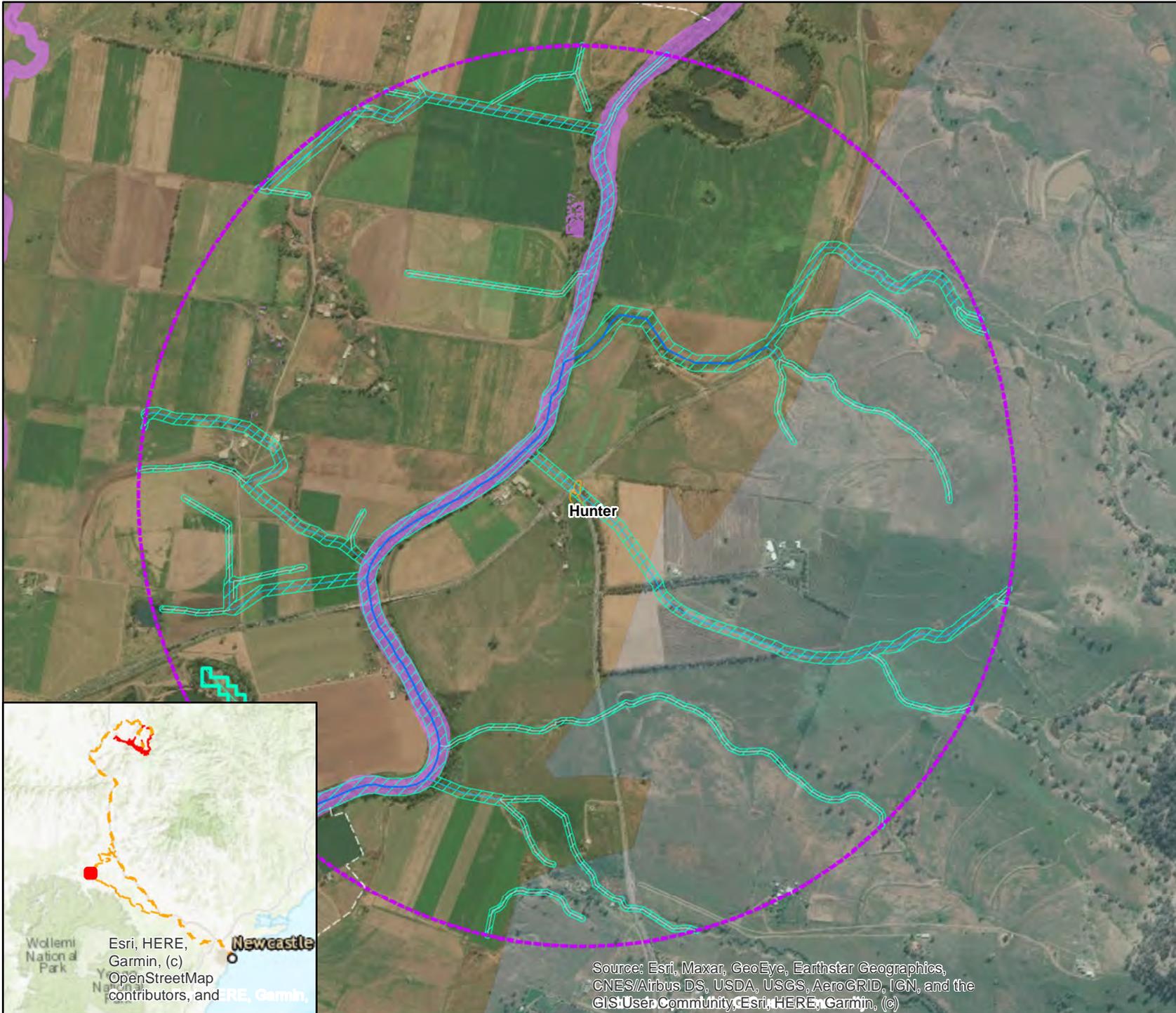
Job No 270335-00	Drawing No 003
----------------------------	--------------------------



Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS User Community, Esri, HERE, Garmin, (c)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Site\Figures_Draft\B04R_CJune2020\Draft\Figures_revised.mxd



- Transport route (port to site)
- Landscape assessment buffer (study area)
- IBRA subregion

Streams

Strahler stream order

- 1
- 2
- 3
- NSW wetlands
- Riparian lands (1500m buffer)
- Biodiversity Values Map (DPIE, 2020)

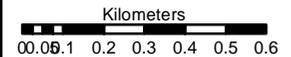
Mitchell Landscapes

landscapeN

- Central Hunter Foothills
- Upper Hunter Channels and Floodplain



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Site map and location map
 Page 20**

Scale at A4 1:18,542	Drawing Status Final
--------------------------------	--------------------------------

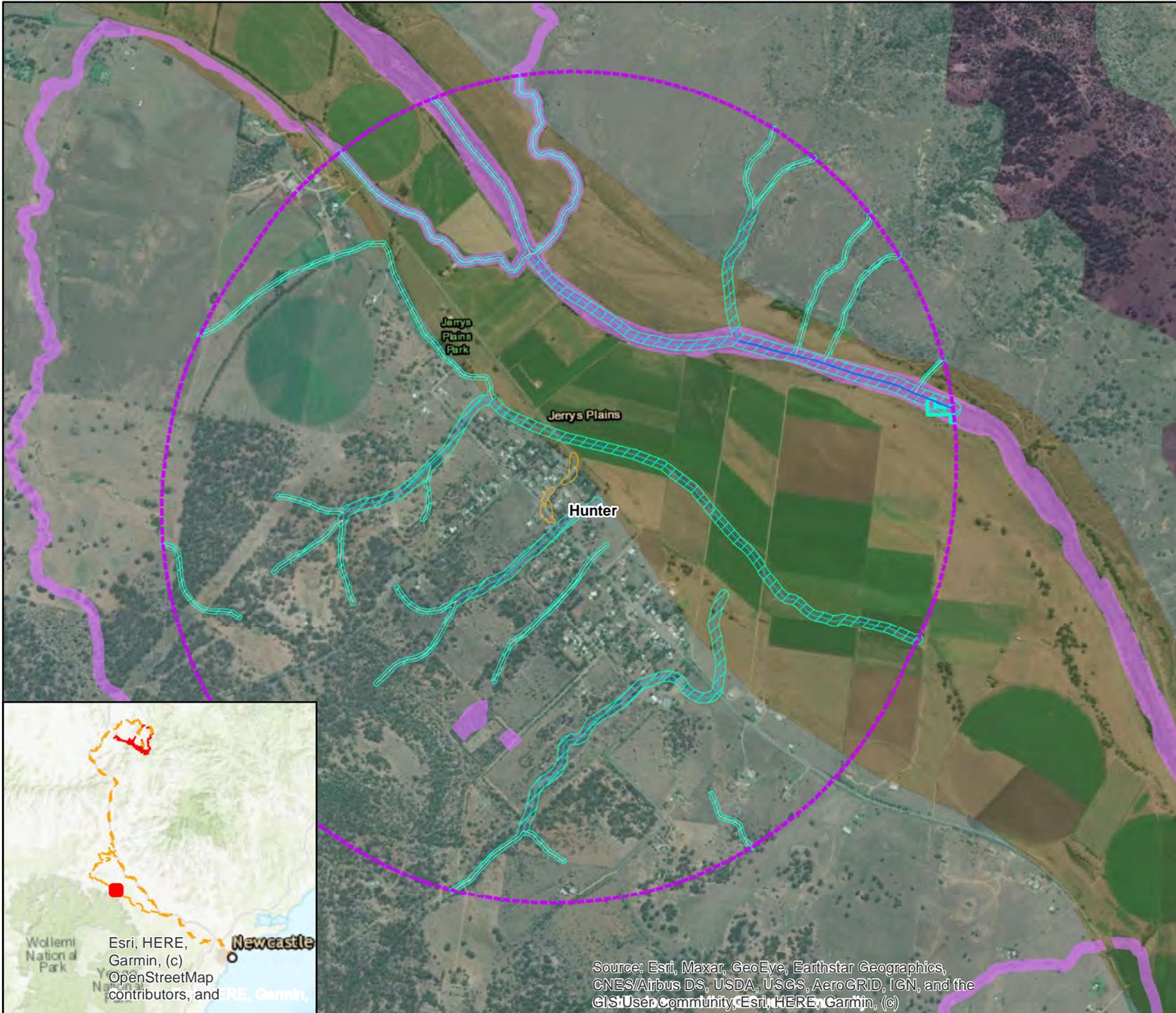
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 003
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270335\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\B04R_CJune2020\Draft\Figures_revised.mxd



	Transport route (port to site)
	Landscape assessment buffer (study area)
	IBRA subregion

Streams

Strahler stream order

	1
	2
	3

	NSW wetlands
	Riparian lands (1500m buffer)
	Biodiversity Values Map (DPIE, 2020)

Mitchell Landscapes

landscapeN

	Central Hunter Foothills
	Hunter River Basalts
	Upper Hunter Channels and Floodplain

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

00.075 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Site map and location map
Page 21**

Scale at A4	Drawing Status
1:21,135	Final

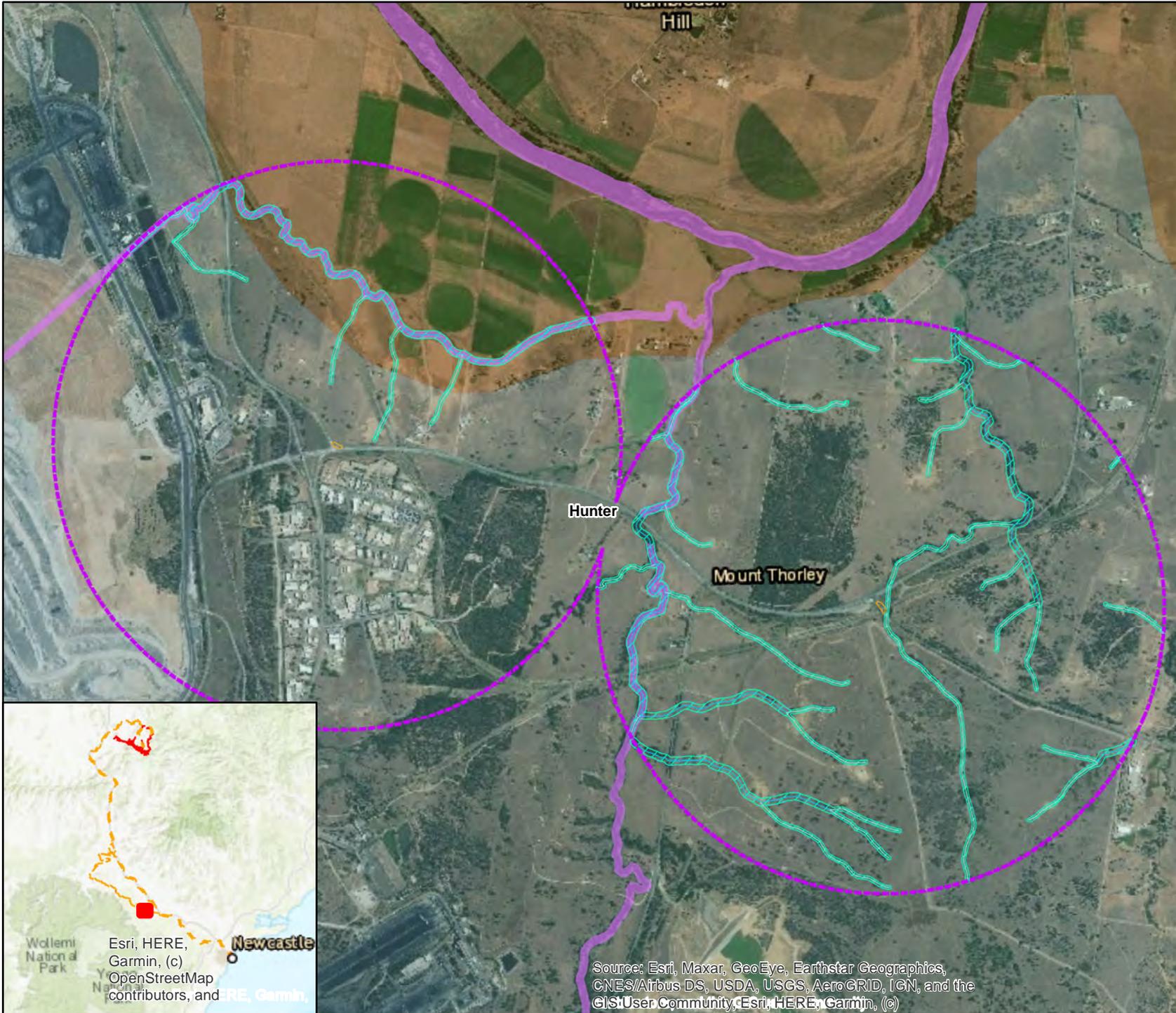
Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	003



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



Transport route (port to site)
 Landscape assessment buffer (study area)
 IBRA subregion

Streams

Strahler stream order

- 1
- 2

Riparian lands (1500m buffer)
 Biodiversity Values Map (DPIE, 2020)

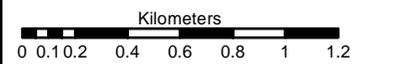
Mitchell Landscapes

landscapeN

- Central Hunter Alluvial Plains
- Central Hunter Foothills



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Site map and location map
 Page 22**

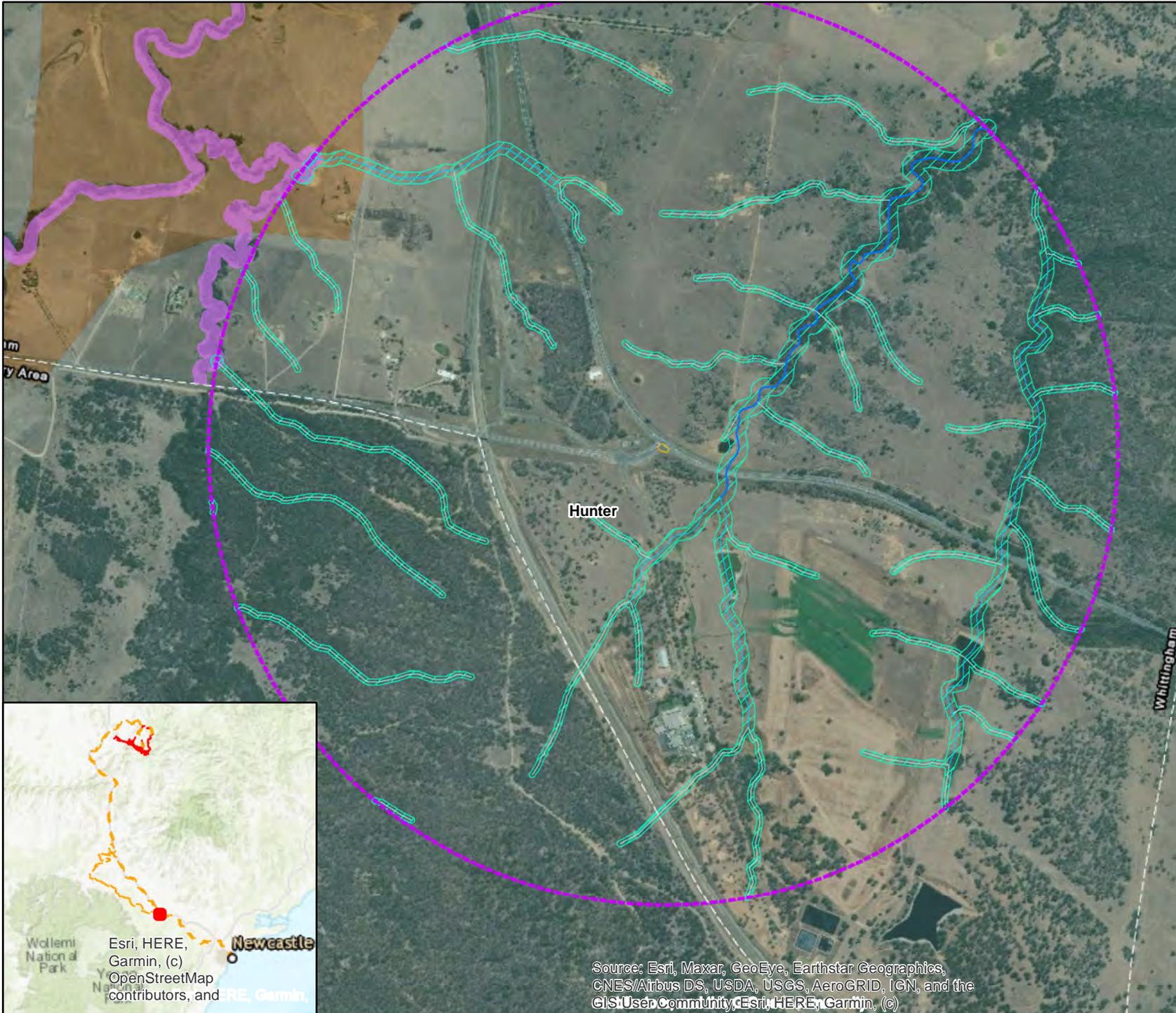
Scale at A4 1:28,669	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 003
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



Transport route (port to site)
 Landscape assessment buffer (study area)
 IBRA subregion

Streams

Strahler stream order

- 1
- 2
- 3

Riparian lands (1500m buffer)
 Biodiversity Values Map (DPIE, 2020)

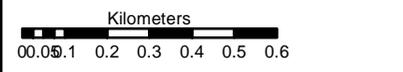
Mitchell Landscapes

landscapeN

- Central Hunter Alluvial Plains
- Central Hunter Foothills



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Site map and location map
 Page 23**

Scale at A4 1:17,790	Drawing Status Final
--------------------------------	--------------------------------

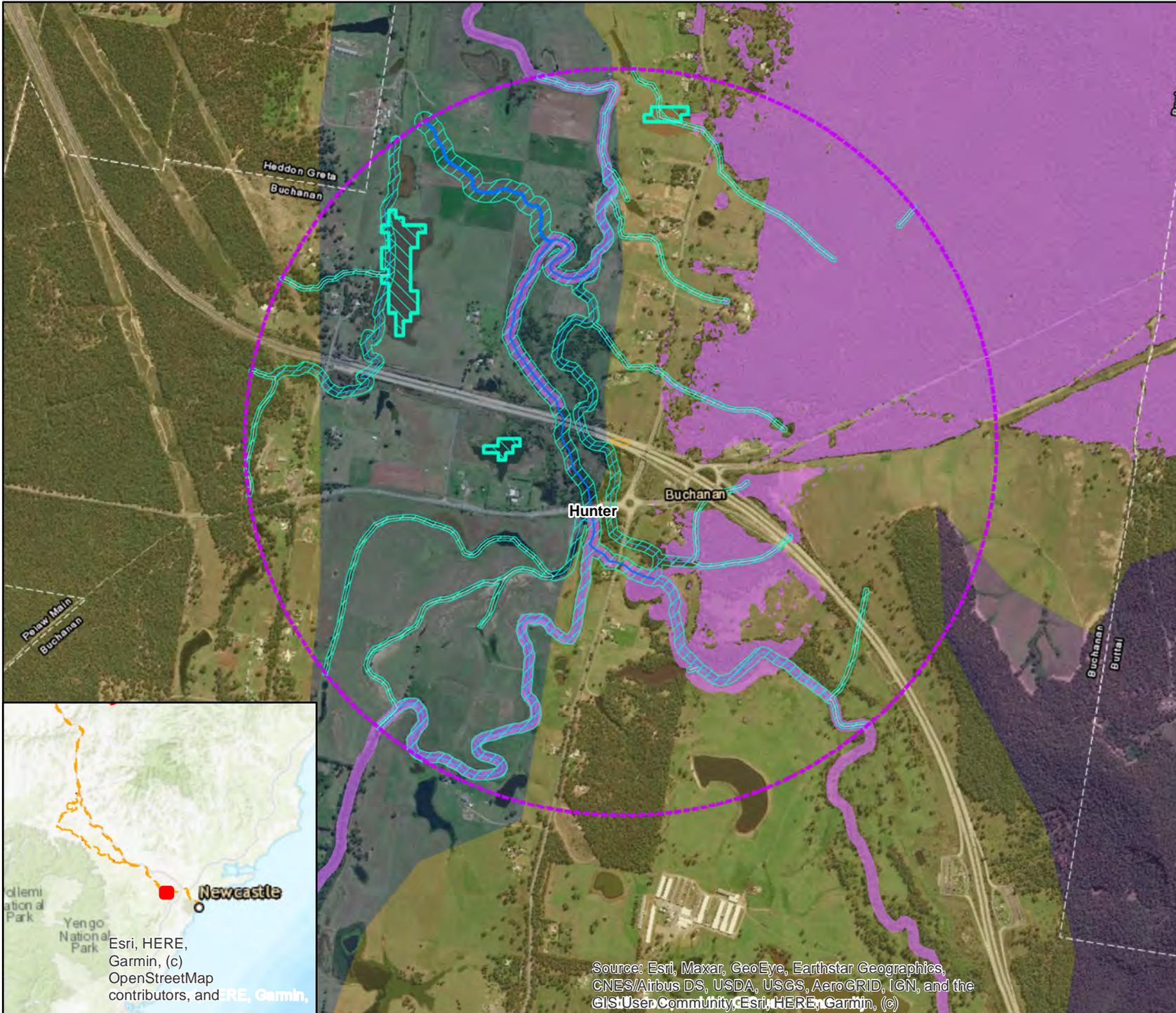
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 003
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Site\Figures_Draft\B0AR_270335-00_Draft\Figures_revised.mxd



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

Transport route (port to site)
 Landscape assessment buffer (study area)
 IBRA subregion

Streams

Strahler stream order

- 1
- 2
- 3
- 4

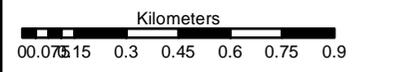
- NSW wetlands
- Riparian lands (1500m buffer)
- Biodiversity Values Map (DPIE, 2020)

Mitchell Landscapes

landscapeN

- Lower Hunter Channels and Floodplains
- Newcastle Coastal Ramp
- Watagan Ranges

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

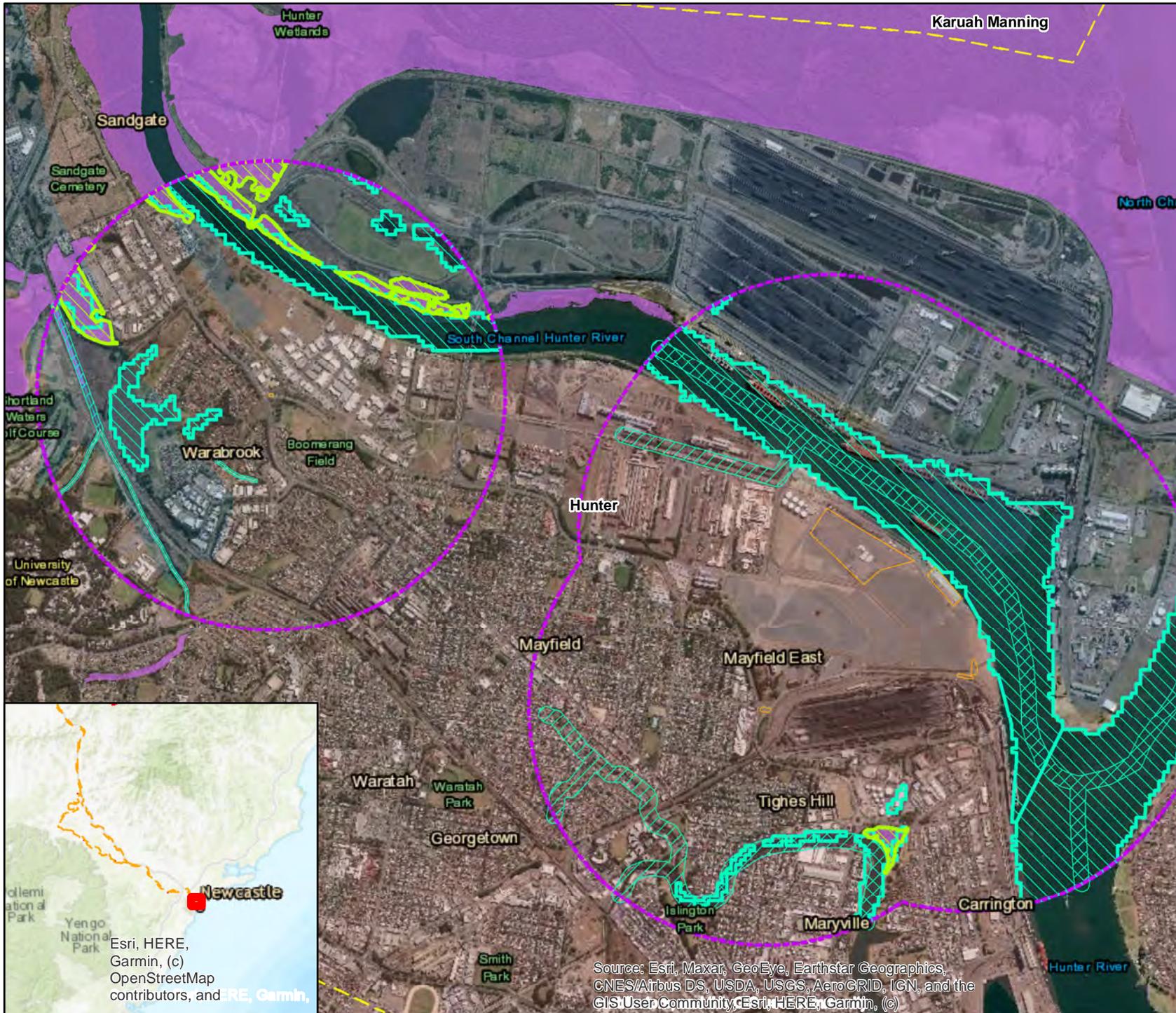
Drawing Title
**Site map and location map
 Page 24**

Scale at A4 1:21,756	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 003
----------------------------	--------------------------

I:\270335\270335-00 Hills of Gold\Work\mxd\Design\Site Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



Transport route (port to site)
 Landscape assessment buffer (study area)
 IBRA subregion

Streams

Strahler stream order

1
2

Coastal wetlands
 NSW wetlands
 Riparian lands (1500m buffer)
 Biodiversity Values Map (DPIE, 2020)

Mitchell Landscapes

landscapeN

Gosford - Coorabong Coastal Slopes
 Lower Hunter Channels and Floodplains
 Sydney - Newcastle Barriers and Beaches

↑

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

0.0 0.25 0.5 0.75 1 1.25 1.5

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

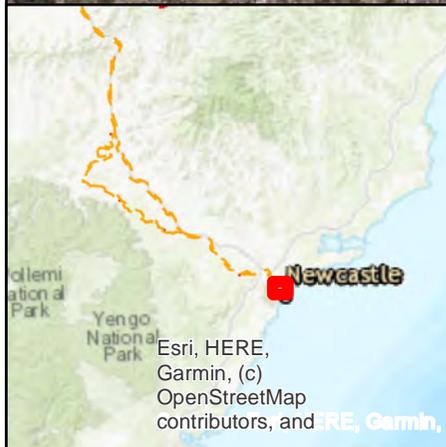
**Site map and location map
Page 25**

Scale at A4	Drawing Status
1:34,514	Final

Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	003



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\SiteMap\Figures_01\Figures_01_revised.mxd

3.2 Site context

Site context considerations include the assessment of native vegetation cover and patch size, in accordance with Section 4.3 of the BAM. These assessments were undertaken using the following existing vegetation mapping available for the region:

- Ground-truthed PCT map prepared for the wind farm infrastructure area and haul route sites;
- State Vegetation Type Map: Border Rivers Gwydir / Namoi Region Version 2.0. VIS_ID 4467 (OEH, 2020a);
- State Vegetation Type Map: Upper Hunter Version 1.0. VIS_ID 4894 (OEH, 2020b);
- Greater Hunter Native Vegetation Mapping Version 4.0. VIS_ID 3855 (DPIE, 2015).
- OEH BioNet Vegetation Classification Database;

Figure 4, Pages 1 to 24 shows native vegetation cover and patch assignment relative to the estimated development footprint.

3.2.1 Native vegetation cover

49% of the 42,316 hectares study area the subject of the landscape assessment has been cleared of native vegetation. However, approximately 21,540ha (or 51% of the study area) consists of native vegetation which is classified as having a cover class of between 30-70% meaning that this is the percentage of native vegetation cover within the study area. This is summarised in **Table 9**.

The extent of native vegetation cover across all areas of the landscape context maps are provided in **Figure 4, Pages 1 to 24**.

Table 9: Native vegetation cover

Native vegetation extent (ha)	Study area extent (ha)	% landscape assessment area	Native vegetation cover class
21,540	42,316	51%	30-70%

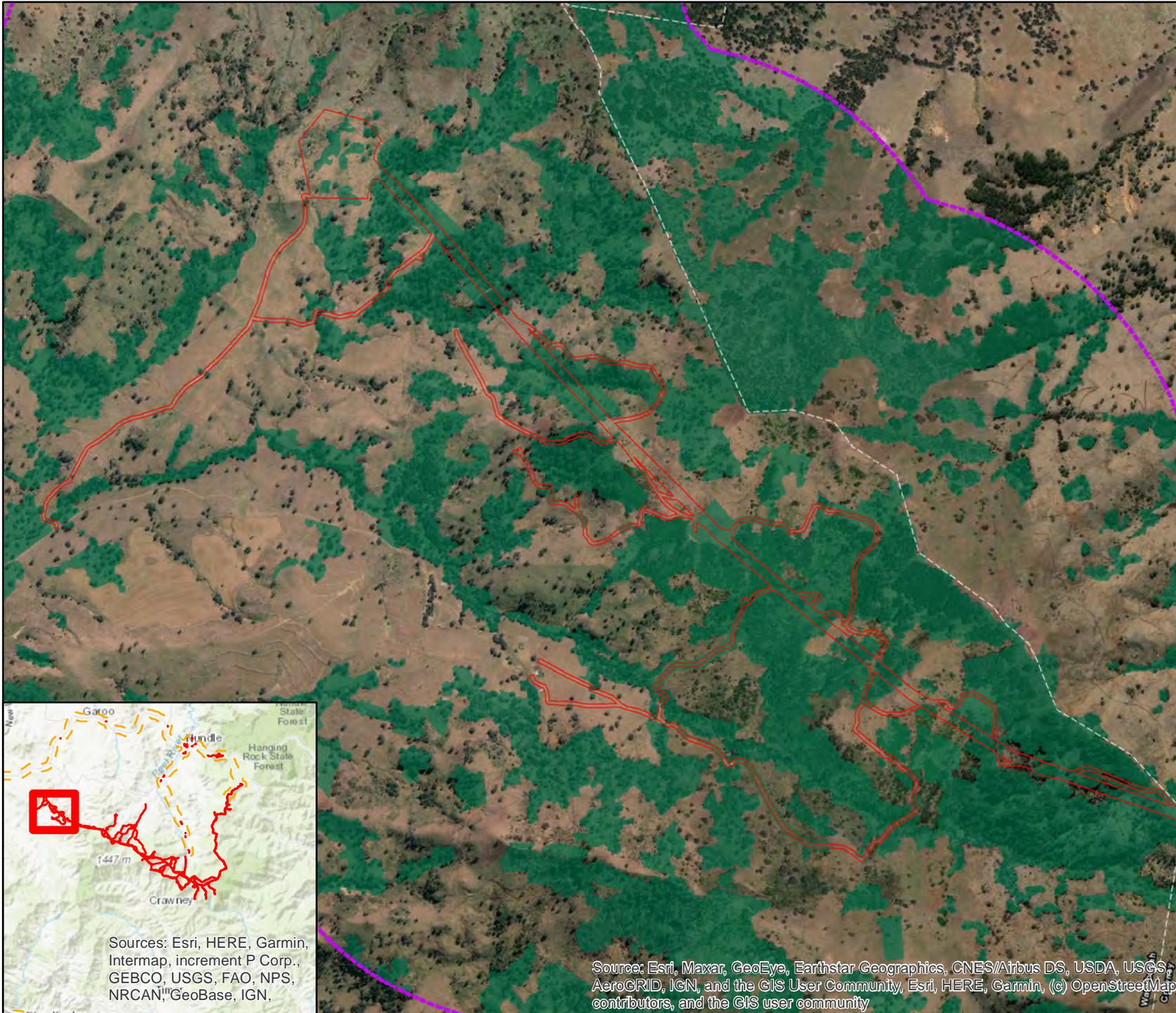
3.2.2 Patch size

Patch size for the native vegetation within the study area has been assessed in accordance with the requirements of Section 5.3.2 of the BAM. Each native vegetation zone in the development footprint was assessed and assigned to a required patch size class, being <5ha, 5–24ha, 25–100ha or ≥100ha.

Patch size was assessed in accordance with the BAM using ArcGIS to select, measure and classify native vegetation patches. Within each NSW Landscape, all native vegetation not defined as low condition and separated by a distance of less than 100 metres (woody vegetation types) and 30 metres (non-woody vegetation

types) was mapped sequentially using the development footprint PCT mapping and desktop mapped data.

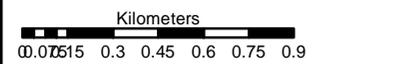
Vegetation patches and associated patch size classes were all classified in the greater than 100ha patch size class in accordance with Section 5.3.2 of the BAM. This is due to the vegetation zones within the development footprint occurring less than 100 m apart and so being assigned to the same patch as under the BAM, the definition of a patch is an area of intact native vegetation that occurs within the development footprint and includes other areas of native vegetation that are within 100m of the patch.



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	28/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

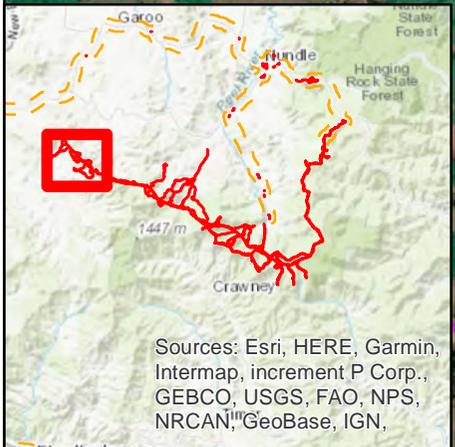
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 1**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

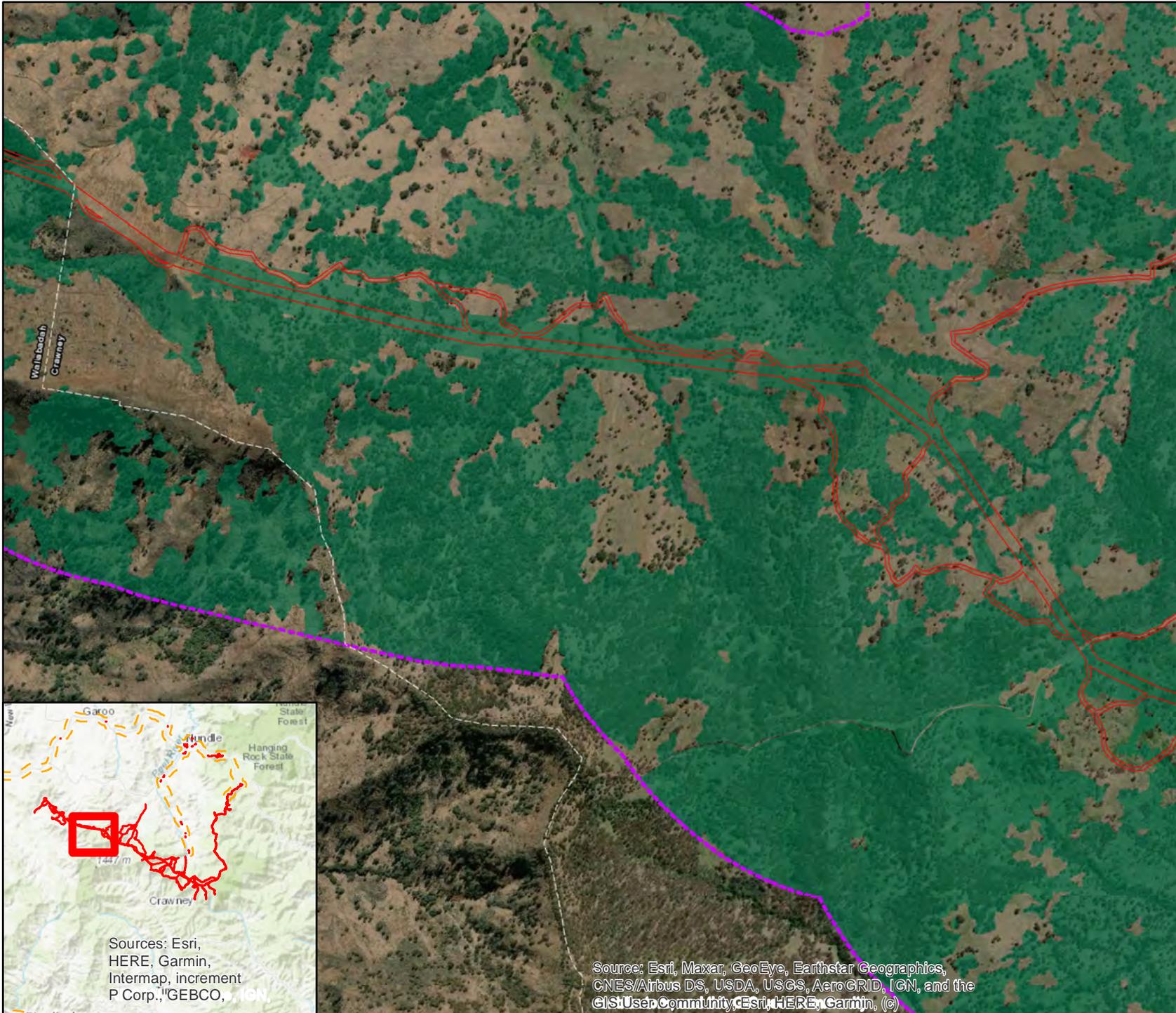
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN,

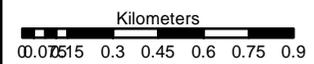
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

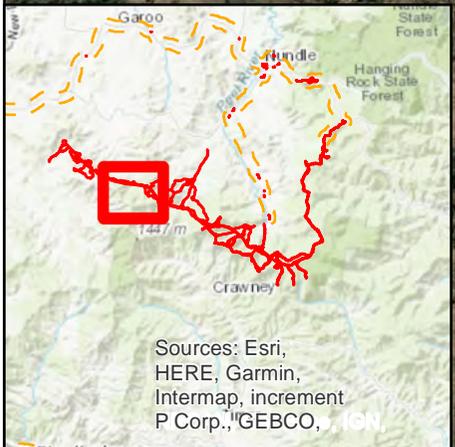
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 2**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

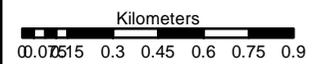
I:\270335\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 3**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

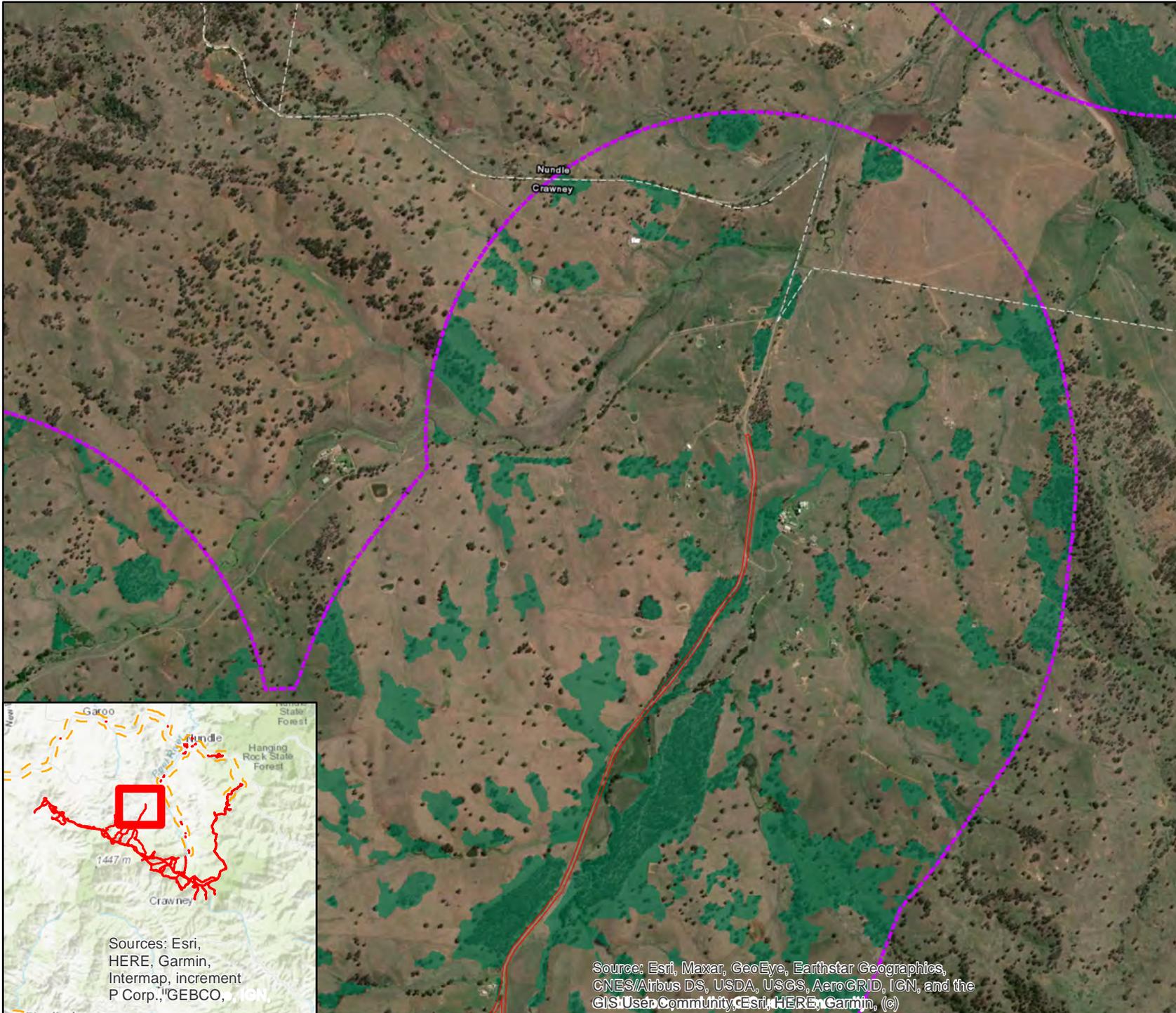
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

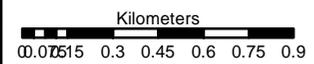
I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

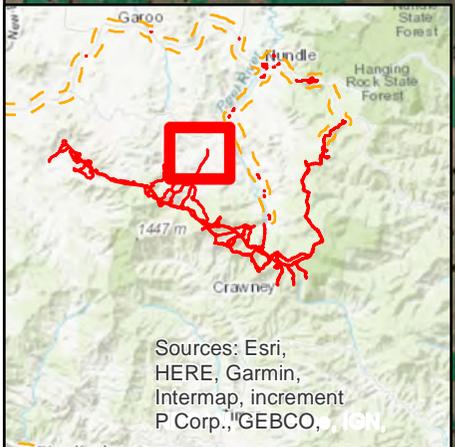
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 4**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

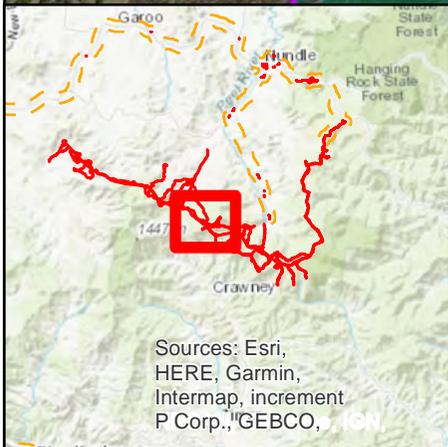
Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd

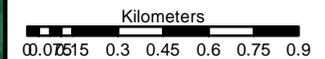


Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Location map native vegetation cover
Page 5**

Scale at A4	Drawing Status
1:25,000	Final

Coordinate System

GDA 1994 MGA Zone 56

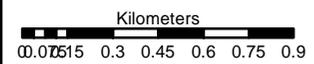
Job No	Drawing No
270335-00	004



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

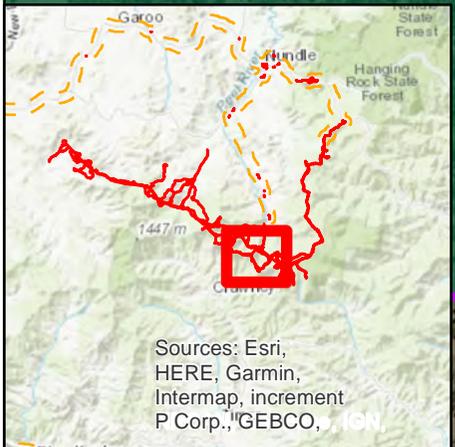
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 6**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

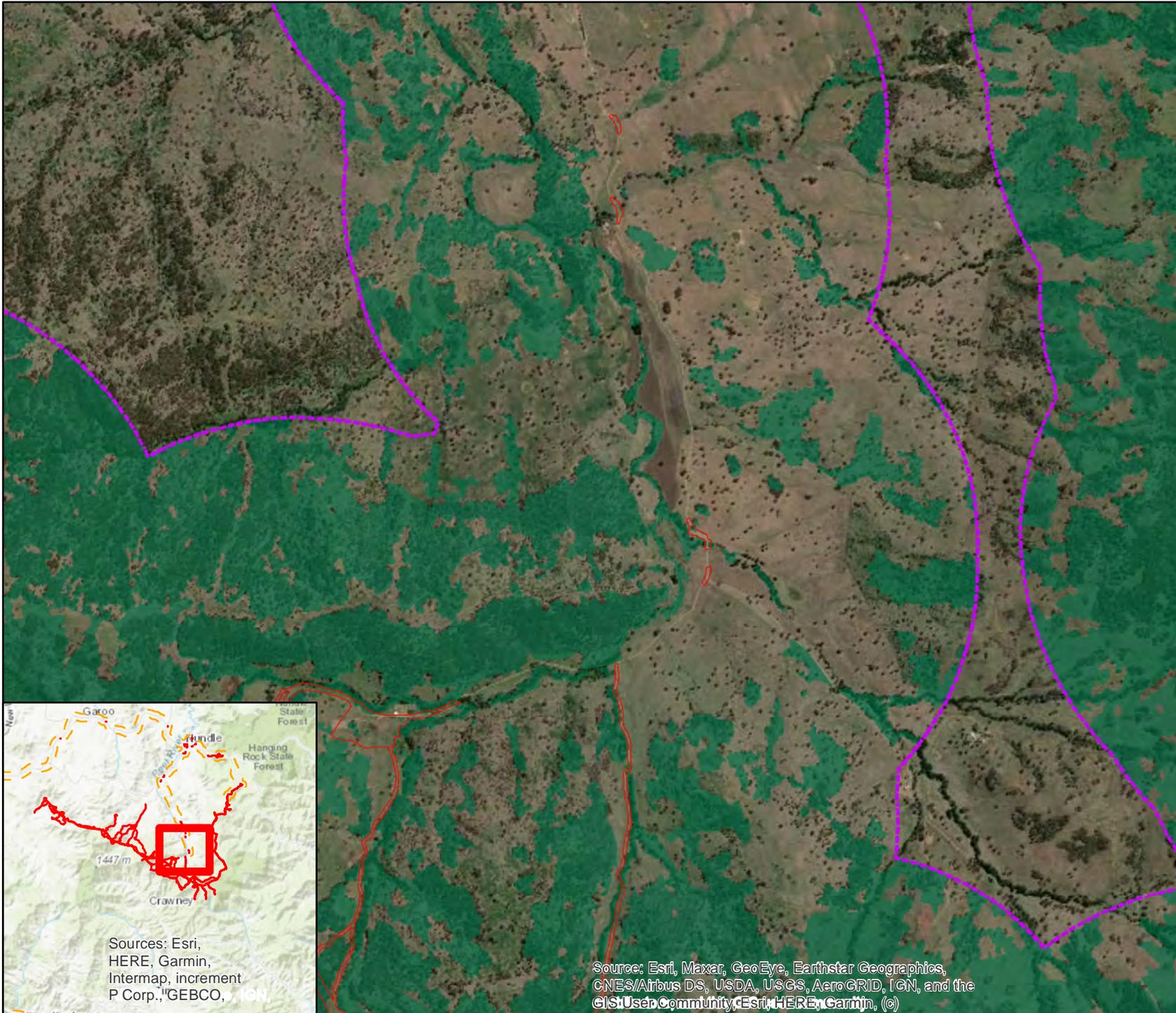
Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

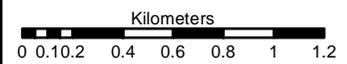
I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 7**

Scale at A4 1:30,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

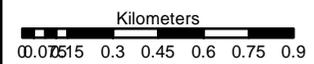
I:\270335\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

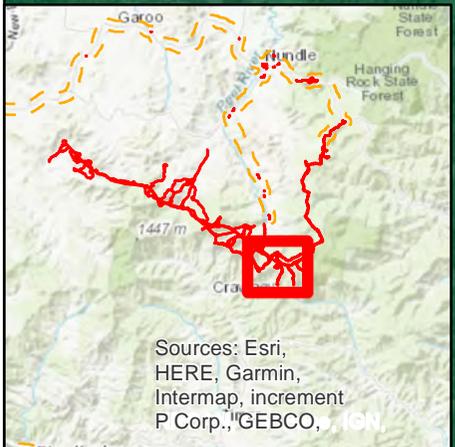
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 8**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

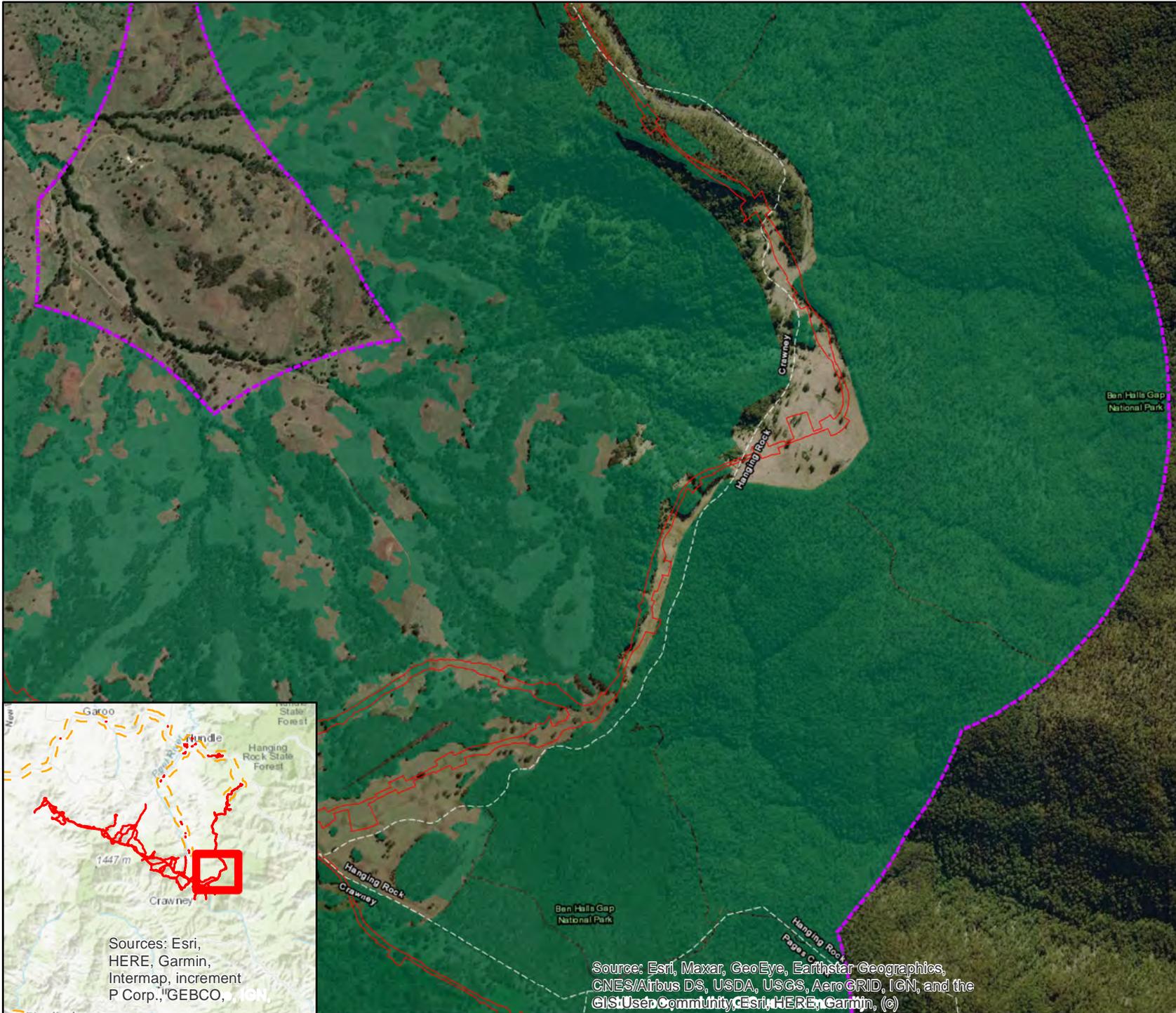
Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

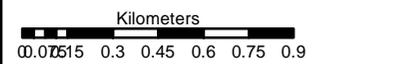
I:\270335\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

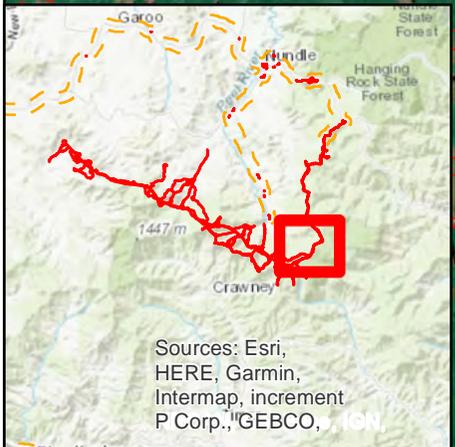
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 9**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

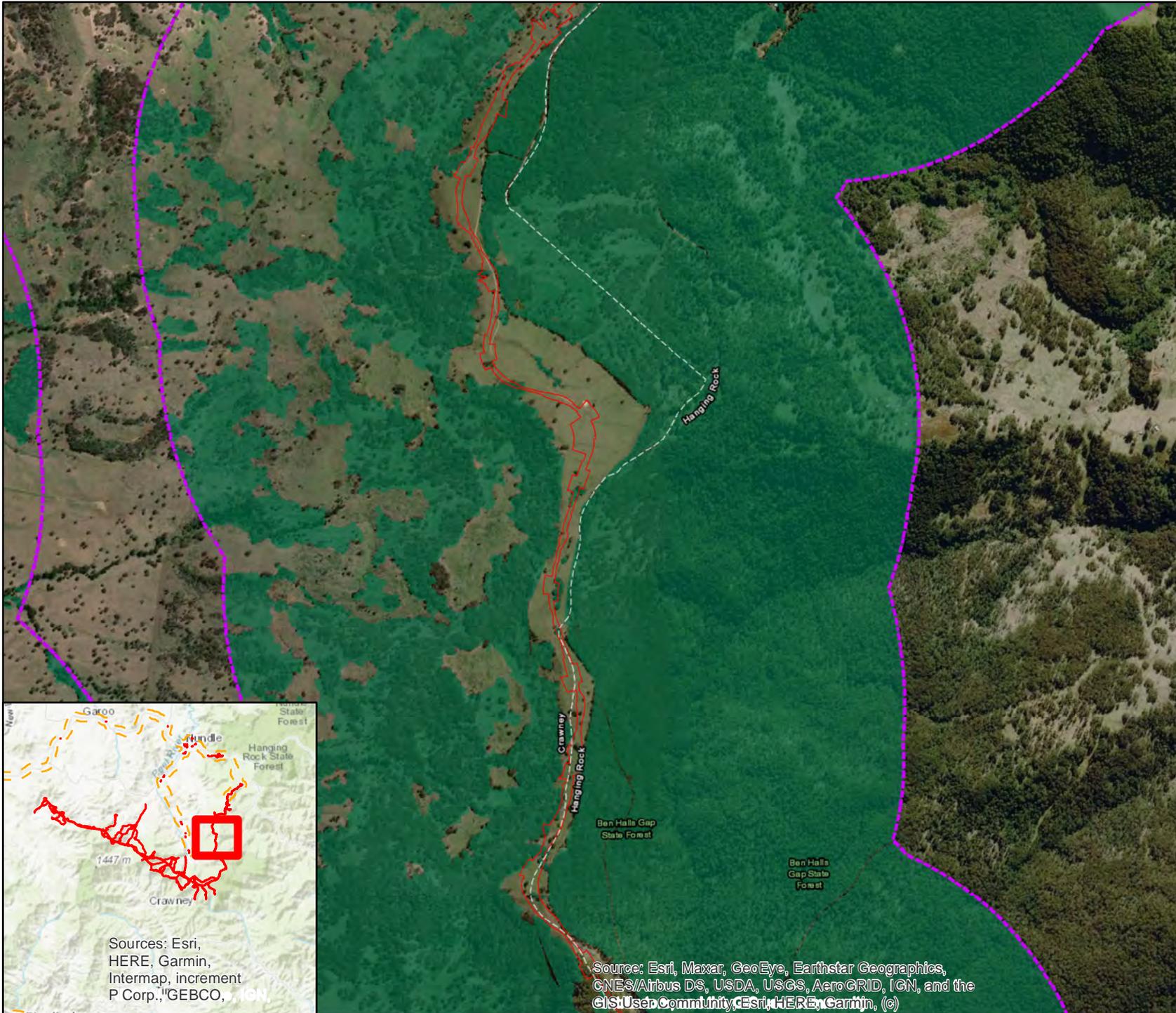
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

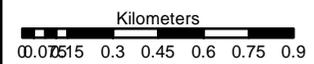
I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

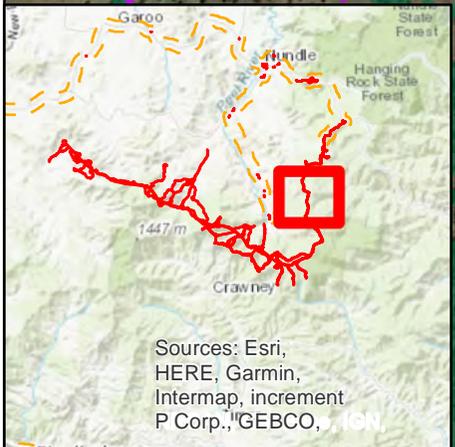
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 10**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

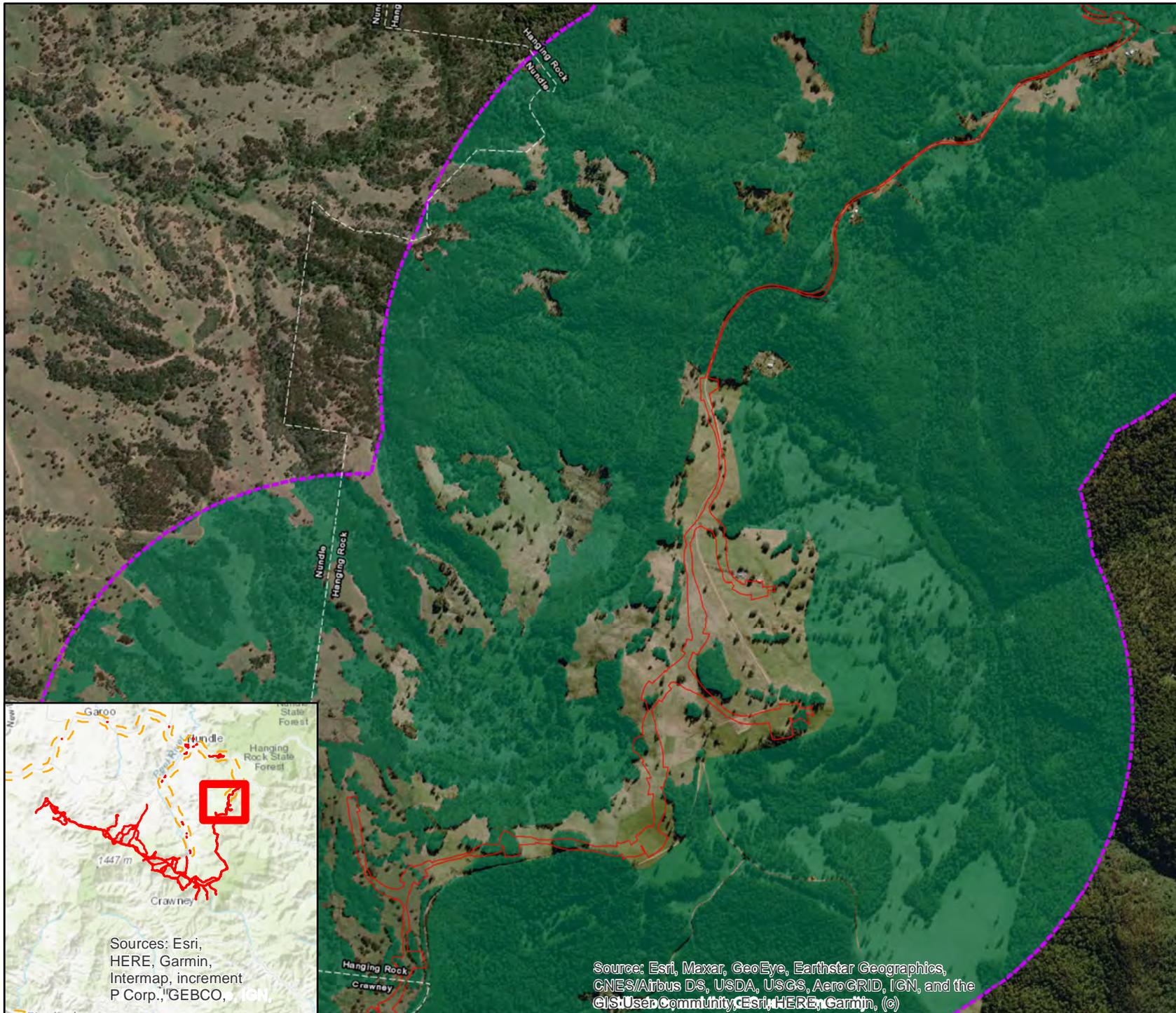
Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

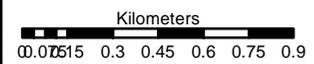
I:\270335\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\GIS\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 11**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

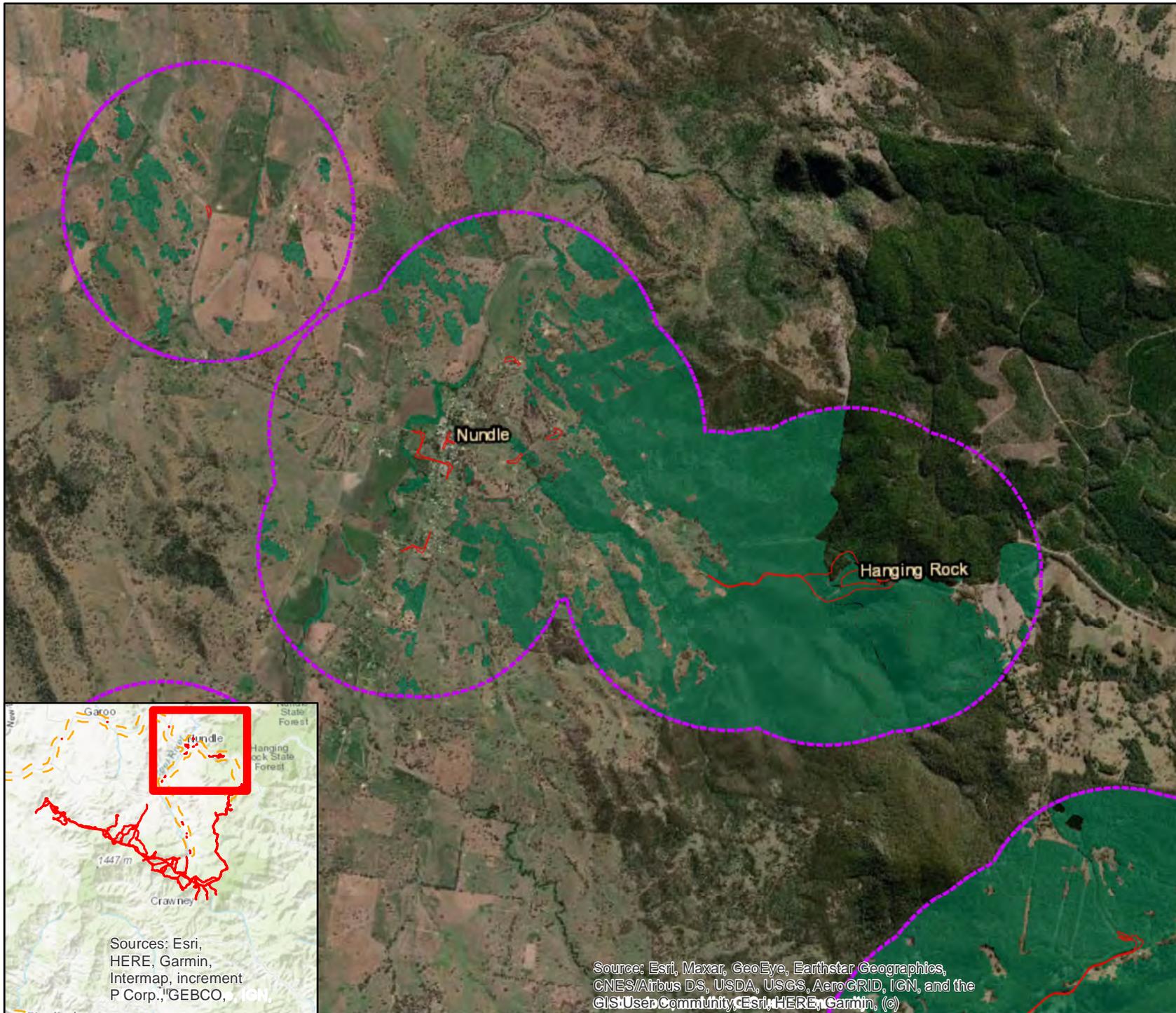
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

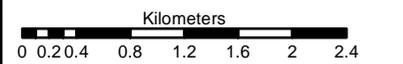
I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\CS1\Figures\Draw1B04R_June2020\Draw1\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

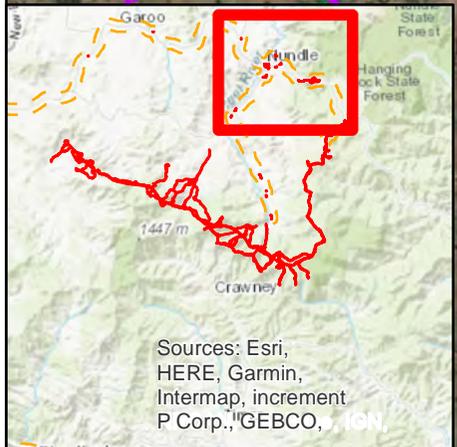
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 12**

Scale at A4 1:55,885	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

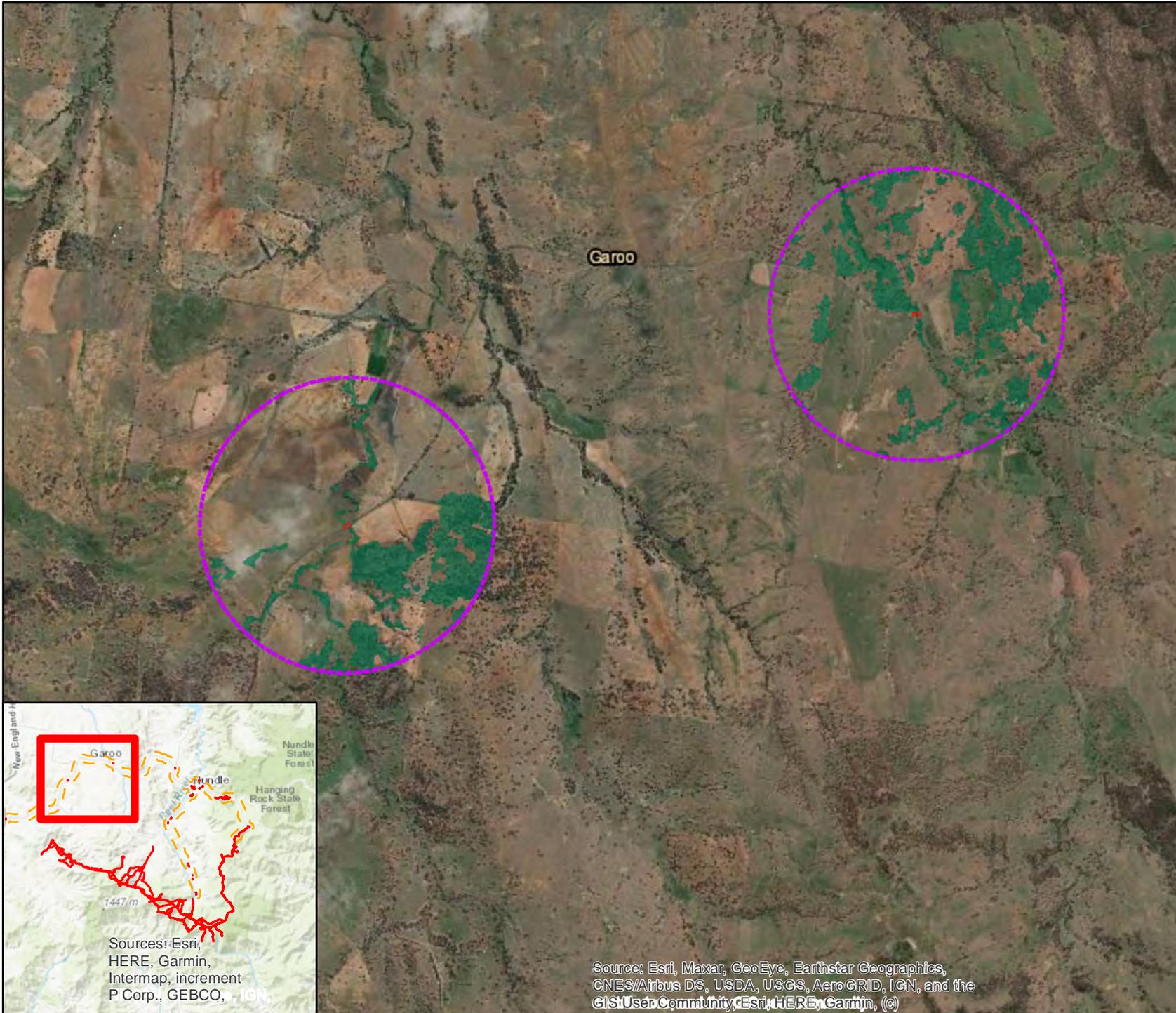
Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

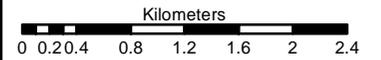
I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

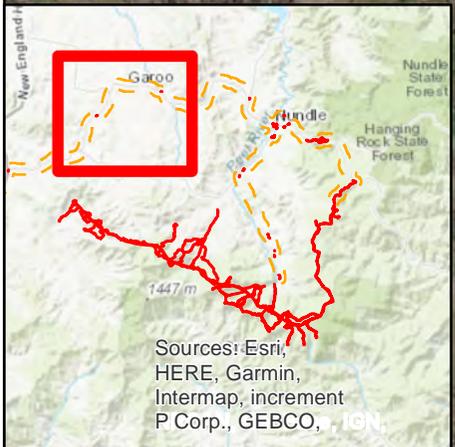
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 13**

Scale at A4 1:55,753	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

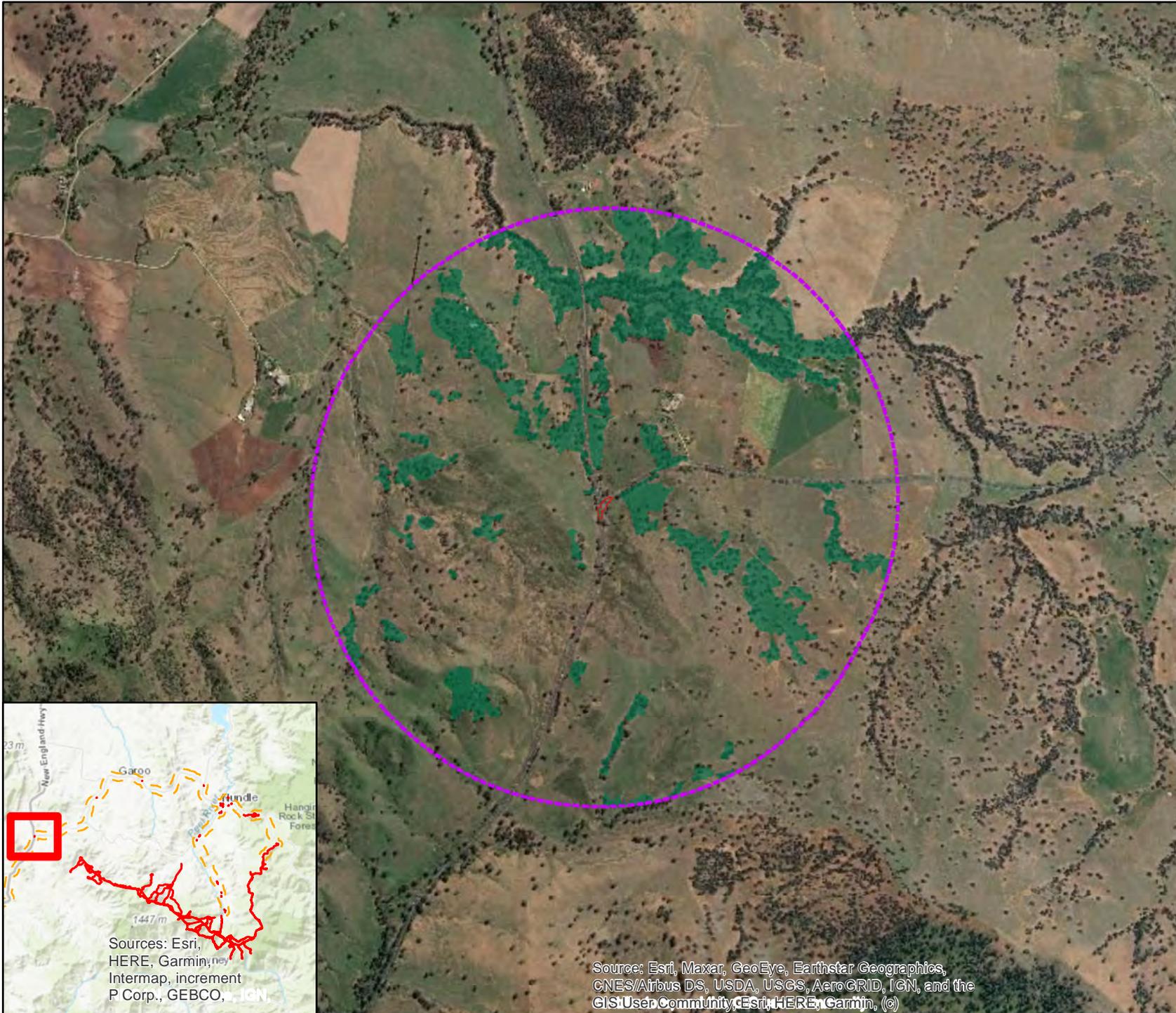
Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

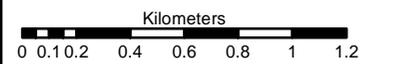
I:\270000\270335-00 Hills of Gold\Work\mains\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

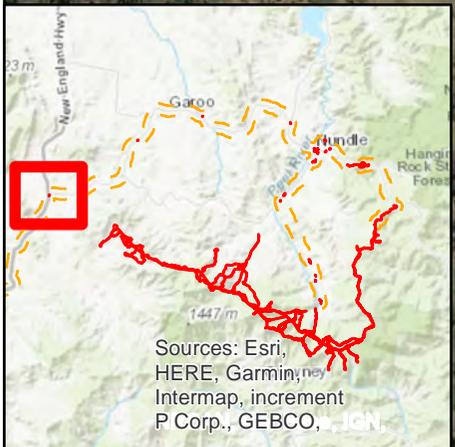
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 14**

Scale at A4 1:27,942	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

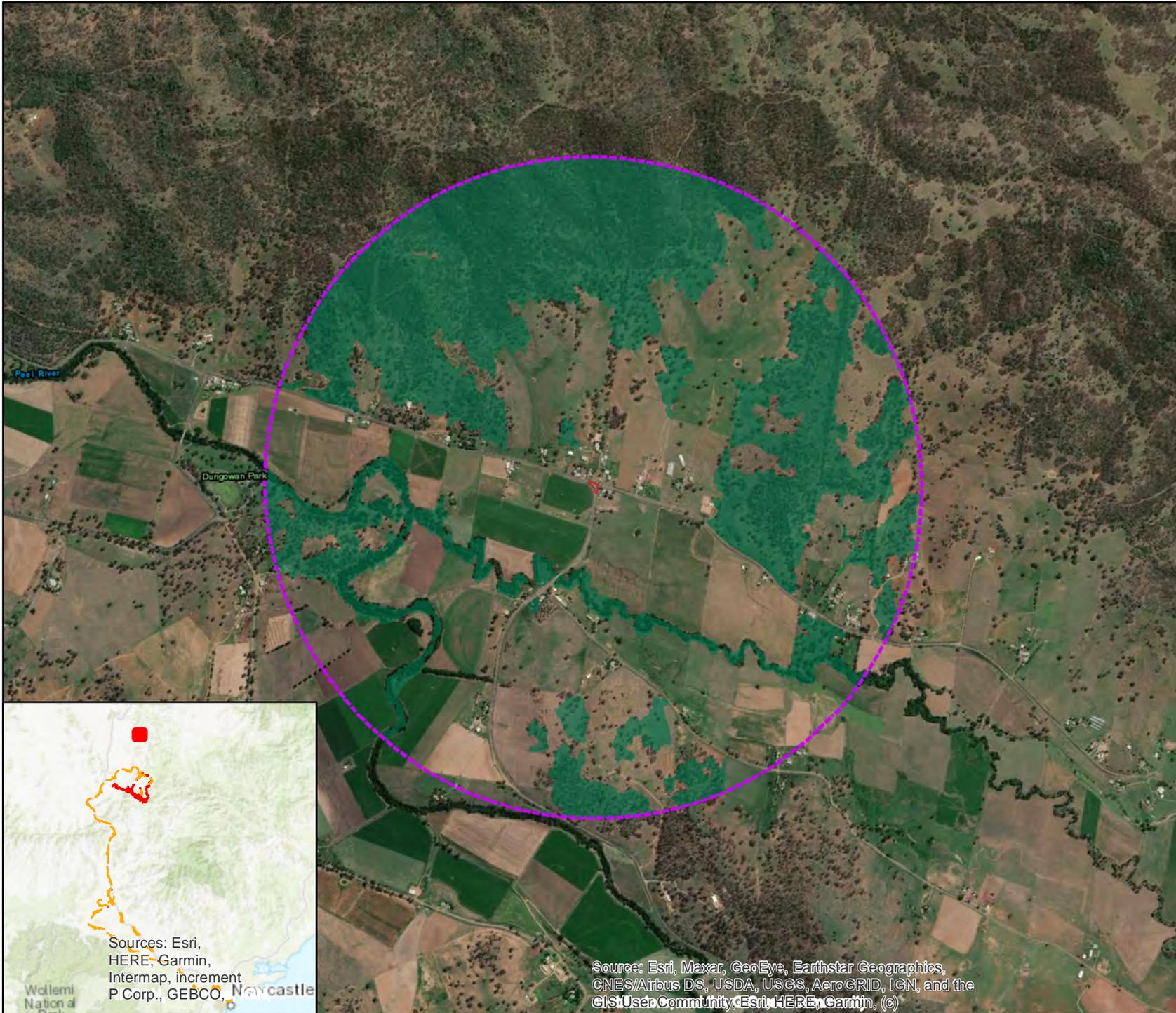
Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

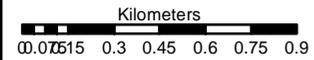
I:\270335\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

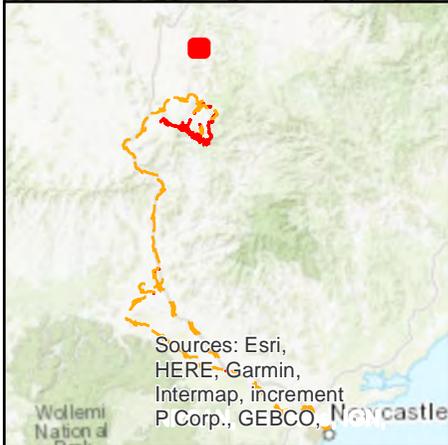
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 15**

Scale at A4 1:24,718	Drawing Status Final
--------------------------------	--------------------------------

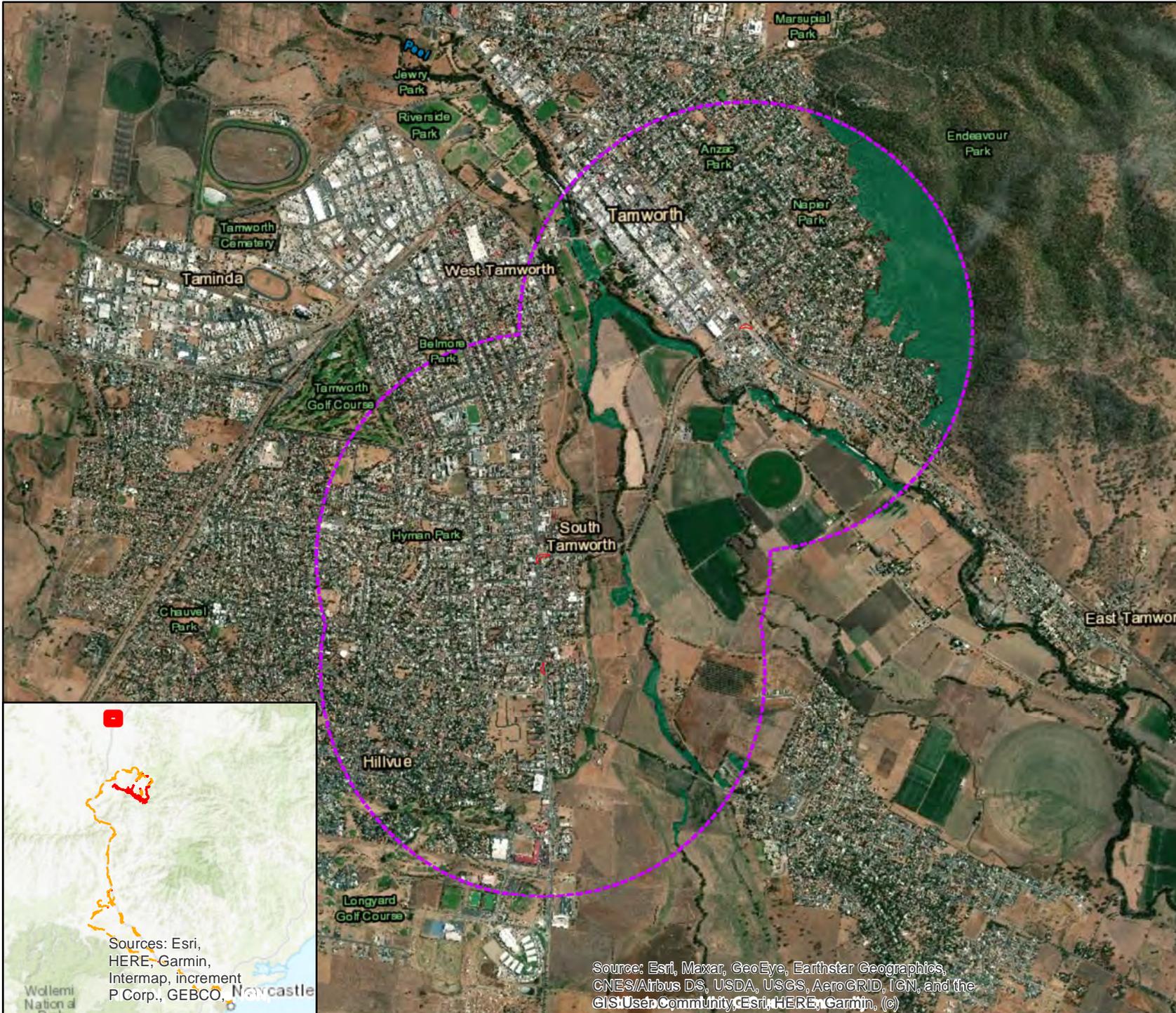
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, Newcastle

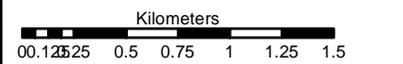
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

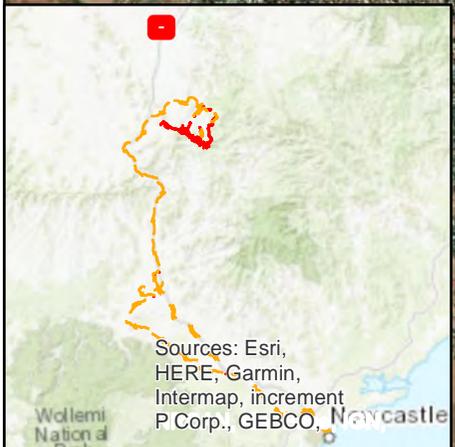
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 16**

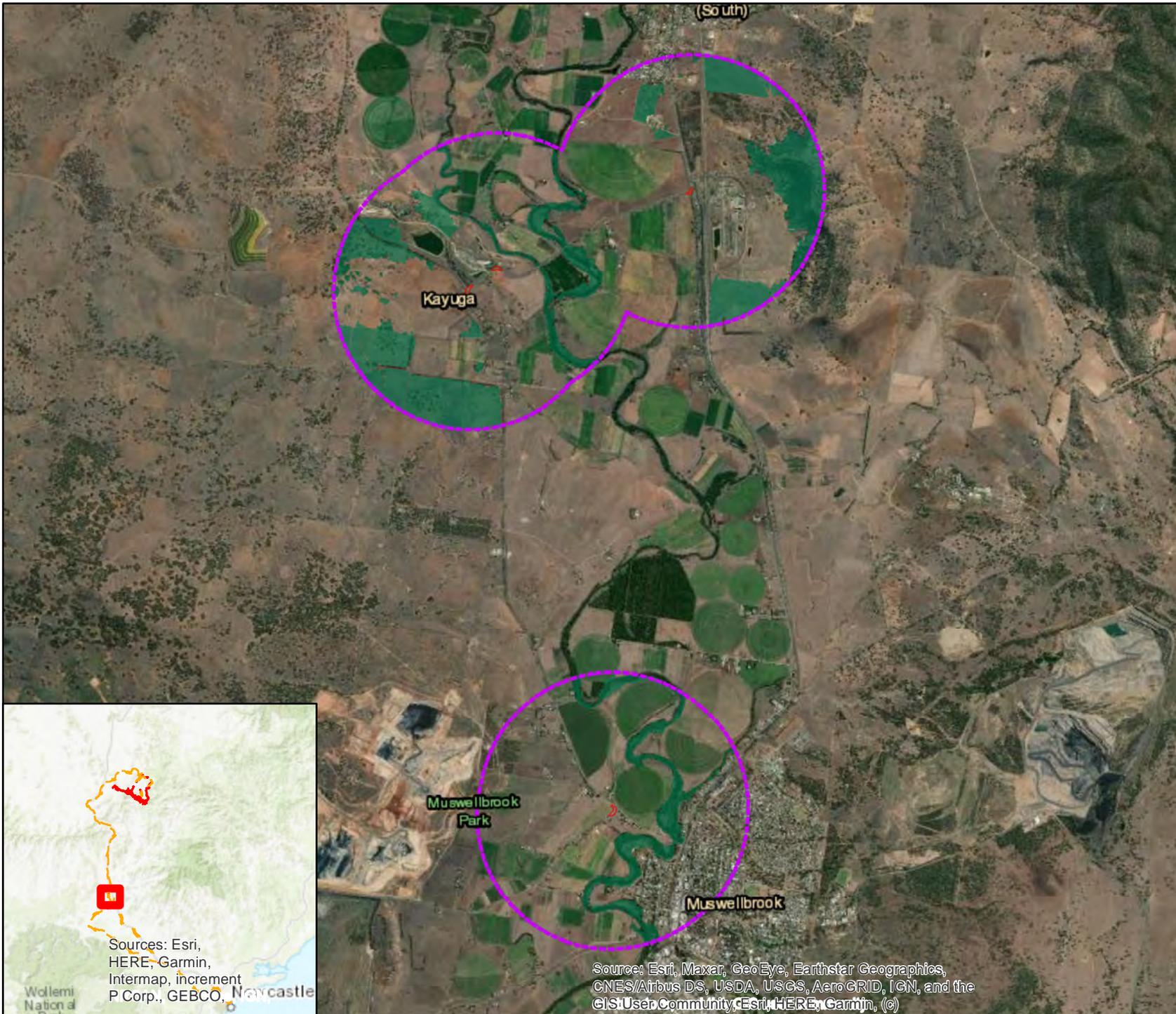
Scale at A4 1:36,327	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------



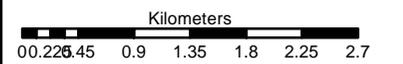
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

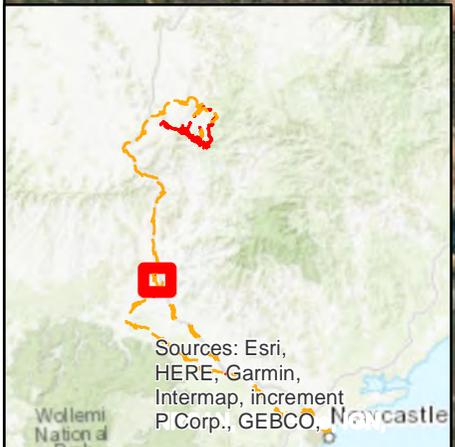
Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 17**

Scale at A4 1:60,672	Drawing Status Final
--------------------------------	--------------------------------

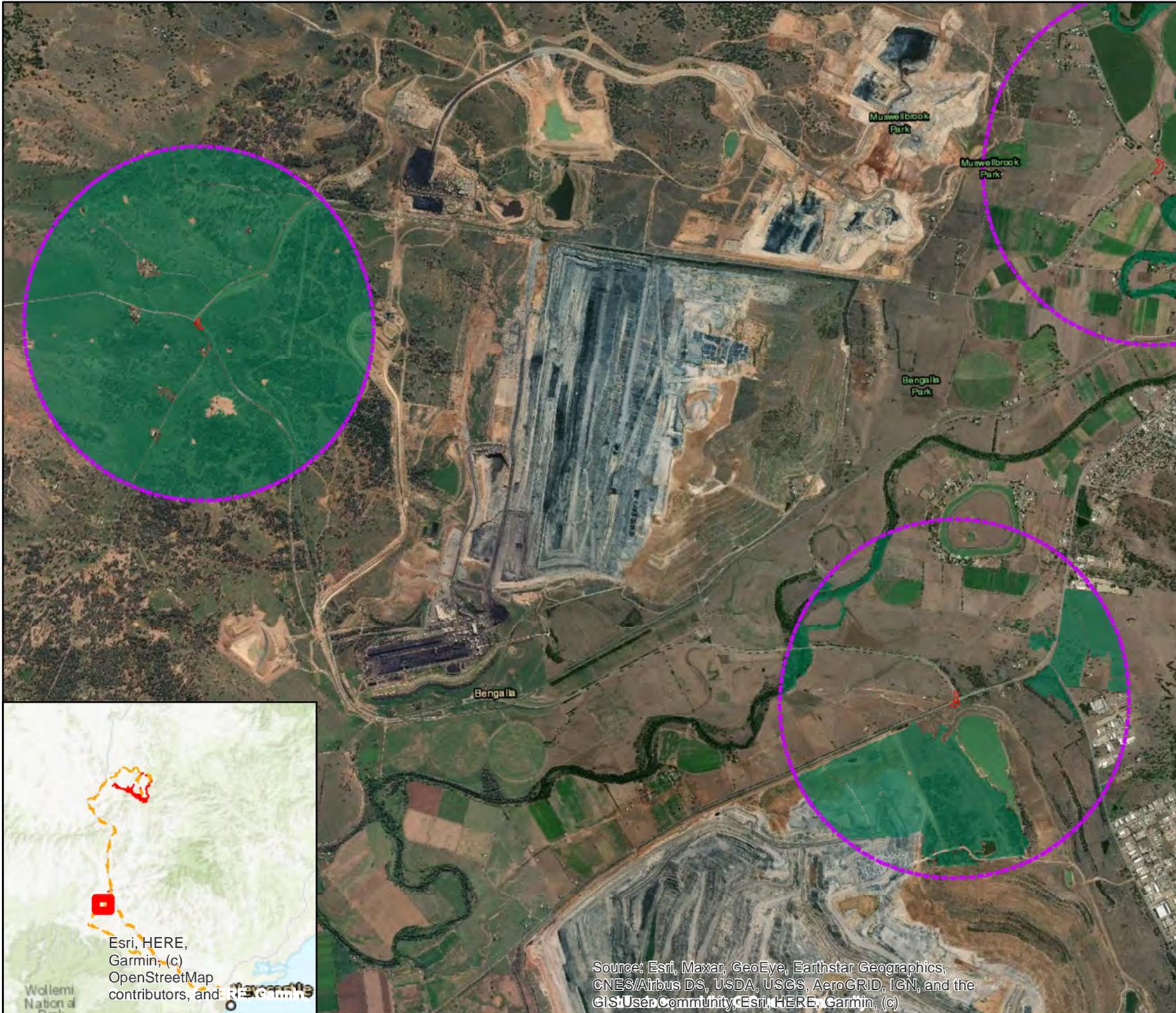
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, Newcastle

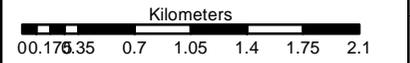
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

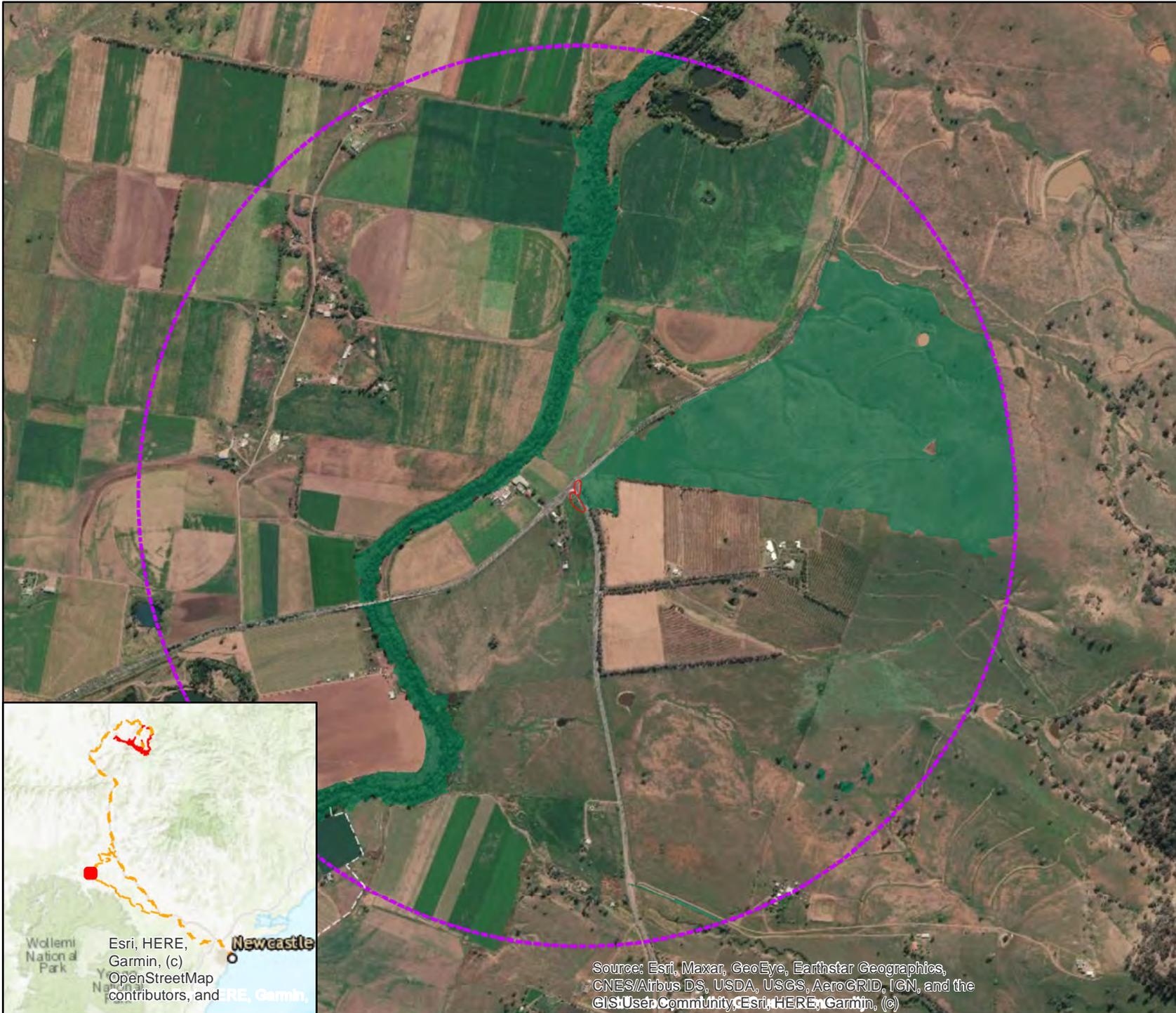
Drawing Title
**Location map native vegetation cover
 Page 18**

Scale at A4 1:46,989	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------

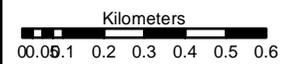
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 19**

Scale at A4 1:18,542	Drawing Status Final
--------------------------------	--------------------------------

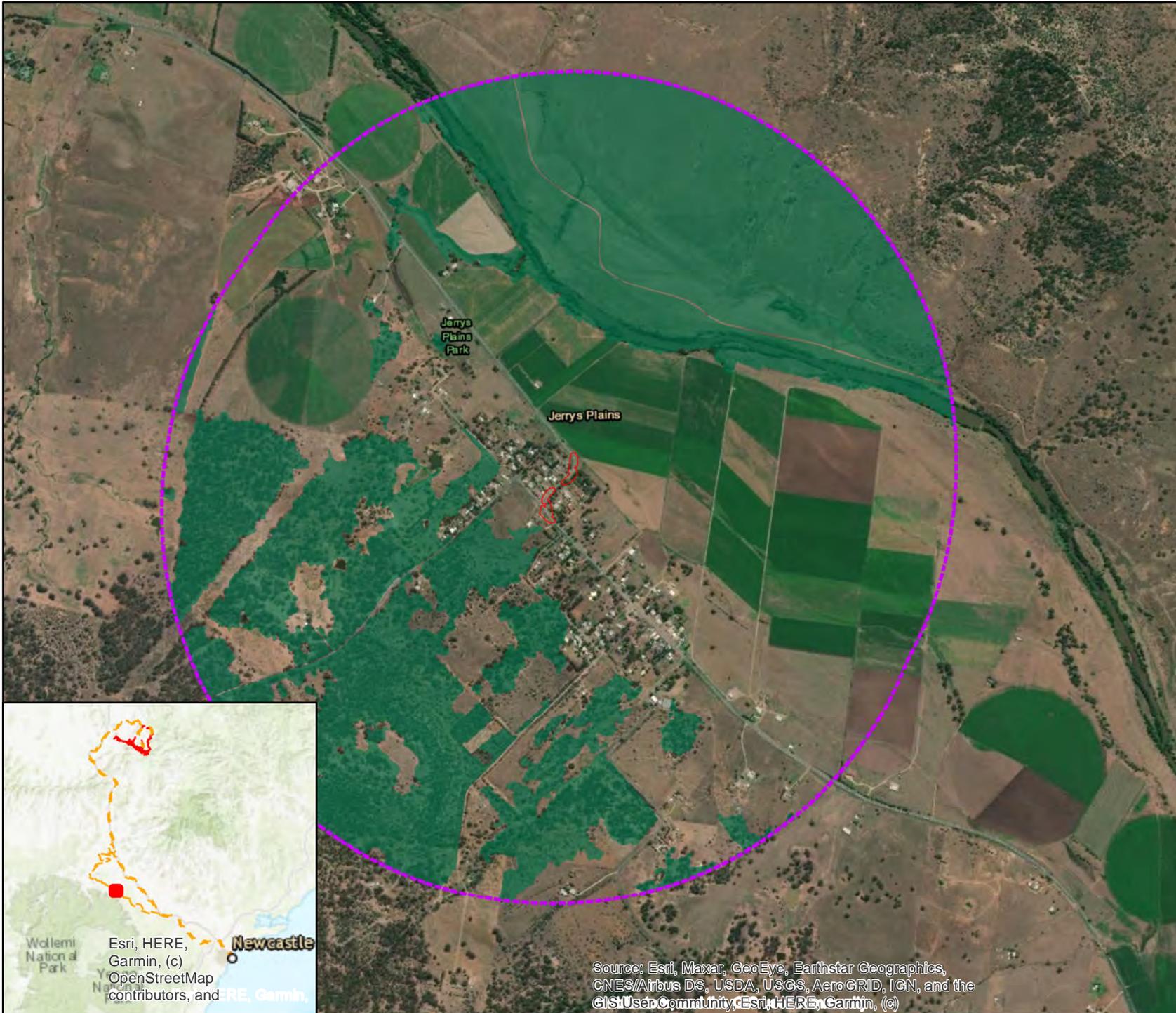
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

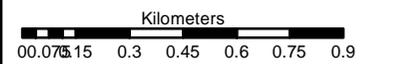
I:\270000\270335-00 Hills of Gold\Work\mxd\design\GIS\Figures\GIS\Figures_Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 20**

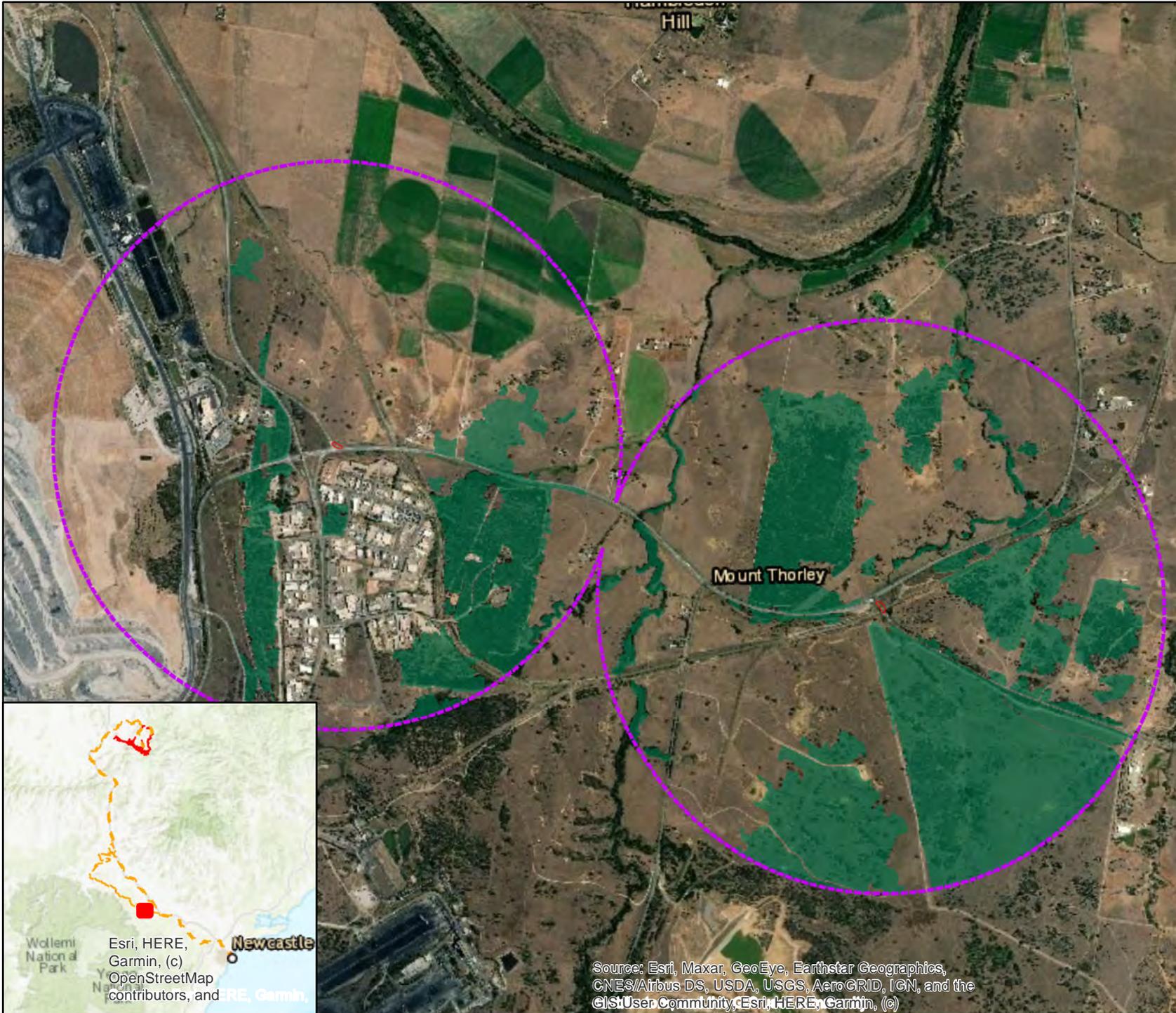
Scale at A4 1:21,135	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

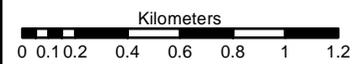
I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\GIS\Figures_Draft\BOARD_June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
Page 21**

Scale at A4 1:28,669	Drawing Status Final
--------------------------------	--------------------------------

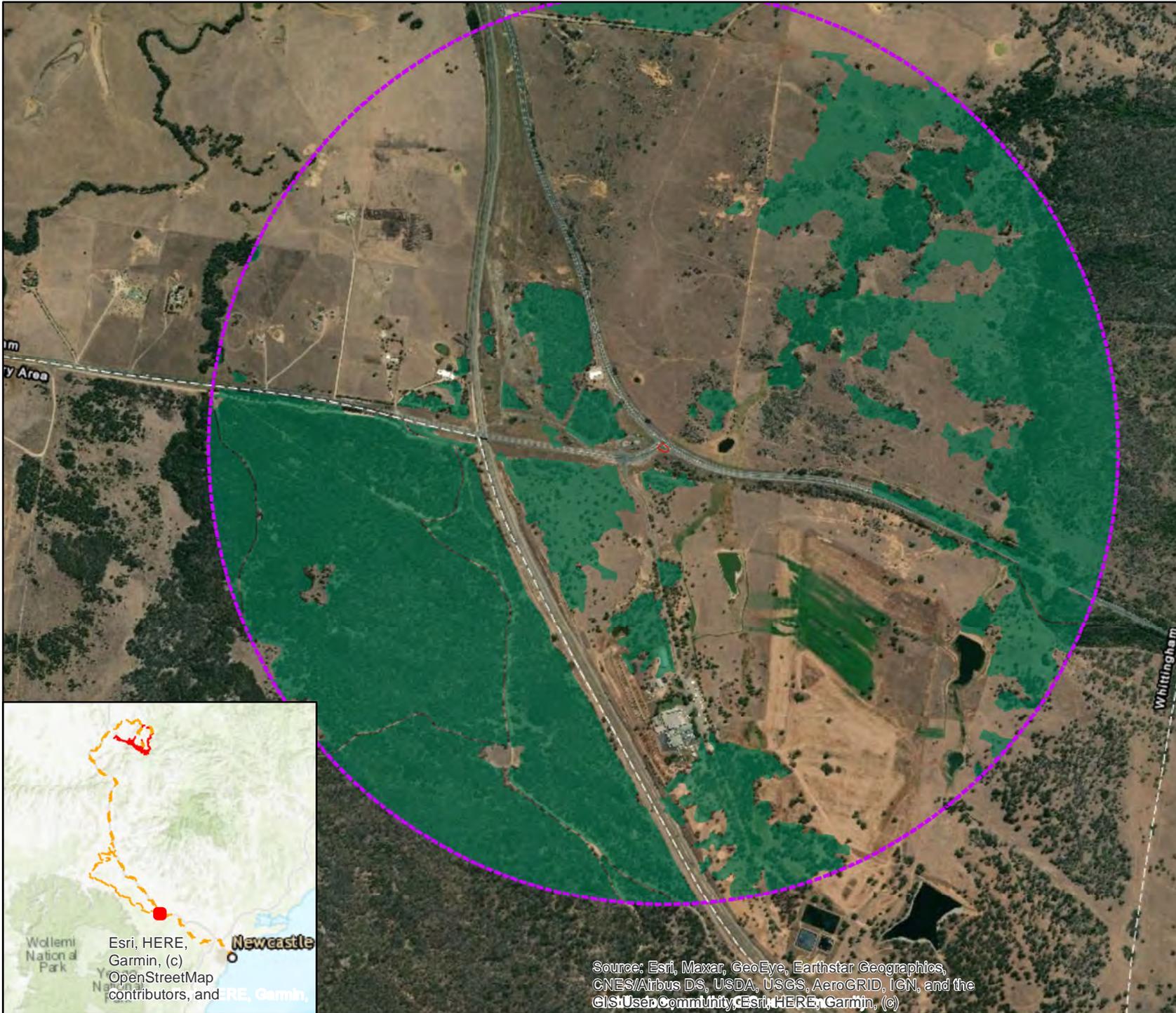
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

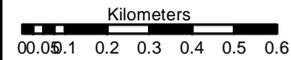
I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\GIS\Figures_Draft\BOARD June2020\Draft\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 22**

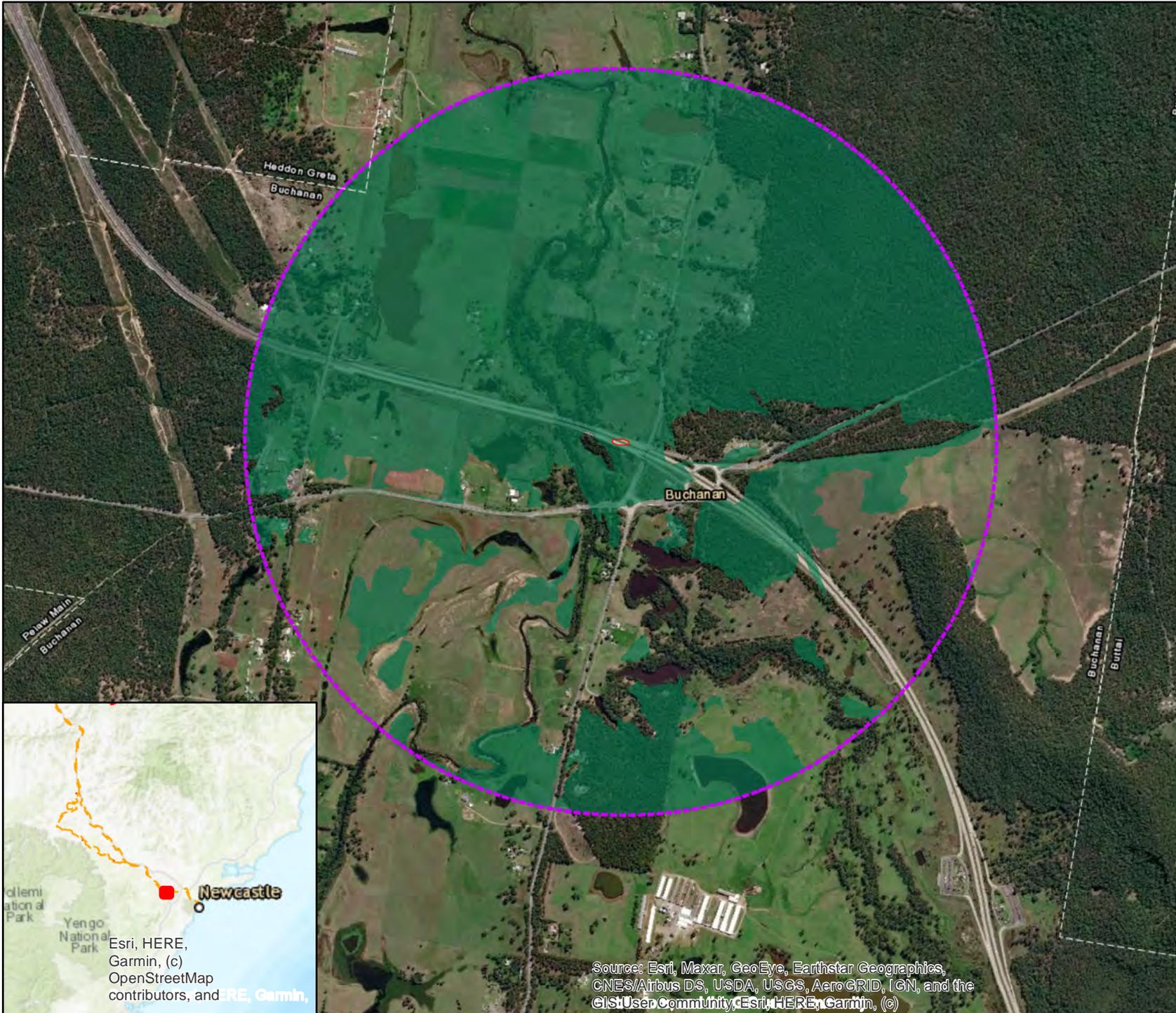
Scale at A4 1:17,790	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------



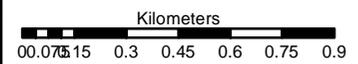
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
Page 23**

Scale at A4 1:21,756	Drawing Status Final
--------------------------------	--------------------------------

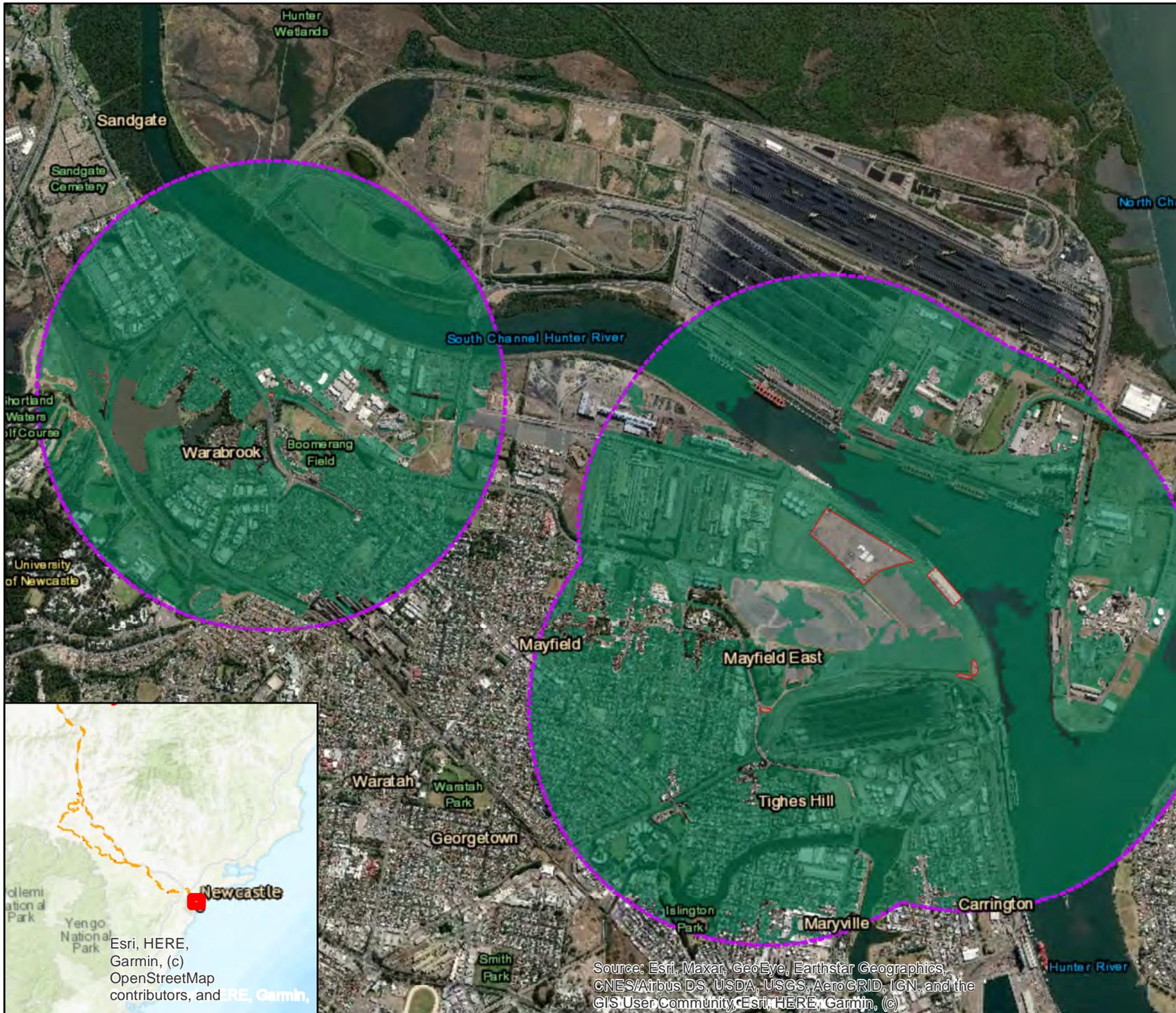
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

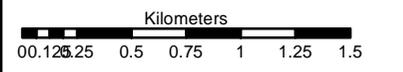
I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\GIS\Figures_Draft\BOARD_June2020\Figures_revised.mxd



- Development footprint
- Landscape assessment buffer (study area)
- Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Location map native vegetation cover
 Page 24**

Scale at A4 1:34,514	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 004
----------------------------	--------------------------

Esri, HERE, Garmin, (c) OpenStreetMap contributors, and HERE, Garmin,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_CJune2020\Draft\Figures_revised.mxd

4 Native vegetation

4.1 Methodology

4.1.1 Data gathering

Existing spatial datasets and documentation relevant to terrestrial vegetation communities within the study area was gathered to inform plant community mapping and requirements for more targeted field surveys. Relevant information sources for the review are outlined in Section 1.6 of this document.

4.1.2 Vegetation surveys and timing

Plant community delineation and mapping of vegetation zones involved review and field validation of OEH mapped vegetation communities over a number of field events over 21 days, as follows:

- An initial survey of the wind farm development footprint from 12 November 2018 to 15 November 2018 by two ecologists totalling 60 person hours.
- Subsequent winter survey of the wind farm development footprint over 5 days in August 2019 by two ecologists totalling 80 person hours
- Subsequent spring survey over 5 days in November 2019 for the proposed transmission line and wind farm development footprint by two ecologists totalling approximately 80 person hours.
- Subsequent summer survey over 5 days in February 2020 for the proposed transmission line and wind farm development footprint totalling approximately 50 person hours.
- Supplementary winter survey completed 17-21 August 2020 for the proposed access/transportation routes, adjusted transmission line corridor and within Ben Halls Gap Nature Reserve, extending 100m buffer from the development footprint, by two ecologists totalling 100 person hours.

Each field event incorporated the rapid survey of vegetation at locations where distinct PCTs could be observed within the development footprint, noting the extent and structure of existing vegetation and dominant species within each stratum. Signs of disturbance such as clearing, fire damage or weed invasion were also noted. Weather conditions (BOM, 2020) during the field surveys are provided in **Table 10**.

Table 10: Weather observations during flora and vegetation surveys

Survey date	Temperature (°C) ¹		Rainfall to 0900 hrs (mm) ²
	Minimum	Maximum	
12 November 2018	10.1	30.6	0.0
13 November 2018	12.8	32.2	0.0
14 November 2018	12.8	26.1	0.0
15 November 2018	9.3	32.2	0.0
27 August 2019	3.4	23.5	0.0
28 August 2019	1.2	22.5	0.0
29 August 2019	0.6	20.9	0.0
30 August 2019	0.5	18.4	0.0
31 August 2019	5.0	19.8	0.0
18 November 2019	11.2	30.4	0.0
19 November 2019	10.8	36.4	0.0
20 November 2019	14.6	35.4	0.0
21 November 2019	13.6	37.0	0.0
25 February 2020	16.2	30.3	11.4
26 February 2020	19.0	31.0	1.2
27 February 2020	16.6	30.5	15.2
28 February 2020	13.6	30.4	0.2
29 February 2020	15.2	No record	0.0
17 August 2020	4.2	16.0	1.0
18 August 2020	4.4	19.0	0.0
19 August 2020	3.8	20.0	0.0
20 August 2020	7.8	15.8	0.0
21 August 2020	3.0	15.6	0.0

¹ Recorded at Quirindi Post Office (42.7km away), BOM station 055049

² Recorded at Head of Peel station, BOM station 55336

4.1.3 PCT confirmation and condition classification

Native vegetation confirmed within the site was classified using the BioNet Vegetation Classification application and stratified according to broad condition state to map vegetation zones across the development footprint. Each PCT and associated condition class was mapped for the development site as a separate vegetation zone based on vegetation structure and condition attributes. In accordance with Section 5.3.1.4 of the BAM, condition classes were assigned from recorded observations of tree, shrub and ground cover, grazing pressure and weed extent. The factors used to assign a condition class to each PCT are described in **Table 11**.

Table 11: Criteria used to assign vegetation condition class

Condition class	Criteria
Non-native exotic grassland	Ground layer dominated by exotics, no native overstorey present. If trees are present in the overstorey they are non-native or outside of known species range.
Non-native planted/urban vegetation	Clearly modified vegetation that is subject to regular maintenance, such as slashing. Vegetation species composition not composed of locally-occurring species.
Native Derived Native Grassland (DNG)	Trees and shrubs absent to very sparse and ground layer dominated by one or two native grass species
Native vegetation – Low condition	Relatively intact canopy cover, young age class of trees (regrowth), moderate shrub and ground layer diversity. No old growth canopy trees Grazing pressure moderate to high. Presence of exotic species
Native vegetation – moderate condition	Intact canopy cover, advanced tree age class, moderate to high shrub and ground layer diversity. Limited old growth canopy trees with hollows Grazing pressure low. Low cover of exotic or weed species
Native vegetation – High condition	High structural and floristic diversity. Old growth canopy trees with hollows present. Grazing pressure absent.

Preliminary mapping of vegetation communities was conducted in the field using tablet computers (Samsung Galaxy Tab 3) running the ArcGIS Collector application in the field, with spatial data collection on the boundaries of each PCT and attribute data collected on dominant flora species and vegetation condition. A PCT and vegetation zone maps was prepared using the data collection from the field verification surveys and aerial photograph interpretation. The mapping process involved using ArcMap to draw vegetation polygons around areas of vegetation using aerial photograph interpretation, then assigning each polygon a PCT and condition class. Aerial photographs utilised included a high resolution photograph captured by drone on

Areas of native vegetation for which a PCT could validly be assigned were identified and delineated in the field, and their condition determined. Identification of PCTs within the study area was confirmed with reference to the community profile descriptors held within the OEH (2012) mapping Project and the NSW the BioNet Vegetation Classification).

General classification of native vegetation in NSW used in this report is based on the classification system in Keith (2004) which uses three groupings of vegetation: vegetation formation, vegetation class and vegetation type (PCT), with vegetation type the finest grouping. The grouping referred to in this report is PCT.

4.1.4 Vegetation condition plots

Vegetation zones and minimum plot requirements are detailed in **Table 12**, based on the development footprints.

In consideration of this, a reasonable survey effort was applied incorporating a total of 25 vegetation integrity plots carried out in accordance with the BAM (**Figure 5, Page 1 and Page 2**). Where minimum plot requirements have not been met under the BAM, benchmark condition has been assumed for the required plots relevant PCTs that were not mapped as derived native grasslands. Where derived native grasslands were mapped and not plot data existing, the required vegetation condition scores were amended so that benchmark values for grasses were used, but no shrub or canopy trees were recorded in the plot data.

This approach assumes the best possible vegetation integrity score is allocated to vegetation zones that do not have sufficient plot data. By including benchmark data where there are insufficient BAM plots, the vegetation condition scores obtained in the BAM Calculator reflect the highest possible condition value.

The assessment of plot requirements summarised in **Table 12** is only calculated on the area of impact within the development footprint to those vegetation communities that can be allocated to a PCT. It does not include vegetation communities that have been mapped as

Table 12: Vegetation zones and BAM plot requirements

Vegetation zone	PCT and condition class	Vegetation zone impact area (ha)	Minimum plot requirements	No. plots surveyed
1	84 - Low	0.08	1	0
2	84 - Moderate	0.09	1	0
3	433 – Low	0.01	1	0
4	433 - Moderate	0.07	1	0
5	434 – Low	0.02	1	0
6	450 – High	1.47	1	0
7	486 – DNG	0.14	1	0
8	486 – High	0.71	1	0
9	486 - Low	1.04	1	0
10	486 - Moderate	5.69	3	0
11	490 - Low	3.14	2	0
12	492 - Moderate	0.77	1	1
13	492 – Low	5.27	3	2
14	492 - DNG	2.85	2	0
15	492 - High	0.94	1	0
16	507 - Moderate	0.15	1	1
17	510 - Low	0.05	1	0
18	526 - High	0.35	1	0

Vegetation zone	PCT and condition class	Vegetation zone impact area (ha)	Minimum plot requirements	No. plots surveyed
19	526 – Moderate	0.15	1	0
20	538 – Low	0.00	1	0
21	540 – High	13.83	3	1
22	540 – Moderate	28.09	4	1
23	540 – Low	16.20	4	1
24	540 – DNG	11.51	3	0
25	541 – DNG	5.70	3	0
26	541 – High	12.91	3	0
27	541 – Low	2.78	2	0
28	541 – Moderate	8.61	3	0
29	591 – Moderate	0.65	1	0
30	599 – Low	1.75	1	1
31	599 – DNG	0.06	1	0
32	599 – High	0.39	1	0
33	599 – Moderate	1.14	1	0
34	931 - Low	0.22	1	1
35	931 – High	3.98	2	1
36	931 – Moderate	1.37	1	1
37	934 – Moderate	3.23	2	1
38	934 – High	7.03	3	1
39	934 – Low	0.62	1	1
40	934 – DNG	4.68	2	1
41	954 – High	1.41	1	1
42	1192 – Low	1.02	1	0
43	1194 - DNG	5.96	3	2
44	1194 – Low	4.78	2	2
45	1194 – High	21.87	4	3
46	1194 – Moderate	23.79	4	2
47	1604 – Low	0.10	1	0
48	1691 - Low	0.03	1	0

4.1.5 Plant identification and nomenclature

All vascular flora recorded during vegetation surveys were identified to species level where possible. Species that could not be identified in the field were recorded to the nearest possible family or genus and collected for later identification. Where they could not be identified confidently, specimens were lodged with the NSW Herbarium for identification.

Nomenclature, including common names, follows Harden (1990-1993, and revised editions 2000-2002). Recent taxonomic revisions were identified using the PlantNET website, developed by the Royal Botanic Gardens (n.d.).

4.2 Vegetation communities

4.2.1 Development footprint

Within the total combined development footprint, a total of 486.45ha of vegetation was mapped, which includes vegetation communities classified as native vegetation, exotic grassland and planted/urban vegetation.

The majority (58% or 279.75ha) of the mapped vegetation within the development footprint is composed of exotic grassland or planted/urban vegetation, with only 42% of the mapped vegetation being classified as native (**Table 13**). The 206.70ha of mapped native vegetation within the development footprint, occurs across 22 separate PCTs with varying levels of disturbance and condition, stratified into 48 vegetation zones.

The native vegetation within the development footprint comprises isolated patches of vegetation in a predominantly agricultural land-use matrix. While isolated, patches were generally within 100m of other patches of native vegetation and in some locations directly connected to areas of larger, contiguous areas of native vegetation.

The condition of these patches of native vegetation ranges from low, with heavy weed infestation (especially Blackberry *Rubus spp.*) supporting little native species richness or diversity, to high condition areas with high native species floristic and structural diversity and low weed infestation. Zones in lower condition also show high levels of modification and fragmentation.

Poor condition vegetation zones are characterised by a canopy of mature and semi mature native trees over an understorey dominated by exotic pasture grasses. Resilience in the understorey in these zones was seen to be low, with a low cover and abundance of native species. Higher condition vegetation condition zones are characterised by complex vegetation structure with a high diversity and abundance of native species within each strata.

Table 13: Vegetation condition class within combined development footprint

Vegetation condition class	Area (ha)	Percentage of mapped vegetation
Planted or urban vegetation	7.39	2%
Exotic grassland	272.36	56%
Derived Native Grasslands	30.91	6%
Native vegetation – Low condition	37.11	8%
Native vegetation – Moderate condition	73.80	15%
Native vegetation – High condition	64.88	13%
TOTAL	486.45	100%

4.2.2 Vegetation communities and infrastructure type

There is also substantial variation in the composition of the vegetation communities within the infrastructure types that compose the development footprint. To show the contribution that each infrastructure element has to the overall impacts within the development footprint a breakdown of the area of each condition class of vegetation is provided in **Table 14**.

This summary shows that most of the impacts associated with the wind turbines (74%), internal roads (64%) and transmission line access tracks (68%), are to non-native vegetation, with exotic grassland being the most common vegetation community mapped in these areas. This reflects the history of disturbance on the ridgeline from the historical and ongoing use as a grazing property. The concept alignment for the transmission line access tracks have also followed existing farm tracks and trails as much as possible to minimise impacts on native vegetation.

Within the transmission line corridor, most of the vegetation (62%) has been mapped and classified as native vegetation. This is due to the requirement for the transmission line to traverse steeper areas of terrain where open eucalypt forest and woodland has been retained. The current concept design has proposed full clearing of the required 60m corridor along the transmission line, however this will be revised during detailed design and clearing limited where practicable and where required operational and safety clearances to the wires can be achieved.

There is also a majority of native vegetation mapped within the road upgrade works proposed on the transport route component of the development footprint. Most of these impacts are associated with works required on Morrisons Gap Road and Head of Peel Road, where curve realignments are necessary to transport the turbine infrastructure up the existing steep roads.

Table 14: Summary of vegetation and condition type for each infrastructure type

Vegetation condition class	Infrastructure element vegetation extent (ha and percentage within each infrastructure type)				
	Wind turbines	Internal roads	Transmission line	Transmission line access tracks	Transport route upgrades
Planted or urban vegetation	0.01 (<1%)	1.27 (1%)	13.18 (10%)	0.009 (<1%)	5.72 (19%)
Exotic grassland	55.70 (74%)	117.55 (64%)	52.11 (38%)	38.90 (68%)	7.67
Derived Native Grasslands	4.75 (6%)	8.43 (5%)	13.18 (10%)	3.67 (6%)	0.89 (3%)
Native vegetation – Low condition	1.60 (2%)	8.33 (5%)	22.27 (16%)	4.04 (7%)	0.87 (3%)
Native vegetation – Moderate condition	5.71 (8%)	31.24 (17%)	26.46 (19%)	6.47 (11%)	3.90 (13%)
Native vegetation – High condition	7.54 (10%)	18.00 (10%)	23.86 (17%)	4.14 (7%)	11.35 (37%)
Total native vegetation (ha)	19.59 (26%)	65.99 (36%)	85.76 (62%)	18.32 (32%)	17.00 (56%)
Total area planted or exotic (ha)	55.71 (74%)	118.81 (64%)	52.48 (38%)	38.91 (68%)	13.39 (44%)

4.2.3 Combined development footprint

Table 15 provides a detailed summary of the PCTs, vegetation zones, condition, extent, integrity score and associated TECs for the total combined development footprint, which has been used in assessing the impacts of the project. This information was used as the basis for a combined vegetation zone map for the entire development footprint (**Figure 5, Pages 1 to 26**).

PCT descriptions and photographs are provided in **Appendix B**.

Table 15: Vegetation communities within the development footprint

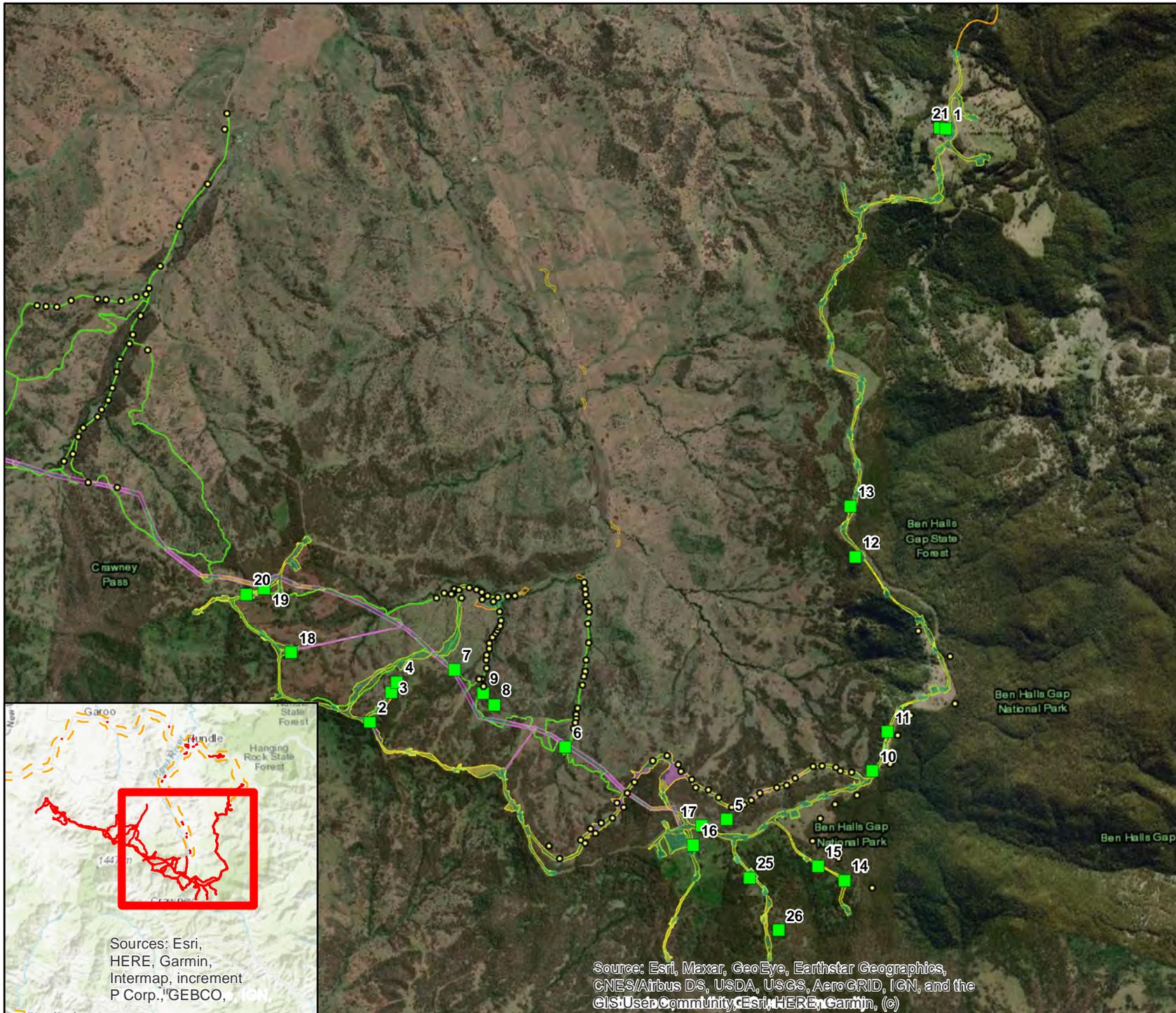
PCT	Associated TECs and status under the BC Act and EPBC Act	Vegetation zones/ condition	Total area
PCT 84: River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South Bioregion and Nandewar Bioregion	NA	VZ 1 - Low	0.08
		VZ 2 - Moderate	0.09
		TOTAL	0.17
PCT 433: White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, BBS Bioregion	White Box Yellow Box Blakely's Red Gum Woodland, critically endangered under the BC Act and EPBC Act	VZ 3 – Low	0.01
		VZ 4 - Moderate	0.07
		TOTAL	0.08
PCT 434: White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion	NA	VZ 5 – Low	0.02
		TOTAL	0.02
PCT 450: Smooth-barked Apple - White Cypress Pine grass shrub woodland on lower slopes and sandy flats, north-western Brigalow Belt South Bioregion	NA	VZ 6 – High	1.47
		TOTAL	1.47

PCT	Associated TECs and status under the BC Act and EPBC Act	Vegetation zones/ condition	Total area
PCT 486 - River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range	NA	VZ 7 - DNG	0.14
		VZ 9 – Low	1.04
		VZ 10 – Moderate	5.69
		VZ 8 – High	0.71
		TOTAL	7.58
PCT 490 - Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion	NA	VZ 11 – Low	3.14
		TOTAL	3.14
PCT 492 - Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion	White Box Yellow Box Blakely's Red Gum Woodland, critically endangered under the BC Act and EPBC Act	VZ 14 – DNG	2.85
		VZ 13 – Low	5.27
		VZ 12 – Moderate	0.77
		VZ 15 - High	0.94
		TOTAL	9.83
PCT 507 - Black Sallee - Snow Gum grassy woodland of the New England Tableland Bioregion	NA	VZ 16 - Moderate	0.15
		TOTAL	0.15
PCT 510 - Blakely's Red Gum - Yellow Box grassy woodland of the New England Tableland Bioregion	White Box Yellow Box Blakely's Red Gum Woodland, critically endangered under the BC Act and EPBC Act	VZ 17	0.05
		TOTAL	0.05

PCT	Associated TECs and status under the BC Act and EPBC Act	Vegetation zones/ condition	Total area
PCT 526 - Mountain Ribbon Gum - Messmate - Broad-leaved Stringybark open forest on granitic soils of the New England Tableland Bioregion	NA	VZ 19 – Moderate	0.15
		VZ 18 – High	0.35
		TOTAL	0.50
PCT 538 - Rough-barked Apple - Blakely's Red Gum open forest of the Nandewar Bioregion and western New England Tableland Bioregion	White Box-Yellow Box Blakely's Red Gum Woodland, critically endangered under the BC Act and EPBC Act	VZ20 – Low	0.004
		TOTAL	0.004
PCT 540 - Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion	NA	VZ 24 - DNG	11.51
		VZ 23 – Low	16.20
		VZ 22 – Moderate	28.09
		VZ 21 – High	13.83
		TOTAL	69.63
PCT 541 - Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion	NA	VZ 25 – DNG	5.70
		VZ 27 – Low	2.78
		VZ 28 - Moderate	8.61
		VZ 26 – High	12.91
		TOTAL	29.99
PCT 591 - White Box shrubby open forest on hills mainly in the Nandewar Bioregion	NA	VZ 29 - Moderate	0.65
		TOTAL	0.65

PCT	Associated TECs and status under the BC Act and EPBC Act	Vegetation zones/ condition	Total area
PCT 599- Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion	White Box Yellow Box Blakely's Red Gum Woodland, critically endangered under the BC Act and EPBC Act	VZ 31 – DNG	0.06
		VZ 30 – Low	1.75
		VZ 33 – Moderate	1.14
		VZ 32 – High	0.39
		TOTAL	3.34
PCT 931 - Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion	NA	VZ34 – Low	0.22
		VZ36 – Moderate	1.37
		VZ35 – High	3.98
		TOTAL	5.57
PCT 934 - Messmate open forest of the tableland edge of the NSW North Coast Bioregion and New England Tableland Bioregion	NA	VZ 40 – DNG	4.68
		VZ 39 – Low	0.62
		VZ 37 – Moderate	3.23
		VZ 38 – High	7.03
		TOTAL	15.56
PCT 954 - Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion	NA	VZ 41 - High	1.41
		TOTAL	1.41
PCT 1192 - Snow Gum - Mountain Gum - Mountain Ribbon Gum	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland	VZ 42 - Low	1.02

PCT	Associated TECs and status under the BC Act and EPBC Act	Vegetation zones/ condition	Total area
grassy open forest of the New England Tableland Bioregion	of the New England Tableland Bioregion, endangered under the BC Act.	TOTAL	1.02
PCT 1194 - Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion, endangered under the BC Act.	VZ43 – DNG	5.96
		VZ44 – Low	4.78
		VZ46 - Moderate	23.79
		VZ45 – High	21.87
		TOTAL	56.41
PCT 1604 - Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	NA	VZ 48 - Low	0.10
		TOTAL	0.10
PCT 1691 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	NA	VZ49 - Low	0.03
		TOTAL	0.03

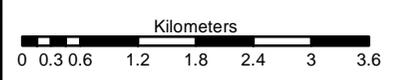


● PCT verification point
 ■ Vegetation Plot

Plant Community Types

- Planted Urban Vegetation
- 84
- 450
- 486
- 492
- 507
- 526
- 538
- 540
- 541
- 599
- 931
- 934
- 954
- 1192
- 1194
- Exotic grassland
- Transport route (port to site)
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 1 (wind farm overview)**

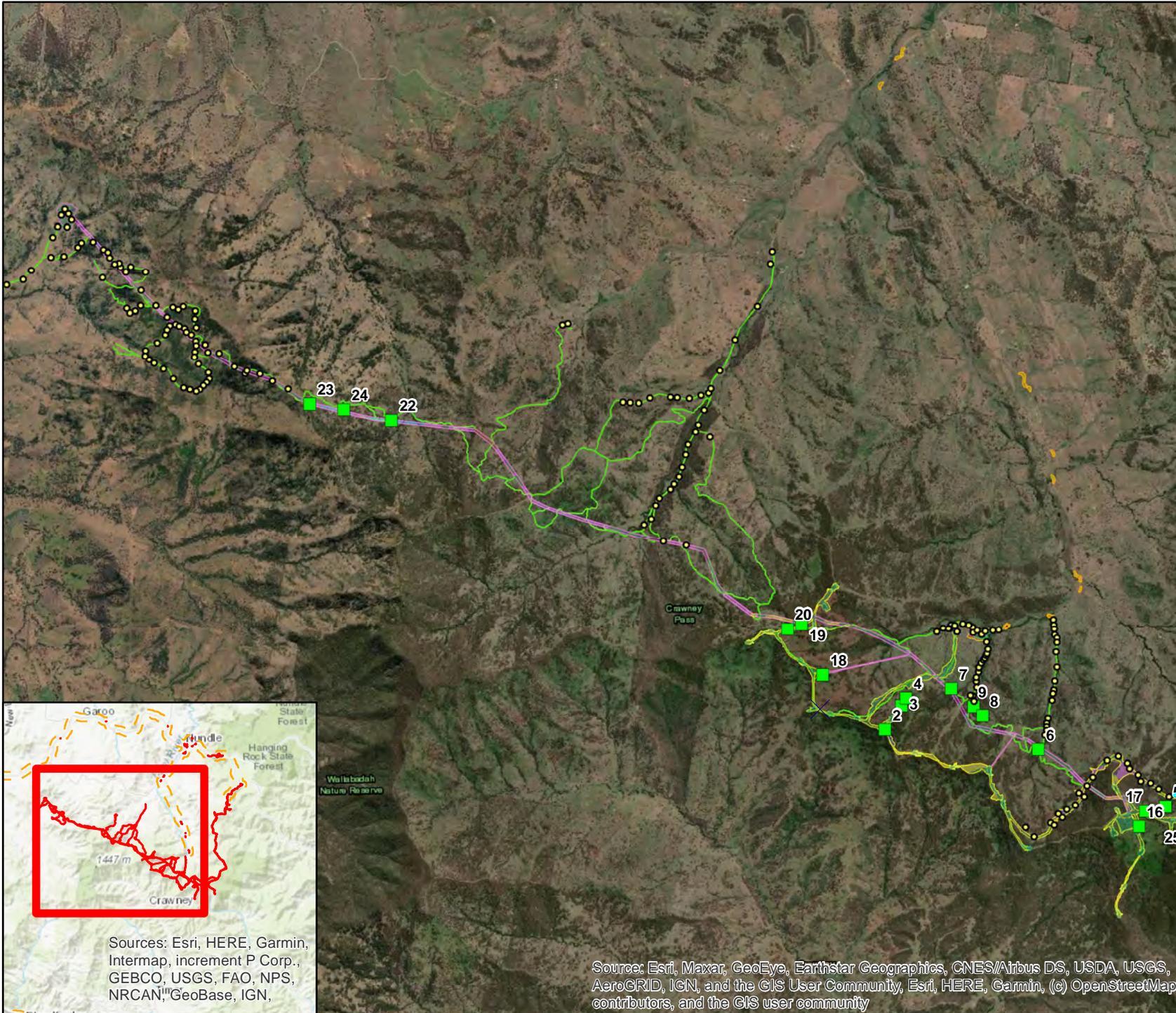
Scale at A4 1:78,304	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, ©

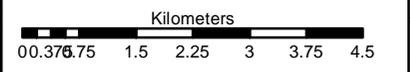


● PCT verification point
 ■ Vegetation Plot

Plant Community Types

- Planted Urban Vegetation
- 84
- 433
- 434
- 450
- 486
- 490
- 492
- 507
- 526
- 538
- 540
- 541
- 591
- 599
- 931
- 934
- 954
- 1192
- 1194
- Exotic grassland
- Transport route development footprint (port to site)
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

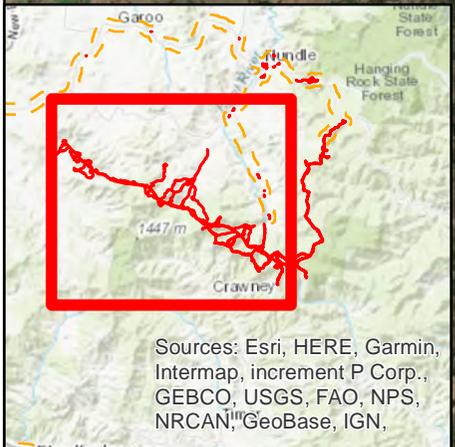
Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 2 (transmission overview)**

Scale at A4 1:99,700	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

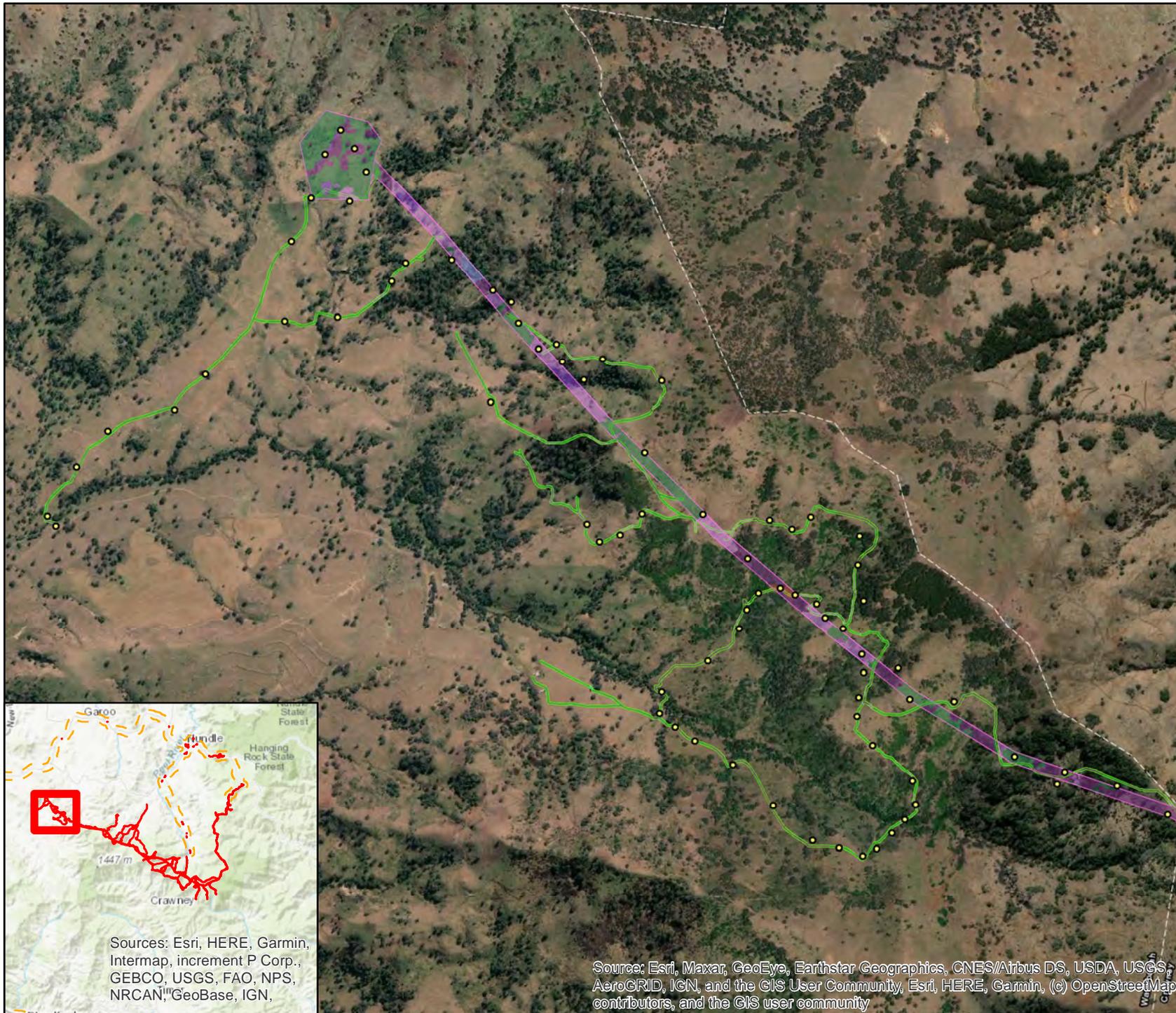
Job No 270335-00	Drawing No 005
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

J:\270000\270335-00 Hills of Gold\Work\mmap\05signets\Figures\Drawn\ARUP_270335-00\Drawn\Figures_revised.mxd



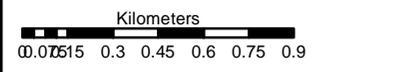
● PCT verification point

Plant Community Types

- Planted Urban Vegetation
- 433
- 434
- 486
- 540
- 541
- 591
- 599
- Exotic grassland
- Transmission line and switching
- Transmission line access tracks



D1	28/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 3**

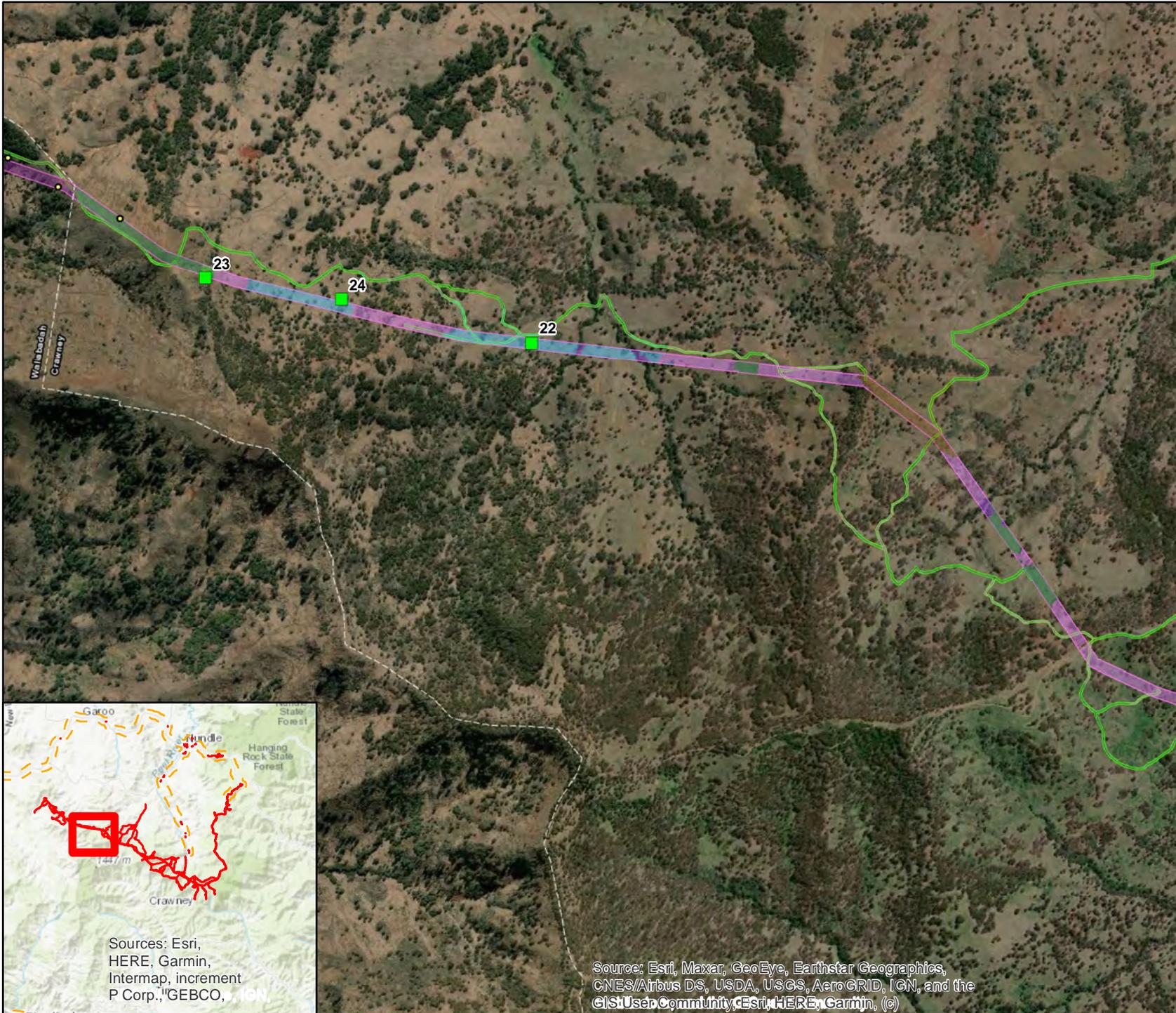
Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community



● PCT verification point
 ■ Vegetation Plot

Plant Community Types

- 486
- 490
- 492
- 540
- 541
- 599
- Exotic grassland
- Transmission line and switching
- Transmission line access tracks

↑

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

0.0 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Plant Community Types
Page 4**

Scale at A4	Drawing Status
1:25,000	Final

Coordinate System

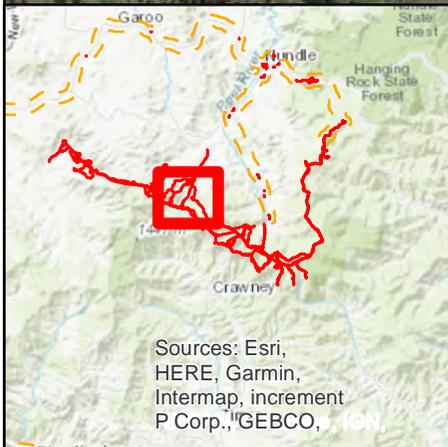
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	005

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

● PCT verification point

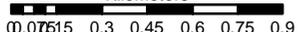
Plant Community Types

- 486
- 540
- 541
- 599
- 1194
- Exotic grassland
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers



0.0 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Plant Community Types
Page 5**

Scale at A4	Drawing Status
1:25,000	Final

Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	005

© Arup and Biosis



- PCT verification point

Plant Community Types

- 84
- 486
- 538
- 541
- 599
- Exotic grassland
- Transmission line access tracks



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 6**

Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

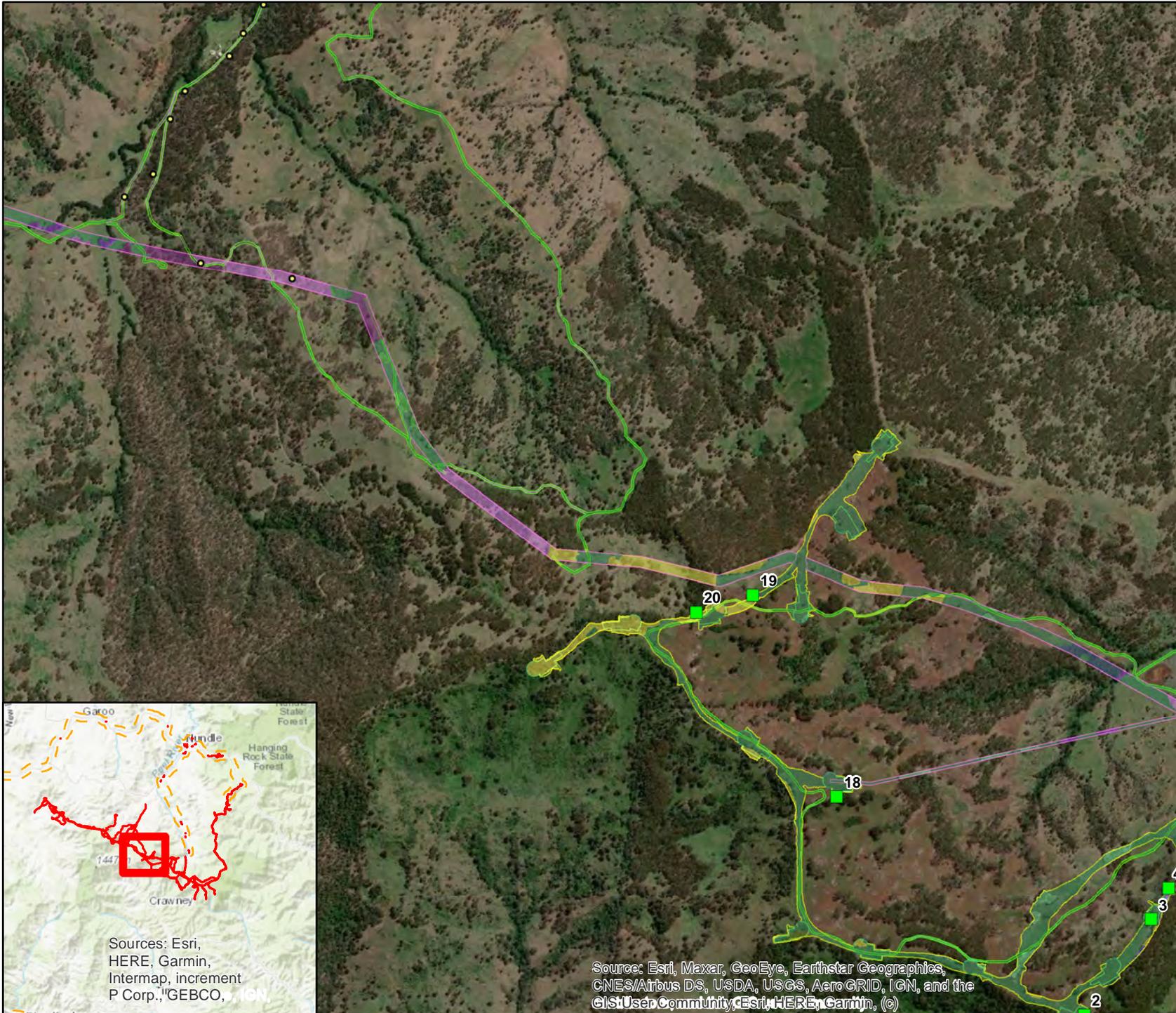
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



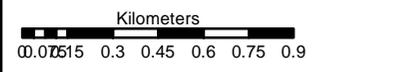
- PCT verification point
- Vegetation Plot

Plant Community Types

- 450
- 486
- 507
- 540
- 541
- 599
- 931
- 934
- 954
- 1194
- Exotic grassland
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
Page 7**

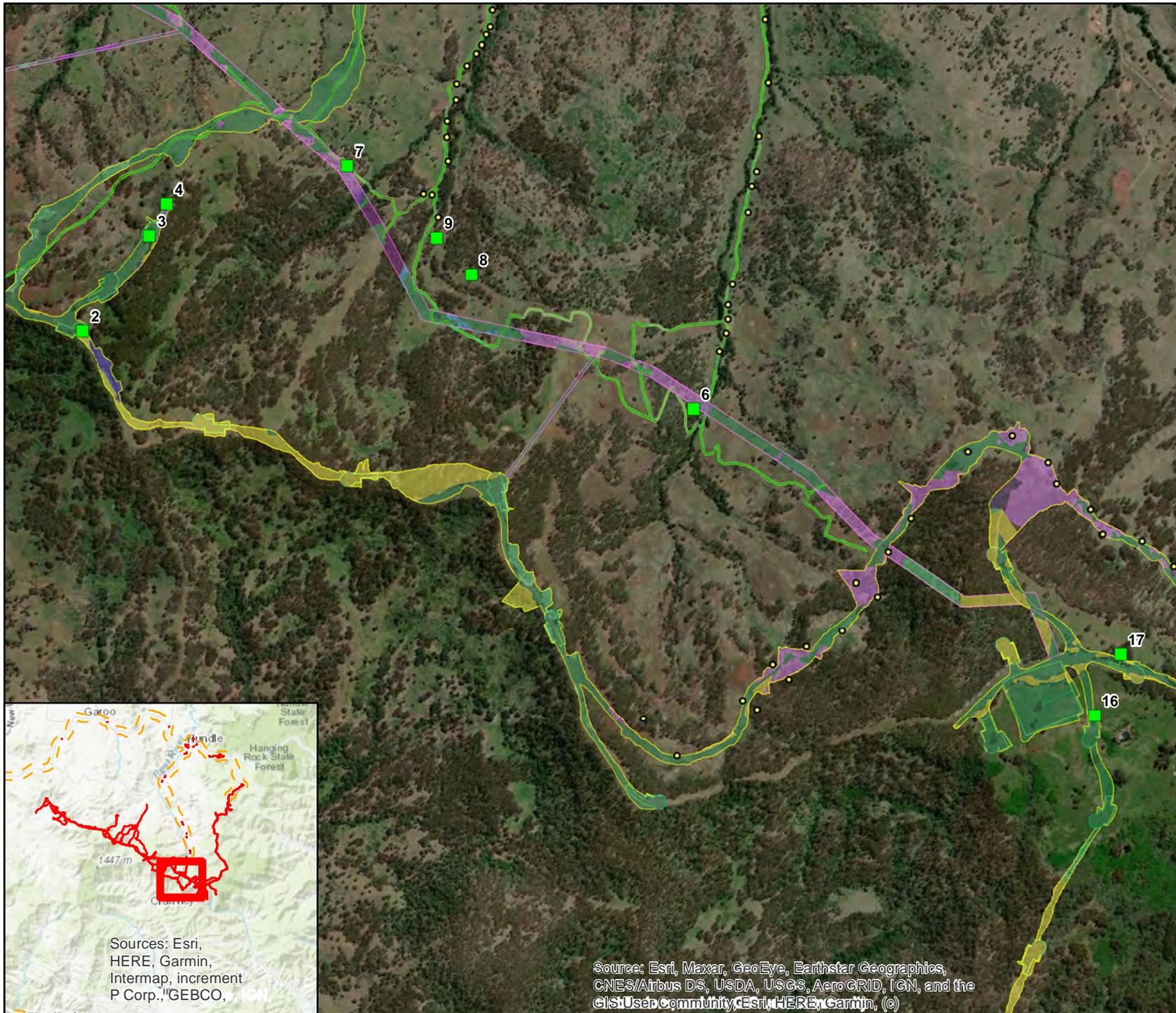
Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



● PCT verification point
 ■ Vegetation Plot

Plant Community Types

- 486
- 492
- 540
- 541
- 931
- 934
- 954
- 1192
- 1194
- Exotic grassland
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

0.0 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

Plant Community Types
Page 8

Scale at A4	Drawing Status
1:25,000	Final

Coordinate System

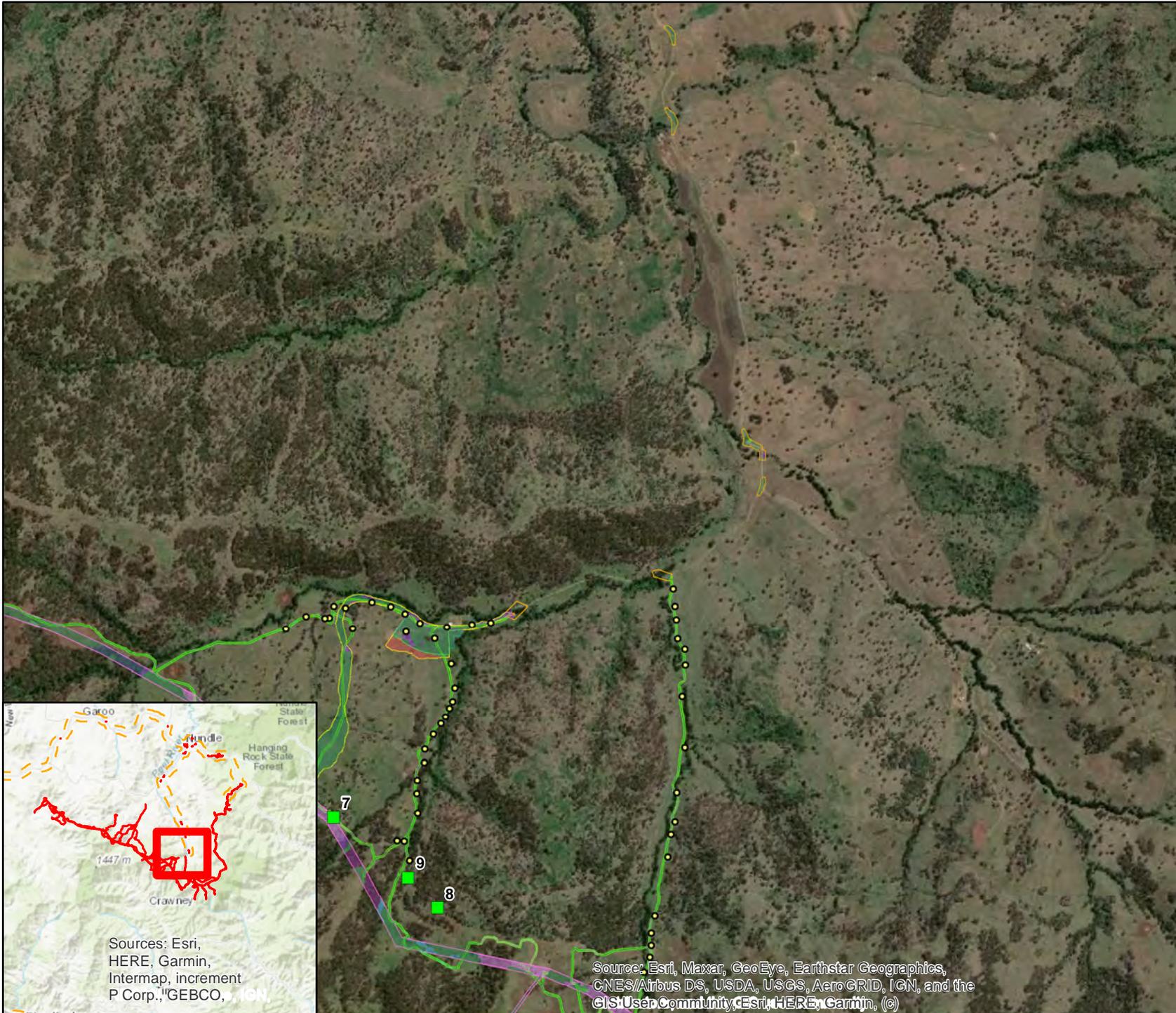
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	005

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



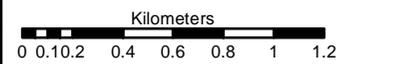
● PCT verification point
 ■ Vegetation Plot

Plant Community Types

- Planted Urban Vegetation
- 84
- 450
- 486
- 492
- 540
- 541
- 599
- 931
- 934
- 954
- 1194
- Exotic grassland
- Transport route (port to site)
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 9**

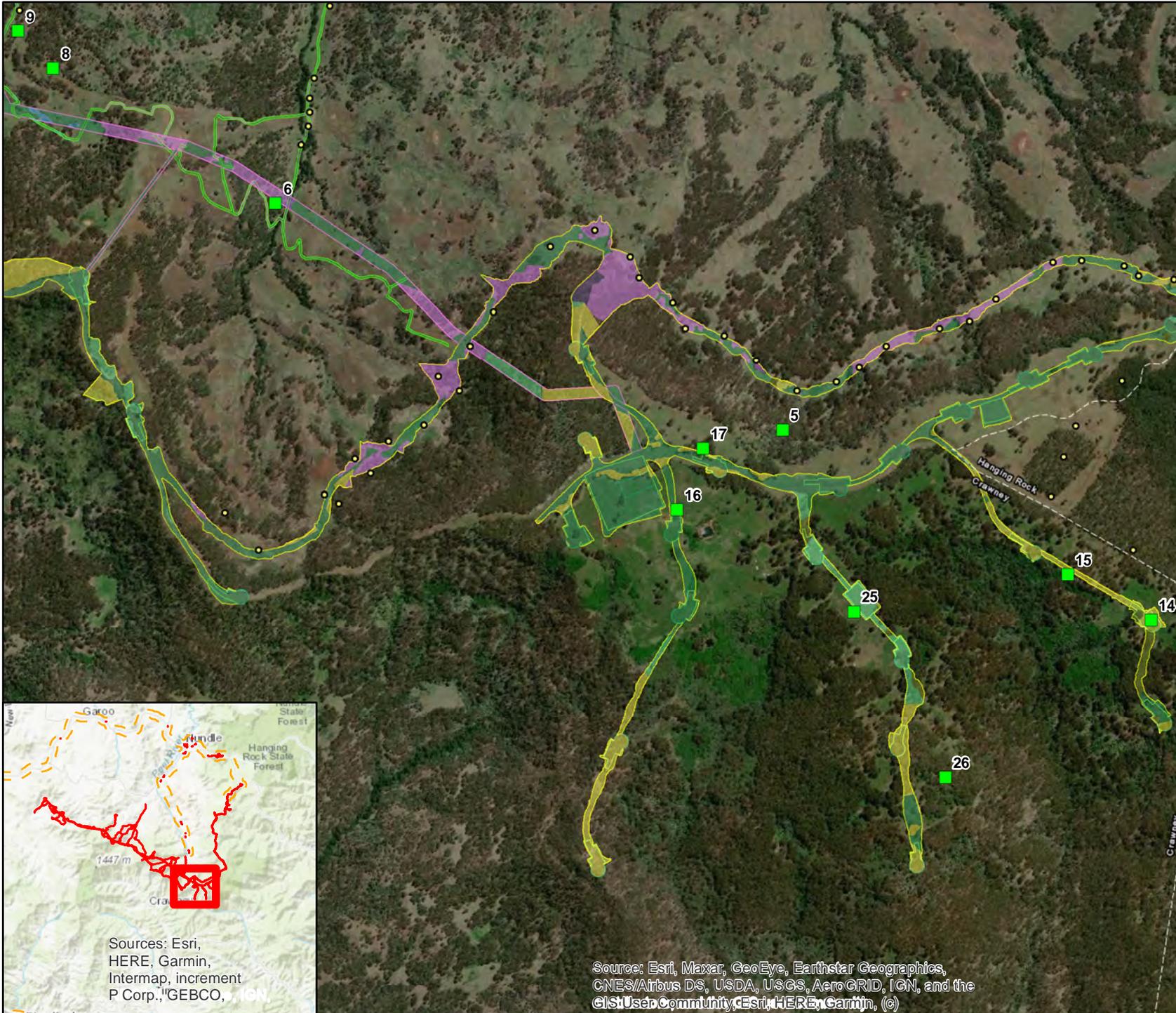
Scale at A4	Drawing Status
1:30,000	Final

Coordinate System
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	005

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



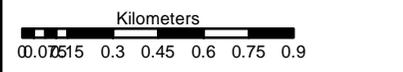
● PCT verification point
 ■ Vegetation Plot

Plant Community Types

- 486
- 492
- 526
- 540
- 931
- 934
- 1192
- 1194
- Exotic grassland
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

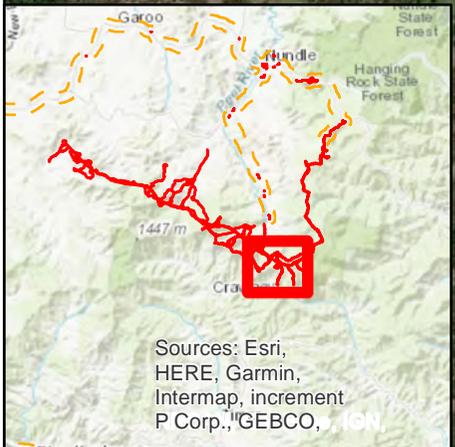
Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 10**

Scale at A4	Drawing Status
1:25,000	Final

Coordinate System
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	005



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, ©

J:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_CJune2020\Draft\Figures_revised.mxd



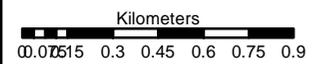
● PCT verification point
 ■ Vegetation Plot

Plant Community Types

- 526
- 540
- 931
- 934
- 1194
- Exotic grassland
- Wind farm infrastructure
- Transmission line and switching
- Internal roads



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

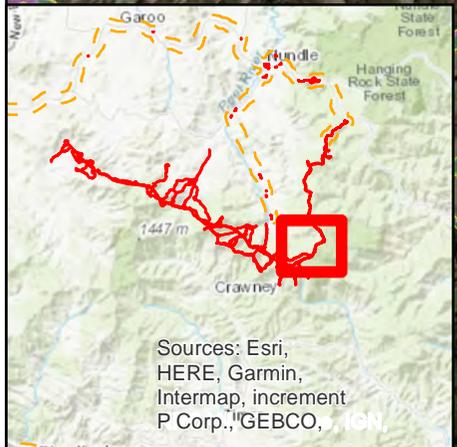
**Plant Community Types
Page 11**

Scale at A4	Drawing Status
1:25,000	Final

Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	005



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



Vegetation Plot

Plant Community Types

- 1194
- Exotic grassland
- Wind farm infrastructure
- Internal roads

↑

D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

0 0.15 0.3 0.45 0.6 0.75 0.9

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Plant Community Types
Page 12**

Scale at A4	Drawing Status
1:25,000	Final

Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	005

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN, Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

D:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd

© Arup and Biosis

© Arup



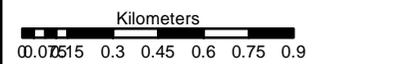
Vegetation Plot

Plant Community Types

- Planted Urban Vegetation
- 490
- 526
- 931
- 1194
- Exotic grassland
- Transport route (port to site)
- Wind farm infrastructure
- Internal roads



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
Page 13**

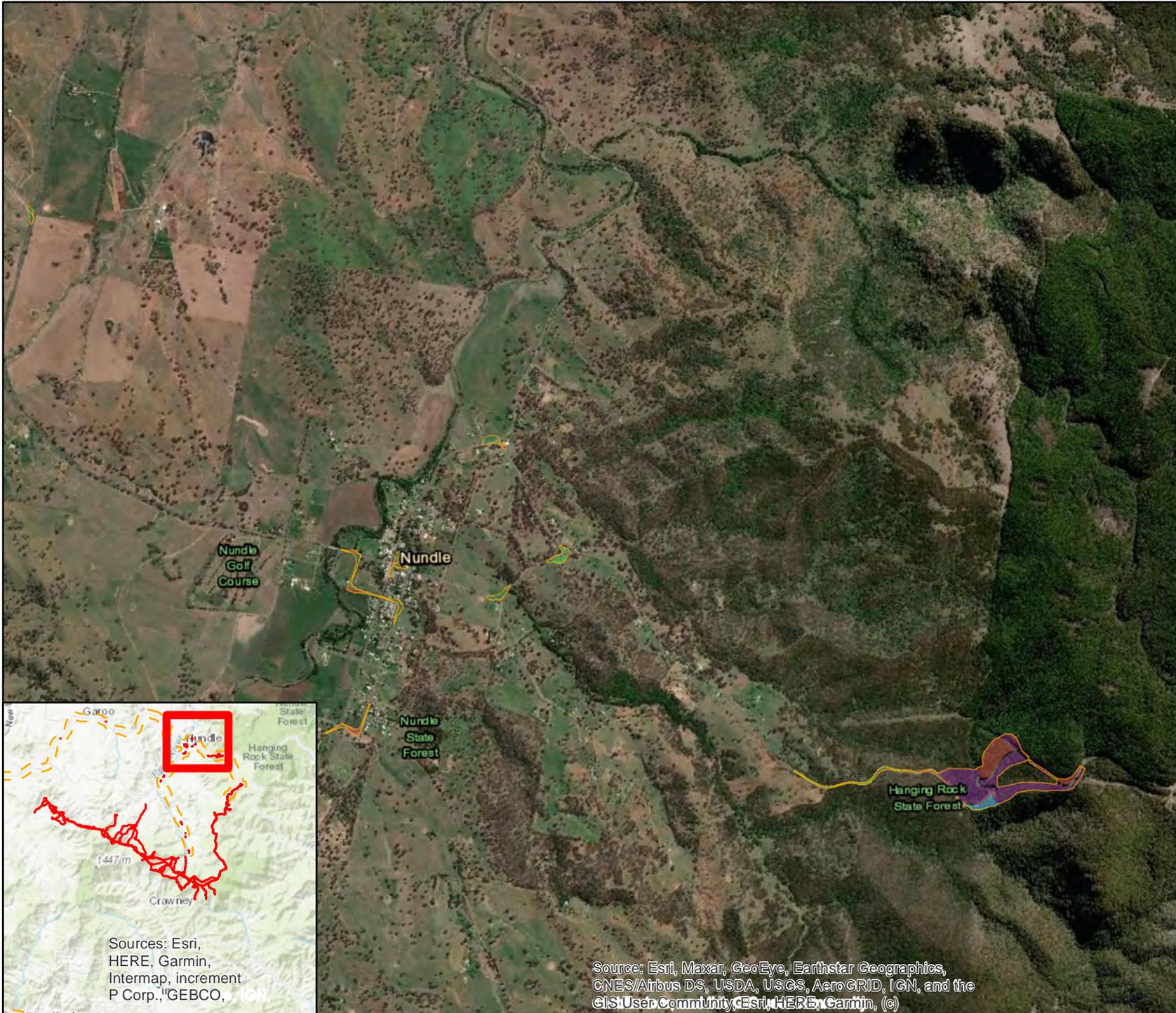
Scale at A4 1:25,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



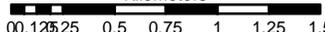
Plant Community Types

- Planted Urban Vegetation
- 492
- 510
- 541
- 599
- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers



00.125 0.25 0.5 0.75 1 1.25 1.5

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

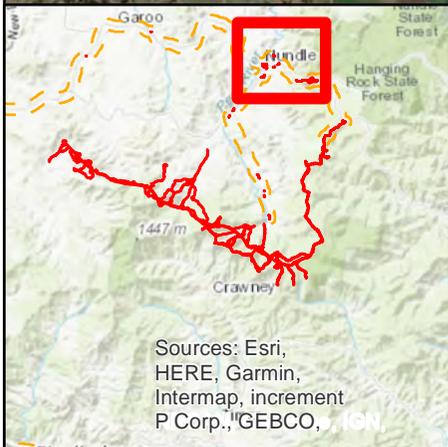
**Plant Community Types
Page 14**

Scale at A4	Drawing Status
1:36,600	Final

Coordinate System

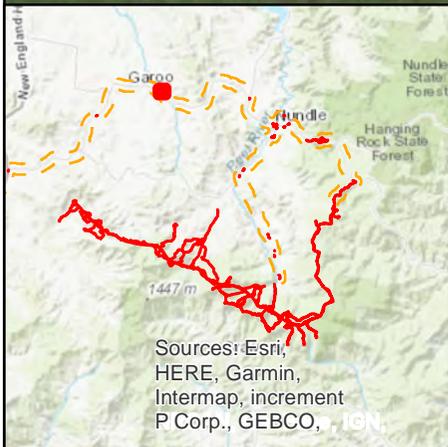
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	005



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOARD June2020\Draft\Figures_revised.mxd



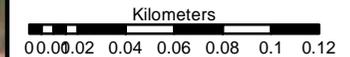
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

Plant Community Types

- 84
- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
Page 15a**

Scale at A4 1:3,122	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------

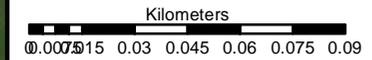


Plant Community Types

- 84
- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

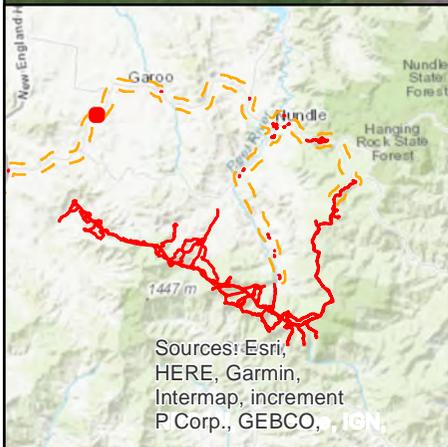
Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 15b**

Scale at A4 1:2,147	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

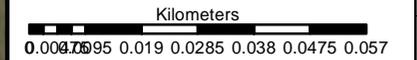


Plant Community Types

- 433
- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

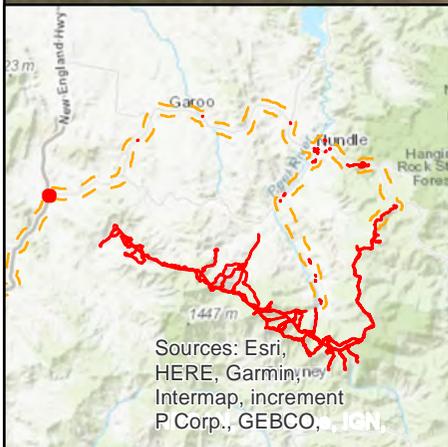
Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 16**

Scale at A4 1:1,275	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270335\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

0 0.00 0.02 0.04 0.06 0.08 0.1 0.12

ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

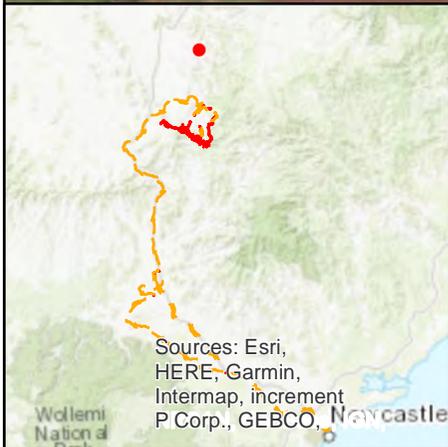
Plant Community Types
Page 17

Scale at A4	Drawing Status
1:2,973	Final

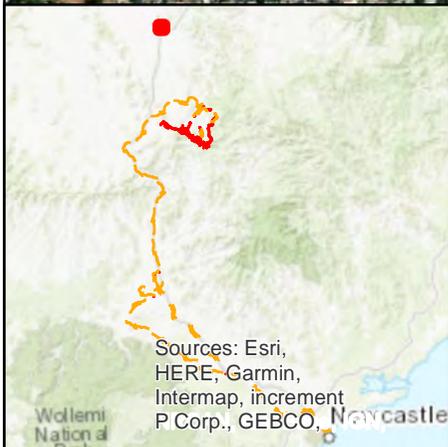
Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	005



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, Newcastle

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers
0 0.050.1 0.2 0.3 0.4 0.5 0.6

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

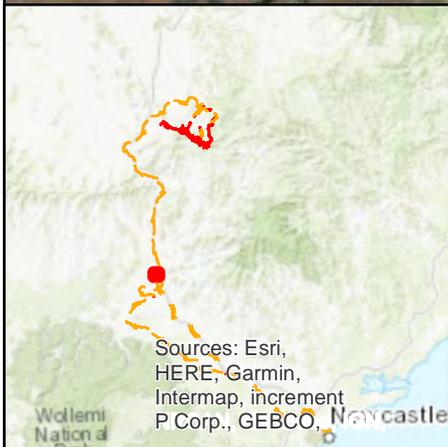
Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
Page 18**

Scale at A4 1:14,107	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, Newcastle

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

Plant Community Types

- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
Page 19a**

Scale at A4 1:14,392	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd

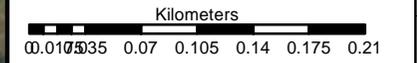


**Plant
Community
Types**

- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

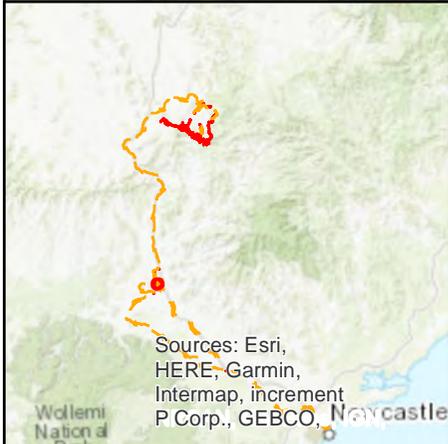
Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
Page 19b**

Scale at A4 1:4,718	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------



Sources: Esri,
HERE, Garmin,
Intermap, increment
P Corp., GEBCO, Newcastle

Source: Esri, Maxar, GeoEye, Earthstar Geographics,
CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the
GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\19b\Figures_19b_revised.mxd

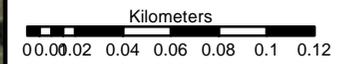


Plant Community Types

- 1604
- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Plant Community Types
 Page 20a**

Scale at A4

1:3,150

Drawing Status

Final

Coordinate System

GDA 1994 MGA Zone 56

Job No

270335-00

Drawing No

005

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

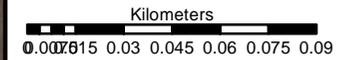


Plant Community Types

- Planted Urban Vegetation
- 1691
- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Plant Community Types
 Page 20b**

Scale at A4

1:2,345

Drawing Status

Final

Coordinate System

GDA 1994 MGA Zone 56

Job No

270335-00

Drawing No

005

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

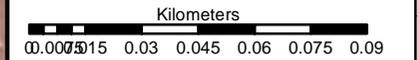


Plant Community Types

- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 21**

Scale at A4 1:2,010	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



©Arup and Biosis

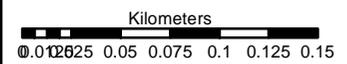
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

Plant Community Types

- Planted Urban Vegetation
- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Type
Page 22**

Scale at A4 1:3,828	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOARD_June2020\Draft\Figures_revised.mxd

© Arup

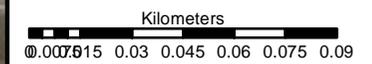


**Plant
Community
Types**

- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
Page 23a**

Scale at A4 1:2,208	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\GIS\Figures\23a\Figures_23a.mxd



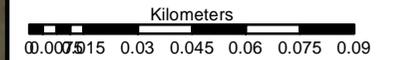
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

Plant Community Types

- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Plant Community Types
Page 23b**

Scale at A4

1:2,090

Drawing Status

Final

Coordinate System

GDA 1994 MGA Zone 56

Job No

270335-00

Drawing No

007

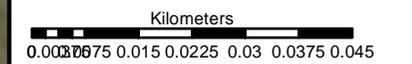


Plant Community Types

- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 24**

Scale at A4 1:1,059	Drawing Status Final
-------------------------------	--------------------------------

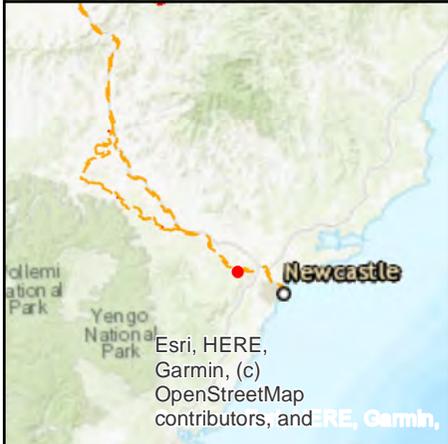
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\GIS\Figures_Draft\BOARD_June2020\Draft\Figures_revised.mxd

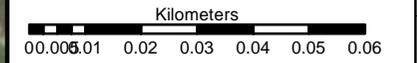


Plant Community Types

- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 25**

Scale at A4 1:1,348	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\GIS\Figures_01\Figures_revised.mxd



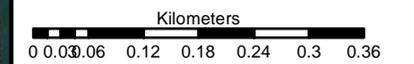
Mayfield East

Plant Community Types

- Planted Urban Vegetation
- Exotic grassland
- Transport route (port to site)



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

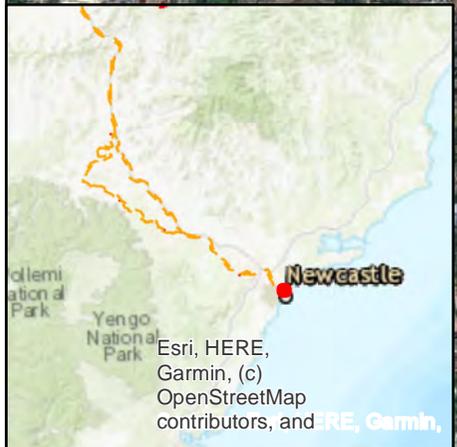
Job Title
Hills of Gold Wind Farm

Drawing Title
**Plant Community Types
 Page 26**

Scale at A4 1:8,206	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 005
----------------------------	--------------------------



©Arup and Biosis

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and HERE, Garmin, (c)

I:\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_CJune2020\Draft\Figures_revised.mxd

© Arup

4.3 Threatened ecological communities

Two threatened ecological communities (TEC) were confirmed to occur within and immediately adjacent to the development footprint. These are identified in **Table 16**, with their occurrence shown in **Figure 6, Pages 1 to 3**.

Table 16: Threatened ecological communities mapped within the development footprint, their conservation status,

TEC	PCT	Conservation status ¹	
		EPBC Act	BC Act
Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	PCT 1194: Snow Gum – Mountain Gum – Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion	Not listed	E
	PCT 1192: Snow Gum – Mountain Gum – Mountain Ribbon Gum grassy open forest of the New England Tableland Bioregion		
White Box Yellow Box Blakely’s Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions	PCT 492 – Silvertop Stringybark – Yellow Box – Apple Box – Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion	CE	CE
	PCT 599- Blakely’s Red Gum – Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion		

1 Conservation status – CE: critically endangered; E: endangered

4.3.1 Ribbon Gum-Mountain Gum-Snow Gum Grassy Forest/Woodland

The distribution of Ribbon Gum-Mountain Gum-Snow Gum Grassy Forest/Woodland across the development footprint is strongly influenced by topography and location within the landscape, this TEC occurs at elevations of 700m -1,500m on deep basalt or loam soils.

Within the development footprint, it is comprised of two PCTs and classified as endangered under the BC Act only. These two PCTs are:

- PCT 1194 – Snow Gum – Mountain Gum – Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion; and
- PCT 1192: 1192 – Snow Gum – Mountain Gum – Mountain Ribbon Gum grassy open forest of the New England Tableland Bioregion

The location of this BC Act listed TEC within the development footprint is confined to the upper ridgelines and more shallow slopes at the top of the escarpment (**Figure 6, Page 3**). Where it does occur on the ridgeline within the development footprint, this TEC is predominantly in a low or moderate condition and fragmented spatial distribution due to the history of land clearing and grazing.

There is a total of 57.43 hectares of Ribbon Gum-Mountain Gum-Snow Gum Grassy Forest/Woodland within the development footprint, or 5.4% of the total estimated extent of this TEC in the study area. Field and desktop analysis identified a total area of 1,059 hectares of this TEC within the study area

Due to these topography and soil constraints, the majority of the Ribbon Gum-Mountain Gum-Snow Gum Grassy Forest/Woodland within the development footprint is impacted by the wind farm and internal road infrastructure type, with the internal roads contributing to the majority of these impacts (**Table 17**). As much as possible the placement of wind farm infrastructure avoided these areas of TEC, however engineering constraints with steeper slopes and ridgelines require internal access roads to have a concept earthworks design that increases the footprint.

Field surveys also confirmed substantial areas of high quality Ribbon Gum-Mountain Gum-Snow Gum TEC within the adjacent Ben Halls Gap Nature Reserve. These areas were in much higher condition than the patches of this TEC within the development footprint, largely due to the exclusion of cattle grazing pressure and weed management along fence lines. These areas also contained a much higher density of larger eucalypt trees supporting various sized hollows, containing improved habitat resources for native fauna.

Table 17: Distribution of Ribbon Gum-Mountain Gum-Snow Gum TEC within each infrastructure type in the development footprint.

Vegetation condition class	Ribbon Gum-Mountain Gum-Snow Gum TEC area in each infrastructure type (ha)				
	Wind turbine infrastructure	Internal roads	Transmission line	Transmission line access tracks	Transport route road upgrades
Derived Native Grasslands	1.99	3.10	0.32	0.30	0.26
Native vegetation – Low condition	1.31	3.08	1.19	0.00	0.23
Native vegetation – Moderate condition	4.86	16.90	1.40	0.01	0.62
Native vegetation – High condition	5.95	10.73	4.53	0.22	0.44
Total (ha)	14.11	33.81	7.43	0.53	1.55

4.3.2 White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland is a critically endangered TEC listed under both the EPBC Act and the BC Act. Its distribution is strongly associated with more fertile soils on lower elevations across the known range in Queensland, New South Wales and Victoria. Over much of its range, this TEC has been subject to extensive clearing and modification for agriculture and grazing, so it often occurs as derived native grasslands with no overstorey.

Within the development footprint, there is a total of 13.33 hectares of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland TEC, which meets the classification of both the EPBC Act TEC and the BC Act. All of the occurrence of this TEC is located within the development footprint associated with the transmission line corridor, transmission line access tracks and transport route (**Figure 6, Page 2**). This area of TEC within the development footprint represents 0.8% of the extent of this TEC within the study area, which is 1,694 hectares. Within the development footprint, this TEC consists of the following PCTs:

- PCT 492 - Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion
- PCT 599- Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion

Consistent with the topographic, geological and soils requirements of this TEC, there is none across the ridgelines where the wind turbines and internal roads are located (**Table 18**). The vast majority (82%) of the occurrence of this TEC within the development footprint is associated with the transmission line, including the proposed construction access tracks. There are some very small, fragmented, isolated and low condition patches located within road reserve that will be impacted as part of the transport haul route road upgrades, however the value of these patches is negligible.

Table 18: Distribution of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland TEC within each infrastructure type in the development footprint.

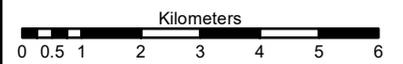
Vegetation condition class	White Box-Yellow Box-Blakely's Red Gum Grassy Woodland TEC area in each infrastructure type (ha)				
	Wind farm infrastructure	Internal roads	Transmission line	Transmission line access tracks	Transport route
Derived Native Grasslands	0.00	0.00	2.46	0.39	0.06
Native vegetation – Low condition	0.00	0.00	6.29	6.29	0.39
Native vegetation – Moderate condition	0.00	0.00	0.62	0.62	0.74
Native vegetation – High condition	0.00	0.00	0.06	0.00	1.26
Total (ha)	0.00	0.00	9.43	1.45	2.45



- Threatened ecological communities**
- Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion
 - White Box Yellow Box Blakely's Red Gum Woodland
 - Transport route (port to site)
 - Wind farm infrastructure
 - Transmission line and switching
 - Internal roads
 - Transmission line access tracks



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

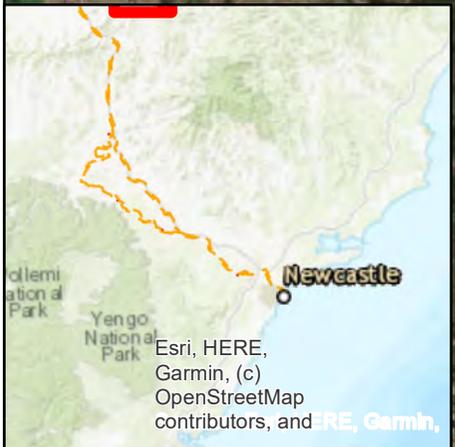
Job Title
Hills of Gold Wind Farm

Drawing Title
**Threatened ecological communities
Page 1 (overview)**

Scale at A4 1:127,009	Drawing Status Final
---------------------------------	--------------------------------

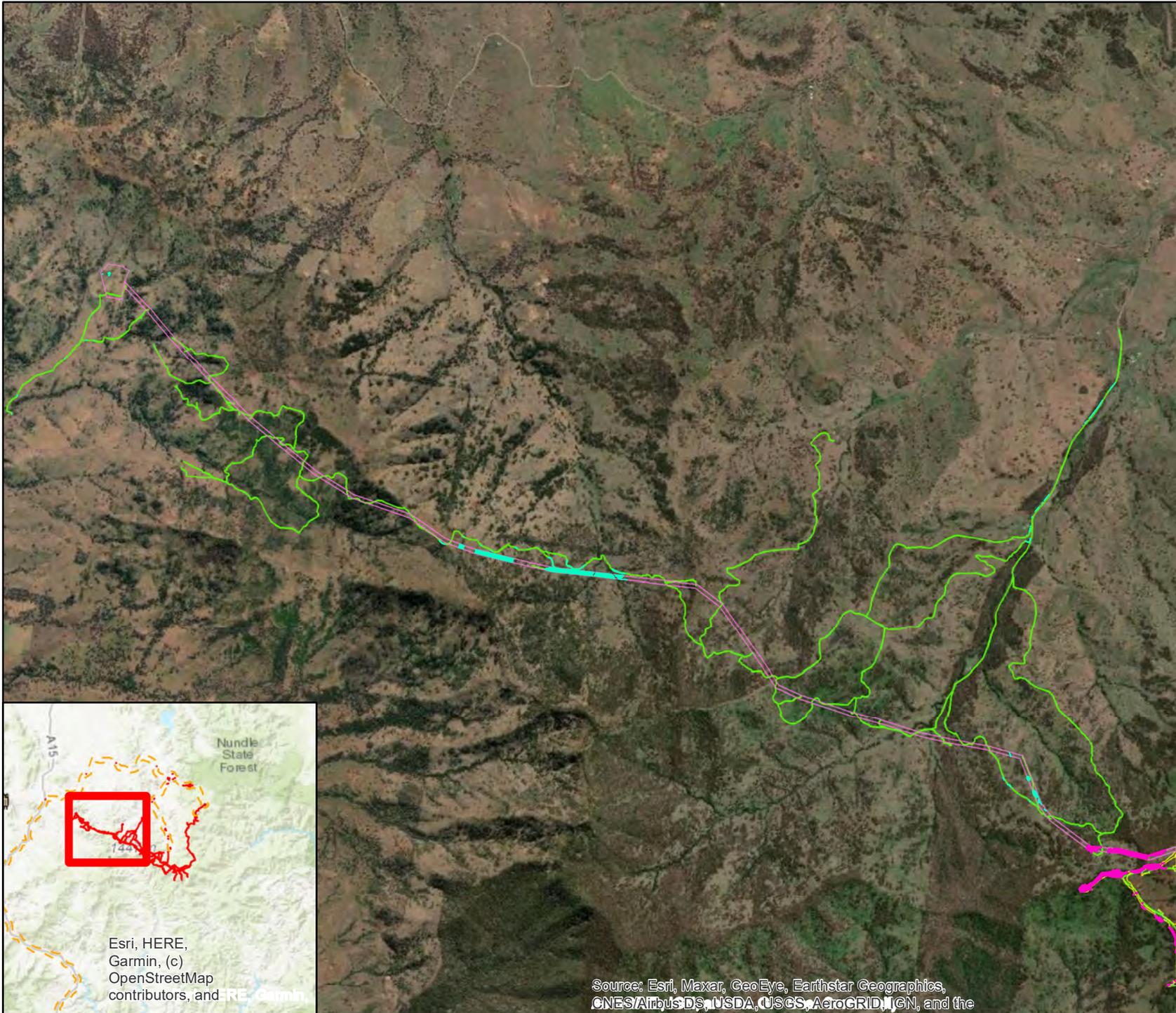
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 006
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\CS1\Figures\CS1\Figures\Draw1\BOAR_June2020\Draw1\Figures_revised.mxd



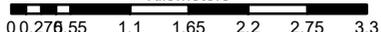
Threatened ecological communities

- Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion
- White Box Yellow Box Blakely's Red Gum Woodland
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers



0 0.278.55 1.1 1.65 2.2 2.75 3.3

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

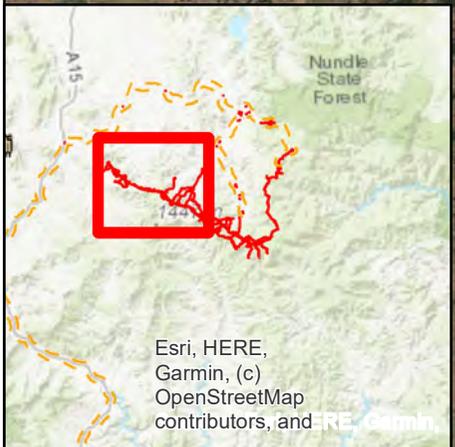
**Threatened ecological communities
Page 2 - transmission corridor**

Scale at A4	Drawing Status
1:70,057	Final

Coordinate System

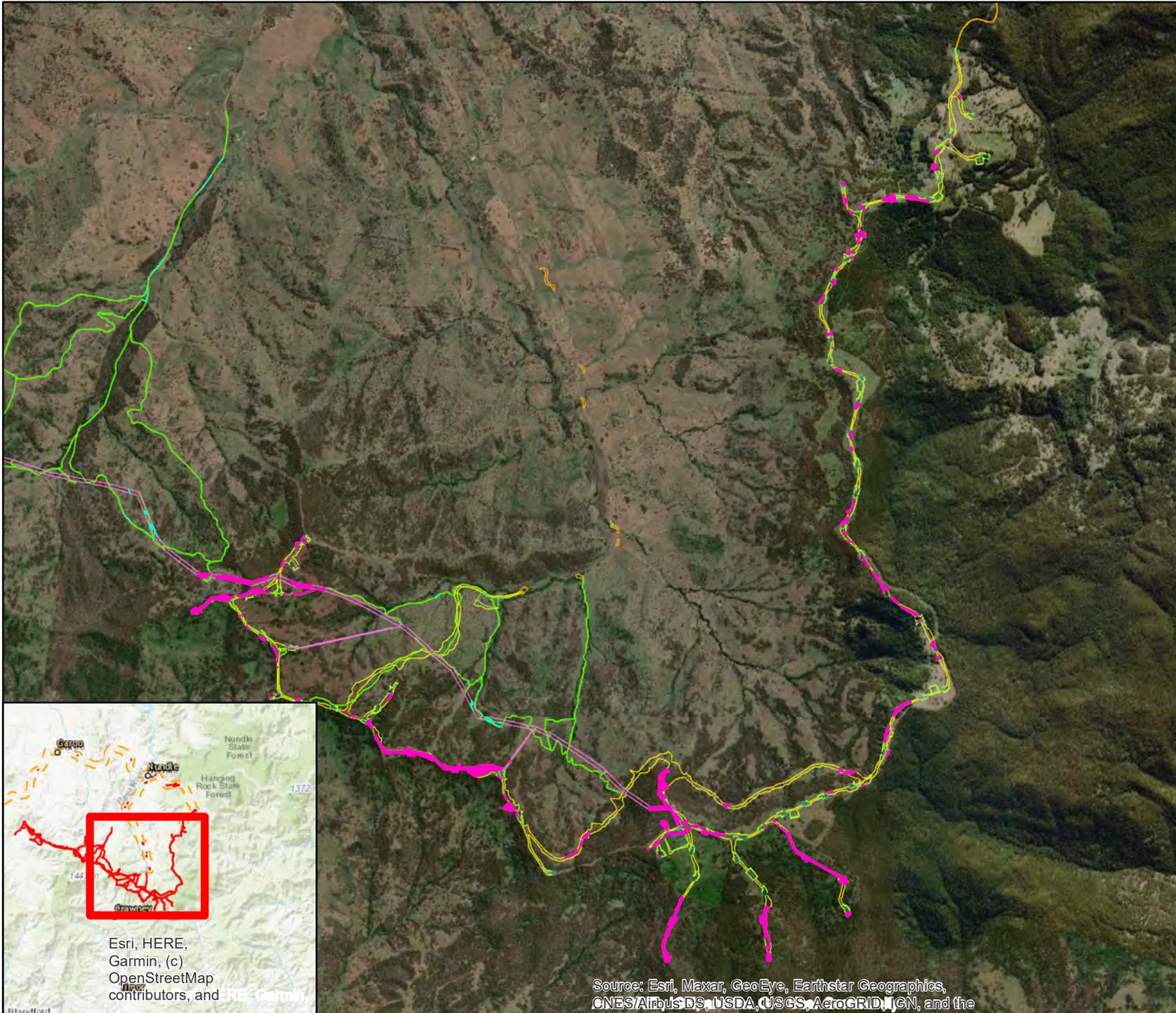
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	006



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

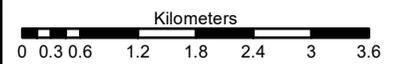
I:\27000\270335-00 Hills of Gold\Work\Internal\Design\GIS\Figures\GIS\Figures\2020\Drawn\Figures_revised.mxd



- Threatened ecological communities**
- Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion
 - White Box Yellow Box Blakely's Red Gum Woodland
 - Transport route (port to site)
 - Wind farm infrastructure
 - Transmission line and switching
 - Internal roads
 - Transmission line access tracks



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Threatened ecological communities
Page 3 - wind farm infrastructure**

Scale at A4 1:78,304	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 006
----------------------------	--------------------------



4.4 Groundwater dependent ecosystems

Review of the Groundwater Dependent Ecosystem (GDE) Atlas (BOM, 2020) indicates the presence of low, moderate and high potential GDEs within and immediately adjacent to the development footprint. High potential GDEs identified for the development footprint are detailed in **Table 19**.

Table 19: Groundwater dependent ecosystems with a high potential of occurring within the development footprint

Groundwater dependent ecosystem name	Extent within the development footprint (ha)
Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion	1.89
Blakely's Red Gum - Yellow Box grassy woodland of the New England Tablelands Bioregion	2.00
Forest Ribbon Gum - Silvertop Stringybark - Mountain Gum tall open forest on basalt on the Liverpool	1.84
Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion	1.06
Messmate open forest of the tableland edge of the NSW North Coast Bioregion and New England Tableland	0.24
Mountain Gum/ Messmate/ Snow Gum grassy open forest of the New England Tablelands	3.82
Narrow-leaved Peppermint/ Forest Ribbon Gum grassy open forest of the New England Tablelands	2.80
Ribbon Gum - Mountain Gum - Snow Gum grassy open forest or woodland of the New England Tablelands Bi	0.59
River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt	0.78
River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range	14.94
Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liver	6.47
Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nand	67.90
Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southe	0.27
Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly o	5.48
Silvertop Stringybark/ Tussock Grass grassy open forest of the Northern Tablelands escarpment *	3.29
Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion	0.01
Snow Gum - Mountain Gum - Silver Wattle tall open forest of the Liverpool Range, Brigalow Belt South	3.90

Groundwater dependent ecosystem name	Extent within the development footprint (ha)
Tea-tree riparian shrubland / heathland wetland on drainage areas of Nandewar Bioregion and New Engl	0.06
White Box - Silvertop Stringybark +/- White Cypress Pine grass shrub open forest of the southern Nan	3.13
White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the s	0.01
White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-reg	0.47

Further assessment of the potential for the vegetation within the study area to be a GDE reliant on the subsurface presence of groundwater was undertaken based on the information provided in the GDE Atlas and the rulesets detailed Atlas of Groundwater Dependent Ecosystems (GDE Atlas), Phase 2 Task 5 Report: Identifying and mapping GDEs (SKM 2012).

The GDE Atlas illustrates vegetation present in the vicinity of the Newports Creek floodplain, in the vicinity of Englands Road, to be the only area of High Potential GDE (from regional studies), with all other vegetation across the study area considered to be Low Potential GDE (from regional studies) (Figure 6). The landscape setting and flora species composition of the vegetation within the study area supports the GDE Atlas as to the potential presence of GDEs within the study area.

From the results of the field surveys and observation made of the location and topography, it is considered unlikely that any of these ecosystems are actually dependent on the subsurface or surface expression of groundwater. These PCTs occur on the top of ridgelines or steep slopes. A single spring was observed during the field investigations on top of the ridge, however it had been historically cleared, modified and utilised for agricultural purposes.

Review of groundwater wells carried out as part of the EIS investigations identified that the groundwater aquifer occurs at depths significantly greater than would be intercepted by earthworks associated with the Project construction. The project has been assessed to not have any material impact on groundwater flows, so impacts to GDEs are considered unlikely to occur.

5 Threatened species and habitat

This section outlines the field survey methods and results for identifying threatened flora and fauna, and their habitats within the development footprint, in accordance with Section 6 of the BAM. Prior to the detailed assessment, some preliminary descriptions of the broad habitat types and their conditions is provided.

5.1 General habitat types and features

5.1.1 Exotic pasture

The most common habitat type across the development footprint is exotic grasslands, which also has the lowest value to threatened flora and fauna (**Photograph 1**). These areas are prevalent due to the current and historical use of the development footprint and surrounding landscape for grazing and agriculture. Habitat features for native fauna are limited in these areas; however they may be utilised by common species adapted to disturbance.

Areas of open, exotic pasture can also provide foraging opportunities for large, diurnal raptors who predate on small mammals and birds. Exotic pastures within the development footprint are also used by common, large bodied birds that do not require forest cover for shelter and foraging. These birds will forage in more open areas, however, will require adjacent forests for breeding.

Other fauna species observed utilising these areas of exotic pasture include bare-nosed wombat *Vombatus ursinus* and red-bellied black snake *Pseudechis porphyriacus*.

Habitat for threatened flora is very limited in areas of exotic grassland due to altered plant community dynamics, with exotic pasture grasses being more competitive. Changed light, water and nutrient dynamics in this habitat type will also limit the suitability of this habitat to support threatened flora species.

5.1.2 Derived native grasslands

Derived native grasslands occur where the canopy and shrub layer has been historically cleared and native grasses and forbs have been retained or regenerated within the ground layer (**Photograph 2**).



Photograph 1: Exotic pasture located within the internal road infrastructure footprint



Photograph 2: Derived native grassland with *Poa spp.* dominant with exotic grasses and forbs sub-dominant. Retained eucalypt trees form extremely sparse canopy.

5.1.3 Open eucalypt forest and woodland

Open eucalypt forests and woodlands are the most common, intact habitat type within the development footprint and study area (**Photograph 3**). These habitat types represent the dominant important habitat type for threatened native fauna within the development footprint and have a strong influence on the flora and fauna composition observed. Eucalypt forest vegetation types within the development footprint include:

- Grassy woodlands;
- Open eucalypt forest;
- Tall moist eucalypt forest; and
- Riparian open forest and woodland with co-dominant river oak *Casuarina cunninghamiana*.

These eucalypt woodlands provide foraging, shelter, movement and breeding resources for native fauna. Within the development footprint, patches of eucalypt forest in a high or moderate condition contained mature eucalypt trees that contained hollows of varying size. These hollows provide roosting and breeding resources for threatened mammals observed on the development footprint, including Greater Glider *Petauroides volans*, Squirrel Glider *Petaurus norfolcensis* and microbat species.

5.1.4 Steep cliffs and rocky outcrops

Adjacent to the development footprint and on the edges of the ridgeline associated with the wind farm infrastructure and internal roads, there are a number of steep sections with exposed rock outcroppings (**Photograph 4**). These areas provide habitat resources, including shelter and roosting opportunities, for native fauna. In particular there areas have been identified as potential overnight roost sites for threatened cave-dwelling bat species recorded on the site during field surveys. These areas were identified and have been avoided by the development footprint during the project concept design and are not located within the development footprint.



Photograph 3: Grassy open eucalypt forest in the development footprint, showing Mountain Gum and stringybark eucalypts over a grassy ground layer.



Photograph 4: Example of rocky outcrops, with rounded boulders in the foreground and steep, incised cliffs in the background

5.1.5 Waterways

The waterways which intersect with the development footprint are dominated by first order streams due to the steep topography of the location and location on a ridgeline at the top of catchments. On top of the ridgeline and upper slopes, waterways are highly ephemeral and are likely to experience flows only immediately following rainfall. These waterways are unlikely to provide habitat for any threatened frogs or fish.

Further down the catchment in areas of the development footprint covered by the transmission line and haul route, there several 3rd and 4th order waterways. These waterways are characterised by shallow banks, with rocky substrates. A very thin zone of riparian vegetation is usually present, with substantial evidence of impacts from cattle grazing and incursion of exotic pasture grasses (**Photograph 5**).



Photograph 5: 4th order waterway located along Head of Peel road transport haul route.

5.2 Identifying habitat suitability for threatened species

A preliminary assessment was undertaken using the BAM Calculator to identify threatened flora and fauna species with potential to occur within the study area. Ground-truthed PCTs were entered into the BAM calculator including maximum values for native vegetation cover, patch size and vegetation integrity. Ecosystem credit species and species credit species predicted for the study area are provided in **Appendix C**.

A search of relevant government databases, including the Bionet database and the EPBC Act Protection Matters Search Tool (PMST) was also carried out for a 10 km radius to the development footprint to identify any additional threatened species not identified by the BAM calculator. Desktop sources for the review are detailed in Section 1.6.

A wider desktop assessment area was developed for reviewing potential bat roost sites, including possible maternity roosts to understand more detail on cave systems where known threatened bats may have important roosts. This resulted in an additional three sites in known cave network being assessed for microbat activity.

The suitability of habitat in the study area was assessed according to the steps outlined in BAM Section 6.4- *Steps for identifying habitat suitability for threatened species* (Appendix C). The results of the assessment are presented in the following sections and form the basis for the removal of species from the assessment where relevant.

5.2.1 Ecosystem credit species

Under the BAM, threatened species with a likelihood of occurrence that can be predicted by vegetation surrogates and landscape features or for which targeted survey has a low probability of detection are identified as ecosystem credit species. These species are not required to be subject to targeted surveys, and their habitat within the development footprint is linked directly to the PCTs present. Habitat for these ecosystem credit species is assumed to be present and their impacts are addressed as part of impacts and loss of habitat. Despite no requirement under the BAM to carry out targeted surveys for these species, the survey design employed for species credit species was sufficient to detect these.

Table 20 identifies ecosystem credit species predicted for the development footprint and an assessment of habitat suitability. The assessment indicates one identified ecosystem species that is unlikely to occur within the development footprint and can be removed from the assessment.

Three predicted ecosystem species that can be discounted from the assessment due to a lack for both foraging and breeding habitat is the white-bellied sea eagle. The development footprint does not occur within 1km of coastal rivers, lakes, large dams or creeks, wetlands and coastlines, with the exception of the minor road upgrade works in the Hunter Bioregion. These small impacts do not contain suitable breeding habitat for white-bellied sea-eagle.. Where Peel River occurs within 1km of the development footprint it is considered a minor watercourse for the purpose of white-bellied sea-eagle habitat.

Table 20: Ecosystem credit species relevant to the assessment

Scientific name	Common name	EPBC Act status	BC Act status	Bionet records within 10km of site	Habitat suitability	Species relevant to the assessment
<i>Anthochaera phrygia</i>	Regent Honeyeater (Foraging and Breeding)	CE	CE	No	Potential forage habitat present, but vagrant species	No
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow	-	V	Yes - 2 records	Potential forage habitat present	Yes
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	-	V	Yes – 1 record	Potential forage habitat present	Yes
<i>Calyptorhynchus lathami</i>	Glossy Black Cockatoo (Foraging and Breeding)	-	V	No	Potential forage habitat present	Yes
<i>Chthonicola sagittata</i>	Speckled Warbler	-	V	No	Potential forage habitat present	Yes
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	-	V	No	Potential forage habitat present	Yes
<i>Daphoenositta chrysoptera</i>	Varied Sitella	-	V	No	Potential forage habitat present	Yes
<i>Glossopsitta pusilla</i>	Little Lorikeet	-	V	Yes - 3 records	Potential forage and breeding habitat present	No
<i>Grantiella picta</i>	Painted Honeyeater	V	V	No	Potential forage habitat present	Yes
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle (Foraging and Breeding)	-	V	No	No habitat present	No
<i>Hieraaetus morphnoides</i>	Little Eagle (Foraging and Breeding)	-	V	No	Potential forage habitat present	Yes

Scientific name	Common name	EPBC Act status	BC Act status	Bionet records within 10km of site	Habitat suitability	Species relevant to the assessment
<i>Lathamus discolor</i>	Swift Parrot (Foraging)	CE	E1	No	Potential forage habitat present, but vagrant species	Yes
<i>Lophoictinia isura</i>	Square-tailed Kite (Foraging and Breeding)	-	V	No	Potential forage habitat present	Yes
<i>Melanodryas cucullata cucullate</i>	Hooded Robin (south-eastern form)	-	V	No	Potential forage and breeding habitat present	Yes
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater	-	V	No	Potential forage habitat present	Yes
<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed Bat	-	V	No	Potential forage habitat present	Yes
<i>Neophema pulchella</i>	Turquoise Parrot	-	V	No	Potential forage habitat present	Yes
<i>Ninox connivens</i>	Barking Owl	-	V	No	Potential forage and habitat present	Yes
<i>Ninox strenua</i>	Powerful Owl (Foraging and Breeding)	-	V	Yes - 4 records	Potential forage habitat present	Yes
<i>Pachycephala olivacea</i>	Olive Whistler	-	V	No	Potential forage habitat present	Yes
<i>Petroica boodang</i>	Scarlet Robin	-	V	Yes - 3 records	Potential forage and breeding habitat present	Yes
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler (eastern species)	-	V	No	Potential forage habitat present	Yes

Scientific name	Common name	EPBC Act status	BC Act status	Bionet records within 10km of site	Habitat suitability	Species relevant to the assessment
<i>Petroica phoenicea</i>	Flame Robin	-	V	Yes - 1 record	Potential forage and breeding habitat present	Yes
<i>Stagonopleura guttata</i>	Diamond Firetail	-		No	Potential forage and breeding habitat present	Yes
<i>Tyto novaehollandiae</i>	Masked Owl (Foraging and Breeding)	-		No	Potential forage habitat present	Yes
<i>Tyto tenebricosa</i>	Sooty Owl (Foraging and Breeding)	-		No	Potential forage habitat present	Yes
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	E	V	Yes - 2 records Also recorded by survey within study area	Potential forage and breeding habitat present	Yes
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	-	V	Yes - 11 records	Potential forage habitat present	Yes
<i>Kerivoula papuensis</i>	Golden-tipped Bat	-	V	No	Potential forage habitat present	Yes
<i>Miniopterus australis</i>	Little Bentwing-bat (Foraging and Breeding)	-	V	No Recorded by survey within study area	Potential forage habitat present	Yes
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat (Foraging and Breeding)	-	V	No Recorded by survey within study area	Potential forage habitat present	Yes
<i>Mormopterus norfolkensis</i>	Eastern Freetail Bat	-	V	No Recorded by survey within study area	Potential forage habitat present	Yes

Scientific name	Common name	EPBC Act status	BC Act status	Bionet records within 10km of site	Habitat suitability	Species relevant to the assessment
<i>Myotis macropus</i>	Southern Myotis	-	V	No Recorded by survey within study area	Potential forage habitat present	Yes
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat	V	V	No	Potential forage habitat present	No Not recorded during acoustic surveys
<i>Petaurus australis</i>	Yellow-bellied Glider	-	V	No	Potential forage and breeding habitat present	Yes
<i>Phascolarctos cinereus</i>	Koala (Foraging and Breeding)	V	V	No Recorded by survey within study area	Potential forage and breeding habitat present	Yes
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox (Foraging and Breeding)	V	V	No Recorded by survey within study area	Potential forage habitat present	Yes
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	-	V	No Recorded by survey within study area	Potential forage habitat present	Yes
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	-	V	Yes - 2 records. Recorded by survey within study area	Potential forage habitat present	Yes
<i>Thylogale stigmatica</i>	Red-legged Pademelon	-	V	No	Potential forage habitat present	Yes
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	-	V	No Recorded by survey within study area	Potential forage habitat present	Yes

Table codes: E- Endangered, V- Vulnerable, C – Critical, CE- Critically Endangered, M- Marine/ Migratory.

5.2.2 Species credit species

Under the BAM, threatened species with a likelihood of occurrence that cannot be confidently predicted by vegetation surrogates and landscape features but can be reliably detected by targeted survey are identified as species credit species.

Table 21 identifies species credit species predicted for the development footprint and an assessment of habitat suitability.

Table 21: Potential species credit species assignment of candidate status

Common name	Scientific name	Habitat suitability	Candidate species requiring targeted survey
<i>Litoria booroolongensis</i>	Booroolong Frog	Marginal habitat supported by a number of minor waterbodies within the wind farm development footprint. Low quality potential habitat present where transmission line and access tracks crosses Wombramurra Creek	Yes
<i>Litoria daviesae</i>	Davies' Tree Frog	Marginal habitat supported by a number of minor waterbodies within the wind farm infrastructure and internal access roads sections of the development footprint.. Habitats degraded on transmission line sections of the development footprint.	Yes
<i>Litoria subglandulosa</i>	Glandular Frog	Marginal habitat supported by a number of minor waterbodies within the wind farm development footprint. Habitats degraded on transmission line and access tracks sections of the development footprint. Species records associated with large areas on intact vegetation to the east of the development footprint, with no records within 100kms of the project site.	No (however species targeted during frog survey)
<i>Mixophyes balbus</i>	Stuttering Frog	Marginal habitat supported by a number of minor waterbodies within the wind farm sections of the development footprint. Habitats degraded on transmission line corridor. Species records associated with large areas on intact vegetation to the east of the project site, with no records within 100kms of the development footprint for the wind farm and transmission line.	No (however species targeted during frog survey)
<i>Anthochaera phrygia</i>	Regent Honeyeater	Potential forage habitat supported across the development footprint and addressed thorough ecosystem credits. Development footprint does not occur within mapped Important Areas for the species.	No
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow	Potential forage habitat supported across the development footprint	No

Common name	Scientific name	Habitat suitability	Candidate species requiring targeted survey
<i>Burhinus grallarius</i>	Bush Stone-curlew	Species occurs at altitudes much lower than the development footprint with the highest elevation record of the species within over 120kms of the wind farm site at an altitude of 500 metres (approx.). The lowest point of the wind farm and transmission line development footprint occurs along the transmission line at an altitude of 750 metres (approx.) and as such the development footprint does not support habitat for the species. Two records of the species occurs at an elevation of approximately 1,000 metres, one near Armidale over 120kms from the development footprint, and the other in Washpool NP, over 270kms from the project site. When these records are compared to the remainder of the 1,350 species' records in BioNet, these occurrences are considered to be a vagrants.	No
<i>Collocephalon fimbriatum</i>	Gang-gang Cockatoo	Of the 16,000 records of the species in ebird (and >600 in BioNet), none occur north of Muswellbrook NSW, except occasional records along coast just south of Coffs Harbour. As such the development footprint does not support habitat for the species.	No
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	Marginal potential forage habitat supported across the development footprint, very few Casuarina spp or Allocasuarina spp. have been recorded during floristic surveys and fauna habitat assessments, with the exception of some very small (less than 1ha) patches of River Oak riparian forest. Breeding habitat potentially present in the form of hollow-bearing trees.	Yes
<i>Chthonicola sagittata</i>	Speckled Warbler	Potential forage habitat supported across the development footprint.	No
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	Potential forage habitat supported across the development footprint.	No
<i>Daphoenositta chrysoptera</i>	Varied Sittella	Potential forage habitat supported across the development footprint.	No
<i>Glossopsitta pusilla</i>	Little Lorikeet	Potential forage habitat supported across the development footprint.	No
<i>Grantiella picta</i>	Painted Honeyeater	Potential forage habitat supported across the development footprint.	No

Common name	Scientific name	Habitat suitability	Candidate species requiring targeted survey
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	The development footprint associated with the wind farm, transmission line, access tracks and internal roads does not occur within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines. Where Peel River occurs within 1km of the development footprint it is a minor watercourse. Some areas of the transport haul route development footprint are within 1km of the coastline, however habitat suitability in these areas of minor impact are not considered to support foraging or breeding functions for White-bellied Sea-eagle.	No
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	Riparian habitats are degraded within the development footprint.	No
<i>Hieraetus morphnoides</i>	Little Eagle	Potential forage and breeding habitat supported across the development footprint	Yes
<i>Lathamus discolor</i>	Swift Parrot	Potential forage habitat supported across the development footprint. Project site does not occur within mapped Important Areas for the species	No
<i>Lophoictinia isura</i>	Square-tailed Kite	Potential forage and breeding habitat supported across the development footprint	Yes
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	Potential forage habitat supported across the development footprint	Yes
<i>Ninox connivens</i>	Barking Owl	Potential forage and breeding habitat supported across the development footprint	Yes
<i>Ninox strenua</i>	Powerful Owl	Potential forage and breeding habitat supported across the development footprint	Yes
<i>Pachycephala olivacea</i>	Olive Whistler	Potential forage habitat supported across the development footprint	No
<i>Petroica boodang</i>	Scarlet Robin	Potential forage habitat supported across the development footprint	No
<i>Petroica phoenicea</i>	Flame Robin	Potential forage habitat supported across the development footprint	No
<i>Stagonopleura guttata</i>	Diamond Firetail	Potential forage habitat supported across the development footprint	No

Common name	Scientific name	Habitat suitability	Candidate species requiring targeted survey
<i>Tyto novaehollandiae</i>	Masked Owl	Potential forage and breeding habitat supported across the development footprint.	Yes
<i>Tyto tenebricosa</i>	Sooty Owl	Potential forage and breeding habitat supported across the development footprint.	Yes
<i>Aepyprymnus rufescens</i>	Rufous Bettong	Marginal and degraded potential habitat occurs within areas of the development corridor associated with the the wind farm and transmission corridor.	Yes
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	Potential habitat is present within the development footprint.	Yes
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Habitat occurs within and adjacent to the development footprint.	Yes
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	Habitat occurs within and adjacent to the development footprint.	No
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	Habitat occurs within and adjacent to the development footprint.	No
<i>Macropus parma</i>	Parma Wallaby	Potential habitat occurs in higher condition areas connected to Ben Halls Gap Nature Reserve. Potential habitats within the transmission line corridor are degraded.	Yes
<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed Bat	Habitat occurs within and adjacent to the development footprint.	No
<i>Miniopterus australis</i>	Little Bent-winged Bat	Habitat occurs within and adjacent to the development footprint.	Yes
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	Habitat occurs within and adjacent to the development footprint.	Yes
<i>Myotis macropus</i>	Southern Myotis	Habitat occurs within and adjacent to the development footprint.	Yes

Common name	Scientific name	Habitat suitability	Candidate species requiring targeted survey
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat	Potential habitat is present within the development footprint.	No
<i>Petauroides volans</i>	Greater Glider	Habitat occurs within and adjacent to the development footprint.	No
<i>Petaurus australis</i>	Yellow-bellied Glider	Habitat occurs within and adjacent to the development footprint.	No
<i>Petaurus norfolcensis</i>	Squirrel Glider	Potential habitat is present within the development footprint.	Yes
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	Potential habitat is present within the development footprint.	Yes
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	Potential habitat is present within the development footprint. However, BioNet notes the species occurrences in the following IBRA subregions relevant to the project site. Walcha Plateau IBRA - Known to occur, but a geographic restriction exists stating "East of the Tia River". This river's headwaters occurs >50kms north-east of the study area. Nearest record of the species is 56kms east. Tomala IBRA - species known, with no geographic restrictions listed. However, only records of the species comprise an inaccurate record (10kms) noted as Mount Royal SF (or NP) from 1991, one more low accuracy (10kms) in similar location (but in Barrington Tops IBRA), one further single record in the IBRA from 1974, and >66kms from the study area. Peel IBRA - Species predicted to occur (ie not known), no geographic restrictions listed. Species never recorded in IBRA.	No
<i>Phascolarctos cinereus</i>	Koala	Breeding and foraging habitat occurs within and adjacent to the development footprint.	Yes
<i>Phoniscus papuensis</i>	Golden-tipped Bat	Potential habitat is present within the development footprint.	No
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Potential forage habitat supported across the development footprint.	Yes

Common name	Scientific name	Habitat suitability	Candidate species requiring targeted survey
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat	Habitat occurs within and adjacent to the development footprint.	No
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	Habitat occurs within and adjacent to the development footprint.	No
<i>Thylogale stigmatica</i>	Red-legged Pademelon	Potential forage habitat supported across the development footprint.	No
<i>Vespadelus trougtoni</i>	Eastern Cave Bat	Habitat occurs within and adjacent to the development footprint.	Yes
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	Species known only to occur at altitudes much lower than the development footprint, within highest elevation BioNet records including 550m elevation (approx.) north of Bindarri NP (>200kms from the project site), 390m elevation (approx.) west of Kwiambal NP (>150kms from the project site) and 375m elevation (approx.) west of Gunnedah (>100kms from the project site). The lowest point of the project site occurs along the transmission line at an altitude of 750 metres (approx.) and as such the development footprint does not support habitat for the species.	No
<i>Uvidicolus sphyrrurus</i>	Border Thick-tailed Gecko	Species distribution is north of the development footprint associated with the wind farm and transmission line corridor and has never been recorded (or predicted to occur in) Tomala or Walcha Plateau IBRA subregions. Peel IBRA has records 20-25kms north of the site across cleared land, which are at the southern extent of the species' occurrence. Peel IBRA abuts parts of the wind farm development footprint and includes the western 60% of the transmission line section of the development footprint.	Yes
<i>Acacia atrox</i>	Myall Creek Wattle	Known populations more than 200km north/ northwest of the study area. No records within proximity to the site. Potential habitat in PCT599 is marginal and unlikely to support the species.	No

Common name	Scientific name	Habitat suitability	Candidate species requiring targeted survey
<i>Eucalyptus nicholii</i>	Narrow-leaved Black Peppermint	Potential habitat within grassy woodland and dry sclerophyll forests within the development footprint.	Yes
<i>Chiloglottis platyptera</i>	Barrington Tops Ant Orchid	Potential habitat within grassy woodland and open forests within the wind farm infrastructure section of the development footprint.	Yes
<i>Dichanthium setosum</i>	Bluegrass	Potential habitat within dry sclerophyll forests, derived native grassland and forested wetlands within the development footprint.	Yes
<i>Digitaria porrecta</i>	Finger Panic Grass	Habitat within box woodland marginal for the species. No other suitable habitat within the site.	No
<i>Homoranthus prolixus</i>	Granite Homoranthus	No suitable habitat within the development footprint.	No
<i>Monotaxis macrophylla</i>	Large-leaved Monotaxis	No suitable habitat within the development footprint.	No
<i>Picris evae</i>	Hawkweed	Open Eucalypt woodland within site does not support <i>Dichanthium</i> spp. dominated ground layer and is marginal for the species.	No
<i>Polygala linariifolia</i>	Native Milkwort	Potential habitat within PCT 1194 in the wind farm sections of the development footprint.	Yes
<i>Commersonia procumbens</i>	Commersonia procumbens	No PCTs known to be associated with the species occur within the development footprint.	No
<i>Tasmannia glaucifolia</i>	Fragrant Pepperbush	Eucalypt forest within PCT 934, 931 and 927 offers marginal habitat for the species.	Yes
<i>Tasmannia purpurascens</i>	Broad-leaved Pepperbush	Suitable habitat within open woodland and forest within the site (PCT 934, 931, 927 and 1194)	Yes
<i>Thesium australe</i>	Austral Toadflax	Suitable habitat within open woodland, Eucalypt forest and derived native grasslands.	Yes

Common name	Scientific name	Habitat suitability	Candidate species requiring targeted survey
<i>Tylophora linearis</i>	<i>Tylophora linearis</i>	Associated PCTs within the development site occur at higher altitudes than recorded for the species.	No
<i>Asterolasia sp.</i> 'Dungowan Creek'	Dungowan Starbush	Marginal habitat within PCT 934.	Yes
<i>Homopholis belsonii</i>	Belson's Panic	Site lacks suitable habitat.	No
<i>Euphrasia arguta</i>	<i>Euphrasia arguta</i>	Suitable habitat within the study area	Yes

5.3 Candidate threatened species and targeted survey methods

Candidate species credit species requiring targeted survey include 33 threatened fauna species and 10 threatened flora species. **Table 22** presents a summary of field survey methods for candidate species credit species relative to BAM survey requirements, with additional detail on the survey methods in the following section.

Table 22: Candidate species credit species and survey design employed

Scientific name	Common name	BAM survey period	Survey guidelines	Survey design employed	Survey effort
Frogs					
<i>Adelotus brevis</i>	Tusked Frog	Oct – Feb	Field survey methods for amphibians (DECC 2009)	Spotlighting, call playback surveys and active searches	Frog surveys were undertaken in spring 2019 and autumn 2020.
<i>Litoria booroolongensis</i>	Booroolong Frog	Nov - Dec	Field survey methods for amphibians (DECC 2009)	Spotlighting, call playback surveys and active searches	12 sites were surveyed between 18 and 21 November 2019.
<i>Litoria daviesae</i>	Davies Tree Frog	Sep – Jan	Field survey methods for amphibians (DECC 2009)	Spotlighting, call playback surveys and active searches	6 sites were surveyed between 24 and 27 March 2020.
<i>Litoria subglandulosa</i>	Glandular Frog	Oct - Dec	Field survey methods for amphibians (DECC 2009)	Spotlighting, call playback surveys and active searches	
<i>Mixophyes balbus</i>	Stuttering Frog	Sep - Mar	Field survey methods for amphibians (DECC 2009)	Spotlighting, call playback surveys and active searches	
Birds					
<i>Anthochaera phrygia</i>	Regent Honeyeater	Sep – Dec	Commonwealth Survey Guidelines for threatened birds (DEWHA 2010)	Diurnal bird surveys during the migration period/survey timing and habitat mapping.	Bird surveys undertaken at 17 sites in August 2019, 21 sites in November 2019 and 21 sites in February 2020.

Scientific name	Common name	BAM survey period	Survey guidelines	Survey design employed	Survey effort
<i>Burhinus grallarius</i>	Bush Stone-curlew	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Habitat mapping, nocturnal call playback and spotlighting.	Nocturnal bird surveys undertaken between 26 and 30 August 2019.
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	Oct - Jan	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Habitat mapping, hollow-bearing tree mapping and diurnal bird surveys.	Bird surveys undertaken at 17 sites in August 2019, 21 sites in November 2019 and 21 sites in February 2020.
<i>Calyptorhynchus lathamii</i>	Glossy Black Cockatoo	Mar - Aug	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Habitat mapping, hollow-bearing tree mapping and diurnal bird surveys.	Bird surveys undertaken at 17 sites in August 2019, 21 sites in November 2019 and 21 sites in February 2020.
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	Sep - Nov	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Stick-nest surveys.	Bird surveys undertaken at 17 sites in August 2019, 21 sites in November 2019 and 21 sites in February 2020.
<i>Hieraaetus morphnoides</i>	Little Eagle	Aug - Oct	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Stick-nest surveys.	Bird surveys undertaken at 17 sites in August 2019, 21 sites in November 2019 and 21 sites in February 2020.
<i>Lathamus discolor</i>	Swift Parrot	May - Aug	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Winter diurnal bird survey targeting flower eucalypts.	Bird surveys undertaken at 17 sites in August 2019.

Scientific name	Common name	BAM survey period	Survey guidelines	Survey design employed	Survey effort
<i>Lophoictinia isura</i>	Square-tailed Kite	Sep - Jan	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Stick-nest surveys.	Bird surveys undertaken at 17 sites in August 2019, 21 sites in November 2019 and 21 sites in February 2020.
<i>Ninox strenua</i>	Powerful Owl	May - Aug	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Call Playback and spotlighting.	Nocturnal bird surveys undertaken between 26 and 30 August 2019.
<i>Tyto novaehollandiae</i>	Masked Owl	May – Aug	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Call Playback and spotlighting.	
<i>Tyto tenebricosa</i>	Sooty Owl	May – Aug	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Call Playback and spotlighting.	
Mammals					
<i>Aepyprymnus rufescens</i>	Rufous Bettong	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Deployment of baited terrestrial camera traps and spotlighting.	Total of 1362 trap nights using ground deployed infrared motion sensing cameras.
<i>Cercartetus nanus</i>	Eastern Pygmy Possum	Oct - Mar	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Deployment of baited arboreal camera traps and spotlighting.	Total of 1014 trap nights using arboreal deployed infrared motion sensing cameras.
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Sep - Mar	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Ultrasonic detection and habitat mapping.	24 Ultrasonic bat detectors were deployed for a total of 1042 trap nights.

Scientific name	Common name	BAM survey period	Survey guidelines	Survey design employed	Survey effort
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Deployment of baited terrestrial camera traps and spotlighting.	Total of 1362 trap nights using ground deployed infrared motion sensing cameras.
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	Dec - Feb	'Species credit' threatened bats and their habitats (EES 2018)	Ultrasonic detection and habitat mapping.	24 Ultrasonic bat detectors were deployed for a total of 1042 trap nights.
<i>Macropus parma</i>	Parma Wallaby	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Deployment of baited terrestrial camera traps and spotlighting.	Total of 1362 trap nights using ground deployed infrared motion sensing cameras.
<i>Miniopterus australis</i>	Little Bentwing-bat	Dec - Feb	"Species credit' threatened bats and their habitats (EES 2018)	Ultrasonic detection and habitat mapping.	24 Ultrasonic bat detectors were deployed for a total of 1042 trap nights.
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	Nov - Feb	'Species credit' threatened bats and their habitats (EES 2018)	Ultrasonic detection and habitat mapping.	24 Ultrasonic bat detectors were deployed for a total of 1042 trap nights.
<i>Myotis macropus</i>	Southern Myotis	Nov - Mar	'Species credit' threatened bats and their habitats (EES 2018)	Ultrasonic detection and habitat mapping.	24 Ultrasonic bat detectors were deployed for a total of 1042 trap nights.
<i>Petauroides volans</i>	Greater Glider	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Spotlighting.	Total of 1014 trap nights using arboreal deployed infrared motion sensing cameras.

Scientific name	Common name	BAM survey period	Survey guidelines	Survey design employed	Survey effort
<i>Petaurus norfolcensis</i>	Squirrel Glider	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Deployment of baited arboreal camera traps and spotlighting.	Total of 1014 trap nights using arboreal deployed infrared motion sensing cameras.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004)	Deployment of baited terrestrial camera traps and spotlighting.	Total of 1362 trap nights using ground deployed infrared motion sensing cameras.
<i>Phascolarctos cinereus</i>	Koala	Year round	EPBC Act referral guidelines for the vulnerable koala (DoE 2014)	SAT surveys in high quality habitat (high abundance of feed trees), and spotlighting.	Total of 1014 trap nights using arboreal deployed infrared motion sensing cameras.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Year round	Survey-guidelines-bats DEWHA 2010	Habitat mapping and active searches for camps.	No suitable camp habitat within the study area.
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	Nov - Jan	'Species credit' threatened bats and their habitats (EES 2018)	Ultrasonic detection and habitat mapping.	24 Ultrasonic bat detectors were deployed for a total of 1042 trap nights.
Reptiles					
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	Nov - Dec	Survey guidelines for Australia's threatened reptiles (DSeWPac 2011)	Targeted searches and habitat mapping.	No habitat identified to undertake targeted surveys within.

Scientific name	Common name	BAM survey period	Survey guidelines	Survey design employed	Survey effort
<i>Uvidicolus sphyurus</i>	Border Thick-tailed Gecko	Nov - Mar	Survey guidelines for Australia's threatened reptiles (DSeWPac 2011)	Targeted searches and habitat mapping.	A total of 3 nights spotlighting and active searches in marginal habitat present on site
Plants					
<i>Asterolasia sp. 'Dungowan Creek'</i>	Dungowan Star Bush	Year round	<i>NSW Guide to Surveying Threatened Plants</i> (OEH, 2016)	Seasonal surveys involving targeted random meanders, depending on the density of vegetation. All surveys were carried out within the suitable seasonal window for candidate flora except: <ul style="list-style-type: none"> Barrington Tops Ant Orchid: surveys were completed from 18-22 November. Conditions were exceptionally dry for much of spring 2019 due to drought. Review of BOM (2020) indicates there was little change in local conditions from September to October. Finger Panic Grass: Surveys were completed in February 	A reasonable survey effort was employed including: <ul style="list-style-type: none"> A spring survey over 5 days from 18-22 November 2019- limited to suitable habitat within the wind farm development corridor. Summer survey over 5 days in February 2020- including suitable habitat within the wind farm development corridor and transmission line corridor (where accessible).
<i>Chiloglottis platyptera</i>	Barrington Tops Ant Orchid	Sep - Oct			
<i>Dicanthium setosum</i>	Bluegrass	Dec - May			
<i>Digitaria porrecta</i>	Finger Panic Grass	Dec - Jan			
<i>Eucalyptus nicholii</i>	Narrow-leaved Peppermint	Year round			
<i>Polygala linariifolia</i>	Native Milkwort	Year round			
<i>Pterostylis elegans</i>	Elegant Greenhood	Dec - May			
<i>Tasmannia glaucifolia</i>	Fragrant Pepperbush	Year round			
<i>Tasmannia purpurascens</i>	Broad-leaved Pepperbush	Year round			
<i>Thesium australe</i>	Austral Toadflax	Sep - Feb			

5.3.1 Terrestrial flora survey methods

Surveys for candidate threatened flora were carried out over two seasons, as follows:

- Survey of the wind farm development footprint over 5 days from 18-22 November 2019.
- Survey of the wind farm development footprint and accessible parts of the transmission line corridor over 5 days in February 2020.
- Supplementary vegetation community survey to verify PCTs, with incidental searches for threatened species conducted of the internal access roads, Ben Halls Gap Nature Reserve buffer and transport haul route portions of the development footprint over 5 days in August 2020.

Targeted surveys involved searches for target species, depending on the density of vegetation. A summary of survey requirements and deployed field methods is provided for all candidate threatened flora in **Table 22**. The extent of targeted surveys for threatened flora is shown in **Figure 7**.

Following identification of the candidate threatened flora species list, a field survey plan was devised in accordance with the *NSW Guide to Surveying Threatened Plants* (OEH 2016). This plan included identification of potential habitat for each of the candidate threatened flora species based on known vegetation associations, review of threatened species profiles, PlantNet profiles, Recovery Plans Conservation Advices and other available literature to determine the presence of suitable areas of potential habitat for species within the study area, as well as BioNet records available for each species.

Optimum timeframes for surveys, and which species would be targeted when, were also determined based on the recommended survey times for the candidate species provided by the BAM calculator, literature review, as well as prevailing weather conditions on site. Estimation of the survey effort required to adequately assess the species was undertaken in accordance with Table 3 of the *NSW Guide to Surveying Threatened Plants* (OEH 2016) and was based on the distance required between the minimum separation of parallel traverses (20 metres), and the hectares of potential habitat calculated for each of the candidate species. A field guide of identification information was prepared, taken into the field and used as required.

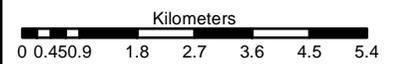
Additional searches for threatened flora were undertaken during PCT verification and habitat assessments completed in Ben Halls Gap Nature Reserve and additional infrastructure elements in August 2020.



-  Targeted survey tracklog
-  Development footprint
-  Native vegetation



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

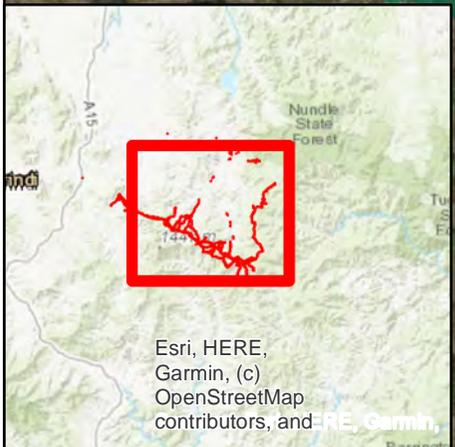
Job Title
Hills of Gold Wind Farm

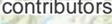
Drawing Title
Flora survey tracklog

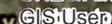
Scale at A4 1:118,219	Drawing Status Final
---------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 007
----------------------------	--------------------------



Esri, HERE, Garmin, (c) OpenStreetMap contributors, and HERE, Garmin,   

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)   

I:\270000\270335-00 Hills of Gold\Work\marmal\Design\Draft\BOAR_Draft\BOAR_Draft\Figures_revised.mxd

5.3.2 Terrestrial fauna survey methods

A range of targeted terrestrial fauna survey methods were implemented over all four seasons between November 2018 and May 2020 to detect the candidate threatened species assessed as likely to occur on the site. Field surveys were carried out during optimal seasonal conditions and weather conditions, with rainfall and temperature (BOM, 2020) during all survey events provided in **Table 23**.

Weather and observations for the deployment of camera traps and passive acoustic detectors which remained in the field for several months have been presented as monthly averages for temperature and total monthly rainfall (**Table 24**). Note, temperature measurements on the wind farm development footprint are likely to be several degrees lower due to higher elevation, however the BOM station presented below is the closest station with temperature data. The monthly observations during the fauna survey period show the drought conditions from November and December 2019, with substantially lower than average total monthly rainfall recorded in these months. These conditions were alleviated from January 2020, with an opposite trend of substantially higher falls than monthly means experience from January 2020 – May 2020, covering a large portion of the field survey campaign.

Also linked to the weather conditions during the field survey was the severe bushfire conditions that were experienced across south-eastern Australia in the 2019/20 summer. During the field survey campaign, the area experienced bushfires within the transmission line and access track footprints. Habitat mapping has taken into consideration these fire events, with the vegetation and condition assessments assuming pre-fire condition for the purpose of PCT mapping, condition assessment and likelihood of occurrence for threatened fauna.

The following sections describe the fauna field methods in detail, with locations of all targeted fauna surveys shown on **Figure 9, Pages 1 to 7**

Table 23: Weather conditions during targeted fauna surveys¹

Survey date	Temperature (°C) ¹		Rainfall to 0900 hrs (mm) ²
	Minimum	Maximum	
12 November 2018	10.1	30.6	0.0
13 November 2018	12.8	32.2	0.0
14 November 2018	12.8	26.1	0.0
15 November 2018	9.3	32.2	0.0
26 August 2019	1.4	24.5	0.00
27 August 2019	3.4	23.5	0.0
28 August 2019	1.2	22.5	0.0
29 August 2019	0.6	20.9	0.0
30 August 2019	0.5	18.4	0.0

Survey date	Temperature (°C) ¹		Rainfall to 0900 hrs (mm) ²
	Minimum	Maximum	
31 August 2019	5.0	19.8	0.0
18 November 2019	11.2	30.4	0.0
19 November 2019	10.8	36.4	0.0
20 November 2019	14.6	35.4	0.0
21 November 2019	13.6	37.0	0.0
22 November 2019	20.8	31.0	0.0
24 February 2020	22.4	25.8	3.4
25 February 2020	16.2	30.3	11.4
26 February 2020	19.0	31.0	1.2
27 February 2020	16.6	30.5	15.2
28 February 2020	13.6	30.4	0.2
29 February 2020	15.2	No recorded	0.0
23 March 2020	15.4	27.5	0.0
24 March 2020	15.9	29.1	0.0
25 March 2020	16.6	23.6	0.0
26 March 2020	14.4	22.9	24.4
11 May 2020	-0.4	Not recorded	0.0
12 May 2020	0.3	20.5	0.0
13 May 2020	4.4	19.5	0.0
14 May 2020	2.4	19.5	0.0
15 May 2020	5.1	19.4	0.0
17 August 2020	4.2	16.0	1.0
18 August 2020	4.4	19.0	0.0
19 August 2020	3.8	20.0	0.0
20 August 2020	7.8	15.8	0.0
21 August 2020	3.0	15.6	0.0

¹ Recorded at Quirindi Post Office, BOM station 055049

² Recorded at Head of Peel station, BOM station 55336

Table 24: Monthly weather observations during camera and acoustic detector deployment.

Month deployed	Temperature (°C) ¹		Total rainfall ^{2,3}
	Mean daily minimum ³	Mean daily maximum ³	
November 2019	13.1 (12.1)	31.5 (28.7)	42.4 (89.6)
December 2019	16.8 (14.8)	36.0 (31.3)	19.8 (131.8)
January 2020	20.8 (16.6)	36.8 (32.4)	137.6 (81.4)
February 2020	18.4 (16.2)	29.8 (31.5)	203.0 (66.7)
March 2020	13.9 (13.6)	27.2 (29.3)	71.8 (56.5)
April 2020	9.9 (9.0)	24.8 (25.0)	95.2 (40.6)
May 2020	4.7 (5.1)	19.0 (20.5)	112.0 (57.5)

¹ Recorded at Quirindi Post Office, BOM station 055049

² Recorded at Head of Peel station, BOM station 55336

³ Numbers in brackets represent summary mean for all years recorded

5.3.2.1 Bird strike collision risk survey and diurnal bird survey

This method provides a standardised measure of bird activity. It is important that a sufficient quantum of utilisation data for a fully representative annual cycle is obtained, for collision risk modelling. A representative sample of point counts were taken across the study area.

Surveys were conducted over three seasons:

- 17 survey points between 27-30 August 2019;
- 21 survey points between 18-22 November 2019; and
- 21 number survey points between 25-29 February 2020.

All survey locations were near proposed turbines as this provided the best access and visual for surveys. The majority of the utilisation survey points were located in open areas between stands of native vegetation.

Method for the bird utilisation surveys is as follows:

- Observers walk to each transect and to move between fixed points on transects. When reaching an observation point on the transect observers stop and allow time for birds to habituate to their presence (approximately 10 minutes). The area is then scanned for 5 minutes, during which all birds present are recorded. Scanning involves observing at a steady rate in a circle while remaining on the spot (over 360 degrees);
- Observers record all birds as far as the eye can see over 20 minutes at each observation point (which does bias large birds over smaller ones, as the former are more conspicuous, however this can be accounted for in the analyses). Observations are to be made using the naked eye only. Binoculars can only be used to assist with the identification of a bird;

- As it is the number of movements of birds that is the important variable for modelling, all movements were noted even if it is the same individual. Only birds that were seen are to be recorded, although bird calls can be used to alert the observer to the presence of a bird and its location; and
- The order in which transects were sampled was randomised to ensure that transects are equally sampled over the various times of day.

The information collected included:

- Time of the observation;
- Point and transect number;
- Species;
- Number;
- Direction of flight;
- Height above ground;
- Distance from observer; and
- Behaviour.

The location of all bird surveys is shown on **Figure 9, Page 1**.

5.3.2.2 Nocturnal bird surveys and spotlighting

Spotlighting was aimed to detect small macropods, owls and arboreal mammals.

General and targeted spotlighting and call-broadcast surveys for candidate (and potential candidate) threatened mammal, reptile and bird fauna species over nine nights total between:

- 26-30 August 2019 (2 nights)
- 18-21 November 2019 (2 nights)
- 24-26 March 2020 (3 nights)
- 11-12 May 2020 (2 nights)

During the August 2019 winter survey event, call playback was conducted at six locations, near locations identified as supporting some potential suitable owl roosting/breeding habitat, to detect the presence of owls in the area. Species targeted which included Powerful Owl *Ninox strenua*, Masked Owl *Tyto novaehollandiae* and Sooty Owl *Tyto tenebricosa*.

Additional nocturnal bird surveys undertaken to assess areas of identified better quality habitat for threatened owls, an additional four nights at 7 locations within the windfarm corridor between 26-30 August 2019, and 11-12 May 2020. Call-broadcast surveys over 6 locations over 2 nights in August 2019.

Call-broadcast surveys at 1 location near area of highest potential habitat over 2 nights in May 2020.

During the Stage 2 spring survey, spotlighting survey was conducted in the development corridor along the edge of Ben Halls Gap Nature Reserve to gain additional information on the presence of potential nocturnal birds. The intent of this survey was to provide additional data about the species present within the interface between the development footprint and the Nature Reserve.

The location of nocturnal bird surveys is shown in **Figure 9, Page 1** and spotlighting transects shown on **Figure 9, Page 6**.

5.3.2.3 Surveys for hollow-dependant birds and raptors in breeding season

A total of 41 days targeted fauna surveys and habitat assessment between August 2019 and August 2020 by teams of between 1 and 4 ecologists/zoologists where the presence of stick nests, tree hollows and evidence of nesting / breeding was captured.

The aim of this survey was to determine whether the study area supports breeding habitat for the target species of birds, and whether that habitat is being used for breeding, tree hollows and stick nests were assessed for their suitability in providing breeding habitat, and evidence of use was recorded.

5.3.2.4 Camera trapping

A total of 19 Reconyx Hyperfire camera trap units were deployed within the wind farm development corridor and transmission line. Of these, 12 were targeted to terrestrial fauna and 7 were targeted for arboreal fauna. Three cameras were also deployed along the transmission line corridor, however two arboreal cameras and one terrestrial camera were destroyed during the bushfires in the summer 2019 fire season.

Deployment methods included:

- Units with strong-odour meat bait for Spotted-tailed Quoll and Brush-tailed Phascogale;
- Units passively deployed (without bait) for Parma Wallaby and Brush-tailed Rock Wallaby, Eastern Pygmy-possum, Greater Glider, Koala and Rufous Bettong.

Total of 12 baited ground deployed infrared motion sensing cameras set 20-21 November 2019 and collected on 9 April 2020 (1 camera) and 11-15 May 2020 (8 cameras), with 3 cameras destroyed in January 2020 bushfires affecting the study area. Camera batteries and memory cards were checked in February 2020, allowing for up to 1,539 trap nights (burnt camera traps excluded).

Total of 7 baited arboreal deployed infrared motion sensing cameras set 20-22 November 2019 and collected on 9 April 2020 (1 camera) and 11-15 May 2020 (5 cameras), with 1 camera destroyed in January 2020 bushfires affecting the study area. Camera batteries and memory cards were checked in February 2020, allowing for up to 1,009 trap nights (burnt camera traps excluded). An example of the arboreal camera trap set up is provided in **Photograph 6**.

Camera trap deployment locations are shown on **Figure 9, Page 2**.



Photograph 6: Arboreal camera trap set up

5.3.2.5 Nocturnal frog surveys

During the 2019 spring survey event, a total of 26 creeks were characterised for habitat considered potentially to support threatened frogs. Of these, eight were suitable for targeted frog survey. This is largely due to the prevalence of first

order streams within the development footprint, providing a lack of permanent water even during optimal rainfall conditions.

Spotlighting and call playback surveys were conducted at sites identified as frog habitat and were damp or containing water at the time of survey.

Frog surveys were undertaken in spring 2019 and autumn 2020 and included:

- 18-21 November 2019 - Areas of potential habitat in the within the windfarm corridor were surveyed as follows:
 - 6 nights watercourse spotlight / call-playback / active search transect, including 300m, 250m, 500m transects.
 - 4 nights spotlight / call-playback / active search dam surveys
 - 6 nights spotlight / call-playback / active search pool surveys
- 23-25 March 2020 - Wombramura Creek (transmission line corridor) was surveyed over 6 nights 3x 2 night watercourse spotlight / call-playback / active search transect over approx. 200m of creekline.

All frog survey and habitat assessment locations are shown on **Figure 9, Page 3**.

5.3.2.6 Koala Spot Assessment Technique (SAT) surveys

SAT surveys are the Commonwealth recommended survey method used to determine the presence/absence of Koalas across the study area, the activity levels to determine resident aggregation and/or transient sites, the population density and size, and habitat availability. Searches are undertaken to identify direct/indirect evidence of activity of Koala including evidence of scats or characteristic, scratches on the trunks of trees. Preferred Koala feed trees will be recorded during flora surveys (i.e. Ribbon Gum *Eucalyptus viminalis*) and during the habitat feature surveys.

All SAT surveys were undertaken between the 24-28 February 2020 within the wind farm development corridor and 11-15 May 2020 within the transmission line corridor. SAT surveys are recommended by the Commonwealth DAWE to assess Koala activity levels within the project area. Additional targeted surveys for Koala was also carried out through the deployment of terrestrial and arboreal camera traps, with confirmed photos of the species obtained in March 2020 (**Photograph 7**).

The location of Koala SAT surveys is provided on **Figure 9, Page 4**.



Photograph 7: Koala recorded in camera trap

5.3.2.7 Microbat surveys and monitoring

Ultrasonic bat detectors were deployed at a total of 24 locations across the windfarm corridor for a total of up to 1,268 trap nights. Detectors were deployed between 26-29 February 2020 and collected between late March and early May 2020. Five units were relocated within the site in April 2020, when batteries and memory cards were also checked and replaced. An example of a ground-deployed detector used on the site is shown in **Photograph 8** and all microbat detectors are shown on **Figure 9, Page 5**.



Photograph 8: Ground-deployed acoustic detector

During the 2019 spring survey, an acoustic/ultrasonic transect assessment for threatened microbats was conducted between 19 – 21 November 2019 (three nights), targeting a variety of habitats such as open-space areas, open waterbodies, riparian corridors, vegetated edges, hollow-bearing trees and areas with rocky outcrops and overhangs that are suitable for foraging and roosting. These habitat types were characterised throughout the day and then subsequently surveyed during the evening.

The transects were approx. 1 hour each and on average 1 kilometre long with a range of 100 metres either side. This rapid assessment method was a preliminary survey to provide a perception of species richness and abundance throughout the study area and refine areas to primarily target during the summer survey event, where acoustic detectors were deployed.

The handheld acoustic equipment (Echo Meter 2 with a directional microphone – Wildlife Acoustics) using live mode and Real Time Expansion (RTE) function, allowed the observer to simultaneously view the spectrogram and identify bat species in audible (transformed data) and ultrasonic frequencies. Species were identified using the app compatible with the recording device (Echo meter) and in most cases; the species was identified via spotlight. The acoustic data was reviewed and cross-referenced using Kaleidoscope analysis software, the observers personal call library and Bat Calls of New South Wales (Pennay et al. 2004).

Further microbat survey was undertaken to assess for impacts relating to the likelihood of bat species being impacted by turbine strike and barotrauma, the rate of impact per turbine per year, and the impacts to the bioregional populations.

This relates not only to bats resident within (or adjacent to) the study area, but those that may fly through the site from surrounding habitats, such as local cave/karst systems.

Additional surveys consisted of deployment of acoustic devices on three meteorological masts within the study area to determine the activity level of bats at different elevations. Consultation was undertaken with BCD in order to confirm the suitability of the location of the masts, height and number of data points suggested.

Three acoustic detectors were deployed per meteorological mast at heights of 10 metres, 30 metres and 60 metres (Figure 8). These detectors were fitted with an omni-directional microphone capable of detecting and recording calls within a 100m radius in all directions. This capability allowed the detection of calls from ground level to a total height of 160m, capturing a large area within the potential rotor swept path of the wind turbines.

Additional acoustic devices were deployed within 3 separate karst cave systems identified within or nearby the study area. All acoustic devices on the met masts and within the karst systems in wider landscape were deployed between the 8-9 April 2020 and were collected on the 11-15 of May 2020.

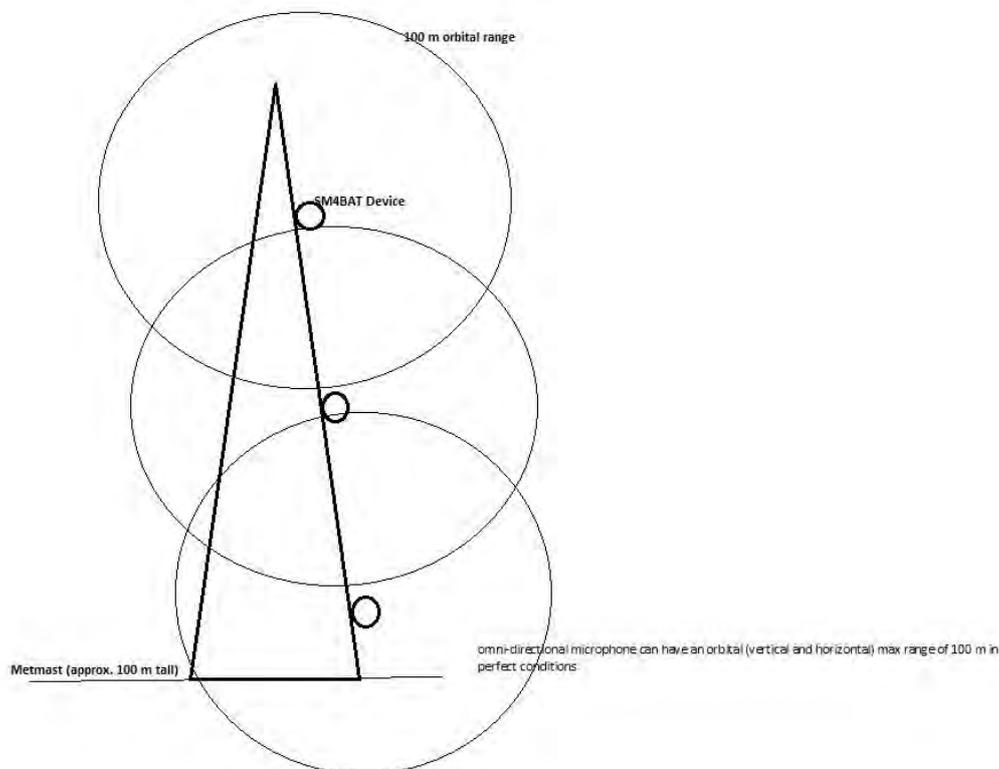
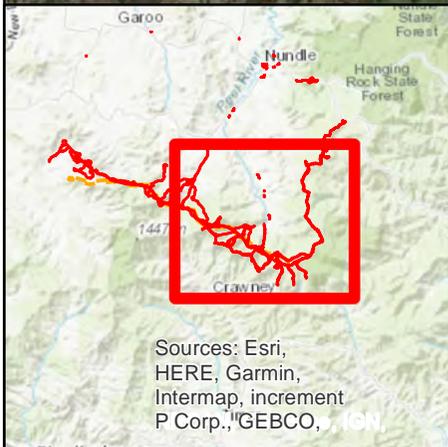
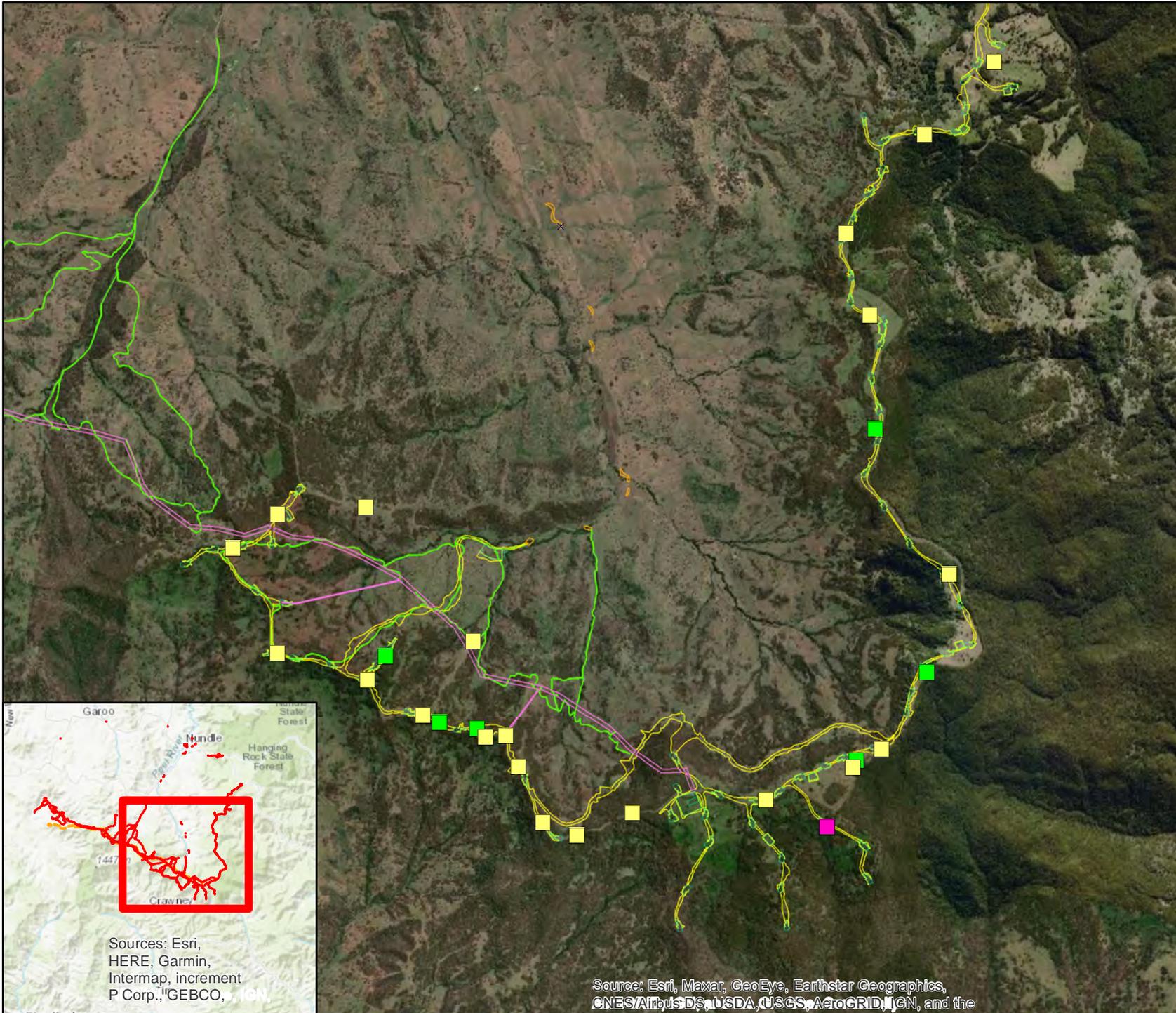


Figure 8: Schematic diagram of installation of acoustic bat detectors on meteorological masts.



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

	Bird utilisation surveys
	Owl call playback - Aug 2019
	Owl call playback - May 2020
	Transport route (port to site)
	Wind farm infrastructure
	Transmission line and switching
	Internal roads
	Transmission line access tracks

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

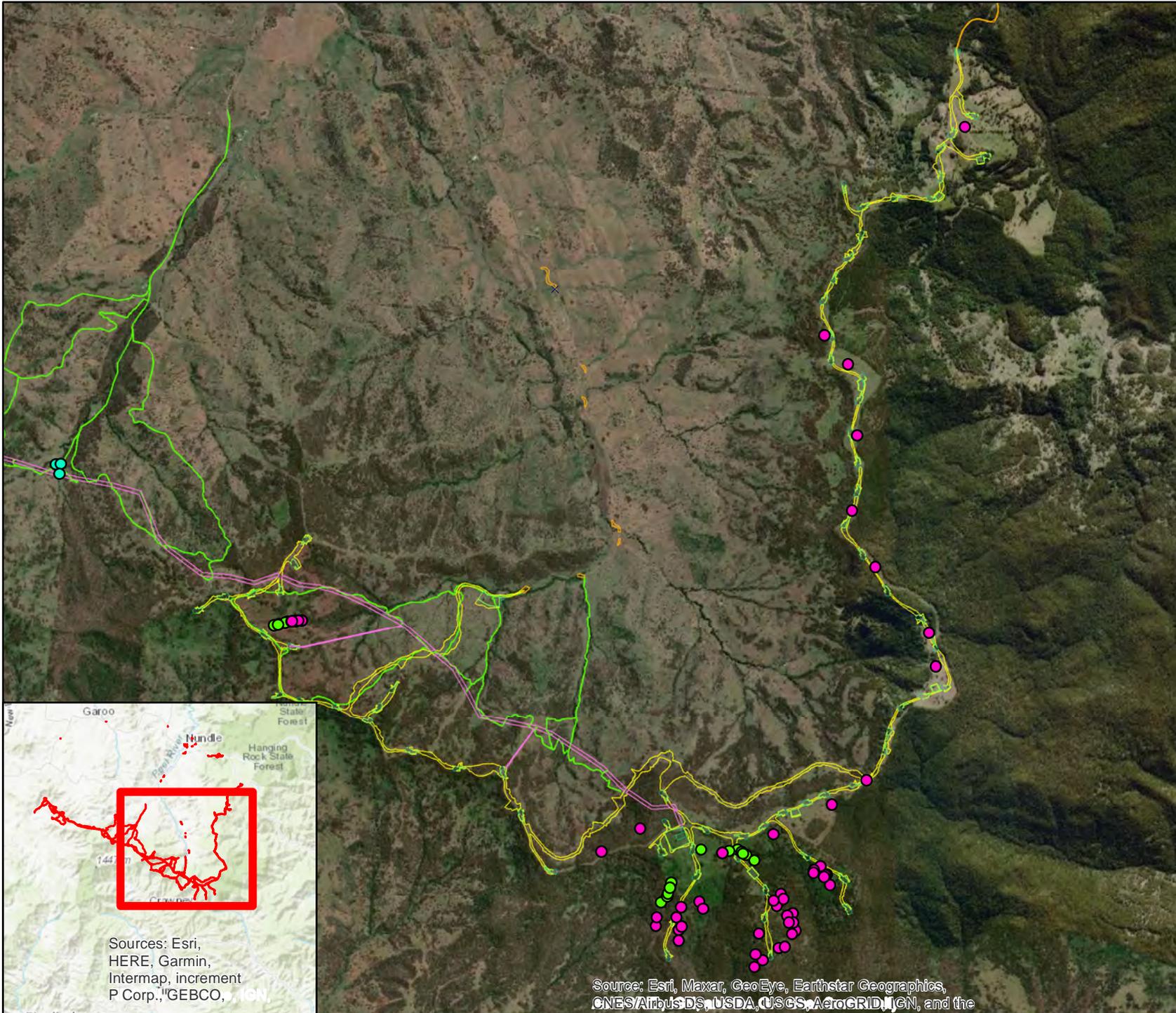
Job Title
Hills of Gold Wind Farm

Drawing Title
**Threatened fauna survey
Page 1 (birds)**

Scale at A4 1:74,645	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

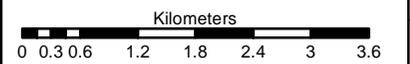
Job No 270335-00	Drawing No 009
----------------------------	--------------------------



- Frog habitat assessment - Nov 2019
- Frog survey points - Mar 2020
- Frog survey points - Nov 2019
- Transport route (port to site)
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

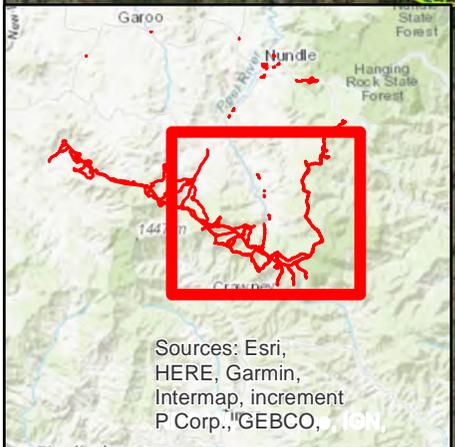
Job Title
Hills of Gold Wind Farm

Drawing Title
**Threatened fauna survey
 Page 3 (frogs)**

Scale at A4 1:78,384	Drawing Status Final
--------------------------------	--------------------------------

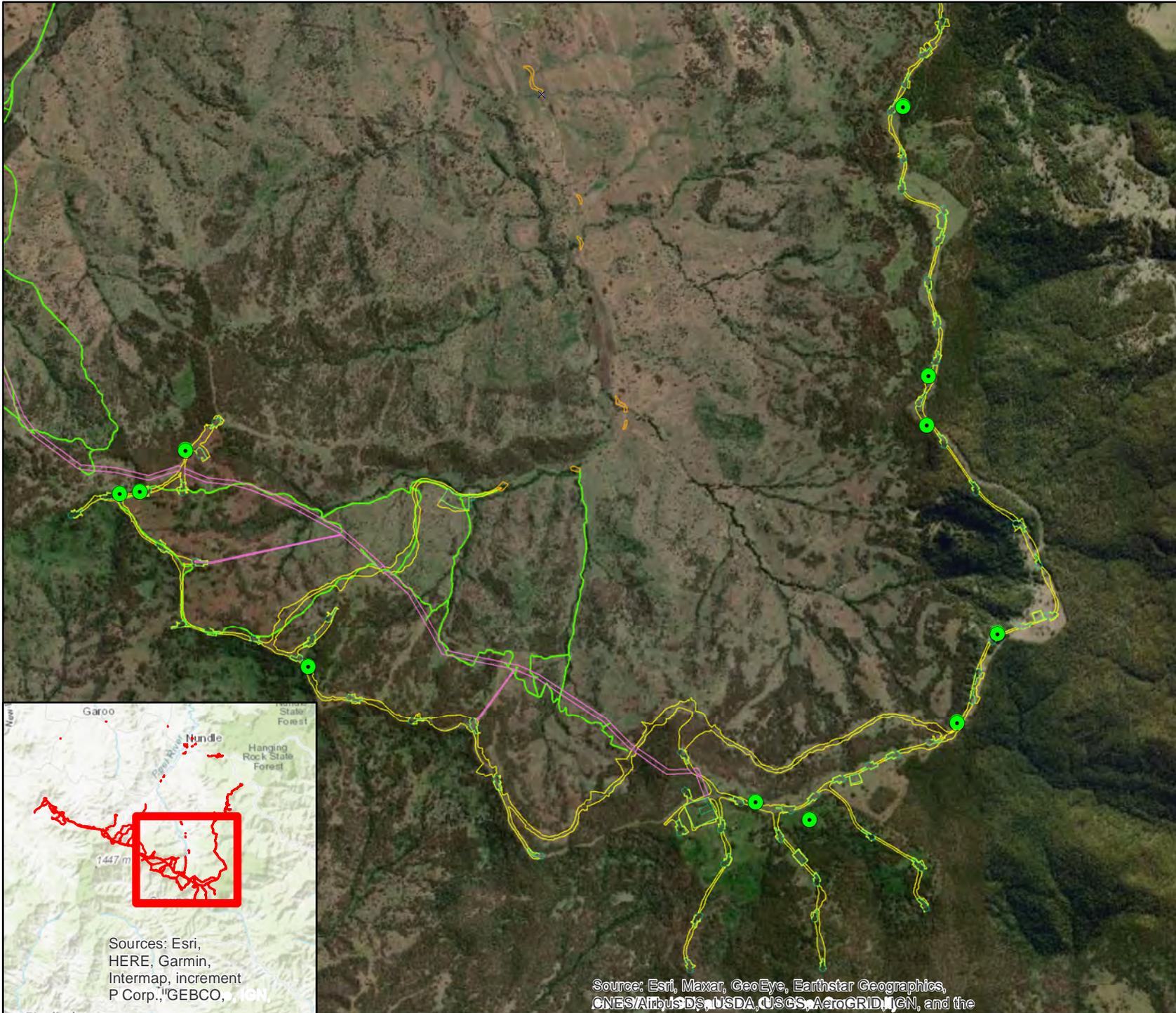
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 009
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

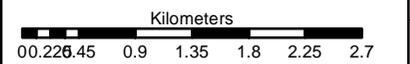
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the



- Koala SAT
- Transport route (port to site)
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

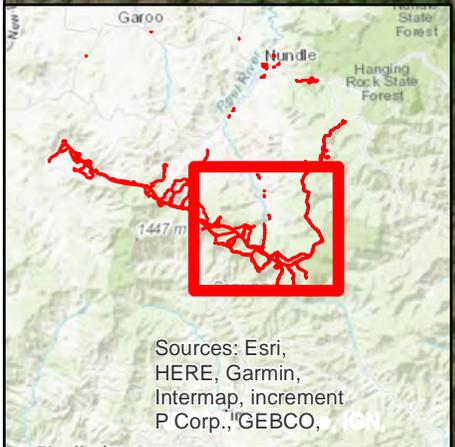
Job Title
Hills of Gold Wind Farm

Drawing Title
**Threatened fauna survey
 Page 4 (Koala SATs)**

Scale at A4 1:60,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

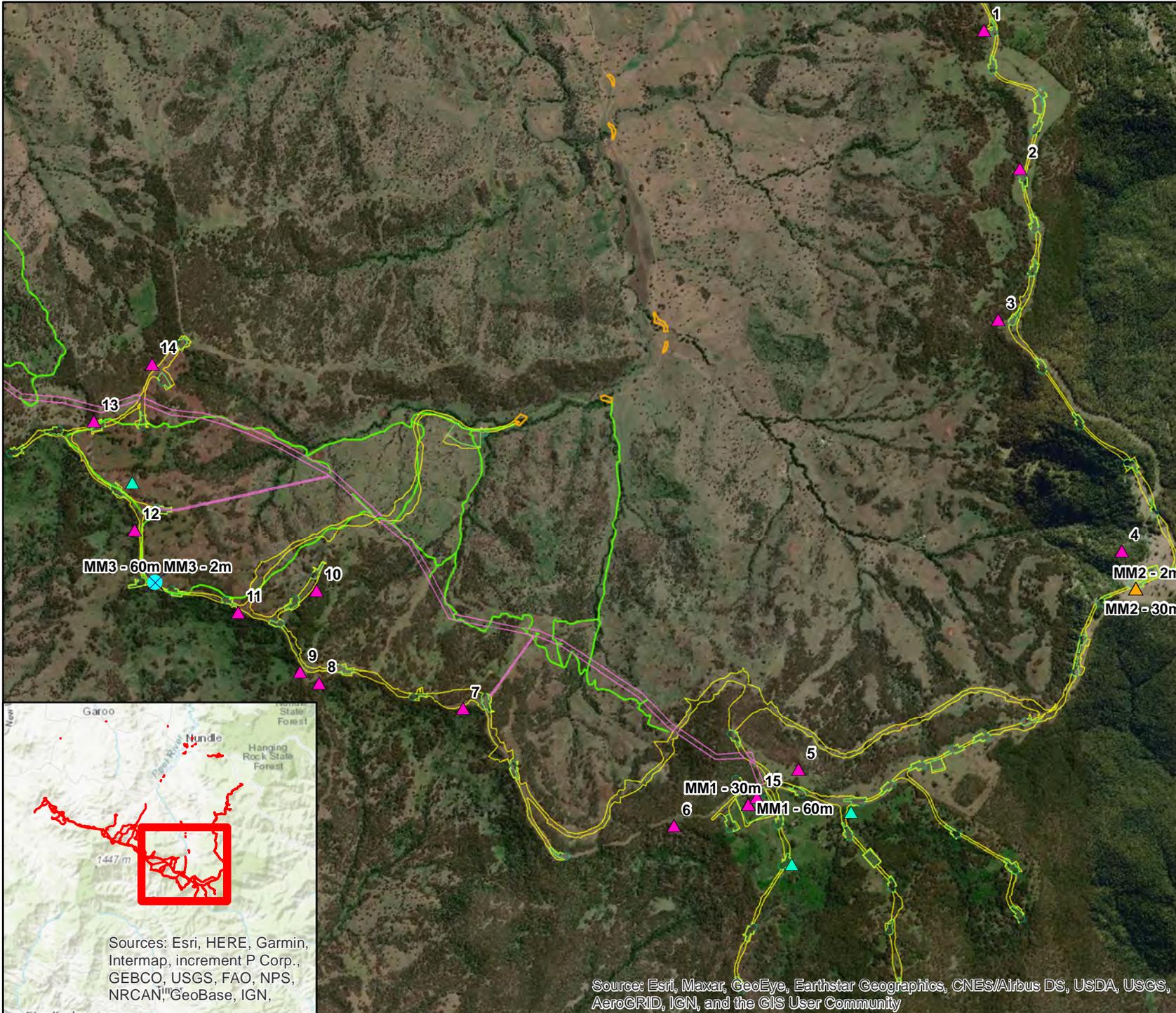
Job No 270335-00	Drawing No 009
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

I:\270000\270335-00 Hills of Gold\Work\marmal\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd

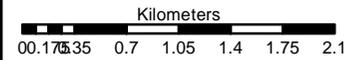


Microbat passive detector

-  Ground level
-  Met mast
-  Microbat active transects
-  Transport route development footprint (port to site)
-  Wind farm infrastructure
-  Transmission line and switching
-  Internal roads
-  Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

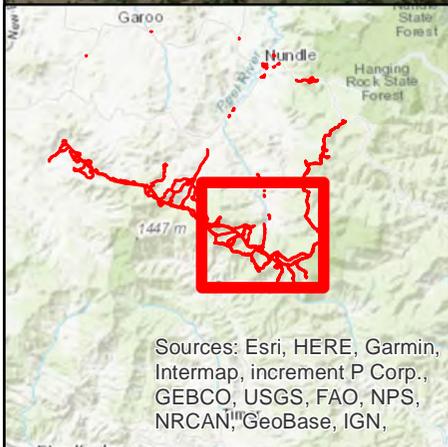
Job Title
Hills of Gold Wind Farm

Drawing Title
**Threatened fauna survey
Page 5 (microbats)**

Scale at A4 1:50,753	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

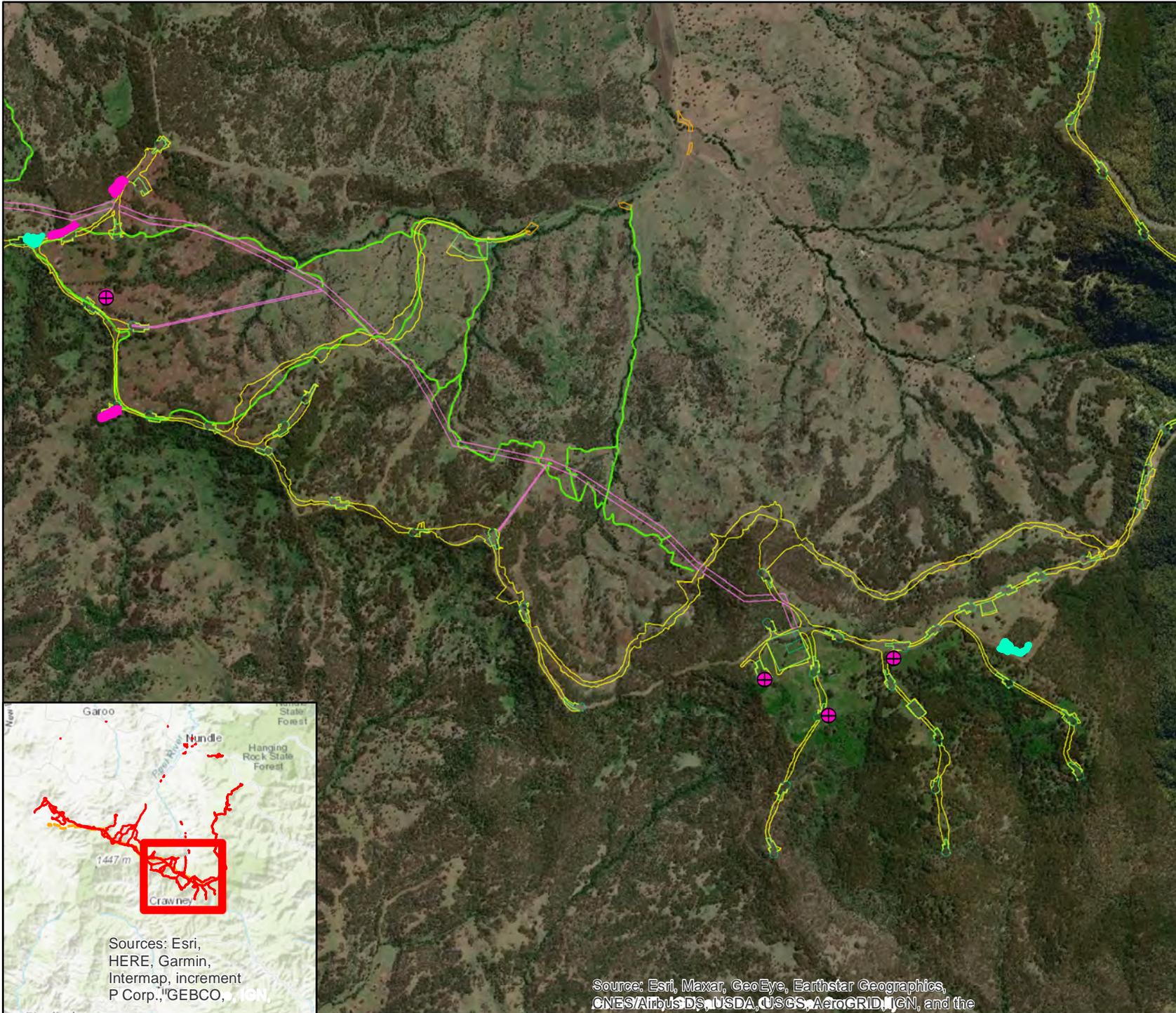
Job No 270335-00	Drawing No 009
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

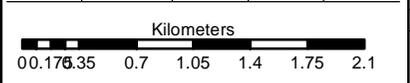
D:\270000\270335-00 Hills of Gold\Work\mama\05\figures\Draft\BDRAR_June2020\Draft_Figures_revised.mxd



-  Spotlighting Nov 2019
-  Border Thick-tailed Gecko search Mar 2020
-  Spotlighting transects - Mar 2020
-  Transport route (port to site)
-  Wind farm infrastructure
-  Transmission line and switching
-  Internal roads
-  Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

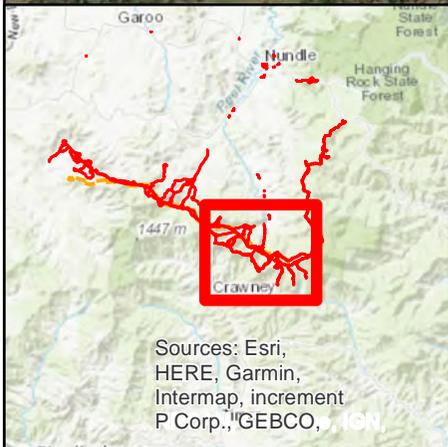
Job Title
Hills of Gold Wind Farm

Drawing Title
**Threatened fauna survey
 Page 6 (spotlighting)**

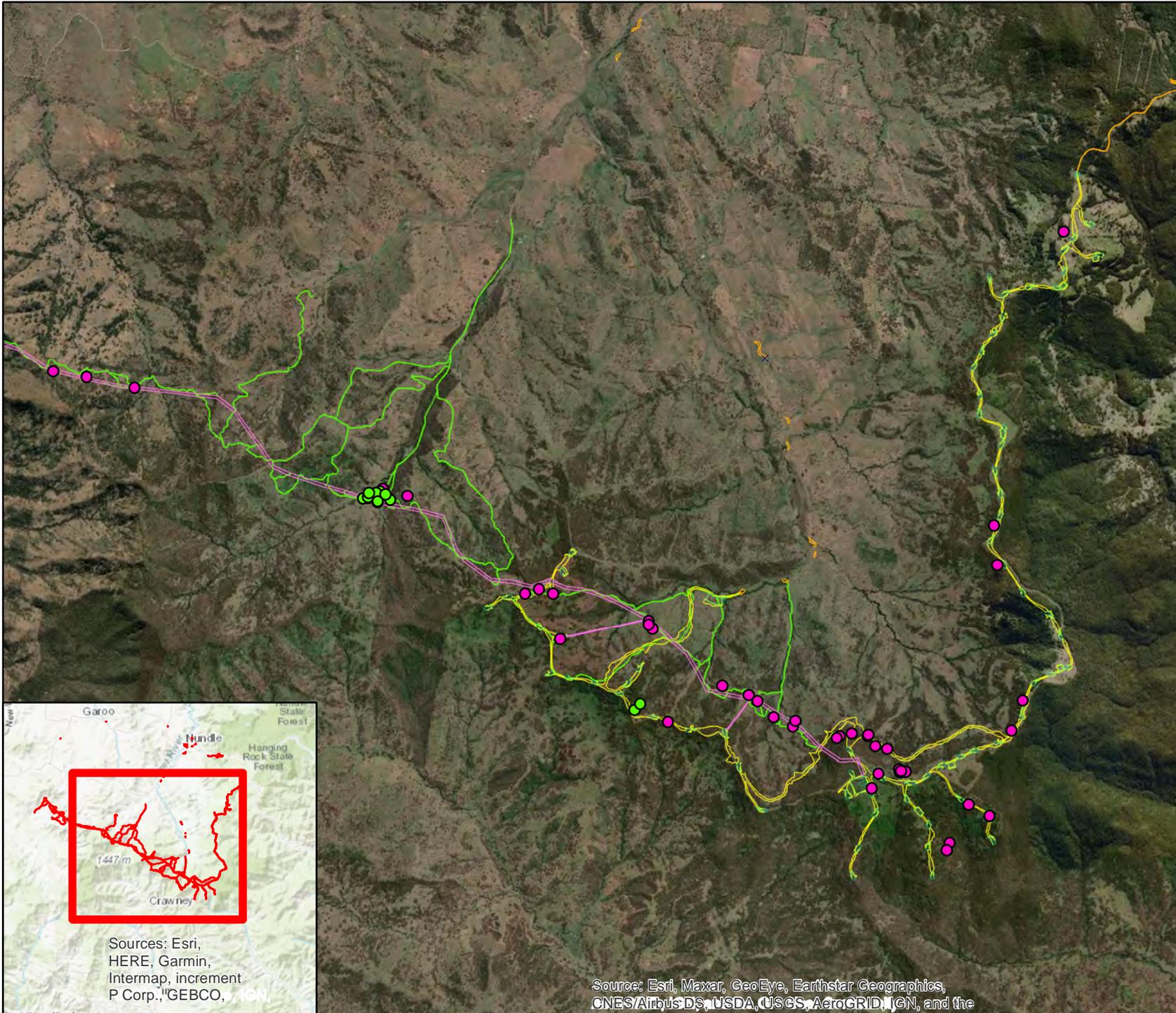
Scale at A4 1:46,318	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 009
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

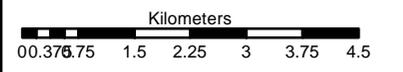


Habitat condition assessments

- Habitat assessment
- Photopoint
- Transport route (port to site)
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

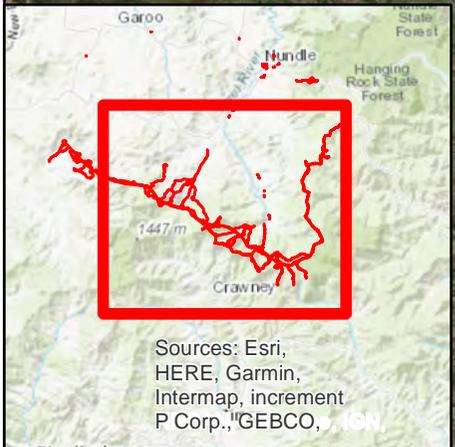
Job Title
Hills of Gold Wind Farm

Drawing Title
**Threatened fauna survey
Page 7 (habitat condition assessment)**

Scale at A4 1:100,937	Drawing Status Final
---------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 009
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

I:\270335\270335-00 Hills of Gold\Work\minal\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd

5.4 Threatened species results

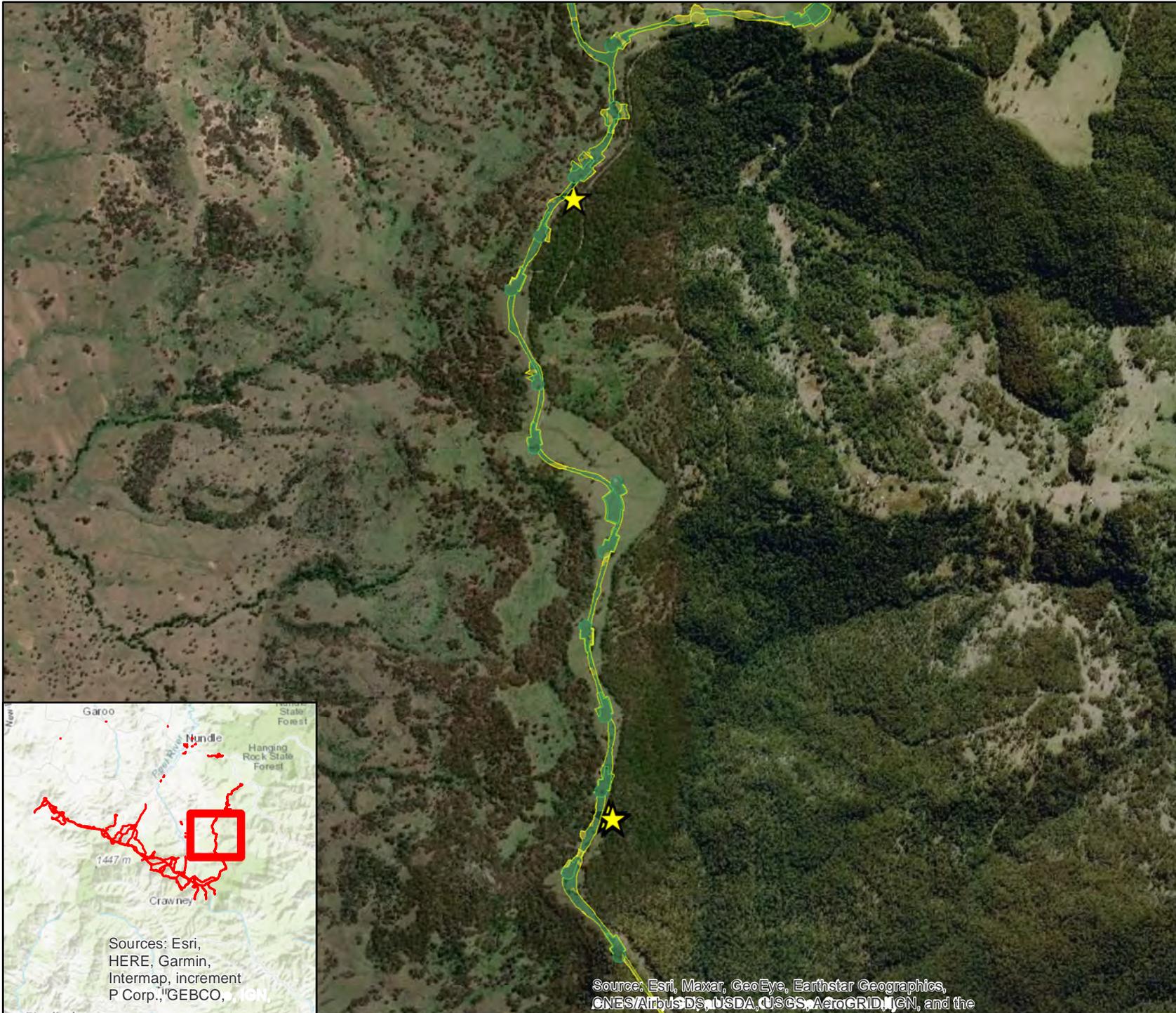
5.4.1 Threatened flora

One threatened flora species, Broad-leaved Pepperbush *Tasmannia purpurescens*, was identified within the study area, as detailed in **Table 25**. The species was recorded in two locations adjacent to the north-eastern section of the wind farm infrastructure section of the development footprint, as shown in **Figure 10**. They were not recorded within the development footprint.

The northern-most record of this species was located in an area of PCT 934, with Messmate *Eucalyptus obliqua* as the dominant canopy tree and an open shrub cover with Broad-leaved Pepperbush being locally abundant in areas. The second, more southerly record for Broad-leaved Pepperbush was within an area of good quality PCT 1194 dominated by Snow Gum *Eucalyptus pauciflora* with a grassy understory and an open shrub layer. The development footprint avoids direct impacts to both of these recorded locations of Broad-leaved Pepperbush.

Table 25: Threatened flora identified in the study area.

Scientific name	Common name	EPBC Act Status	BC Act Status	Count
<i>Tasmannia purpurescens</i>	Broad-leaved Pepperbush	-	V	10

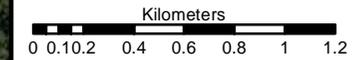


Plant Community Types

- 1194
- Exotic grassland
- Wind farm infrastructure
- Internal roads
- Broad-leaved Pepperbush



D1	9/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

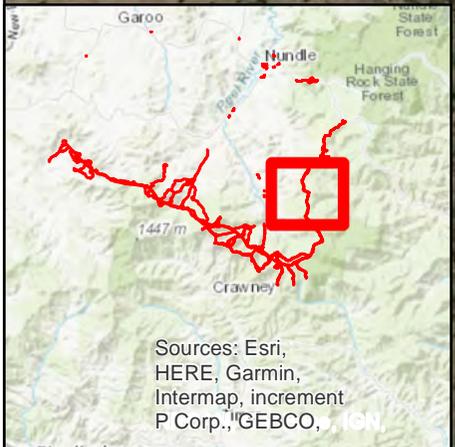
Job Title
Hills of Gold Wind Farm

Drawing Title
Threatened flora records

Scale at A4 1:30,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 010
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

I:\270335\270335-00 Hills of Gold\Work\marmal\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd

5.4.2 Threatened fauna

5.4.2.1 Survey results - bird utilisation survey and diurnal bird survey

The raw data from all bird utilisation surveys, including survey location, species names, abundance, vertical and horizontal distances and flying directions are provided in the Collision Risk Model Report in **Appendix D**.

During the bird utilisation surveys, 51 bird species were recorded with 18 of these species recorded flying at the maximum rotor swept height of 230m (**Table 26**). During the bird utilisation surveys, 224 bird movements (flights) were recorded comprising 33 different bird species. Of the 224 flights recorded, 190 (or 85%) were recorded at between 5 and 20 metres vertical distance (height), indicating that the majority of bird activity within the development footprint will not be at risk of blade strike.

Table 26: Bird species recorded flying at rotor swept height.

Common name	Species name
Brown Goshawk	<i>Accipiter fasciatus</i>
Galah	<i>Cacatua roseicapilla</i>
Nankeen Kestrel	<i>Falco cenchroides</i>
White-browed Treecreeper	<i>Climacteris affinis</i>
Australian Magpie	<i>Gymnorhina tibicen</i>
Yellow-tailed Black- Cockatoo	<i>Calyptorhynchus funereus</i>
Laughing Kookaburra	<i>Dacelo novaeguineae</i>
Red Wattlebird	<i>Anthochaera carunculata</i>
Spotted Pardalote	<i>Pardalotus punctatus</i>
Common Starling	<i>Sturnus vulgaris</i>
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>
Crimson Rosella	<i>Platycercus elegans</i>
Little Wattlebird	<i>Anthochaera chrysoptera</i>
Pied Currawong	<i>Strepera graculina</i>
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>
Australian Raven	<i>Corvus coronoides</i>
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>
Wedge-tailed Eagle	<i>Aquila audax</i>

In the interests of ensuring a conservative assessment, the impact assessment for bird collision risk assumes that all bird species that were recorded flying within the rotor swept height, even if only a single flight was recorded at this height. When the average flight heights are assessed, the majority of these 18 species were flying below the rotor swept height in most recorded flights (**Figure 11**).

The average flight heights shows that only four species have an average recorded flight height that is within the rotor swept height, including Australian Raven, Brown Goshawk, Wedge-tailed Eagle and White-breasted Woodswallow. This indicates that for most flights, there are only a small number of native birds that are considered at risk of collision with turbines.

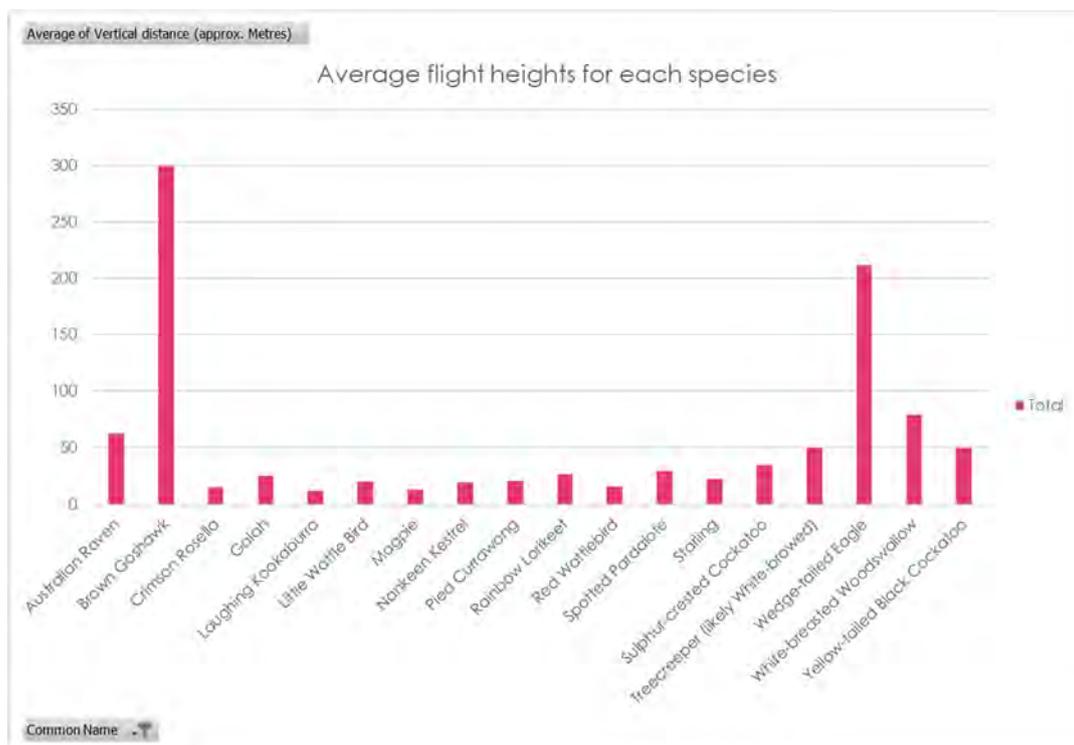


Figure 11: Average flight height for bird species recorded flying within rotor swept height.

This list of at risk species is based on flight height and number of observed movements. All of the birds considered most at risk of collision with turbines are listed as least concern under the NSW BC Act and are not listed as listed threatened species or migratory species under the EPBC Act.

Regarding other diurnal, winter-specific threatened bird species that were assessed as having the potential to occur in the wind farm development corridor, Glossy Black Cockatoo *Calyptorhynchus lathami*, listed as vulnerable under the BC Act, were considered unlikely to utilise the site for breeding, but suitable locations for breeding and foraging were observed down slope of the western section of the wind farm transmission line development footprint. Despite survey during suitable seasons and climatic condition, no Glossy Black Cockatoos were observed.

There were no records of Little Eagle *Hieraaetus morphnoides* during the diurnal bird surveys and no stick nests were recorded, suggesting areas of suitable habitat were not currently being utilised for breeding. There were also no records of Swift Parrot *Lathamus discolor* during the diurnal surveys and there is also a lack of preferred foraging trees within the wind farm development corridor. Swift Parrot breed in Tasmania from September to January, meaning breeding habitat for this species is not a consideration for this project and field surveys are sufficient to rule out presence as a foraging species.

5.4.2.2 Nocturnal bird surveys and spotlighting

During all targeted surveys for threatened owls no response was detected for the species targeted, despite targeted call playback searches in areas considered to be good habitat. Habitat for these threatened owls was focused on areas within and adjacent to the development footprint

The wind farm development corridor is only considered likely to support potential large forest owl breeding habitat in the wetter forested gullies/drainage lines on the three “fingers” and with only low-moderate potential. The majority of the site is not suitable for owl breeding due to a lack of sheltered gullies, existing disturbances associated with clearing and agricultural land use and highly edge-effected patches of vegetation.

Notwithstanding the lack of owls detected during the nocturnal surveys, **Table 27** below shows the threatened fauna that were detected during spotlighting surveys. A total of three threatened mammals were detected over all survey periods.

Table 27: Threatened fauna detected during spotlighting

Scientific name	Common name	EPBC Act Status	BC Act Status	Survey Period Identified
<i>Phascolarctos cinereus</i>	Koala	V	V	Stage 2 winter survey
<i>Petauroides volans</i>	Greater Glider	V	V	Stage 2 winter survey, Stage 2 spring survey
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	V	Stage 2 winter survey

5.4.2.3 Hollow-dependent birds and raptors

Areas of high densities of hollows, fallen timber large trees and an intact understorey were mapped as part of the PCT condition classification, with areas in high condition providing fauna habitat to be targeted for threatened birds.

These areas are not large in the context of the whole site, although these areas are high priority for avoidance of impacts. These areas are also most intact in terms of vegetation structure, and as such likely represent the highest condition vegetation present.

These areas were targeted in the spring and summer survey events, due to the potential importance of these areas. During the field surveys no stick nests or threatened diurnal birds were observed within the development footprint.

5.4.2.4 Nocturnal frog surveys

During the field surveys no threatened frogs were recorded. (Table 28).

Table 28: Frogs identified during nocturnal frog surveys.

Creek/Dam	Survey Methods	Results
HoGCP06	One 200m transect within windfarm development area, surveyed on two separate nights by two ecologists, call play back conducted along transect, boulders and rocks turned over targeting Tusked Frog <i>Adoletus brevis</i> .	No frogs found
HoGCP07	One 200m transect within windfarm development area, surveyed on two separate nights by two ecologists, call play back conducted along transect, boulders and rocks turned over targeting Tusked Frog <i>Adoletus brevis</i> .	Night 1: 1x <i>Litoria verreauxii</i> (observed) Night 2: 1x <i>Litoria verreauxii</i> (observed)
HoGCP07g	Survey conducted around the perimeter of the dam on two separate nights by two ecologists, call play back conducted during survey, boulders and rocks turned over targeting Tusked Frog <i>Adoletus brevis</i> .	Night 1: 2x <i>Litoria peronii</i> (heard) Night 2: 1x <i>Litoria peronii</i> (heard & observed)
HoGCP07h	Survey conducted around the perimeter of the dam on two separate nights by two ecologists, call play back conducted during survey, boulders and rocks turned over targeting Tusked Frog <i>Adoletus brevis</i> . Tadpoles captured with non-abrasive net and photos taken for identification.	Night 1: 1x <i>Litoria verreauxii</i> (heard), several <i>L. verreauxii</i> tadpoles identified Night 2: 1x <i>Litoria verreauxii</i> (heard), several <i>L. verreauxii</i> tadpoles identified
HoGCP22 (Woodleys Ck)	One 200m transect within and immediately downstream of windfarm development area, surveyed on two separate nights by two ecologists, call play back conducted along transect, boulders and rocks turned over targeting Tusked Frog <i>Adoletus brevis</i> . ----- Survey conducted around the perimeter of large dam located upstream of transect on two separate nights by two ecologists, call play back conducted during survey, boulders and rocks turned over targeting Tusked Frog <i>Adoletus brevis</i> .	Night 1: 1x <i>Litoria peronii</i> (heard & observed) Night 2: 1x <i>Litoria peronii</i> (heard), 1x <i>Crinia signifera</i> (observed) ----- Night 1: 3x <i>Litoria peronii</i> (heard & observed) Night 2: Multiple <i>Litoria peronii</i> (heard),

Creek/Dam	Survey Methods	Results
		4x <i>Litoria peronii</i> (observed), Multiple <i>Crinia signifera</i> (heard), 3x <i>Crinia signifera</i> (observed),
HoGCP24	Survey conducted around the perimeter of the pool on two separate nights by two ecologists, call play back conducted during survey, boulders and rocks turned over targeting Tusked Frog <i>Adoletus brevis</i> . Tadpoles captured with non-abrasive net and photos taken for identification.	No frogs found
HoGCP26	Survey conducted around the perimeter of the pool on one night two ecologists, call play back conducted during survey, boulders and rocks turned over targeting Tusked Frog <i>Adoletus brevis</i> . Tadpoles captured with non-abrasive net and photos taken for identification.	No frogs found

5.4.2.5 Microbats

High levels of bat activity was found to occur throughout the study area, with 28 species recorded during field surveys (**Table 29**). The majority of the species recorded were not threatened species listed under the BC Act or the EPBC Act, with 20 least concern species detected.

The species with the highest mean calls per night recorded across the site is the White-striped Freetail Bat *Austronomus australis*, a common bat found throughout most of Australia. Other species found commonly across site but with lower mean calls per night were Gould's Wattled Bat *Chalinolobus gouldii* and Little Broad-nosed Bat *Scoterepens greyii*, both also species with no threatened status in New South Wales.

Eastern Bentwing Bat *Miniopterus orianae oceanensis*, which is a cave dwelling species and listed as vulnerable under the BC Act, was also recorded at two sites with a high mean call rate including at site 3 and the existing meteorological mast 3 at canopy height. As this species forages at or above canopy height it is highly likely that the existing meteorological mast 3 is situated within the area of foraging habitat for this species. Site 3 also has high potential to contain roosting habitat for this species. During the spring 2019 transect surveys 29 calls of this species were recorded within the southern extent of the study area.

Table 29: Detailed summary of bat detector data listing mean number of calls per night

	1	3	8	9	10	11	13	12	14	6	7	5	15	2	4	MM1 – 2m	MM1- 30m	MM1 - 60m	MM2 – 2m	MM2- 30m	MM2- 60m	MM3 – 2m	MM3- 30m	MM3 – 60m	Southern transect Spring 2019	Grand averages
White-striped free-tailed bat <i>Austronomus australis</i>	25.73	54.93	31.44	14.30	23.40	3.20	4.00	38.75	98.75	16.75	31.50	1.00	141.25	173.00	218.75	88.25	38.75	21.12	106.00	169.53	15.00	60.00	37.75	41.88	17.00	58.88
Large-eared Pied Bat <i>Chalinolobus dwyeri</i> #*	0.36	0.29	0.44	0.00	0.10	0.20	3.00	0.75	7.00	0.00	0.00	0.00	0.00	0.00	0.00	7.25	0.25	0.06	2.00	0.32	0.00	1.75	0.50	0.03	0.00	1.52
Gould's Wattled Bat <i>Chalinolobus gouldii</i>	14.36	10.47	17.56	19.70	4.20	16.40	10.00	10.75	40.25	7.50	11.25	0.75	5.50	14.75	2.75	15.50	4.50	2.29	0.00	7.00	0.50	4.50	3.50	3.25	2.00	9.55
Chocolate Wattled Bat <i>Chalinolobus morio</i>	0.09	0.30	0.11	0.40	0.90	0.40	3.00	6.50	42.50	4.50	8.50		5.75	10.00	3.75	7.00	0.00	0.00	0.00	0.32	0.00	2.00	5.25	0.31	1.00	5.13
Little Pied Bat <i>Chalinolobus picatus</i> +*	1.00	0.10	1.22	0.00	0.00	0.00	18.00	3.75	7.25	5.50	12.75	0.25	5.00	4.00	17.25	15.50	2.75	0.21	0.00	0.00	0.00	2.50	2.50	0.19	0.00	5.54
Eastern False Pipistrelle <i>Falsistrellus tasmaniensis</i> +*	9.64	1.10	11.78	7.80	4.50	0.60	0.00	0.00	2.25	0.75	0.00	0.00	1.25	0.50	0.25	0.00	0.00	1.00	4.00	5.89	0.10	0.00	0.00	2.50	2.00	3.29
Eastern Coastal Free- tailed Bat <i>Micronomus norfolkensis</i> +	30.91		37.78		0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.45	0.45	0.00	0.00	0.16		10.04
Little Bent- winged Bat <i>Miniopterus australis</i> #*	3.45	0.27	4.22	5.50	2.60	0.40	0.00		2.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	2.00	0.76	0.00	0.00	0.00	1.16	8.00	2.61
Large Bent- winged Bat <i>Miniopterus orianae oceanensis</i> #*	17.18	14.87	21.00	3.90	6.30	1.80	0.00	4.75	19.50	14.75	17.75	0.00	27.50	19.75	37.00	18.00	2.50	1.74	8.00	15.42	0.95	1.25	2.25	1.66	29.00	12.47
Southern Myotis <i>Myotis macropus</i> #*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.13

	1	3	8	9	10	11	13	12	14	6	7	5	15	2	4	MM1 – 2m	MM1-30m	MM1 - 60m	MM2 – 2m	MM2-30m	MM2-60m	MM3 – 2m	MM3-30m	MM3 – 60m	Southern transect Spring 2019	Grand averages
Lesser Long-eared Bat <i>Nyctophilus geofroyii</i>	0.00	0.00	0.00	0.10	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
<i>Nyctophilus sp.</i>	5.45	1.67	6.67	2.60	2.30	0.20		2.50	6.50	0.50	0.25	0.00	0.75	2.00	1.00	0.25		0.18		8.55	0.05	0.00	0.00	0.31	1.00	2.25
Northern Free-Tailed Bat <i>Ozimops lumsdenae</i>	0.00	0.43	0.00	2.80	0.10	0.00	0.00	2.00	0.25	0.25	0.00	0.00	0.25	0.75		0.50	0.50	0.35	2.00	2.18		0.25	0.75	2.41	0.00	0.99
Inland Free-tailed Bat <i>Ozimops petersi</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	77.75	27.00	0.00	76.25		67.50	50.50	10.25	26.50	12.75	0.00	0.00	0.00	0.00	18.50	30.00	0.00	0.00	39.70
South-eastern Free-tailed Bat <i>Ozimops planiceps</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00	28.25	0.00	4.50	1.75	1.25	8.00		3.75	1.75	0.00	0.00	0.00	0.00	0.25	0.75	0.00	0.00	6.63
Ride's Free-Tailed Bat <i>Ozimops ridei</i>	0.09	3.80	0.11	0.80	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.62		1.79	0.10			6.06	1.00	1.84
Golden-tipped Bat <i>Phoniscus papuensis</i>	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23
Smaller Horseshoe Bat <i>Rhinolophus megaphyllus</i> *	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.25	0.00	1.00	0.00	0.50	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51
<i>Saccolaimus falviventris</i>	0.00	1.00	0.00	0.50	0.10	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.75	0.25	0.18	3.00	0.61	0.10	0.25	0.00	1.16	3.00	0.98
<i>Scoteanax ruepelli</i>	19.91	0.80	24.33	9.80	1.00	1.80	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.88	3.00	6.95	0.55	0.00	0.00	1.97		6.04
<i>Scotorepens balstoni</i>	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	1.25	0.00	0.25	0.25	0.00	0.25	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.44
<i>Scotorepens greyii</i>	3.09	5.23	3.78	0.20	0.30	0.20	0.00	4.50	9.50	2.50	22.25	0.00	5.25	13.00	2.25	3.50	0.50	6.26	8.00	36.53	0.15	1.25	0.50	2.22	14.00	6.30
<i>Scotorepens orion</i>	0.00	5.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.90

	1	3	8	9	10	11	13	12	14	6	7	5	15	2	4	MM1 – 2m	MM1-30m	MM1 - 60m	MM2 – 2m	MM2-30m	MM2-60m	MM3 – 2m	MM3-30m	MM3 – 60m	Southern transect Spring 2019	Grand averages
<i>Vespadelus darlingtoni</i>	5.18	8.67	6.33	9.60	4.50	0.80	0.00	10.00	8.75	1.50	21.00	0.00	7.50	9.25	0.00	0.00	0.00	0.03		0.37	0.05	0.50	0.00	0.69	2.00	5.37
<i>Vespadelus regulus</i>	0.00	0.03	0.00	0.00	0.00	0.40	0.00	0.25	2.50	7.50	6.00	0.00	0.50	4.75	10.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	3.29
<i>Vespadelus sp.</i>	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.50	0.25	0.00	0.00	0.00	0.00	1.25	0.25	0.00	0.00	1.33
<i>Vespadelus trouhntoni</i> #*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	3.00	0.75	2.25	0.00	0.25	0.25	0.00	1.00		0.00	0.00	0.00	0.00	1.75	0.00	0.00	1.00	1.19
<i>Vespadelus vulturinus</i>	0.55	0.90	0.67	0.70	0.10	0.00	0.00	2.25	1.50	3.75	4.75	0.00	9.25	0.00	0.00	4.00	2.00	0.00	0.00	0.00	0.00	2.25	3.50	0.50	0.00	2.44
<i>Vespadelus vulturinus</i> or <i>Miniopterus schreibersii oceanensis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
Total calls per night	137.00	110.99	167.44	79.00	53.00	28.20	38.00	181.00	311.50	66.50	220.50	4.00	279.25	310.75	304.00	197.75	67.00	38.50	138.00	256.66	18.00	98.50	87.50	66.63	81.00	133.63

species credit bats
+ ecosystem credit bat
* cave bats

Analysis determined a high mean number of calls per night from multiple bat species at site 1, 3 and 8, and the top of the meteorological mast MM2 both at 2m and 30m above ground level. Site 1 comprises the broad channel of an ephemeral creekline, with no obvious karst sections visible. This site has dense shrub vegetation and no obvious clear flyways. It is likely to provide foraging habitat for multiple species of microbats. For detectors deployed at canopy height of 30m and within the rotor swept height at 60m the majority of these calls are from White-Striped Freetail Bat.

The highest level of activity detected for microbats was at the 30m high detector on the met masts, with a mean of 257 calls per night detected for all species. This indicates that, as expected for microbats, the highest activity is foraging above canopy levels.

There is still a reasonable level of activity detected at 60m, however very low number of calls were detected at MM2 (18 calls per night) for the 60m height. MM3 had a higher level of bat activity at 60m height at a mean of 68 calls per night, but this is half the level of activity recorded at 30m. There is a general trend towards decreased bat activity for all species combined at rotor swept path height, when compared with the number of calls detected at canopy height (**Table 30**).

Table 30: Mean calls per night on met mast deployed detectors

Met mast location	2m height	30m height	60m height
MM1	197.75	67.00	38.50
MM2	138.00	256.66	18.00
MM3	98.50	87.50	66.63

When the results of the bat detectors installed on met masts are reviewed for the threatened microbats recorded on site, there is also a similar trend for some species of decreased activity at the rotor swept height (**Table 31**). Generally, activity of the threatened bats at the 60m height was low, with the highest number of mean calls recorded being 2.50 for Eastern False Pipistrelle. The majority of threatened bats detected recorded less than 1.00 mean calls per night at each detector installed at 60m. The highest mean calls of 15 and 18 per night were recorded at the 2m and 30m heights.

The BC Act and EPBC Act listed Large-eared Pied Bat showed a marked reduction in the mean number of calls per night with increasing height. At all three met mast locations there were substantially more calls detected at the 2m height, than at the rotor swept height (60m) and canopy height (30m). A very similar trend was observed for the Little Pied Bat. This suggests that bats of this genus (*Chalinobolus spp*) prefer to forage below canopy height.

The two bent-wing bat species belonging to the genus *Miniopterus* and the Eastern False Pipistrelle recorded the highest nightly mean calls at the 60m height. These species are known to forage above the canopy and for most of the

met mast sites there was a greater number of mean calls per night detected at the 30m detector height.

Table 31: Mean calls per night for threatened microbats detected

Threatened species	MM1			MM2			MM3		
	2m	30m	60m	2m	30m	60m	2m	30m	60m
<i>Chalinolobus dwyeri</i> #*	7.25	0.25	0.06	2.00	0.32	0.00	1.75	0.50	0.03
<i>Chalinolobus picatus</i> +*	15.50	2.75	0.21	0.00	0.00	0.00	2.50	2.50	0.19
<i>Falsistrellus tasmaniensis</i> +*	0.00	0.00	1.00	4.00	5.89	0.10	0.00	0.00	2.50
<i>Micronomus norfolkensis</i> +	0.00	0.00	0.35	0.00	0.45	0.45	0.00	0.00	0.16
<i>Miniopterus australis</i> #*	0.00	0.00	0.24	2.00	0.76	0.00	0.00	0.00	1.16
<i>Miniopterus orianae oceanensis</i> #*	18.00	2.50	1.74	8.00	15.42	0.95	1.25	2.25	1.66
<i>Myotis macropus</i> #*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Vespadelus troughtoni</i> #*	1.00	0.00	0.00	0.00	0.00	0.00	1.75	0.00	0.00

5.4.2.6 Greater Glider

The Greater Glider is listed as Vulnerable under the EPBC Act and is not a listed species under the BC Act. It is the largest gliding possum in Australia, with a head and body length of 35 – 46 centimetres, and a tail measuring 45 – 60 centimetres (Menkhorst & Knight 2011). The species is arboreal and nocturnal, and is mostly restricted to eucalypt forests and woodlands. It is typically found in highest abundance in tall, montane and moist eucalypt forests with old trees and abundant

hollows. The species favours forests with a diversity of eucalypt species, due to the seasonal variation in its preferred tree species. During the day Greater Glider shelters in tree hollows, particularly those that are in large, old trees (McKay 2008).

The Greater Glider occurs in eastern Australia, from the Windsor Tableland in north Queensland through to central Victoria. The broad extent of occurrence is unlikely to have changed substantially since European settlement, however the area of occupancy has decreased substantially, mostly due to land clearing (Threatened Species Scientific Committee 2016). This decline is most likely continuing due to further land clearing, fragmentation, fire and forestry activities. The species is considered to be particularly sensitive to forest clearance, logging and fire, and is slow to recover following major disturbance. The species is also considered to be sensitive to fragmentation due to a low dispersal ability, previously showing low persistence in small forest fragments (Threatened Species Scientific Committee 2016).

25 Greater Gliders were recorded within the study area during targeted surveys in the current assessment (Biosis 2019). Previous records of the species are also scattered throughout the adjacent Ben Halls Gap Nature Reserve (EES 2020). As Greater Glider tend to have relatively small home ranges (1 – 4 ha), for the purposes of this assessment, these records throughout the study area and adjacent reserve make up the ‘local population’. Nationally, there are no officially recognised ‘important populations’ of Greater Glider. However in NSW, there are three specific populations listed as Endangered under the BC Act (EES 2020). These are the populations of the Eurobodalla LGA, Mount Gibraltar Reserve, and Seven Mile Beach National Park which are remote from the Project. It is not considered that the local population addressed in this assessment makes up an important population of the species.

Approximately 35.48 hectares of Greater Glider habitat is proposed to be removed from the study area as a part of the current project. This encompasses eucalypt woodland, and the associated hollow-bearing trees throughout. The impacts to Greater Glider habitat are also predominantly to smaller patches of fragmented suitable habitat on the wind farm infrastructure sections of the development footprint, and no large contiguous patches of habitat will be impacted.

5.4.2.7 Koala

Koala is listed as Vulnerable under the Commonwealth EPBC Act and the NSW BC Act. It occurs from north-east Queensland to South Australia, including parts of NSW. A rapid decline in the number of individuals has been seen since European settlement, primarily due to a reduction in available good quality vegetation with appropriate canopy species suitable for supporting the species (DECC 2008).

The study area is located within the Northern Tablelands Koala Management Area (KMA), and the proposed works include the removal of a total of 176 hectares of native vegetation, composed of various forms of eucalypt forest. Of this,

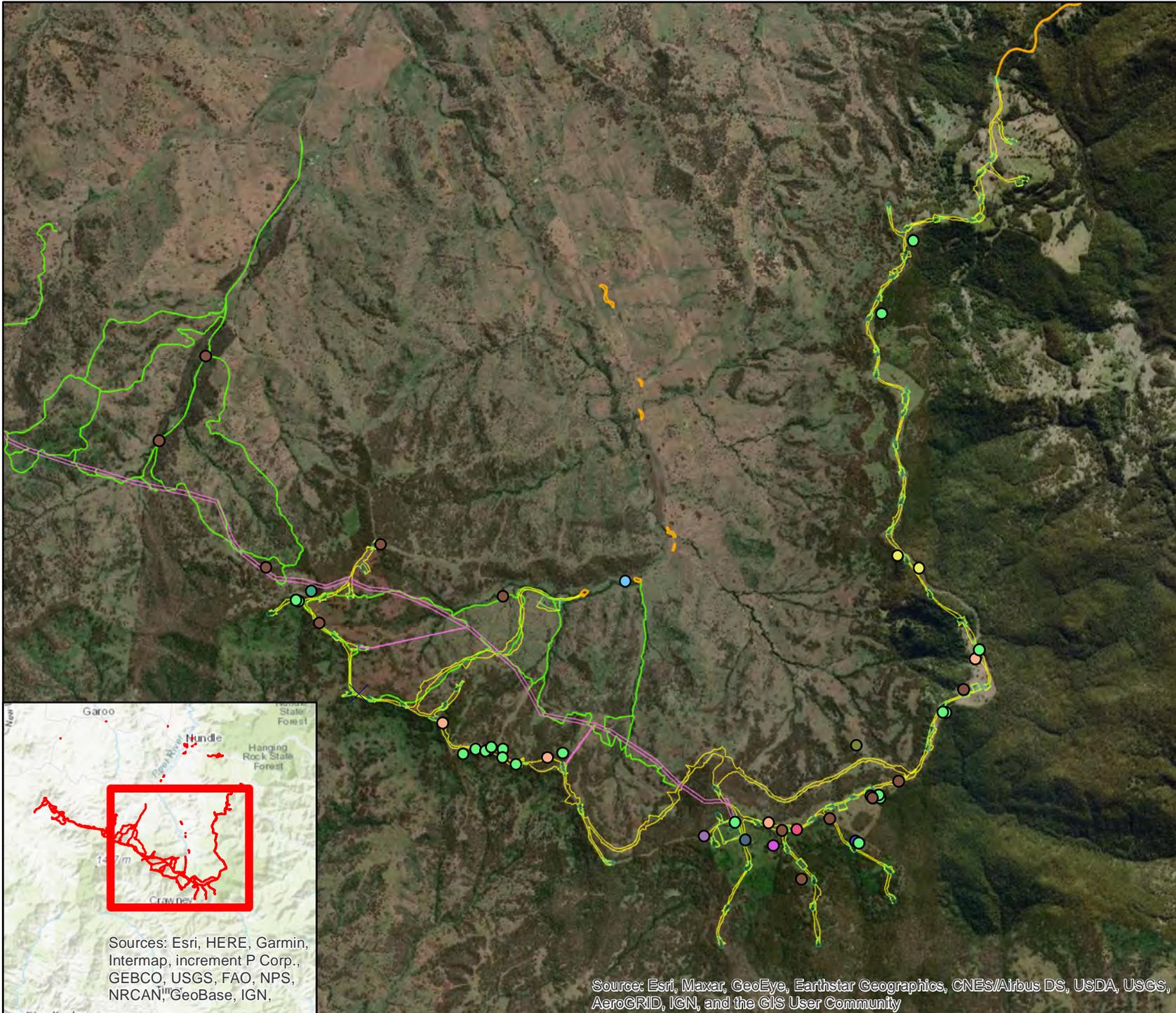
approximately 50 hectares is considered to be Koala breeding habitat as defined using the BAM method for mapping species polygons, encompassing 18 PCTs.

Within 10 kilometres of the study area, the species has been recorded seven times (EES 2020), with an additional two individuals recorded within the study area during the current field assessment (consisting of a mother and joey, Biosis 2019). The closest previous records of Koala occur within Ben Halls Gap Nature Reserve, which is east of, and contiguous with, the study area. Hanging Rock State Forest, Nundle State Forest, and Tomalla State Forest and Nature Reserve all lie within 20 kilometres of the study area, and contain scattered Koala records throughout (EES 2020). For the purposes of this assessment the definition of “the population” encapsulates all contiguous areas of Koala habitat into a singular spatial unit.

The results of the Koala SAT survey indicate that there is a low level of Koala activity across the site. Eight of the eleven SAT surveys had no scats recorded around the 30 surveyed trees, two SATs recorded scats around two trees and one SAT recorded 6 scats. This level of koala activity is consistent with the known population dynamics of Koalas in central NSW, with lower levels in drier areas. The escarpment where the wind farm is located is likely to support higher koala numbers than the transmission line corridor due to the higher soil nutrients and preferred koala food trees.

Phillips and Callaghan (2011) note that low levels of Koala activity assessed using the SAT method can also indicate that Koala use of the site may be transitory or a result of a naturally low density population.

As Koala is listed under the EPBC Act and, as the proposed works include potential impacts to this species, an assessment against the Significant Impact Criteria detailed in the Matters of National Environmental Significance: Significant impact guidelines version 1.1 (Commonwealth of Australia 2013) has been undertaken in this BDAR.

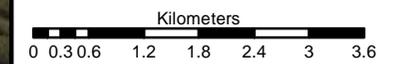


Threatened fauna and raptors

- Australian Hobby
 - Black Kite
 - Flame Robin
 - Glider
 - Greater Glider
 - Grey-headed Flying-fox
 - Koala
 - Large-eared Pied Bat
 - Southern Myotis
 - Spotted-tailed Quoll
 - Wedge-tailed Eagle
 - Yellow-bellied Sheathail-bat
- Transport route development footprint (port to site)
 - Wind farm infrastructure
 - Transmission line and switching
 - Internal roads
 - Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Threatened fauna and raptors
Page 1**

Scale at A4 1:82,084	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 012
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

D:\270000\270335-00 Hills of Gold\Work\mama\05\mcs\Figures\Draft\BDAR_June2020\Draft_Figures_revised.mxd

5.5 Threatened fauna habitat

According to the BAM, impacts to threatened fauna species must be calculated according to the area of suitable habitat identified by the species polygon. For dual credit species, only the breeding habitat for the species is to be mapped. For full credit species, both foraging and breeding habitats need to be included in any species polygons.

A detailed assessment of the mapped fauna habitat for threatened species listed under the BC Act is provided in **Table 32** and mapped in **Figure 13 to Figure 16**.

Table 32: Approach to estimating impacts for species credit species

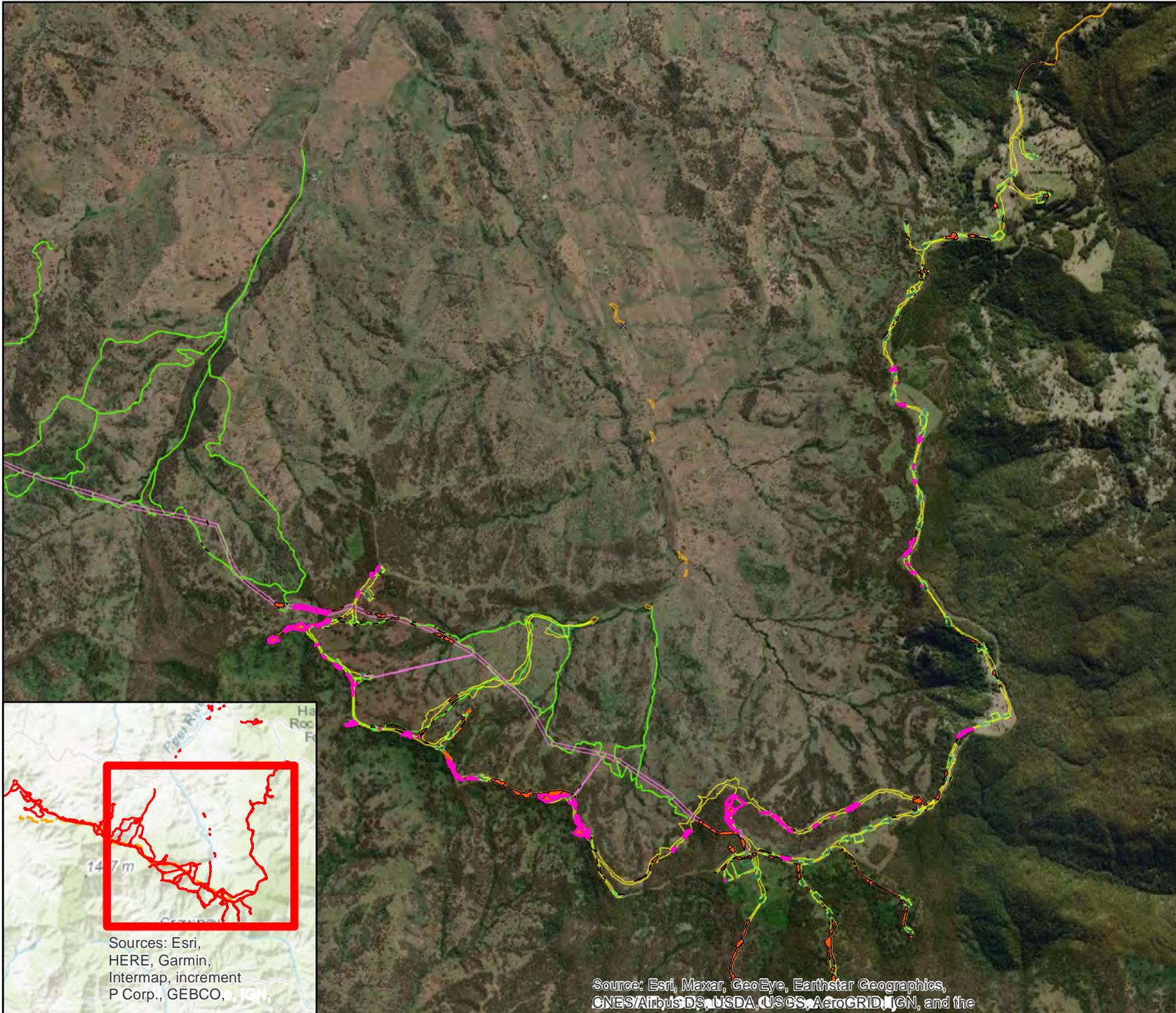
Species credit species	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
Large-eared Pied Bat	<p>The species is a full species credit because it cannot be reliably predicted to occur on a site based on vegetation and other landscape features (either foraging or breeding).</p> <p>Potential breeding habitat is PCTs associated with the species within 100m of rocky areas containing caves, or overhangs or crevices, cliffs or escarpments, or old mines, tunnels, culverts, derelict concrete buildings. Surveys must be undertaken as per the Threatened Bat Survey Guide to confirm breeding habitat.</p> <p>Species mapping polygon for breeding habitat must use high resolution aerial imagery and topographic maps to identify features on the subject land (caves, scarps, cliffs etc). Polygon must be at least 100m wide (or 50m radius for point locations such as caves) with the breeding habitat features (may be multiple) as the centroid (see Threatened Bat Survey Guide). All breeding habitat on or within 100m of the subject land and the area immediately surrounding the feature must be identified.</p> <p>All habitat on the subject land should also be mapped if present. Use high resolution aerial imagery and topographic maps to identify potential roost habitat features on the subject land within 2km caves, scarps, cliffs etc. Species polygon boundary should align with PCTs on the subject land to which the species is associated that are within 2km of identified potential roost habitat features.</p>	<p>Species polygons for 'Forage habitat' include PCTs associated with the species in the BioNet database, in moderate and high condition states, where they occur within 2km of 'High Potential - Microbat breeding polygons', and/or within 2km of Mount Royal Tops soil landscape (Mitchell 2002).</p> <p>Species polygons for "Breeding habitat' include all potential breeding habitat, which for the current assessment is deemed as 'High Potential - Micobat breeding polygons' and the area immediately surrounding this feature.</p> <p>Species polygon boundaries have a 100m radius buffer around the 'High Potential - Micobat breeding polygons' which were captured on site using GIS data. All impacted native vegetation in the development footprint within the buffer areas is captured.</p> <p>Cave bat habitat polygons are mapped in Figure 13.</p>
Eastern Cave Bat	<p>The species is a full species credit because it cannot be reliably predicted to occur on a site based on vegetation and other landscape features (breeding or foraging).</p> <p>Potential breeding habitat is PCTs associated with the species within 100m of rocky areas, caves, overhangs crevices, cliffs and escarpments, or old mines or tunnels, old buildings and sheds within the potential habitat. Surveys must be undertaken as per the Threatened Bat Survey Guide to confirm breeding habitat. All breeding habitat on or within 100m of the subject land and the area immediately surrounding the feature must be mapped. Artificial structures should be inspected and included on the map if the species is using these features for breeding. All habitat for this species</p>	<p>Species polygons for 'Forage habitat' include PCTs associated with the species in the BioNet database, in low, moderate and high condition states, where they occur within 2km of 'High Potential - Micobat breeding polygons', and/or within 2km of Mount Royal Tops soil landscape (Mitchell 2002).</p> <p>Species polygons for "Breeding habitat' include all potential breeding habitat, which for the current assessment is deemed as 'High Potential - Micobat breeding polygons' and the area immediately surrounding this feature.</p> <p>Species polygon boundaries have a 100m radius buffer around the 'High Potential - Micobat breeding polygons' which were captured on</p>

Species credit species	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
	<p>should also be mapped if present. Species mapping polygon for breeding habitat must use high resolution aerial imagery and topographic maps to identify features on the subject land (caves, scarps, cliffs etc). Polygon boundaries must be at least 100m wide (or 50m radius for point locations such as caves) with the breeding habitat features (may be multiple) as the centroid (see Threatened Bat Survey Guide).</p> <p>When the species is present on the subject land and the proposed impact is not a potential SAI, standard species credits will be generated.</p> <p>All habitat on the subject land where the subject land is within 2km of caves, scarps, cliffs, rock overhangs and disused mines must be mapped. Use high resolution aerial imagery and topographic maps to identify potential roost habitat features on the subject land within 2km caves, scarps, cliffs etc.</p> <p>Species polygon boundary should align with PCTs on the subject land to which the species is associated that are within 2km of identified potential roost habitat features.</p>	<p>site using GIS data. All impacted native vegetation in the development footprint within the buffer areas is captured.</p> <p>Cave bat habitat polygons are mapped in Figure 13.</p>
Large Bent-winged Bat	<p>This species is retained as dual credit because foraging habitat is broad ranging but breeding habitat is highly specific. Potential breeding habitat is caves, tunnels, mines or other structures known or suspected to be used by <i>M. schreibersii oceanensis</i> including species records in BioNet with microhabitat code 'IC – in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature.</p> <p>All breeding habitat including the cave, or other features, used for breeding and the area immediately surrounding this feature must be mapped. Species polygon boundaries should have a 100m radius buffer around an accurate GPS point location centred on the cave/feature entrance.</p>	<p>All potential breeding habitat, which for the current assessment is deemed as 'High Potential - Micobat breeding polygons' and the area immediately surrounding this feature.</p> <p>Species polygon boundaries have a 100m radius buffer around the 'High Potential - Micobat breeding polygons' which were captured on site using GIS data.</p> <p>All impacted native vegetation in the development footprint within the buffer areas is captured.</p> <p>Cave bat habitat polygons are mapped in Figure 13.</p>
Little Bent-winged Bat	<p>This species is retained as dual credit because foraging habitat is broad ranging but breeding habitat is highly specific. All breeding habitat including the cave, or other features, used for breeding and the area immediately surrounding this feature must be mapped. Species polygon boundaries should have a 100m radius buffer around an accurate GPS point location centred on the cave/feature entrance.</p>	<p>All potential breeding habitat, which for the current assessment is deemed as 'High Potential - Micobat breeding polygons' and the area immediately surrounding this feature.</p> <p>Species polygon boundaries have a 100m radius buffer around the 'High Potential - Micobat breeding polygons' which were captured on site using GIS data.</p> <p>All impacted native vegetation in the development footprint within the buffer areas is captured.</p>

Species credit species	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
Southern Myotis	<p>The species was allocated to species credit because it is dependent on waterways with pools of 3m wide or greater for foraging (which will be protected under legislation), habitat surrounding waterways is used for breeding and roosting.</p> <p>All habitat on the subject land where the subject land is within 200m of a waterbody with pools/ stretches 3m or wider including rivers, creeks, billabongs, lagoons, dams and other waterbodies on the subject land must be mapped. Use aerial imagery to map waterbodies with pools/ stretches 3m or wider on or within 200m of the subject land. Species polygon boundaries should align with PCTs on the subject land to which the species is associated that are within 200m of waterbodies mapped.</p>	<p>Cave bat habitat polygons are mapped in Figure 13.</p> <p>Dams more than 3m wide were mapped and a 200m buffer applied. All PCTs within the development footprint forming habitat associations for the species, as listed in the BioNet database, were included within the habitat polygons where they were located with 200m of the dams. No waterways >3m wide were identified.</p> <p>Habitat polygons for Southern Myotis are mapped in Figure 14.</p>
Koala	<p>No specific guidance is provided on how to derive habitat polygons for the species.</p>	<p>Habitat polygons include impacted areas of the species' associated PCTs within the development footprint, as listed in BioNet, and mapped in moderate and high condition states. Field captured habitat assessments were used to refine the polygons, with the following characteristics excluded:</p> <ul style="list-style-type: none"> • Areas supporting >50% rock outcropping • Areas mapped as being subject to high severity clearing of the tree canopy <p>Habitat polygons for Koala are mapped in Figure 15.</p>
Eastern Pygmy-possum	<p>Based on BioNet, there are no habitat constraints for these species other known PCT habitat associations.</p>	<p>Habitat polygons include impacted areas of the species' associated PCTs within the development footprint as listed in BioNet, and mapped as in "High" condition. Field captured habitat assessments were used to refine the polygons, with the following characteristics excluded:</p> <ul style="list-style-type: none"> • Areas supporting <5% characteristic understorey feed species • Areas mapped as not supporting any tree hollows • Areas mapped as being subject to high severity clearing of the tree canopy

Species credit species	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
		<ul style="list-style-type: none"> • Areas mapped as being subject to highly or moderately severe agriculture impacts such as cropping, grazing, exotic pasture, soil disturbance. <p>Habitat polygons for Eastern Pygmy Possum are mapped in Figure 15.</p>
Squirrel Glider	No specific guidance is provided on how to derive habitat polygons for the species.	<p>Habitat polygons include impacted areas of the species' associated PCTs, as listed in BioNet, and mapped in Moderate and High condition within the development footprint. Field captured habitat assessments were used to refine the polygons, with the following characteristics excluded:</p> <ul style="list-style-type: none"> • Areas supporting <5% characteristic understorey feed species • Areas mapped as not supporting any tree hollows • Areas mapped as being subject to high severity clearing of the tree canopy • Areas mapped as being subject to high severity agriculture impacts such as cropping, grazing, exotic pasture, soil disturbance <p>Furthermore areas where sufficient survey in the form of arboreal camera trapping has been undertaken for the species have been removed from the habitat polygons (as the species was not recorded). Areas retained are considered to have undergone less intensive survey and include the central-southern portion of the wind farm corridor, due to camera traps being burnt in bushfire in this area, and along the transmission line corridor, where nocturnal surveys did not occur.</p> <p>Habitat polygons for Squirrel Glider are mapped in Figure 15.</p>
Border Thick-tailed Gecko	Based on BioNet, there are no habitat constraints for this species other known PCT habitat associations.	<p>Habitat polygons include impacted areas of the species' associated PCTs as listed in BioNet, and mapped in Moderate and High condition states, where they are associated rocky areas mapped in the development footprint as potentially suitable to support the species, and within the species' known elevation range of 500 - 1000m altitude.</p> <p>Habitat polygons for Border Thick-tailed Gecko are mapped in Figure 16.</p>

Species credit species	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
Booroolong Frog	No specific guidance is provided on how to derive habitat polygons for the species.	<p>Habitat polygons include areas within the development footprint of native vegetation in High and Moderate condition where they occurred within a 40m riparian buffer from Wombramurra Creek (centreline/hydroline). PCTs not listed in the BioNet database as associated with the species were also included in the habitat polygons due to the presence of a high density of records in the area and the known SOS population along the creekline. A 40m buffer was selected as it represents the BAM riparian buffer for a 5th order watercourse, which Wombramurra exists as in this location.</p> <p>Habitat polygons for Border Thick-tailed Gecko are mapped in Figure 16.</p>



	Little Bent-wing Bat (breeding)
	Large Bent-wing Bat (breeding)
	Large-eared Pied Bat (forage and breeding)
	Eastern Cave Bat (forage and breeding)
	Transport route (port to site)
	Wind farm infrastructure
	Transmission line and switching
	Internal roads
	Transmission line access tracks

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

0 0.3 0.6 1.2 1.8 2.4 3 3.6

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave bat habitat polygons
Page 1 (overview)**

Scale at A4 1:80,001	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 013
----------------------------	--------------------------

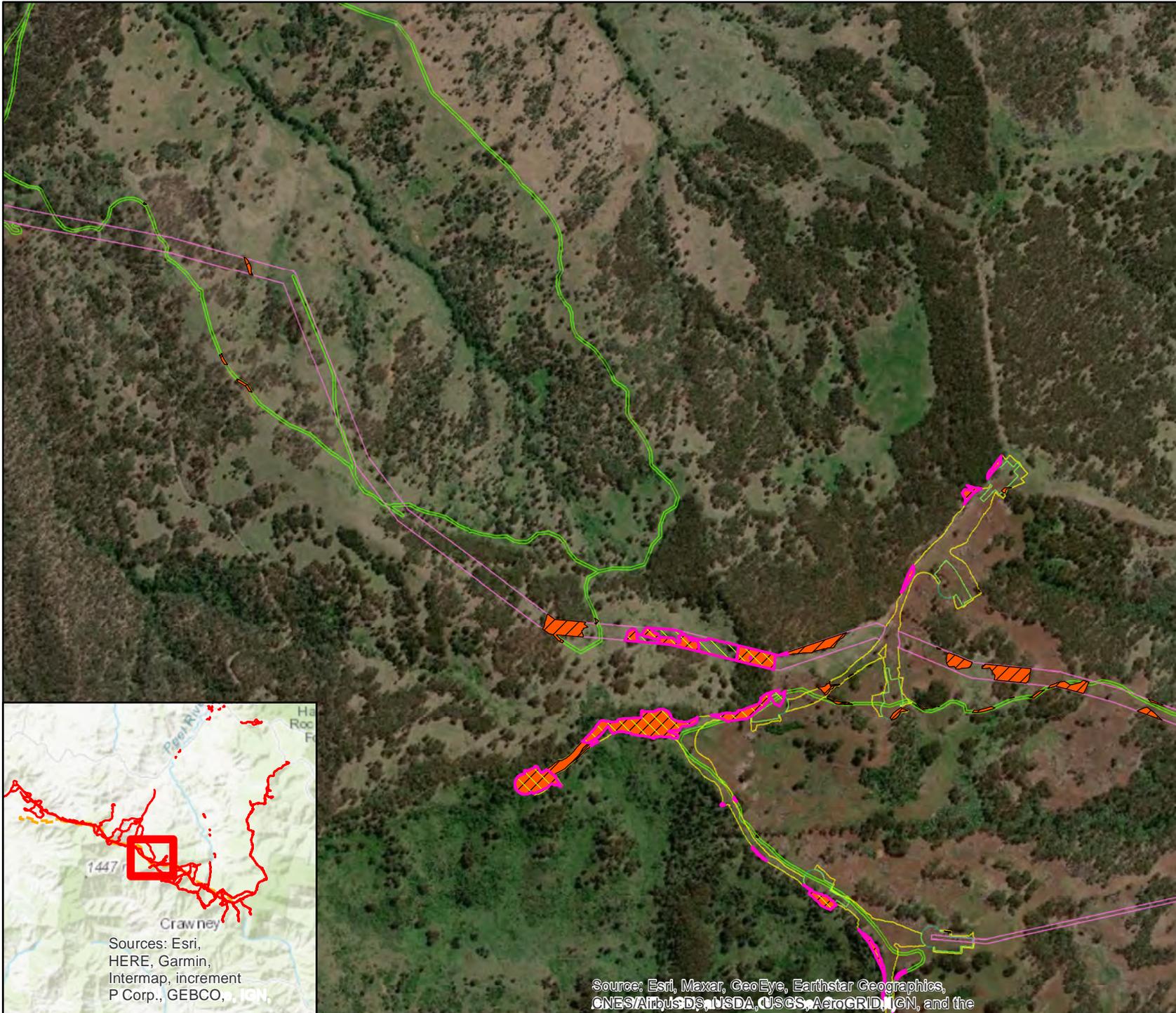
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

©Arup and Biosis

© Arup

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\CSF\figures\CSF_figures_Draft\BOARD_June2020\Draft_Figures_revised.mxd



	Little Bent-wing Bat (breeding)
	Large Bent-wing Bat (breeding)
	Large-eared Pied Bat (forage and breeding)
	Eastern Cave Bat (forage and breeding)
	Wind farm infrastructure
	Transmission line and switching
	Internal roads
	Transmission line access tracks

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

00.00 0.1 0.2 0.3 0.4 0.5 0.6

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

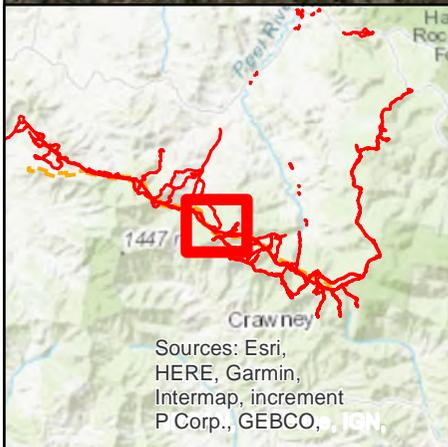
Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave bat habitat polygons
Page 2**

Scale at A4 1:18,226	Drawing Status Final
--------------------------------	--------------------------------

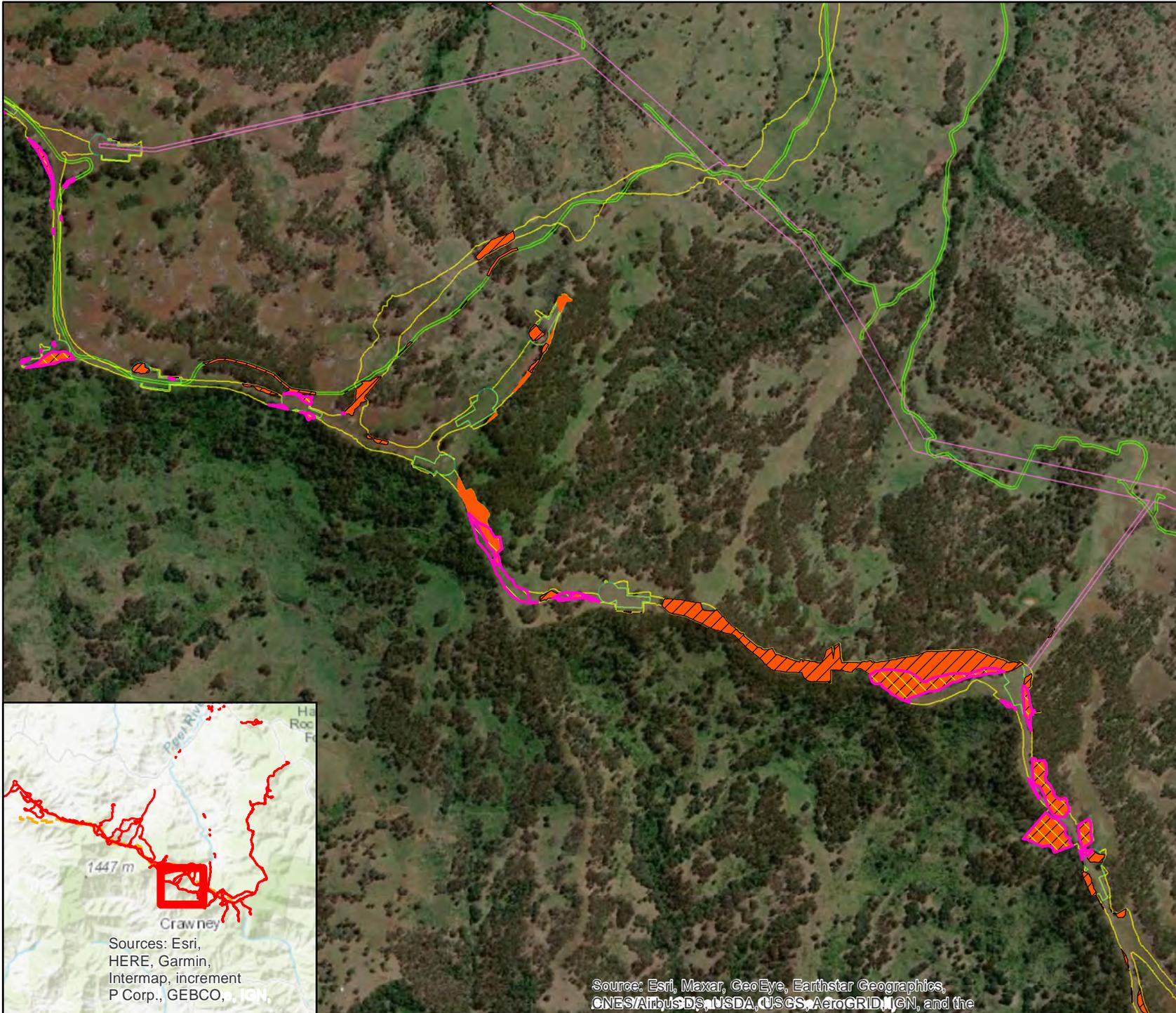
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 013
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Little Bent-wing Bat (breeding)
- Large Bent-wing Bat (breeding)
- Large-eared Pied Bat (forage and breeding)
- Eastern Cave Bat (forage and breeding)
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

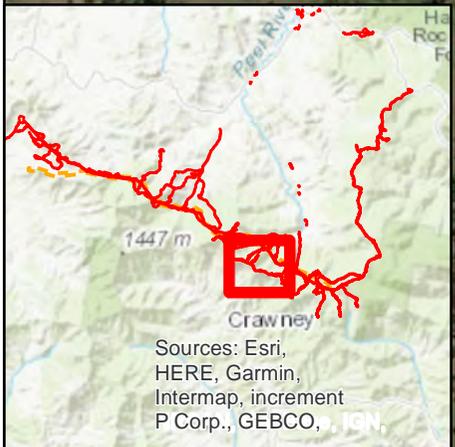
Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave bat habitat polygons
Page 3**

Scale at A4 1:18,226	Drawing Status Final
--------------------------------	--------------------------------

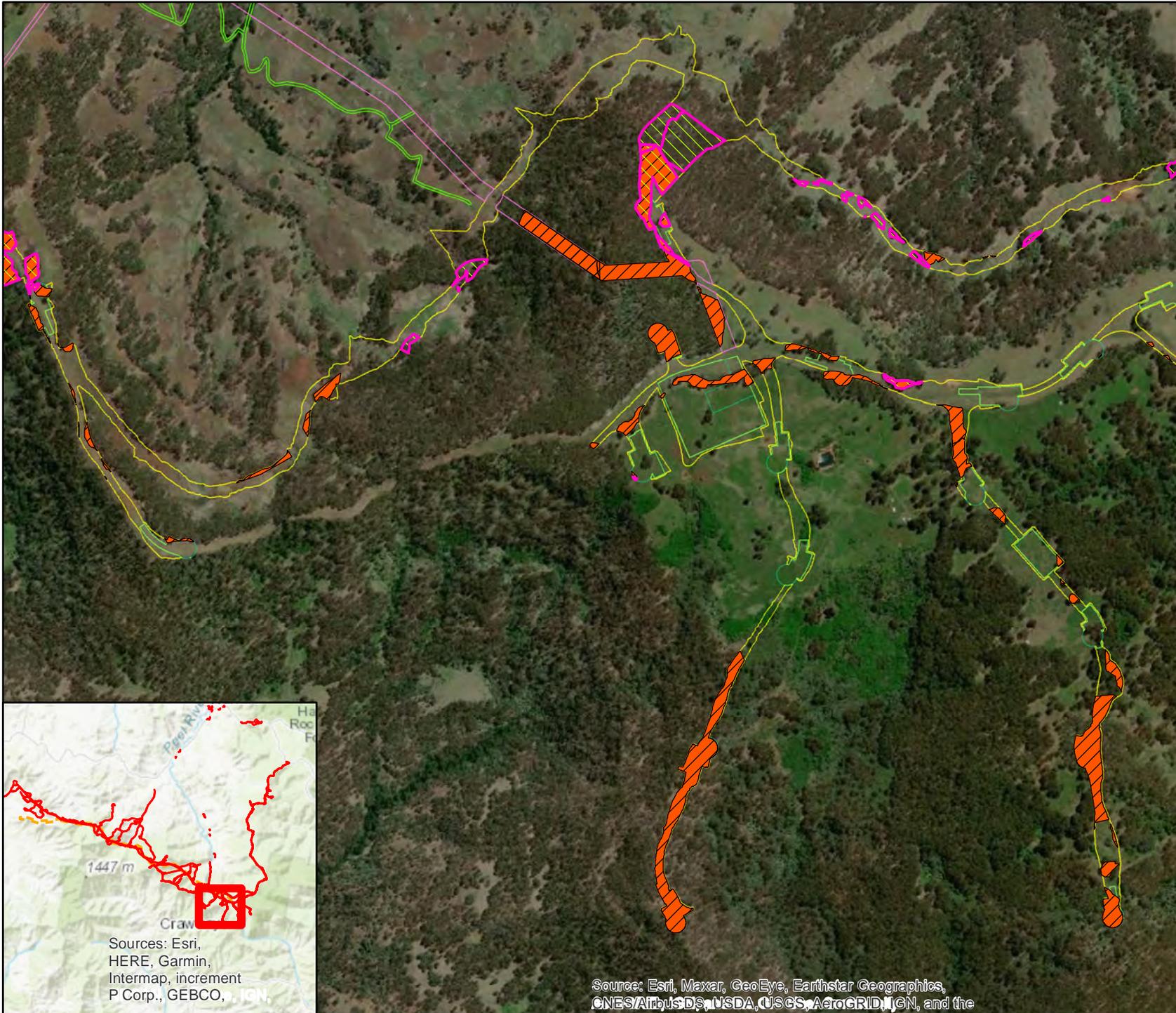
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 013
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

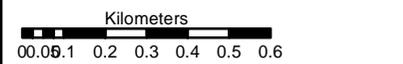
I:\270000\270335-00 Hills of Gold\Work\minal\Design\GIS\Figures\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Little Bent-wing Bat (breeding)
- Large Bent-wing Bat (breeding)
- Large-eared Pied Bat (forage and breeding)
- Eastern Cave Bat (forage and breeding)
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

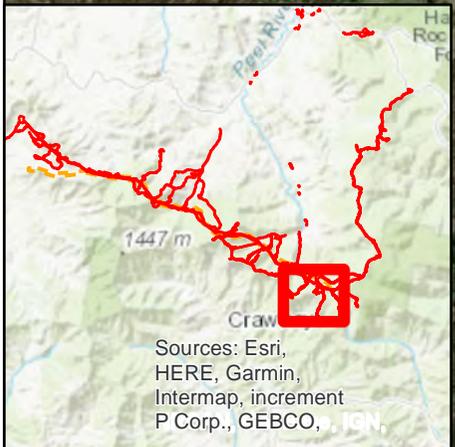
Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave bat habitat polygons
Page 4**

Scale at A4 1:18,226	Drawing Status Final
--------------------------------	--------------------------------

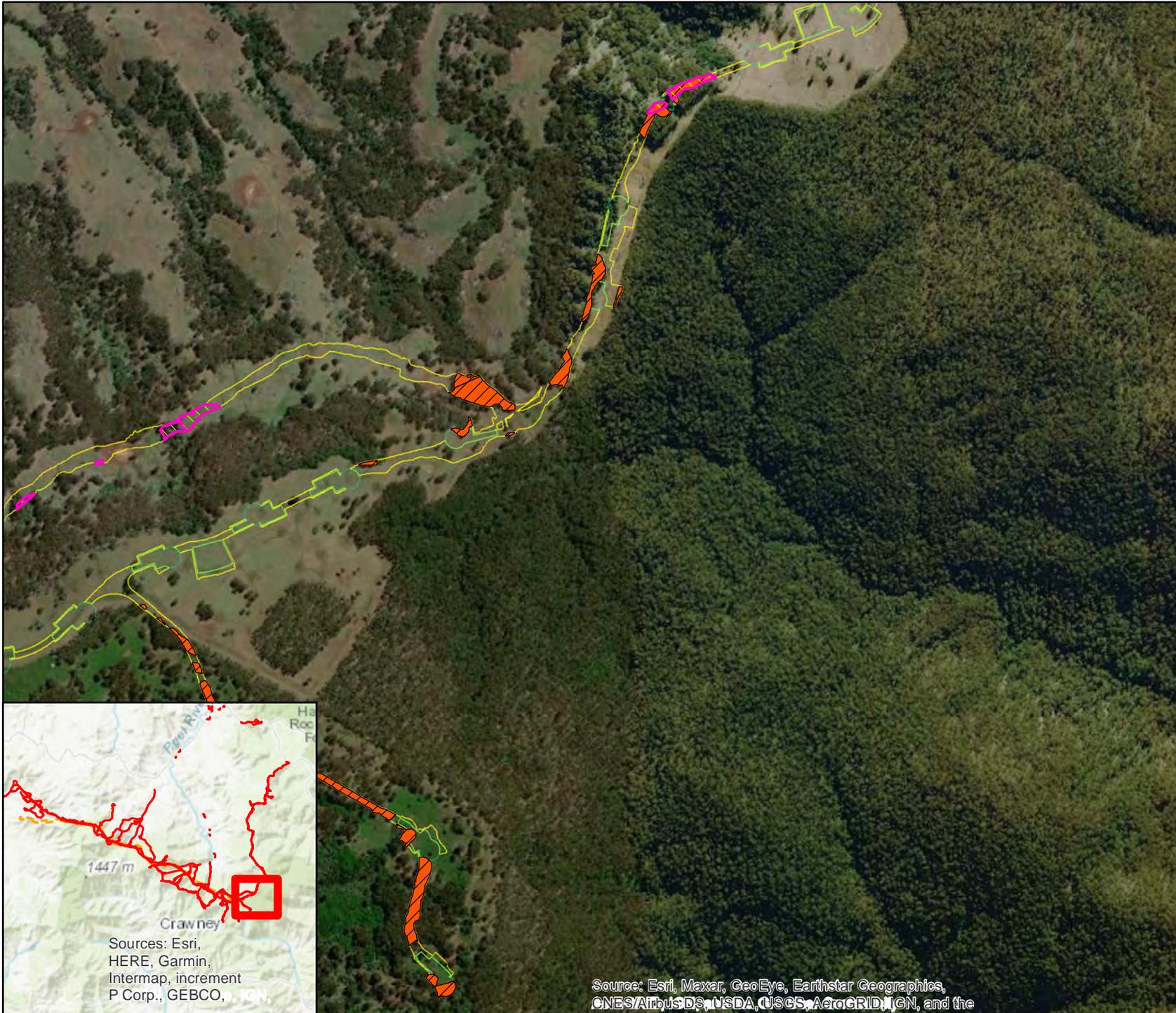
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 013
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOARD June2020\Draft\Figures_revised.mxd



	Little Bent-wing Bat (breeding)
	Large Bent-wing Bat (breeding)
	Large-eared Pied Bat (forage and breeding)
	Eastern Cave Bat (forage and breeding)
	Wind farm infrastructure
	Internal roads

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

0 0.1 0.2 0.3 0.4 0.5 0.6

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

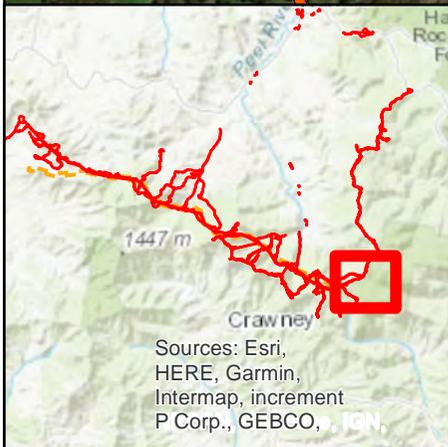
Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave bat habitat polygons
Page 5**

Scale at A4 1:18,226	Drawing Status Final
--------------------------------	--------------------------------

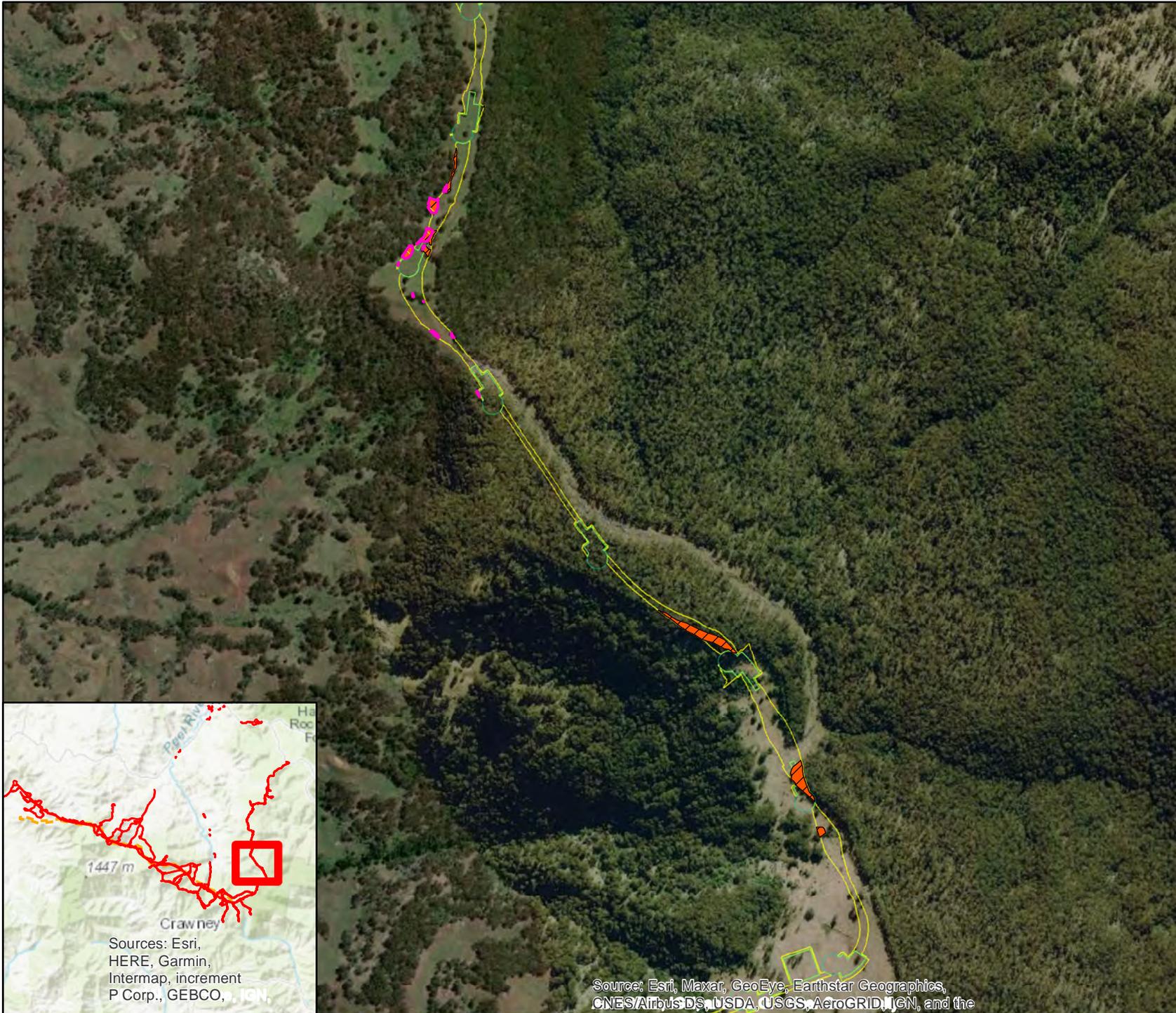
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 013
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

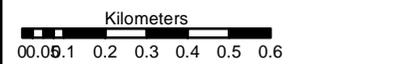
I:\270000\270335-00 Hills of Gold\Work\mains\Design\Draft\BOAR_CaveBat_Habitat_Figures_revised.mxd



- Little Bent-wing Bat (breeding)
- Large Bent-wing Bat (breeding)
- Large-eared Pied Bat (forage and breeding)
- Eastern Cave Bat (forage and breeding)
- Wind farm infrastructure
- Internal roads



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

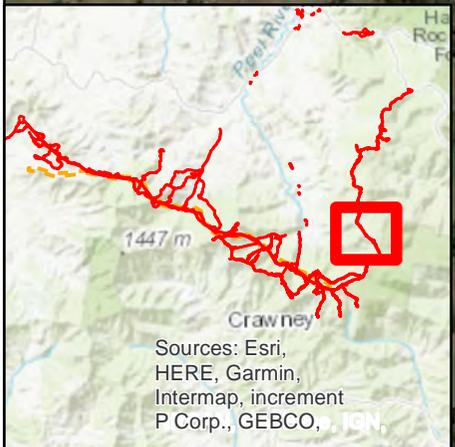
Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave bat habitat polygons
 Page 6**

Scale at A4 1:18,226	Drawing Status Final
--------------------------------	--------------------------------

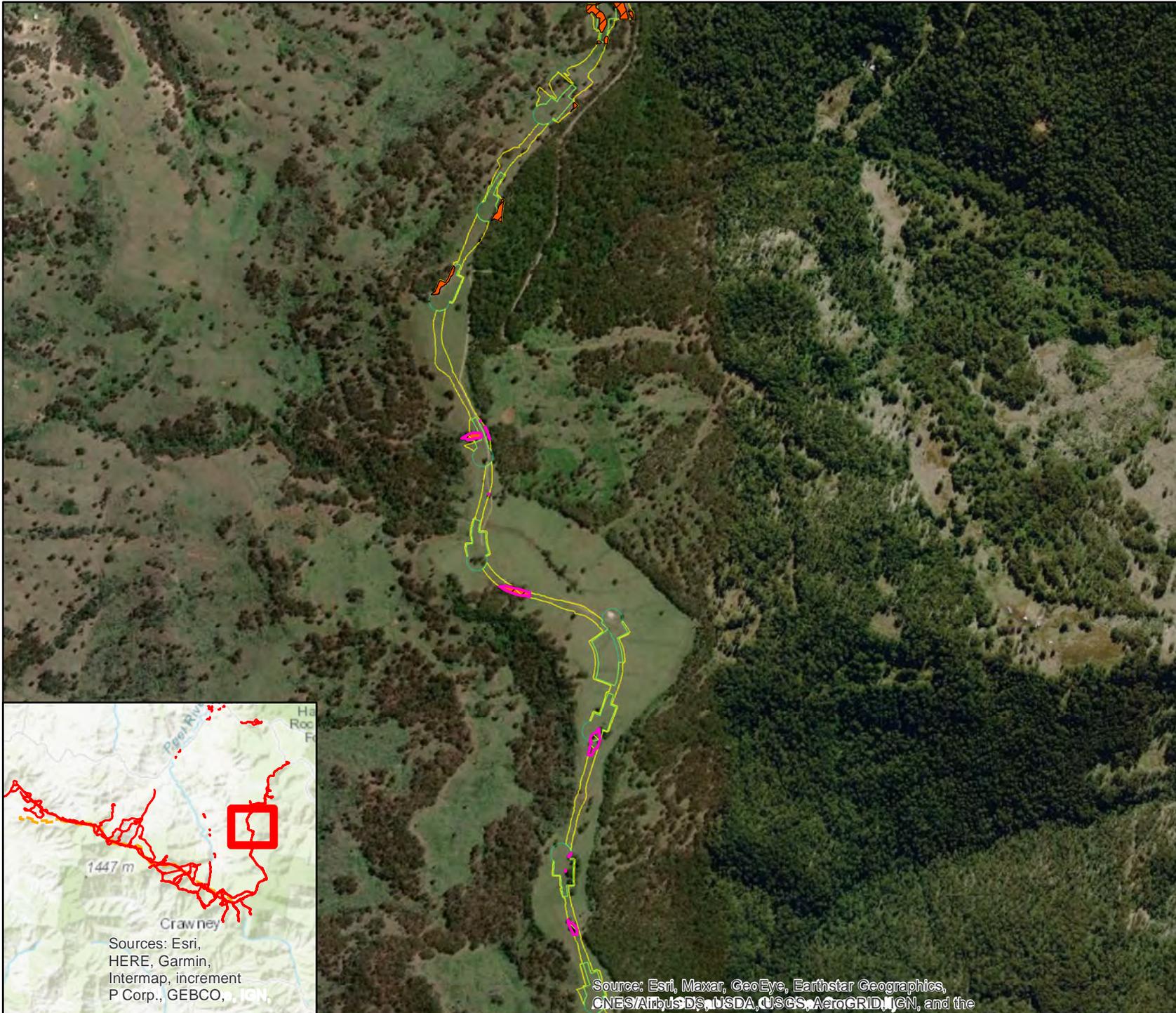
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 013
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

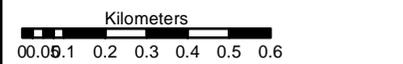
I:\270000\270335-00 Hills of Gold\Work\marmal\Design\GIS\Figures\Draft\BOARD_June2020\Draft\Figures_revised.mxd



- Little Bent-wing Bat (breeding)
- Large Bent-wing Bat (breeding)
- Large-eared Pied Bat (forage and breeding)
- Eastern Cave Bat (forage and breeding)
- Wind farm infrastructure
- Internal roads



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

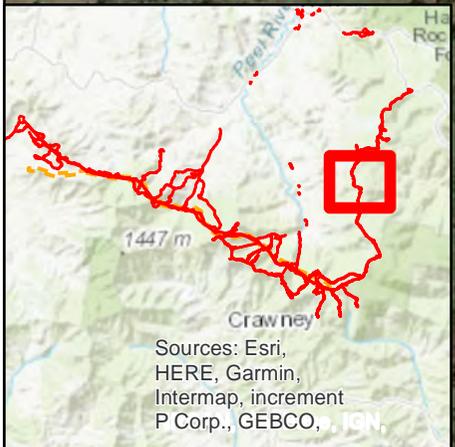
Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave bat habitat polygons
Page 7**

Scale at A4 1:18,226	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 013
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

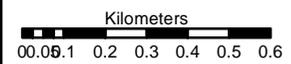
I:\270000\270335-00 Hills of Gold\work\mxd\design\CS1\Figures\CS1\Figures_Draft\BOARD_June2020\Draft\Figures_revised.mxd



-  Large-eared Pied Bat (forage and breeding)
-  Eastern Cave Bat (forage and breeding)
-  Transport route (port to site)
-  Wind farm infrastructure
-  Internal roads



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

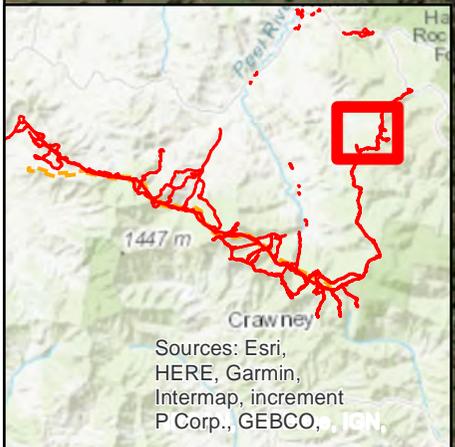
Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave bat habitat polygons
Page 8**

Scale at A4 1:18,226	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 013
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

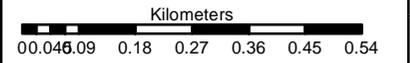
I:\270000\270335-00 Hills of Gold\Work\mxd\design\CS1\Figures\CS1\Figures_Draft\BOAR_CJune2020\Draft\Figures_revised.mxd



-  Southern Myotis
-  Wind farm infrastructure
-  Transmission line and switching
-  Internal roads
-  Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

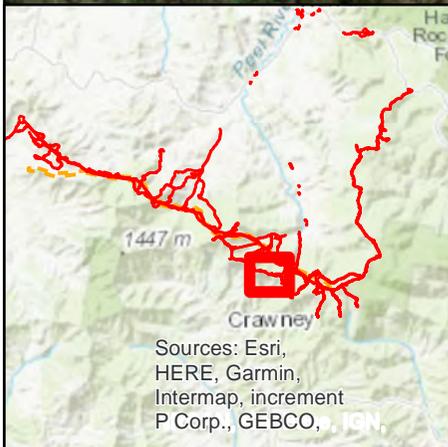
Job Title
Hills of Gold Wind Farm

Drawing Title
**Southern Myotis habitat polygons
 Page 1**

Scale at A4 1:12,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 014
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

I:\270335\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\GIS\Figures_Draft\BOAR_June2020\Draft\Figures_revised.mxd



	Southern Myotis
	Wind farm infrastructure
	Internal roads



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

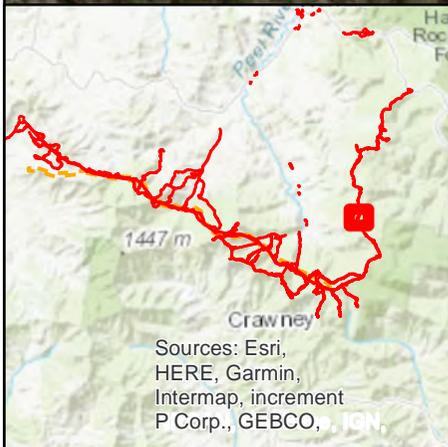
Job Title
Hills of Gold Wind Farm

Drawing Title
**Southern Myotis habitat polygons
Page 2**

Scale at A4 1:5,647	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 014
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd

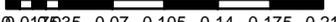


	Southern Myotis
	Wind farm infrastructure
	Internal roads



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers



0.017 0.035 0.07 0.105 0.14 0.175 0.21

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

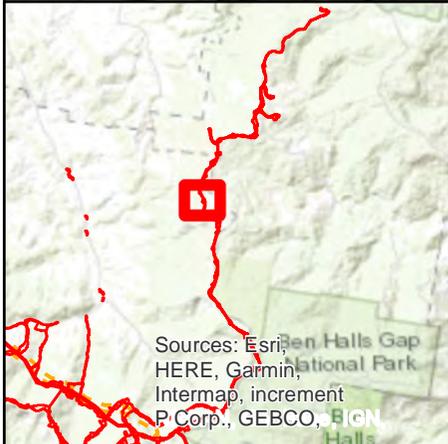
Job Title
Hills of Gold Wind Farm

Drawing Title
**Southern Myotis habita polygons
Page 3**

Scale at A4 1:5,000	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 014
----------------------------	--------------------------



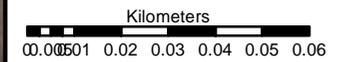
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the



- Southern Myotis
- Transport route (port to site)



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

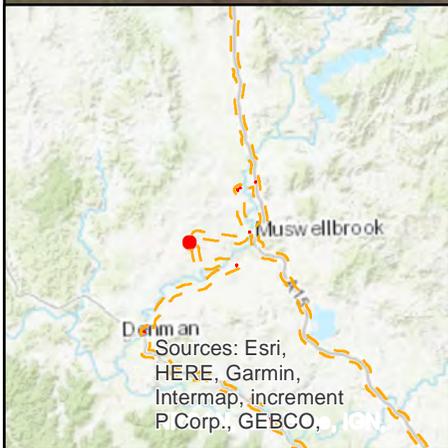
Job Title
Hills of Gold Wind Farm

Drawing Title
**Southern Myotis habitat polygons
 Page 4**

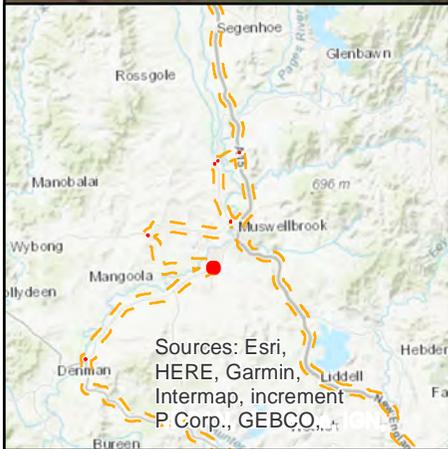
Scale at A4 1:1,605	Drawing Status Final
-------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 014
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the



Southern Myotis

Transport route (port to site)

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

00.00 0.01 0.02 0.03 0.04 0.05 0.06

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client

Wind Energy Partners

Job Title

Hills of Gold Wind Farm

Drawing Title

**Southern Myotis habitat polygons
Page 5**

Scale at A4	Drawing Status
1:1,500	Final

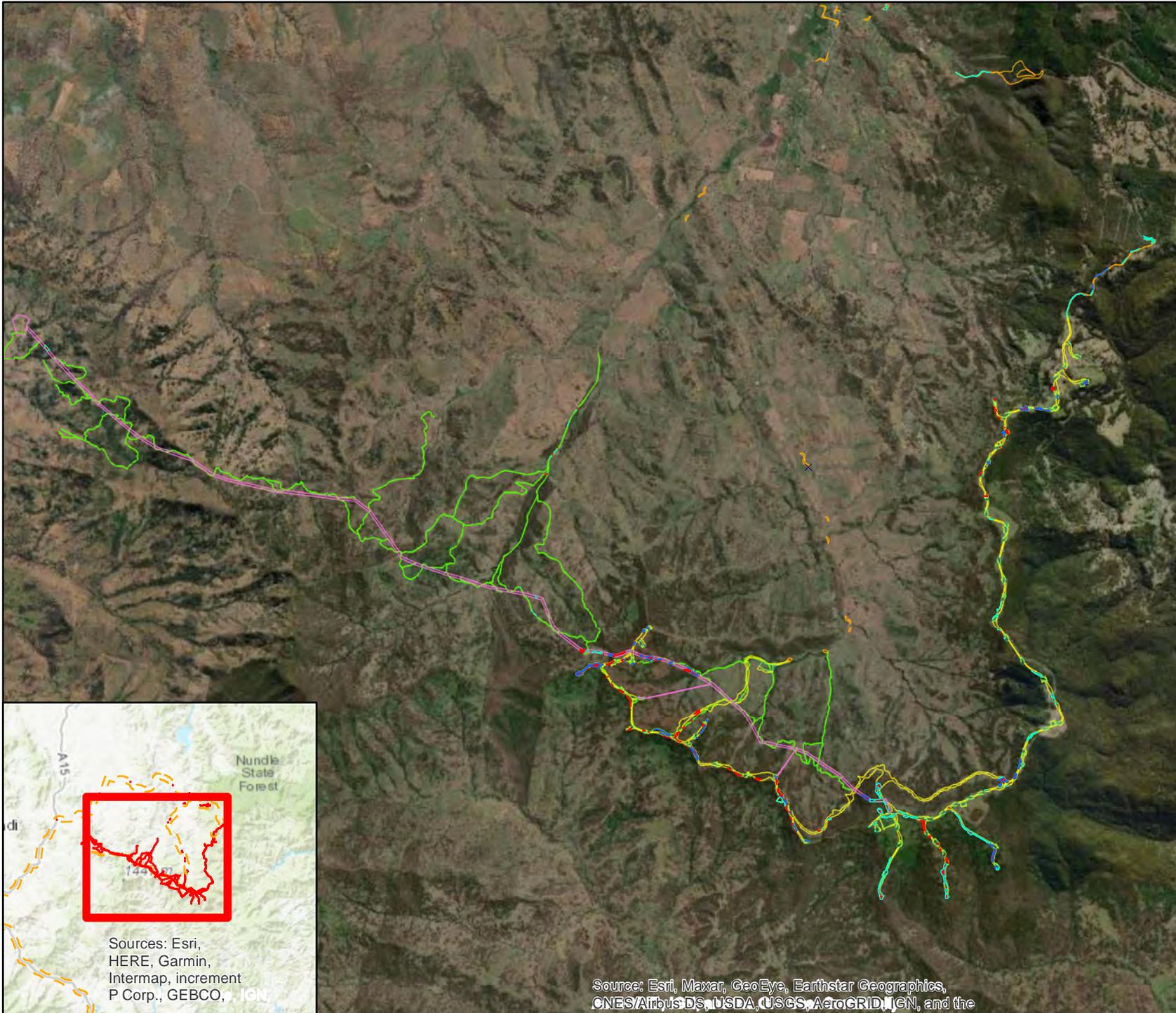
Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	014

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

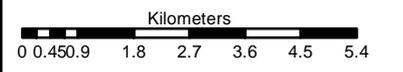
I:\270000\270335-00 Hills of Gold\Work\mxd\Design\CSF\figures\CSF\figures\revised.mxd



-  Squirell Glider
-  Eastern Pygmy Possum
-  Koala
-  Transport route (port to site)
-  Wind farm infrastructure
-  Transmission line and switching
-  Internal roads
-  Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

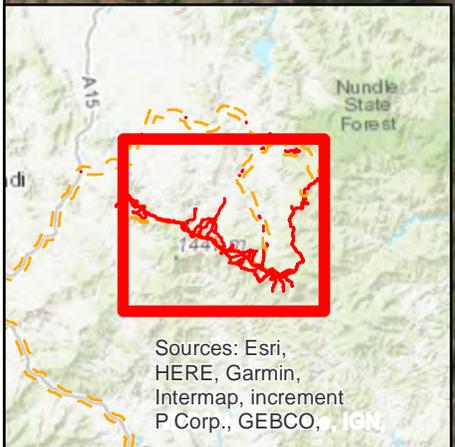
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
 Page 1 (overview)**

Scale at A4 1:121,888	Drawing Status Final
---------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

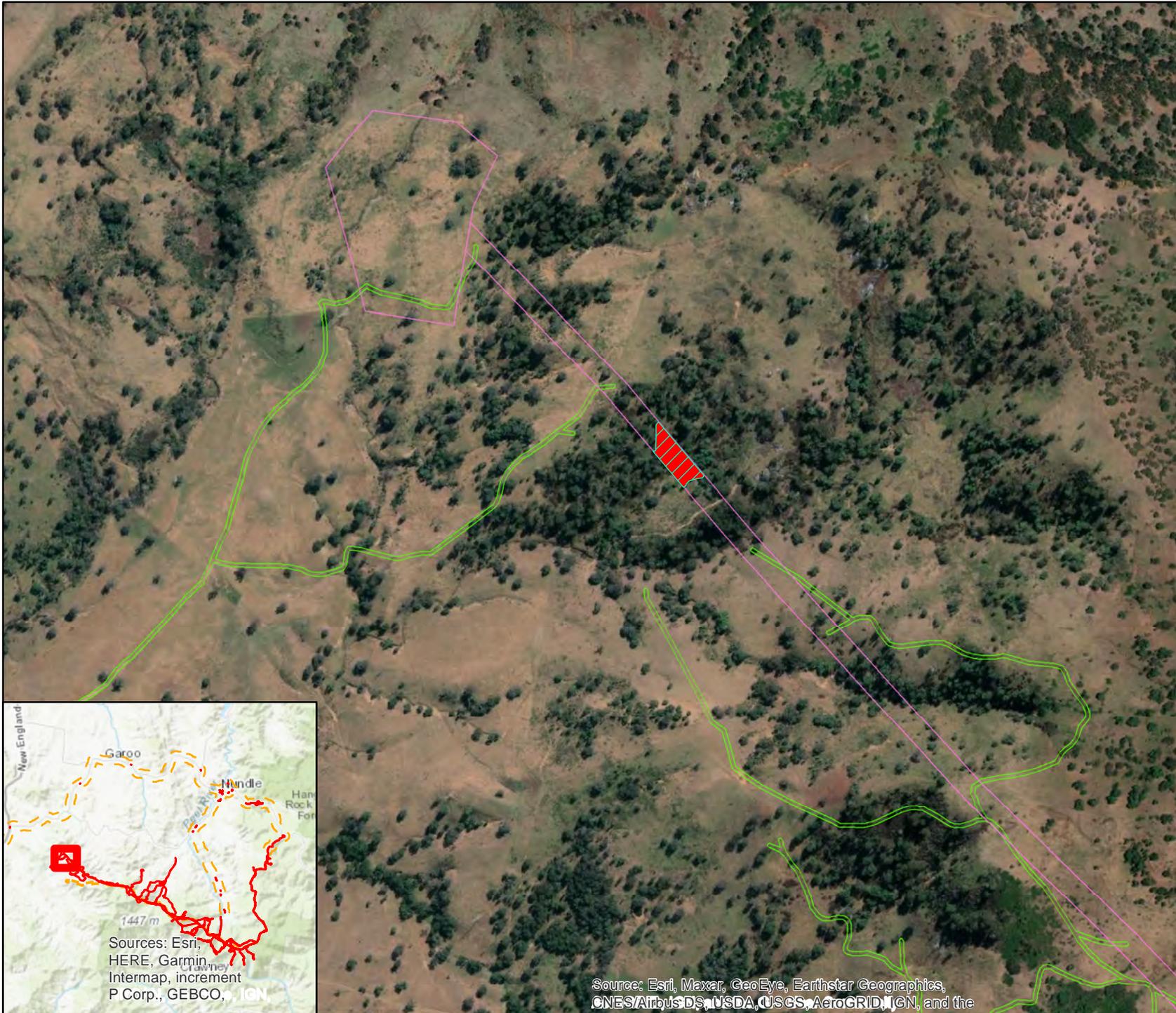
Job No 270335-00	Drawing No 015
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

I:\270000\270335-00 Hills of Gold\Work\mammal\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



	Squirrel Glider
	Koala
	Transmission line and switching
	Transmission line access tracks

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

0.0 0.048 0.09 0.18 0.27 0.36 0.45 0.54

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

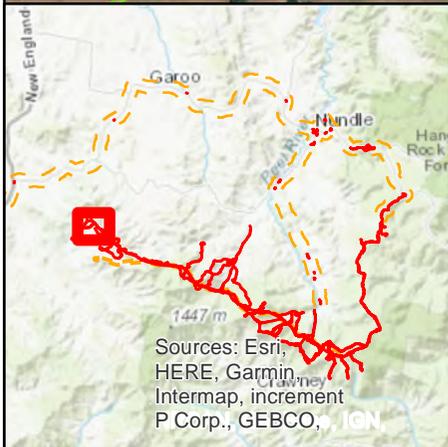
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
Page 2**

Scale at A4 1:11,755	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 015
----------------------------	--------------------------



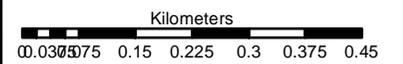
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the



-  Squirell Glider
-  Koala
-  Transmission line and switching
-  Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

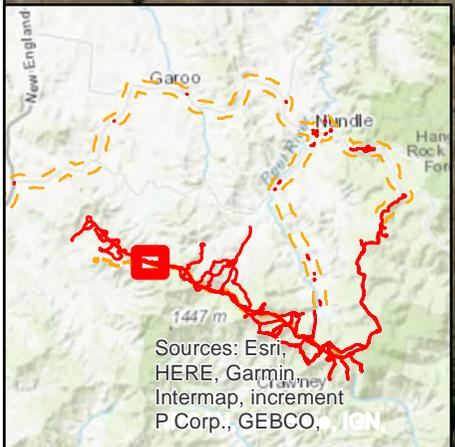
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
 Page 3**

Scale at A4 1:10,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 015
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

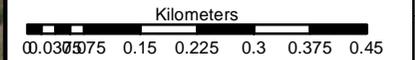
I:\270335-00 Hills of Gold\Work\mammal\Design\CS1\Figures\CS1\Figures_Draft\BOAR_June2020\Draft\Figures_revised.mxd



-  Squirrel Glider
-  Eastern Pygmy Possum
-  Koala
-  Transmission line and switching
-  Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

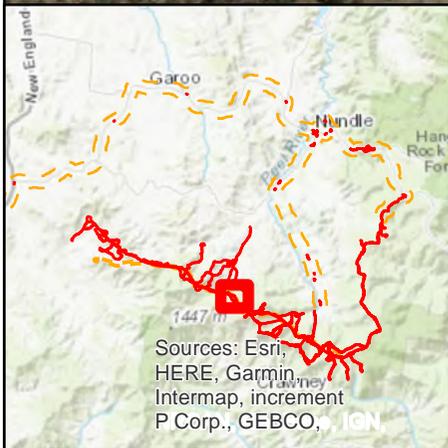
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
Page 4**

Scale at A4 1:10,000	Drawing Status Final
--------------------------------	--------------------------------

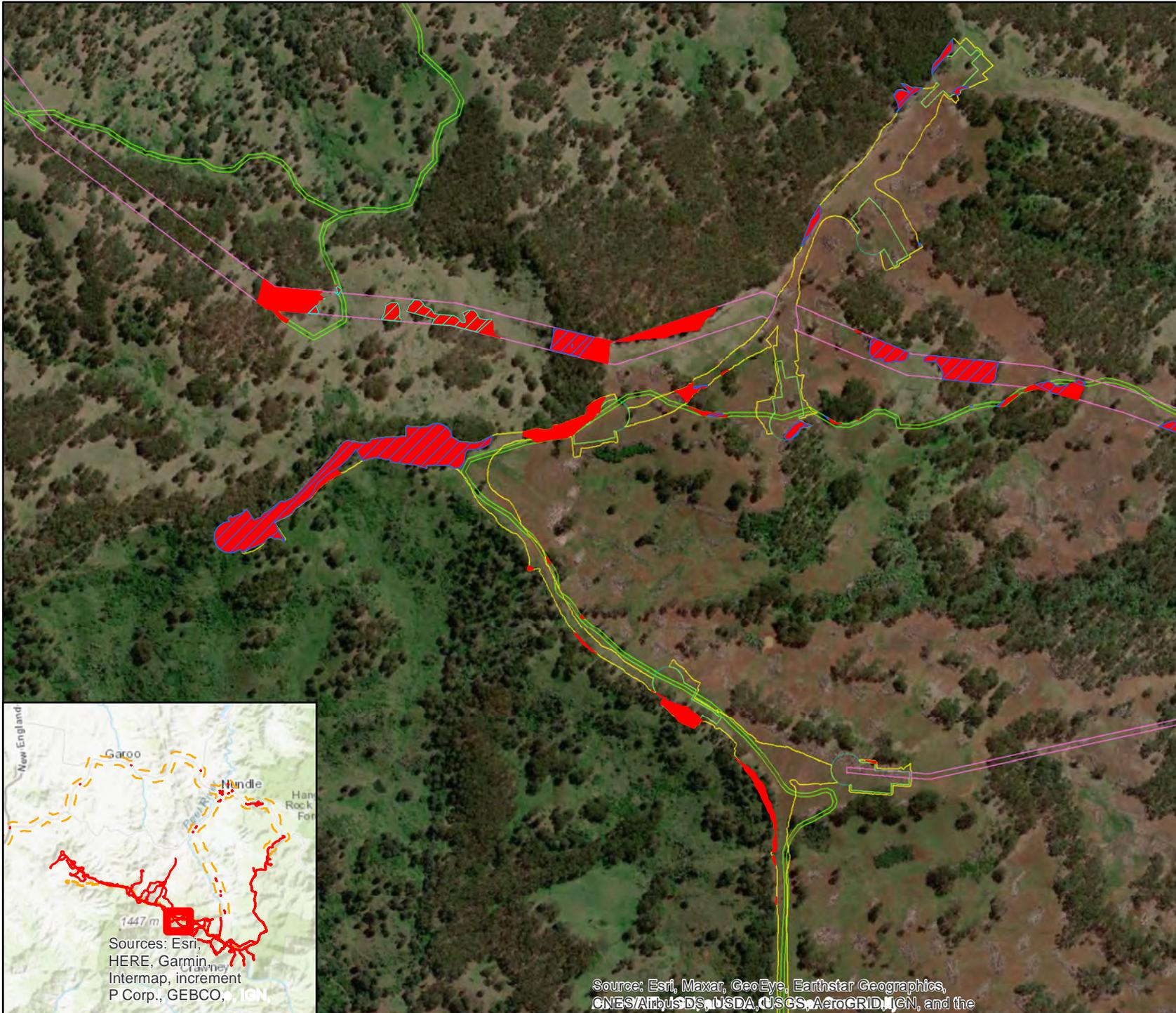
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 015
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN

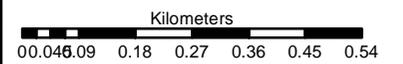
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the



-  Squirell Glider
-  Eastern Pygmy Possum
-  Koala
-  Wind farm infrastructure
-  Transmission line and switching
-  Internal roads
-  Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

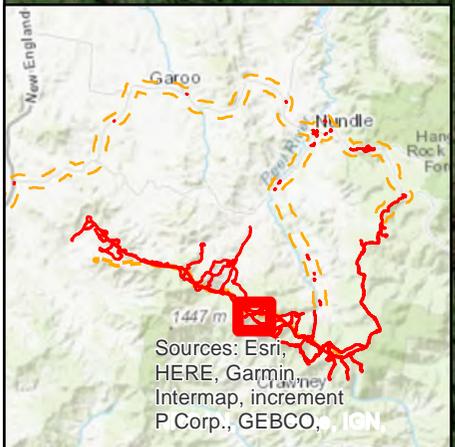
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
Page 5**

Scale at A4 1:12,000	Drawing Status Final
--------------------------------	--------------------------------

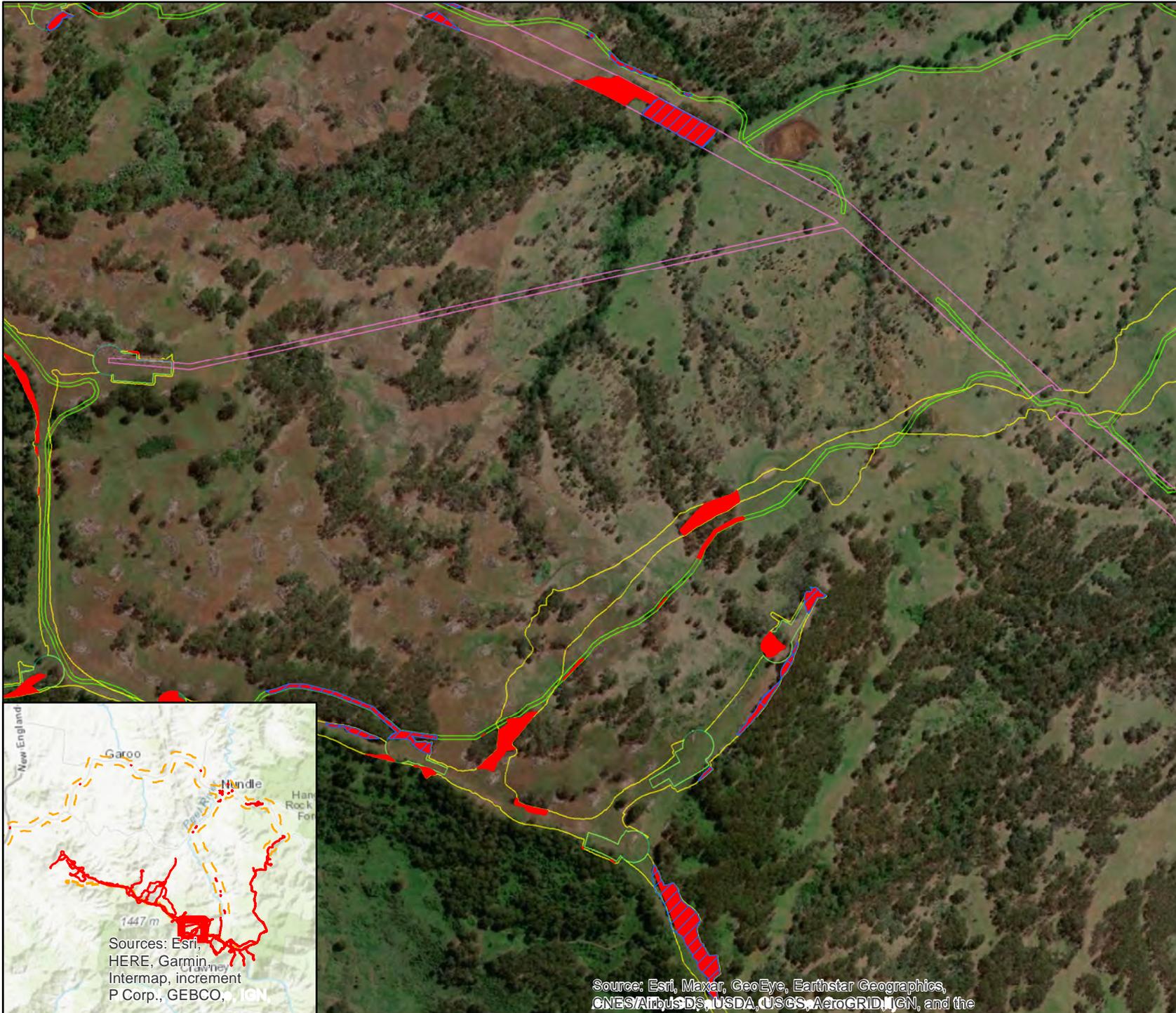
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 015
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

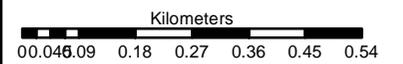
I:\270000\270335-00 Hills of Gold\Work\mammal\Design\Draft\B04R_June2020\Draft_Figures_revised.mxd



-  Eastern Pygmy Possum
-  Koala
-  Wind farm infrastructure
-  Transmission line and switching
-  Internal roads
-  Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

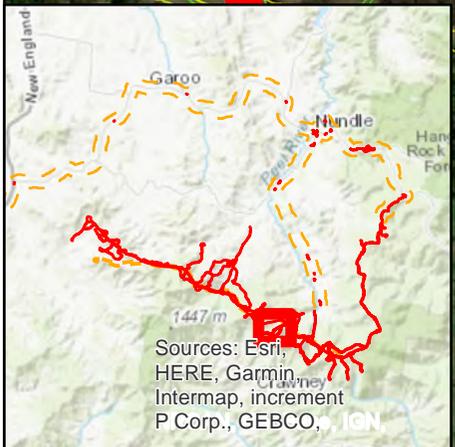
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
Page 6**

Scale at A4 1:12,000	Drawing Status Final
--------------------------------	--------------------------------

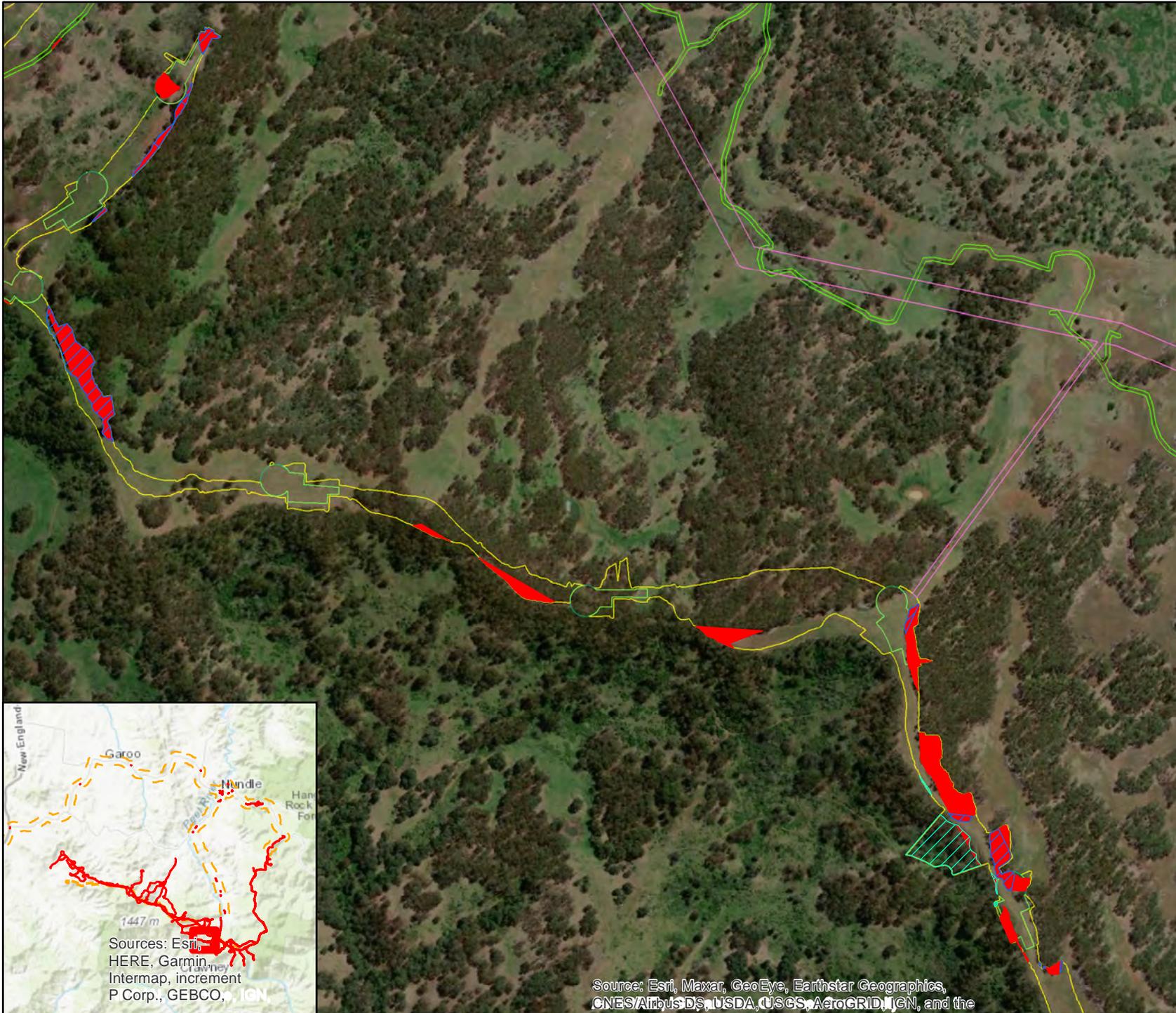
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 015
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

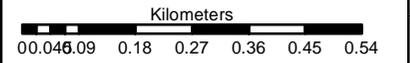
I:\270335\270335-00 Hills of Gold\Work\mammal\design\CS\Figures\CS\Figures\Draft\BOAR_June2020\Detail\Figures_revised.mxd



-  Squirrel Glider
-  Eastern Pygmy Possum
-  Koala
-  Wind farm infrastructure
-  Transmission line and switching
-  Internal roads
-  Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

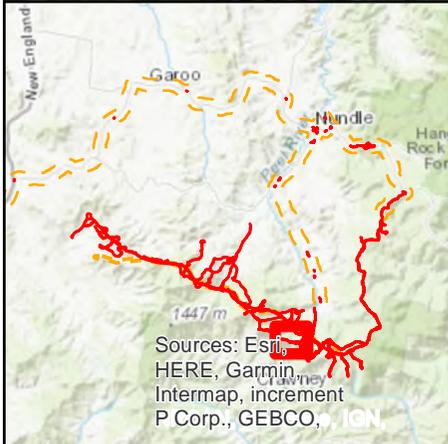
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
Page 7**

Scale at A4 1:12,000	Drawing Status Final
--------------------------------	--------------------------------

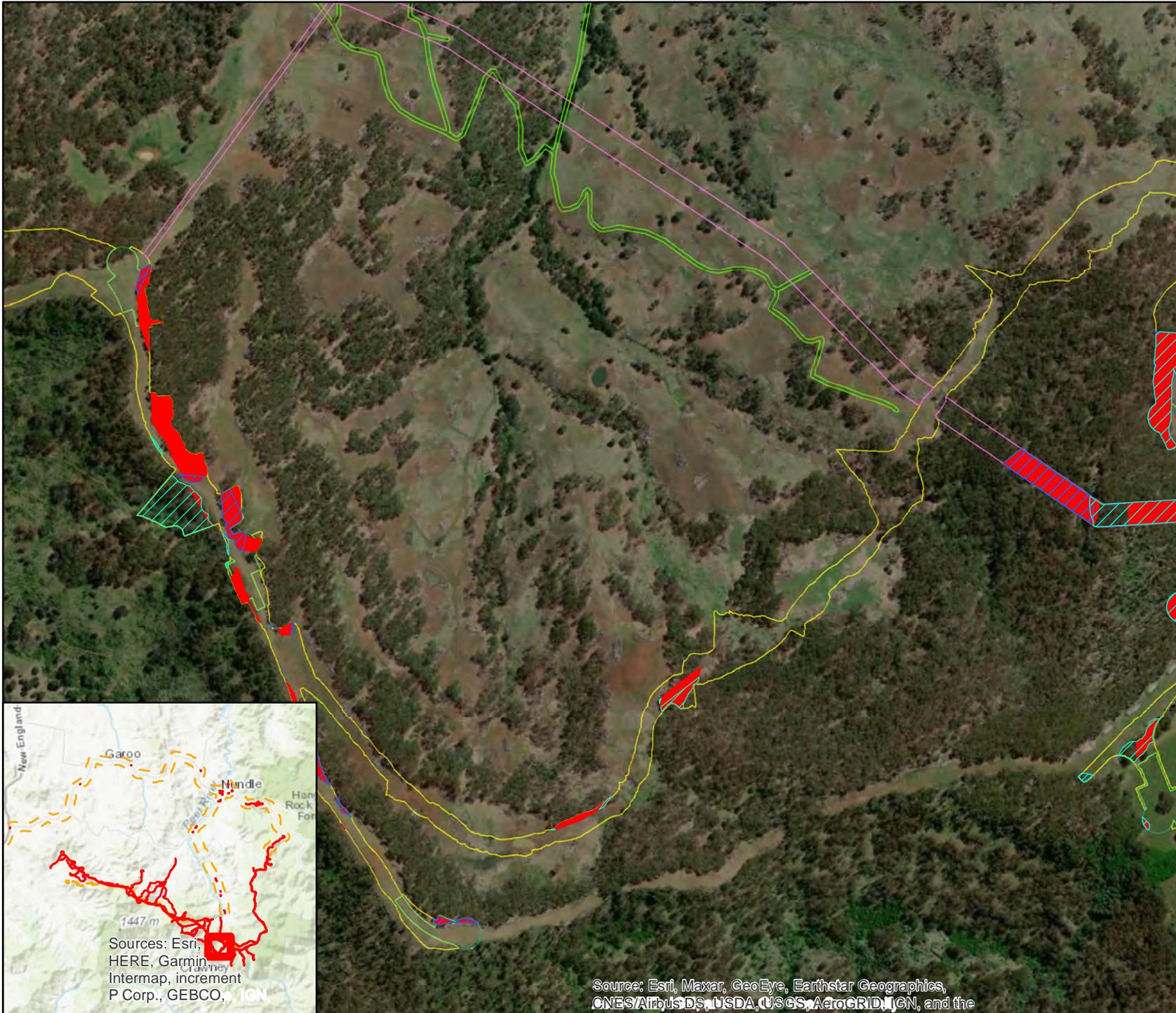
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 015
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

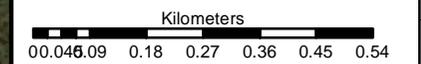
I:\270335\270335-00 Hills of Gold\Work\mammal\Design\CS1\Figures\Draft\BOARD_June2020\Draft\Figures_revised.mxd



- Squirrel Glider
- Eastern Pygmy Possum
- Koala
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

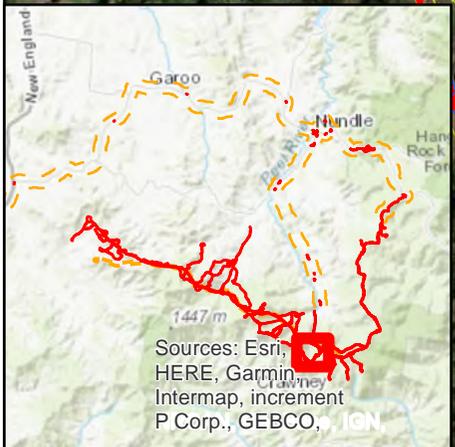
Job Title
Hills of Gold Wind Farm

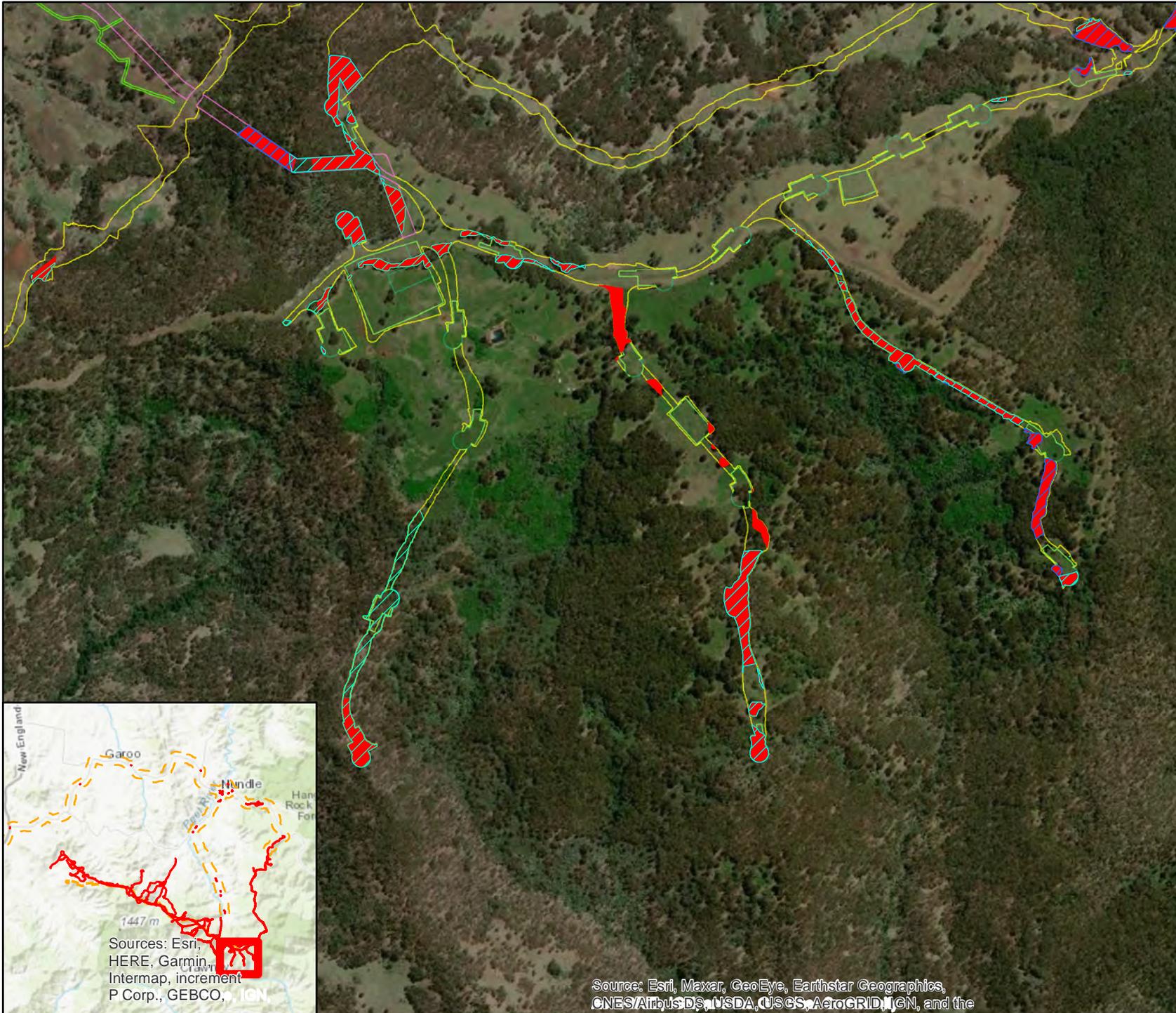
Drawing Title
**Arboreal mammals habitat polygons
 Page 8**

Scale at A4 1:12,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 015
----------------------------	--------------------------

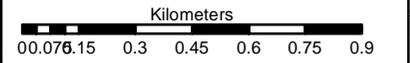




-  Squirrel Glider
-  Eastern Pygmy Possum
-  Koala
-  Wind farm infrastructure
-  Transmission line and switching
-  Internal roads
-  Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

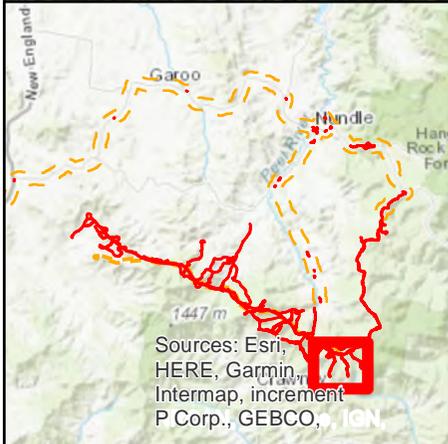
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
 Page 9**

Scale at A4 1:20,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 015
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

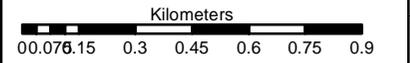
I:\270335-00 Hills of Gold\Work\mammal\Design\CS1\Figures\CS1_Figures_revised.mxd



-  Squirrel Glider
-  Eastern Pygmy Possum
-  Koala
-  Wind farm infrastructure
-  Internal roads



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

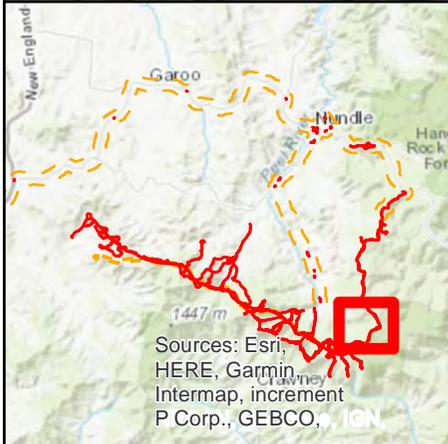
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
 Page 10**

Scale at A4 1:20,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

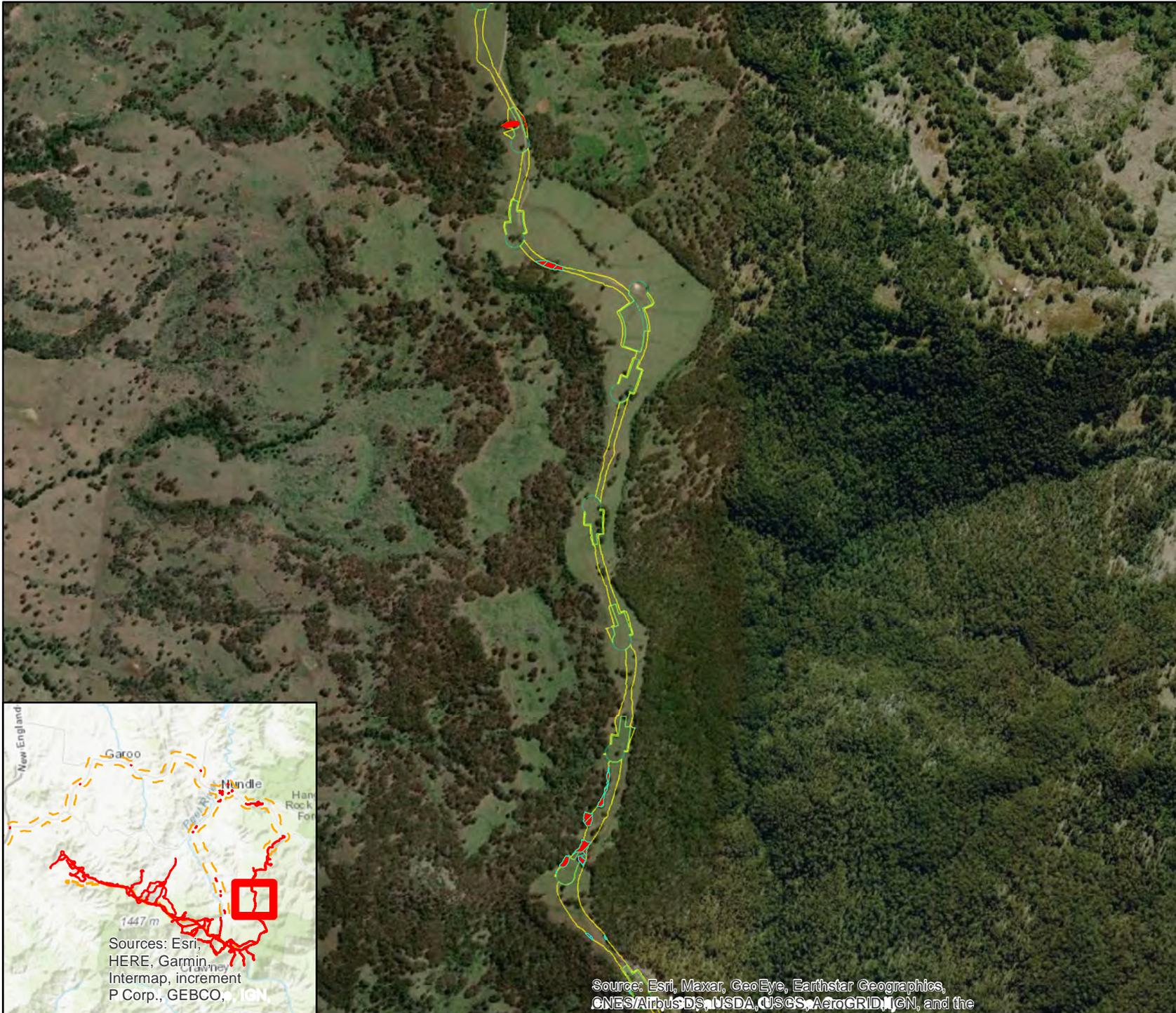
Job No 270335-00	Drawing No 015
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

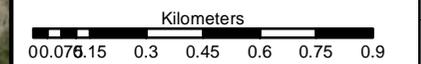
I:\270335\270335-00 Hills of Gold\Work\mammal\design\CS1\Figures\CS1\Figures_Draft\BOARDAR_June2020\Draft\Figures_revised.mxd



-  Squirell Glider
-  Eastern Pygmy Possum
-  Koala
-  Wind farm infrastructure
-  Internal roads



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

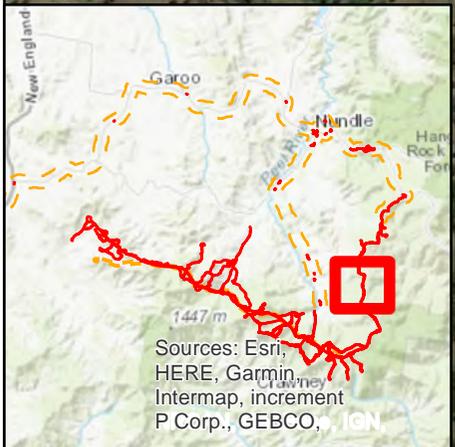
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
 Page 11**

Scale at A4 1:20,000	Drawing Status Final
--------------------------------	--------------------------------

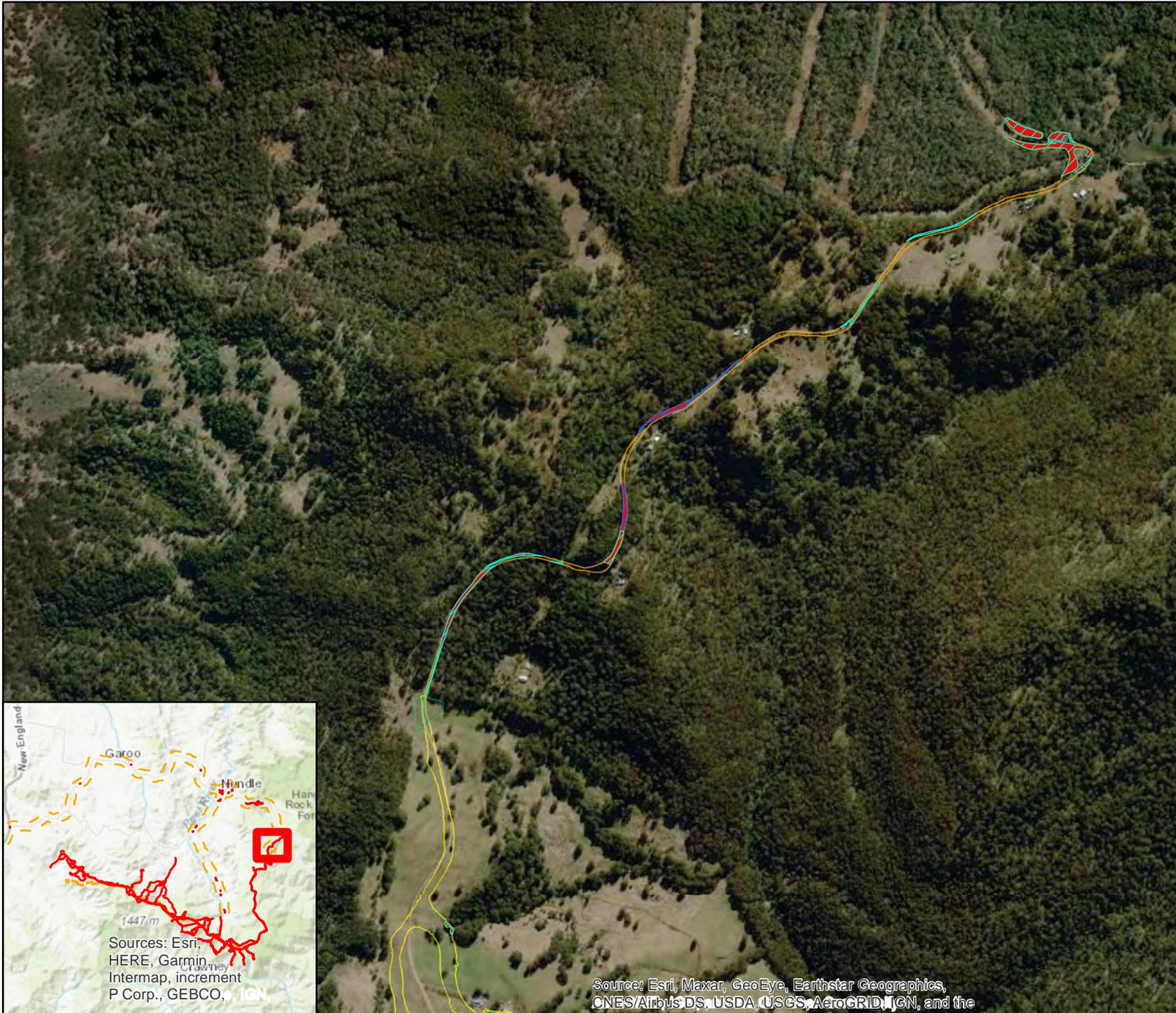
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 015
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

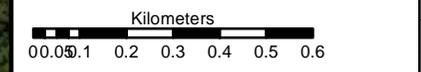
I:\270000\270335-00 Hills of Gold\Work\mammal\Design\GIS\Figures\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



-  Squirell Glider
-  Eastern Pygmy Possum
-  Koala
-  Transport route (port to site)
-  Wind farm infrastructure
-  Internal roads



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

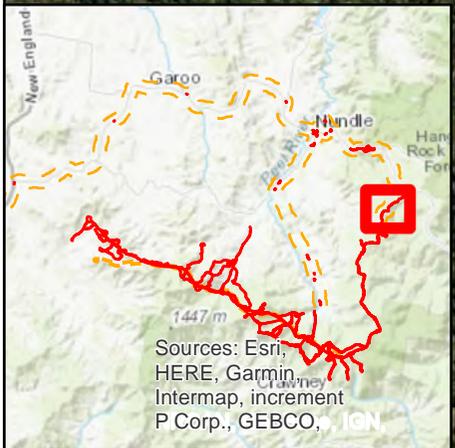
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
 Page 12**

Scale at A4 1:16,177	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

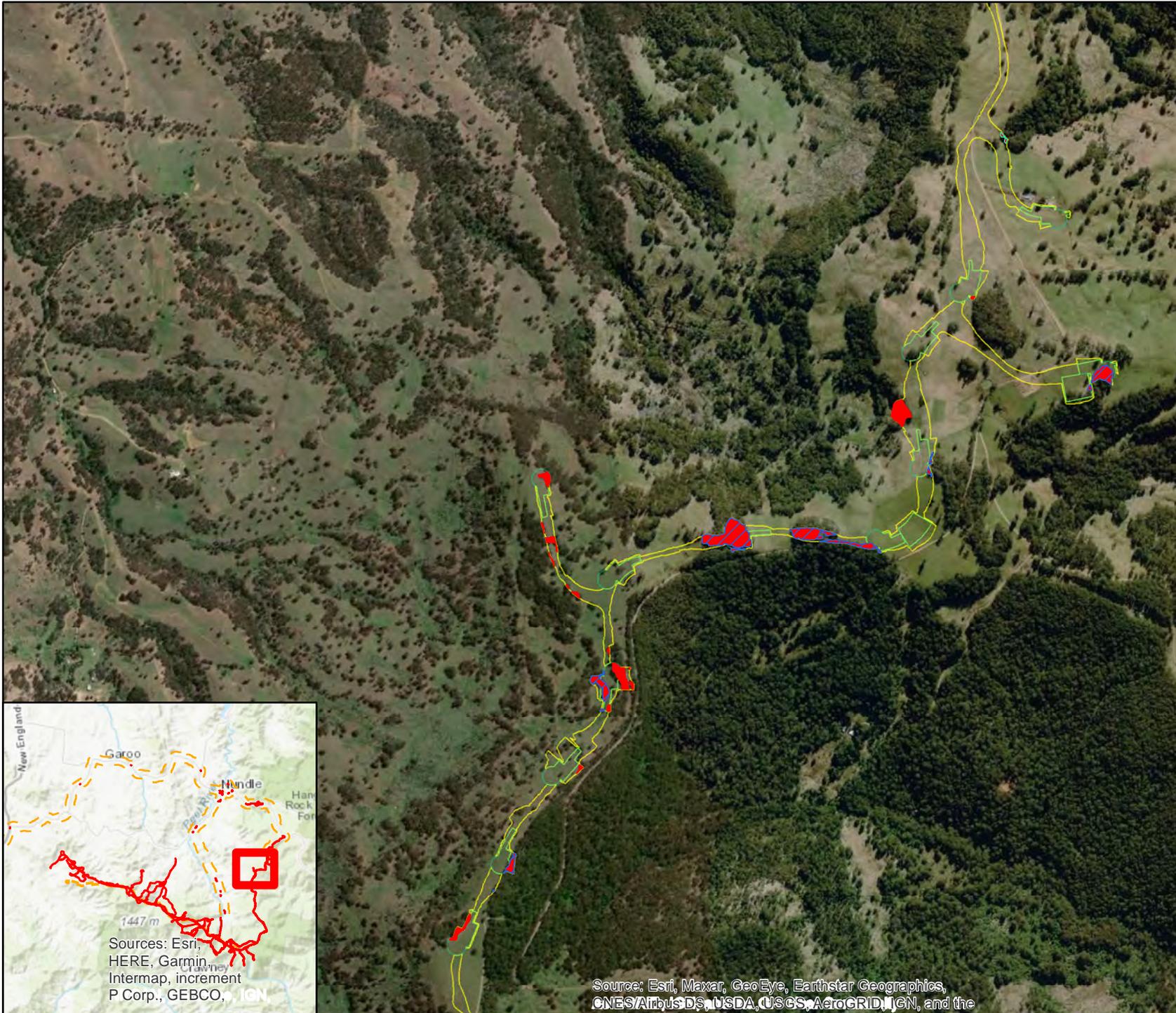
Job No 270335-00	Drawing No 015
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

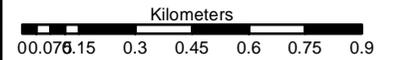
I:\270000\270335-00 Hills of Gold\Work\mammal\Design\Draft\BOAR_June2020\Draft\Figures_revised.mxd



-  Squirrel Glider
-  Eastern Pygmy Possum
-  Koala
-  Wind farm infrastructure
-  Internal roads



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

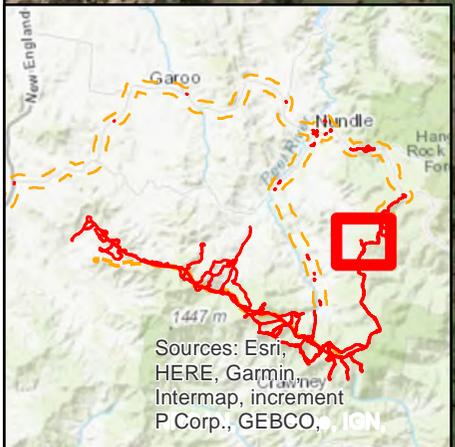
Job Title
Hills of Gold Wind Farm

Drawing Title
**Arboreal mammals habitat polygons
 Page 12**

Scale at A4 1:20,000	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

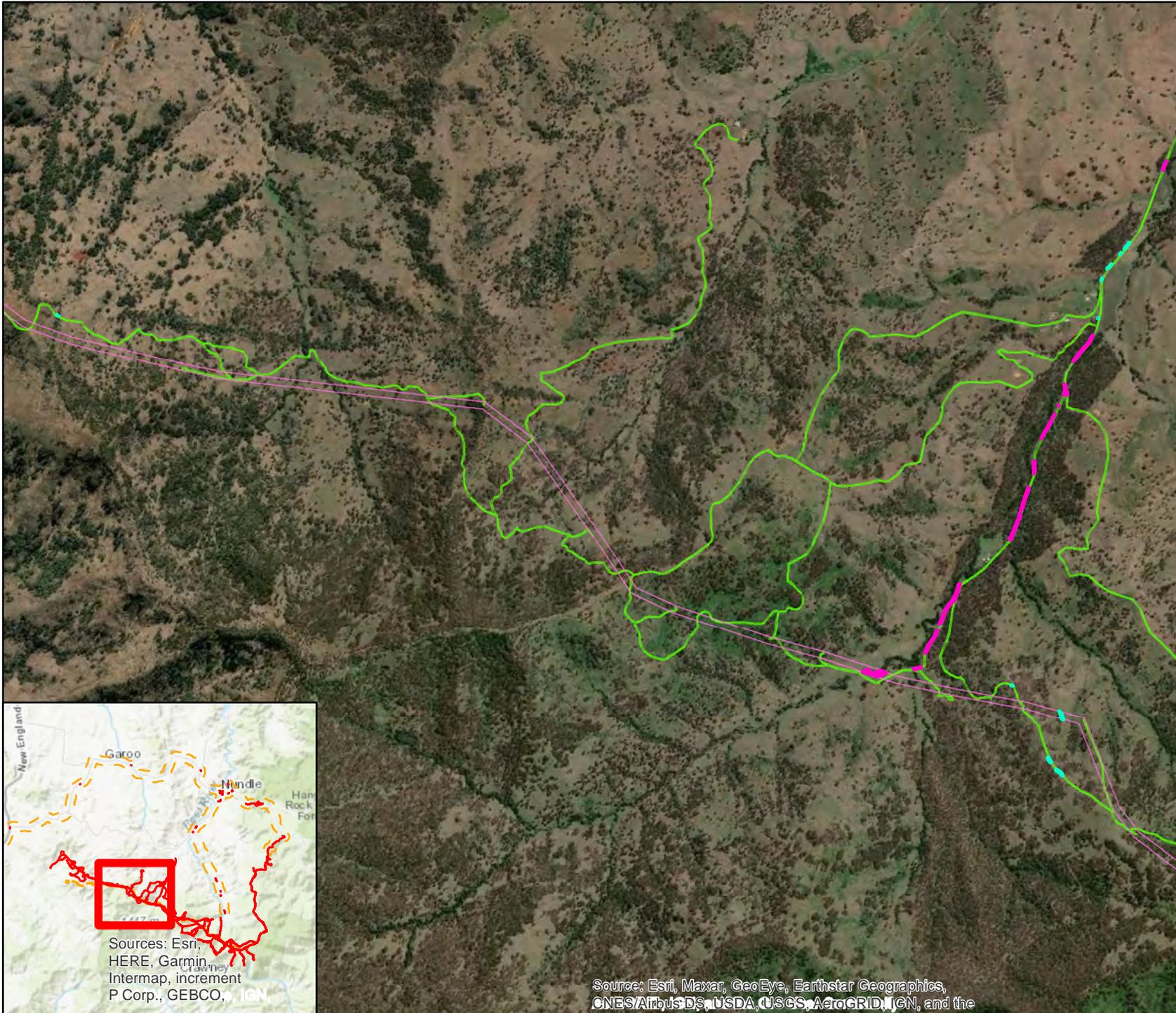
Job No 270335-00	Drawing No 015
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

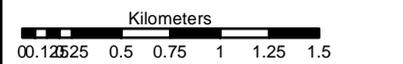
I:\270335-00 Hills of Gold\Work\mammal\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Booroolong Frog
- Border Thick-tailed Gecko
- Transmission line and switching
- Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

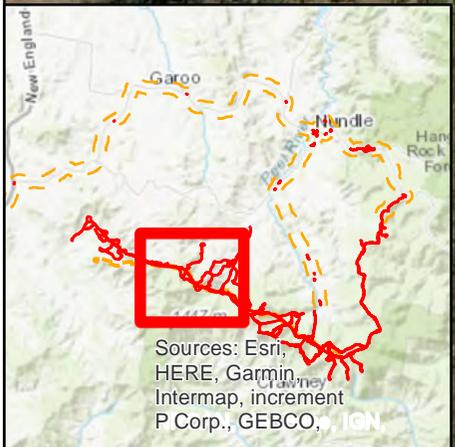
Job Title
Hills of Gold Wind Farm

Drawing Title
Booroolong Frog and Border Thick-tailed Gecko - Page 1 (overview)

Scale at A4 1:38,138	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 016
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

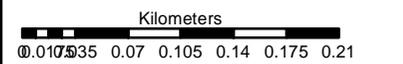
I:\270000\270335-00 Hills of Gold\Work\marmal\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Border Thick-tailed Gecko
- Transmission line and switching
- Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

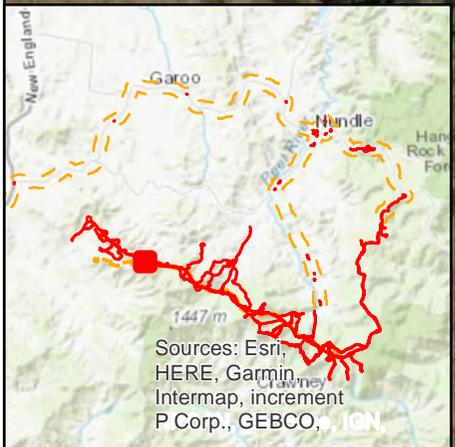
Job Title
Hills of Gold Wind Farm

Drawing Title
Booroolong Forg and Border Thick-tailed Gecko - Page 2

Scale at A4 1:5,000	Drawing Status Final
-------------------------------	--------------------------------

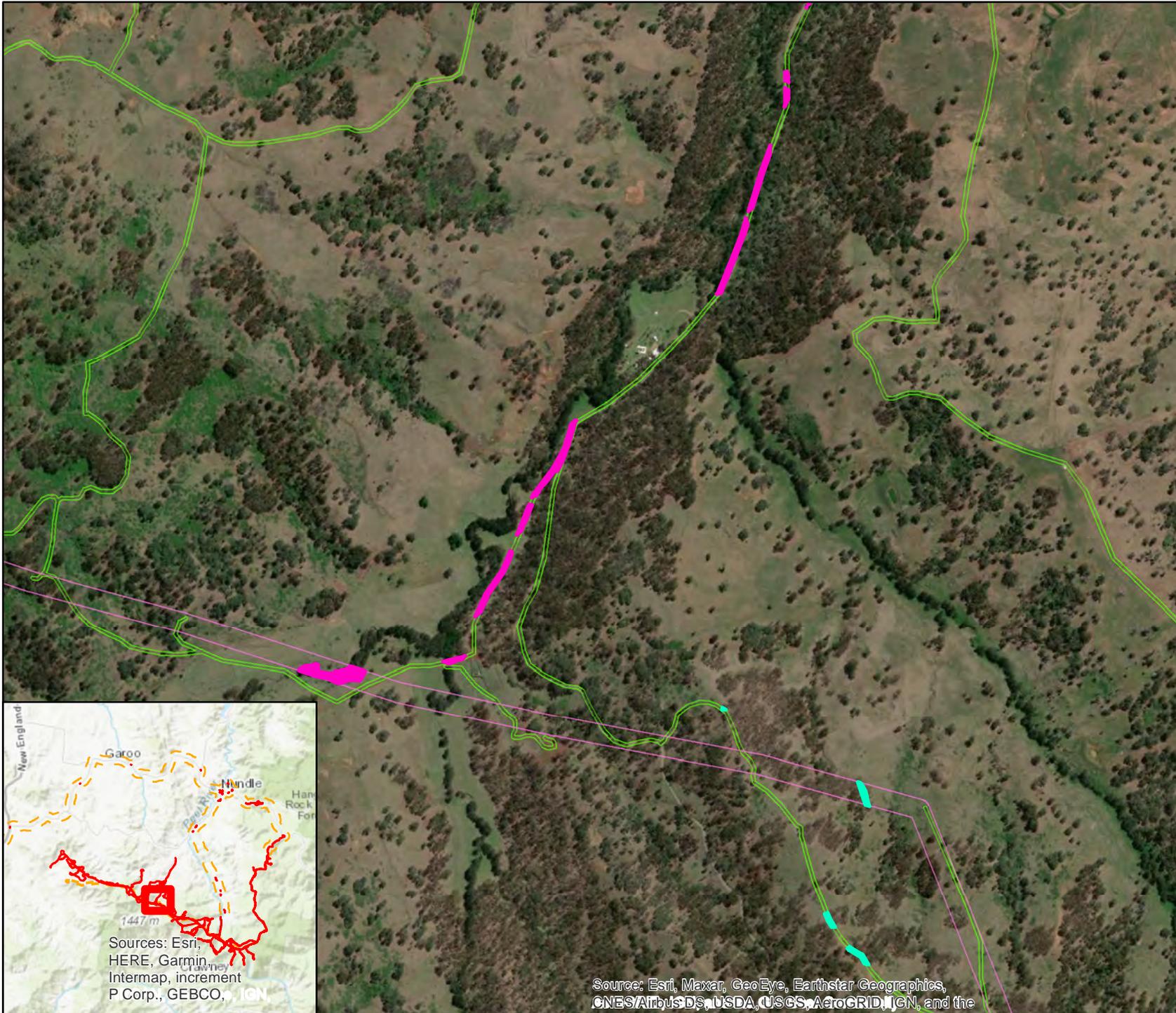
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 016
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

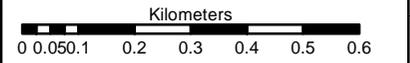
I:\270000\270335-00 Hills of Gold\Work\mxd\design\CS1\Figures\CS1\Figures_Draft\BOAR_June2020\Draft\Figures_revised.mxd



- Booroolong Frog
- Border Thick-tailed Gecko
- Transmission line and switching
- Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

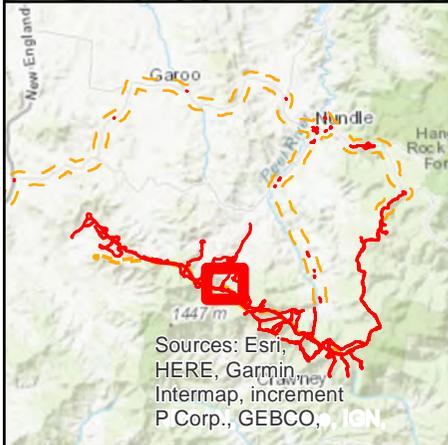
Job Title
Hills of Gold Wind Farm

Drawing Title
Booroolong Frog and Border Thick-tailed Gecko - Page 3

Scale at A4 1:13,424	Drawing Status Final
--------------------------------	--------------------------------

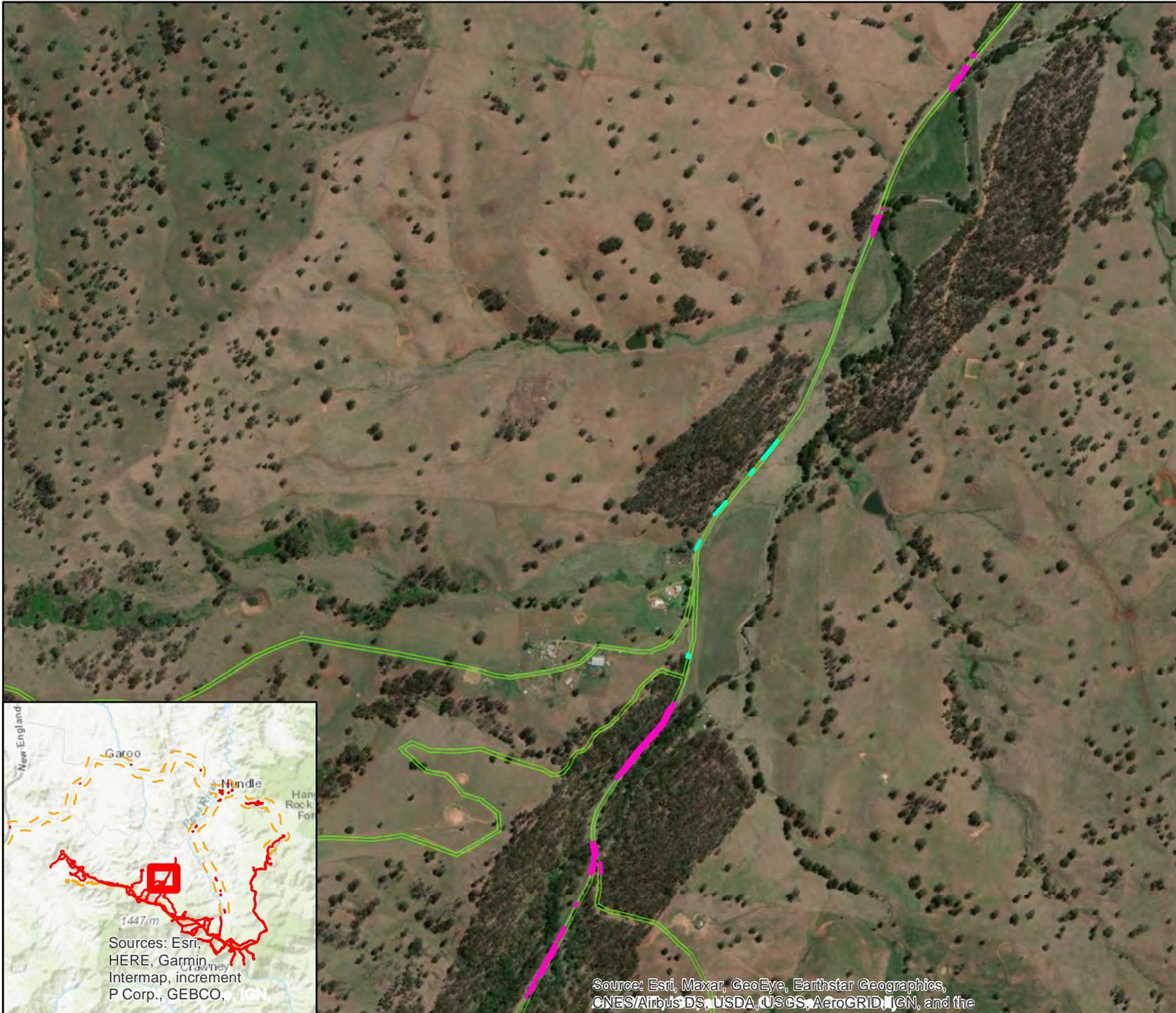
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 016
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN

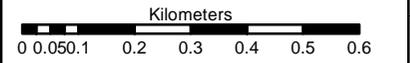
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the



- Booroolong Frog
- Border Thick-tailed Gecko
- Transmission line access tracks



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

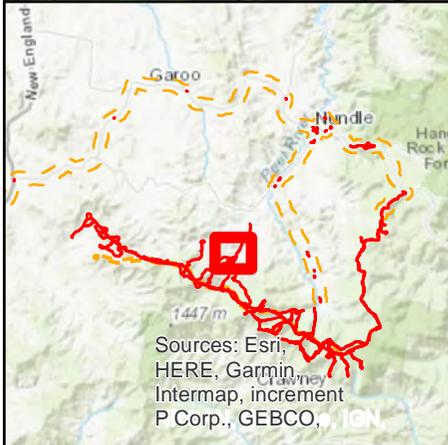
Job Title
Hills of Gold Wind Farm

Drawing Title
Booroolong Frog and Border Thick-tailed Gecko - Page 4

Scale at A4 1:13,424	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 016
----------------------------	--------------------------



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

6 Matters of National Environmental Significance

6.1 Commonwealth determination and controlling provisions

In accordance with the EPBC Act, a referral for the Project was submitted to the Commonwealth Department of Agriculture, Water and Environment (DAWE) (EPBC Ref 2019/8535).

On the 23 December 2019, the Commonwealth determined the Project was a controlled action under section 75 of the EPBC Act. Controlling provisions for the proposed action include listed threatened species and communities (section 18 and 18A) and listed migratory species (section 20 and 20A). Based on the referral documentation (EPBC 2019/8535), the Commonwealth determined there was likely to be significant impacts to the following matters:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland TEC, listed as critically endangered
- Regent Honeyeater *Anthochaera Phrygia*, listed as critically endangered
- Swift Parrot *Lathamus discolor*, listed as critically endangered
- Booroolong Frog *Litoria booroolongensis*, listed as endangered
- Fork-tailed Swift *Apus pacificus*, which is listed as migratory.

In addition, the Commonwealth identified potential for some risk of significant impacts to the following matters:

- Small Snake Orchid *Diuris pedunculata*, listed as endangered.
- Blackbutt Candlebark *Eucalyptus rubida subsp. barbigerorum*, listed as vulnerable
- Fragrant Pepperbush *Tasmannia glaucifolia* listed as vulnerable
- Austral Toadflax *Thesium austral*, listed as vulnerable
- Spotted-tailed Quoll *Dasyurus maculatus maculatus* (SE mainland population), listed as endangered
- Koala *Phascolarctos cinereus* (combined populations of Qld, NSW and the ACT), listed as vulnerable
- White-throated Needletail *Hirundapus caudacutus*, listed as vulnerable
- *Euphrasia arguta*, listed as critically endangered.

Further information was requested by the Commonwealth to determine the extent of potential impacts associated with the transport route road upgrades for the following relevant protected matters:

- New England Peppermint *Eucalyptus nova-anglica* Grassy Woodlands ecological community, listed as critically endangered
- Lowland Rainforest of Subtropical Australia TEC, listed as critically endangered
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland TEC, listed as critically endangered
- Regent Honeyeater *Anthochaera Phrygia*, listed as critically endangered
- *Euphrasia arguta*, listed as critically endangered
- Small Snake Orchid *Diuris pedunculata*, listed as endangered
- *Zieria lasiocaulis*, listed as endangered
- *Diuris eborensis*, listed as endangered
- White-flowered Wax Plant *Cynanchum elegans* – endangered
- Milky Silkpod *Parsonsia dorrigoensis* – endangered
- *Grevillea guthrieana*, listed as endangered
- Craven Grey Box *Eucalyptus largeana*, listed as endangered
- *Solanum sulphureum* listed as endangered
- Blackbutt Candlebark *Eucalyptus rubida subsp. barbigerorum*, listed as vulnerable
- Koala *Phascolarctos cinereus* (combined populations of Old, NSW and the ACT), listed as vulnerable
- Earp's Gum *Eucalyptus parramattensis subsp. decadens* listed as vulnerable
- Austral Toadflax *Thesium austral*, listed as vulnerable
- Greater Glider *Petauroides Volans*, listed as vulnerable
- Leafless Tongue-orchid *Cryptostylis hunteriana*, listed as vulnerable
- Fragrant Pepperbush *Tasmannia glaucifolia*, listed as vulnerable
- Narrow-leaved Peppermint *Eucalyptus nicholii*, listed as vulnerable
- Long-nosed Potoroo (SE Mainland) *Potorous tridactylus tridactylus*, listed as vulnerable
- Tall Velvet Sea-berry *Haloragis exalata subsp. velutina*, listed as vulnerable
- *Hakea archaeoides* listed as vulnerable.

6.2 Significant impact assessment

Based on the results of the desktop investigations, field surveys and the likelihood of occurrence assessments (contained in the EPBC assessment prepared by Arup), significant impact assessments were found to be required for the EPBC Act listed species and TECs that are known to occur or have a 'high' likelihood of

occurrence, as listed below, with a detailed significant impact assessment provided in this BDAR.

Threatened Ecological Communities

- White Box-Yellow Box-Blakely's Red Gum Grassy TEC Woodland and Derived Native Grassland (critically endangered)

Listed threatened fauna species

- Booroolong Frog *Litoria booroolongensis* (endangered)
- Spotted-tailed Quoll *Dasyurus maculatus* (endangered)
- Greater Glider *Petauroides volans* (vulnerable)
- Koala *Phascolarctos cinereus* (vulnerable)
- Large-eared Pied Bat (vulnerable)

The significant impact assessment was completed in accordance with the EPBC Act *Significant Impact Guidelines 1.1 Matters of National Environmental Significance* (Commonwealth of Australia, 2003).

The results of the assessment in this BDAR identified the potential for a significant impact to the following MNES.

- Yellow Box-White Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.
- Koala
- Large-eared Pied Bat
- Spotted-tailed Quoll

7 Avoid and minimise impacts

Measures to avoid and minimise impacts have been included throughout the development of the design for the Project, including the selection of wind farm layouts, access roads and the transmission line route.

The preliminary identification and mapping of biodiversity constraints occurred before the development of the wind farm layout and the selection of the preferred transmission line corridor, with preliminary biodiversity fieldwork completed in the wind farm and transmission line area in November 2019 before concept engineering design commenced. By collecting ecological data early, this allowed for consideration of biodiversity constraints during the concept design development.

Measures to minimise impacts associated with construction and operation have also been considered, with further detail on these provided in Section 8 of this BDAR.

7.1 Wind farm layout

A first pass technically feasible layout for the Project was produced based on the wind resource and required turbine spacing, and resulted in a layout of up to 97 turbines. This layout was made publicly available during in the Preliminary Environmental Assessment to request the SEARs. Subsequent iterations of this layout reduced the layout to 78 turbines and then finally 70 turbines. These updated layouts were derived based on updated turbine technology and the results of the most up to date environmental survey information available. Various design rounds were held with civil, wind and biodiversity expertise and also incorporated community feedback into the project design process.

A high level review of the reduced impact associated with reducing the number of turbines from 97 to 78 was carried out prior to the development of the detailed engineering concepts. At this stage the area of impact was based on an indicative hardstand area for each turbine, with linking 6m wide access tracks only as earthworks modelling was not yet available to quantify the potential extent of cut and fill required for access roads. Based on this initial indicative assessment the 78 turbine layout impacted on 22% less native vegetation than the 97 turbine layout.

During the development of the wind farm layout as part of the preferred 78 turbine option, design workshop was held with the project ecologists, civil engineers and wind modellers to further optimise layout options to avoid impacts to significant biodiversity features, such as fauna habitat and microbat breeding areas. This review resulted in the wind farm layout being further reduced by an additional 8 turbines from a maximum of 78 turbines down to 70 turbines to further minimise biodiversity impacts and limit the clearing required to sensitive vegetation. This further reduction on the number of turbines has contributed to a large reduction in the potential direct and indirect impacts associated with the project.

As part of the design workshop, preliminary ecological data from field surveys was overlaid with initial concept designs and opportunities to amend design elements were assessed. For this workshop, the following ecological data was provided:

- Areas of potential microbat roosts, as mapped using the Lidar classification process, with a 100m buffer included;
- PCT mapping identifying areas of moderate and high condition vegetation communities to be avoided as much as possible
- TEC mapping showing the location of the Ribbon Gum-Mountain Gum-Snow Gum community within the wind farm infrastructure corridor;

Key outcomes of this design review included:

- Removal of turbine locations in areas of steep terrain and located within 100m of identified microbat roosting habitat on rocky outcrops.
- Removal of turbine locations on very steep sections of the site within close proximity to microbat habitat roosts
- Refinement of the access track along Morrisons Gap Road to avoid required vegetation trimming and clearing.

Accordingly, the current project layout avoids all identified microbat roosting habitat and have been optimised to minimise the extent of clearing. An analysis of the wind farm infrastructure layout between the 78 and 70 turbine configuration, shows that this resulted in an approximately 30% reduction in clearing extents (**Table 33**).

Table 33: Review of native vegetation impacts after design refinements to minimise biodiversity impacts

PCT	78 Turbine Layout	70 Turbine Layout	Change (ha)	Change (%)
1194	100.17	75.65	-24.52	-32%
507	0.35	0.19	-0.17	-89%
927	3.64	0.00	-3.64	-100%
931	5.13	6.30	1.17	19%
934	22.46	17.96	-4.50	-25%
954	2.15	2.73	0.58	21%
TOTAL	133.90	102.82	-31.08	-30%

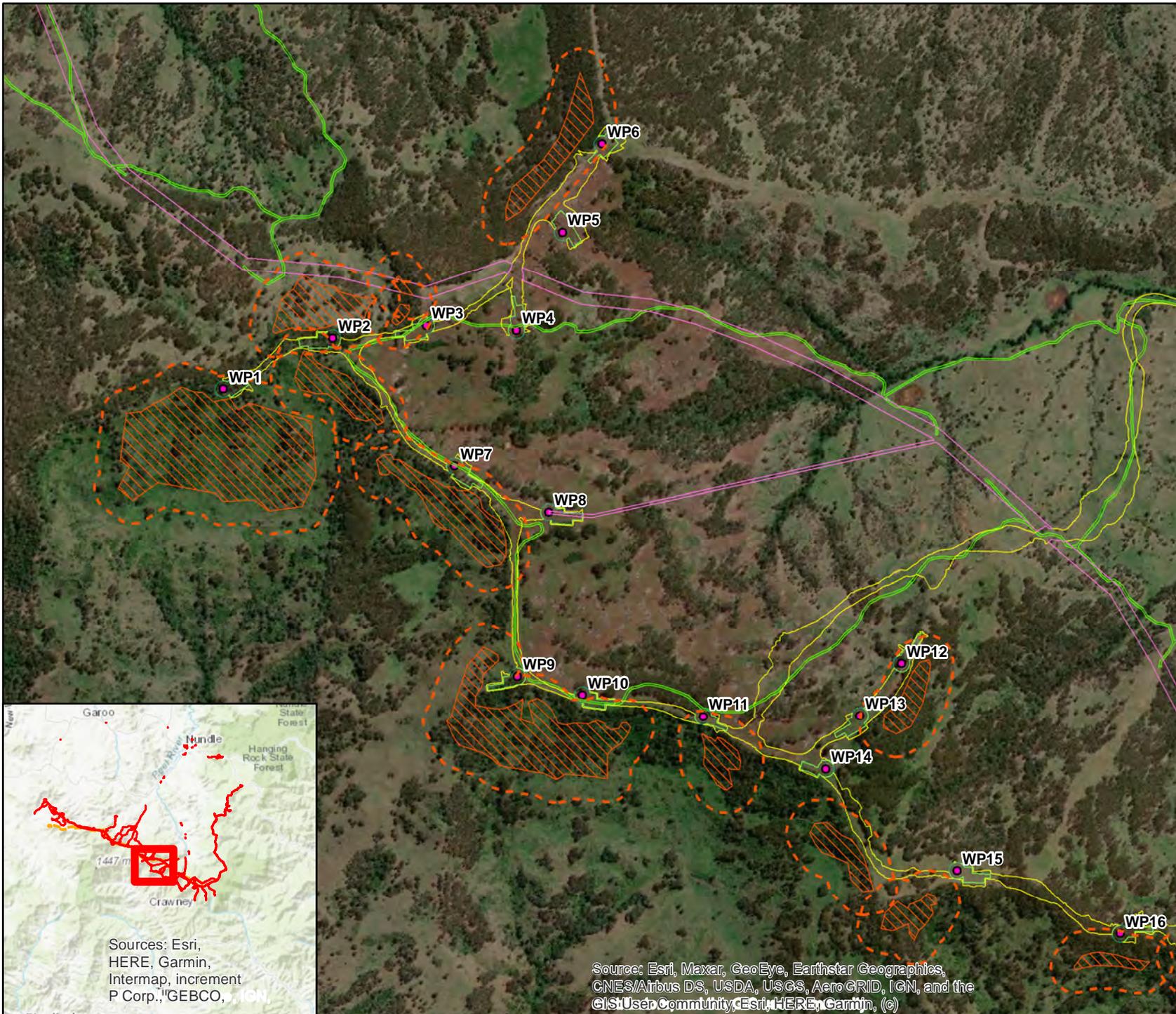
7.2 Microbat breeding and foraging habitat

The results of the field investigations identified substantial species diversity in threatened microbats using the site, including both cave and hollow-dependent species. Some of these bats are assessed as ecosystem credit species, and their impacts are quantified as part of the impacts to native vegetation. These include Little Pied Bat *Chalinolobus picatus*, Eastern False Pipistrelle *Falsistrellus*

tasmaniensis and Eastern Coastal Free-tailed Bat *Micronomus norfolkensis*. The presence of these bats is predicted based on vegetation type and geographic location. The field surveys also confirmed the presence of several species credit bats, where presence cannot be reliably predicted by PCT mapping Large-eared Pied Bat *Chalinolobus dwyeri*, Little Bent-wing Bat *Miniopterus australis*, Large Bent-wing Bat *Miniopterus orianae oceanensis* and Eastern Cave Bat *Vespadelus trougtoni*

Of the ecosystem and species credit bats assessed in this BDAR, all are cave-dwelling bats with the exception of the Eastern Coastal Free-tailed Bat. Due to the high recorded numbers of threatened cave-dwelling bats within the study area, additional mapping and assessment was completed to maximise the buffer from this area of breeding habitat. Using the Lidar data, areas of potential roost habitat was mapped using the method described in Section 2.1.6 of this BDAR. These areas were then subject to ground-truthing to confirm the presence of rocky outcrops where cave-dwelling bats may roost overnight (**Figure 17**).

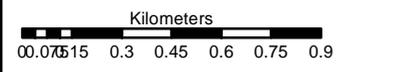
The wind farm layout was amended to avoid any direct impacts to areas of roost habitat for cave-dwelling bats and no Project related infrastructure is proposed within these important areas. To further avoid impacts a 100m buffer was applied around all identified areas of roosting habitat on steep cliffs, and as much as possible, the placement of turbines was designed to avoid this buffer.



- Microbat habitat 100m buffer
- Microbat breeding habitat polygons
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks
- Wind turbine locations



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

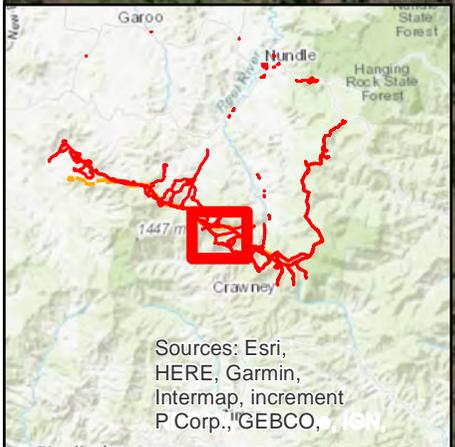
Job Title
Hills of Gold Wind Farm

Drawing Title
Cave-dwelling bat roost and buffer Page 1

Scale at A4 1:22,738	Drawing Status Final
--------------------------------	--------------------------------

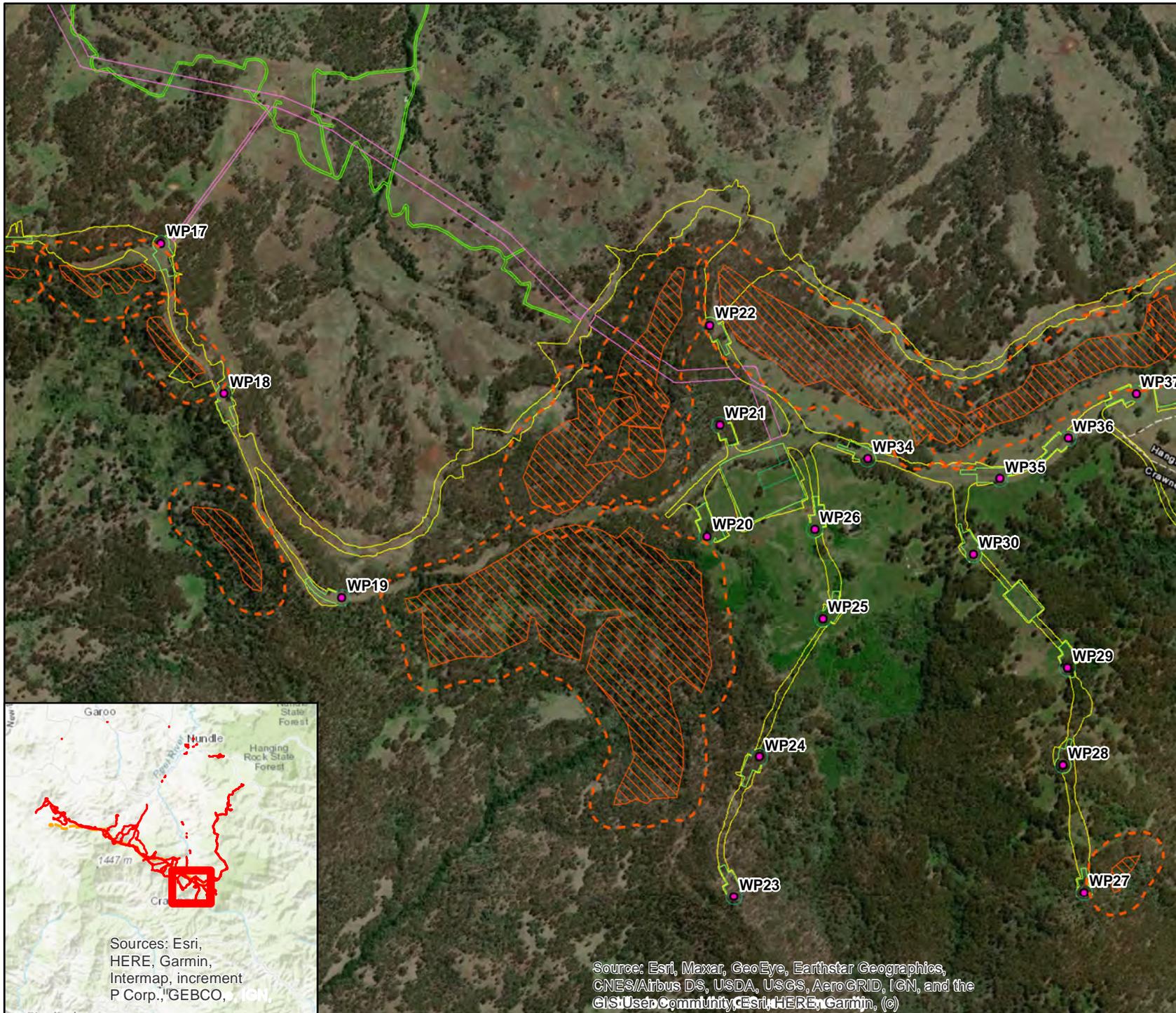
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 017
----------------------------	--------------------------



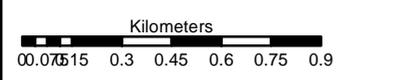
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

I:\270000\270335-00 Hills of Gold\Work\mxd\design\GIS\Figures\Draft\BDR_Cave2020\Draft\Figures_revised.mxd



- Microbat habitat 100m buffer
- Microbat breeding habitat polygons
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Transmission line access tracks
- Wind turbine locations

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave-dwelling bat roosts and buffer
Page 2**

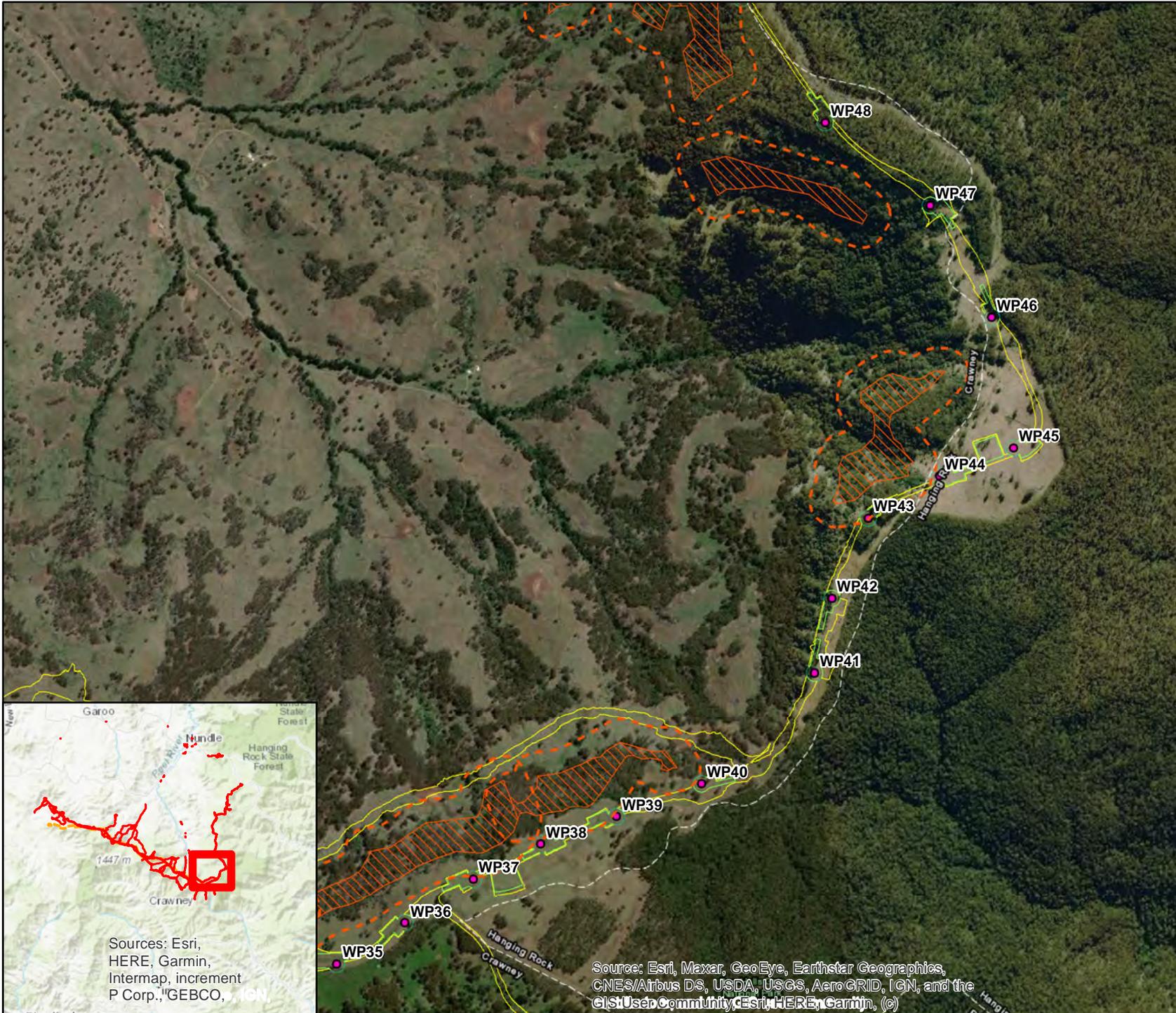
Scale at A4 1:22,738	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 017
----------------------------	--------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, IGN,

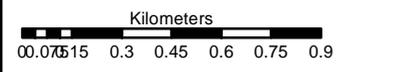
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)



- Microbat habitat 100m buffer
- Microbat breeding habitat polygons
- Wind farm infrastructure
- Transmission line and switching
- Internal roads
- Wind turbine locations



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

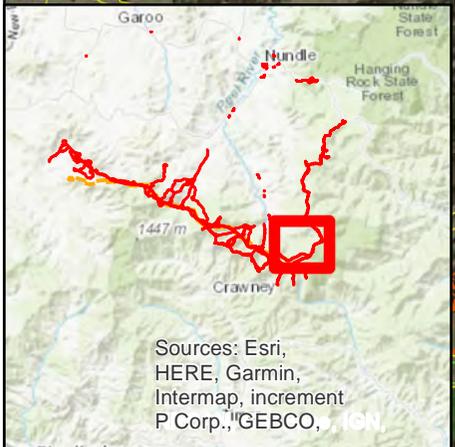
Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave-dwelling bat roosts and buffer
Page 3**

Scale at A4 1:22,738	Drawing Status Final
--------------------------------	--------------------------------

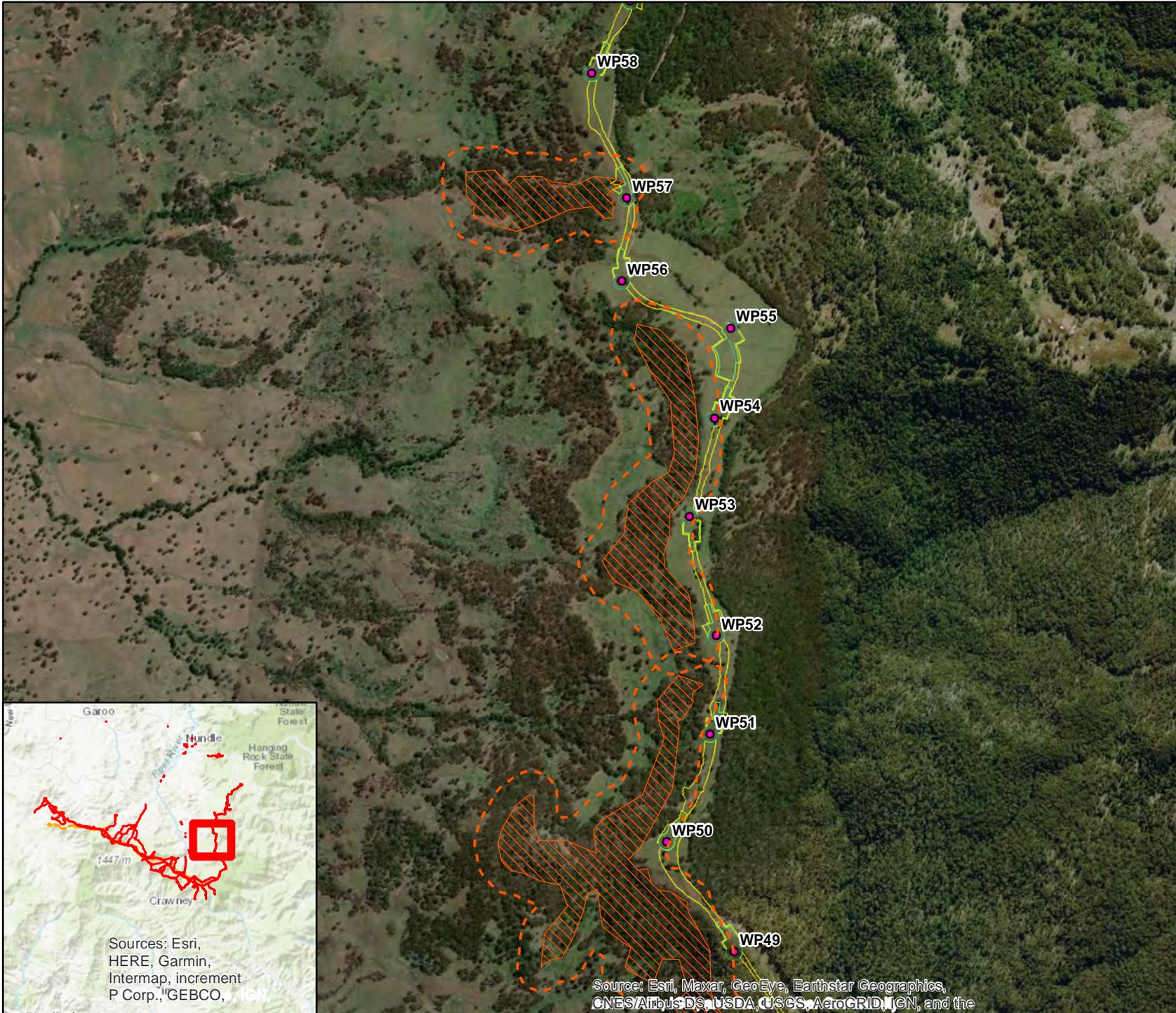
Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 017
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c)

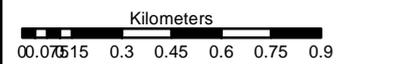
I:\270000\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOARD_June2020\Draft\Figures_revised.mxd



-  Microbat habitat 100m buffer
-  Microbat breeding habitat polygons
-  Wind farm infrastructure
-  Internal roads
-  Wind turbine locations



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

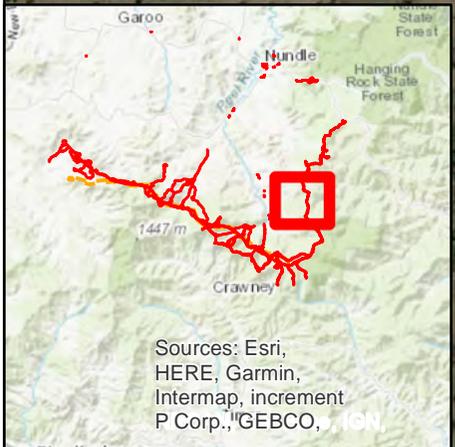
Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave-dwelling bat roosts and buffer
Page 4**

Scale at A4 1:22,738	Drawing Status Final
--------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 017
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

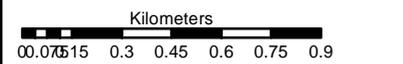
I:\270000\270335-00 Hills of Gold\Work\mxd\design\CS1\Figures\Draft\B04R_Cave2020\Draft\Figures_revised.mxd



- Microbat habitat
- 100m buffer
- Microbat breeding habitat polygons
- Transport route (port to site)
- Wind farm infrastructure
- Internal roads
- Wind turbine locations



D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd



ARUP

Level 4, 108 Wickham Street
 Fortitude Valley, QLD 4006
 Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
 www.arup.com

Client
Wind Energy Partners

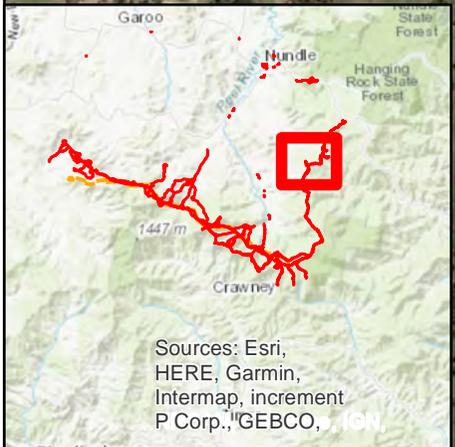
Job Title
Hills of Gold Wind Farm

Drawing Title
**Cave-dwelling bat roosts and buffer
 Page 5**

Scale at A4	Drawing Status
1:22,738	Final

Coordinate System
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	017



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

I:\270000\270335-00 Hills of Gold\Work\mxd\design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd

The location and siting of turbines has also considered including suitable buffers to areas of potential foraging habitat by microbats. The assessment has used the formula for required buffers to areas of vegetation developed in *Natural England Technical Information Note TIN051 – Bats and onshore wind turbines interim guidance*. This method takes into consideration the hub height and blade length of adjacent turbines and identifies the required horizontal distance a turbine should be placed to maintain a suitable buffer (**Figure 18**).

$$b = \sqrt{(50 + bl)^2 - (hh - fh)^2}$$

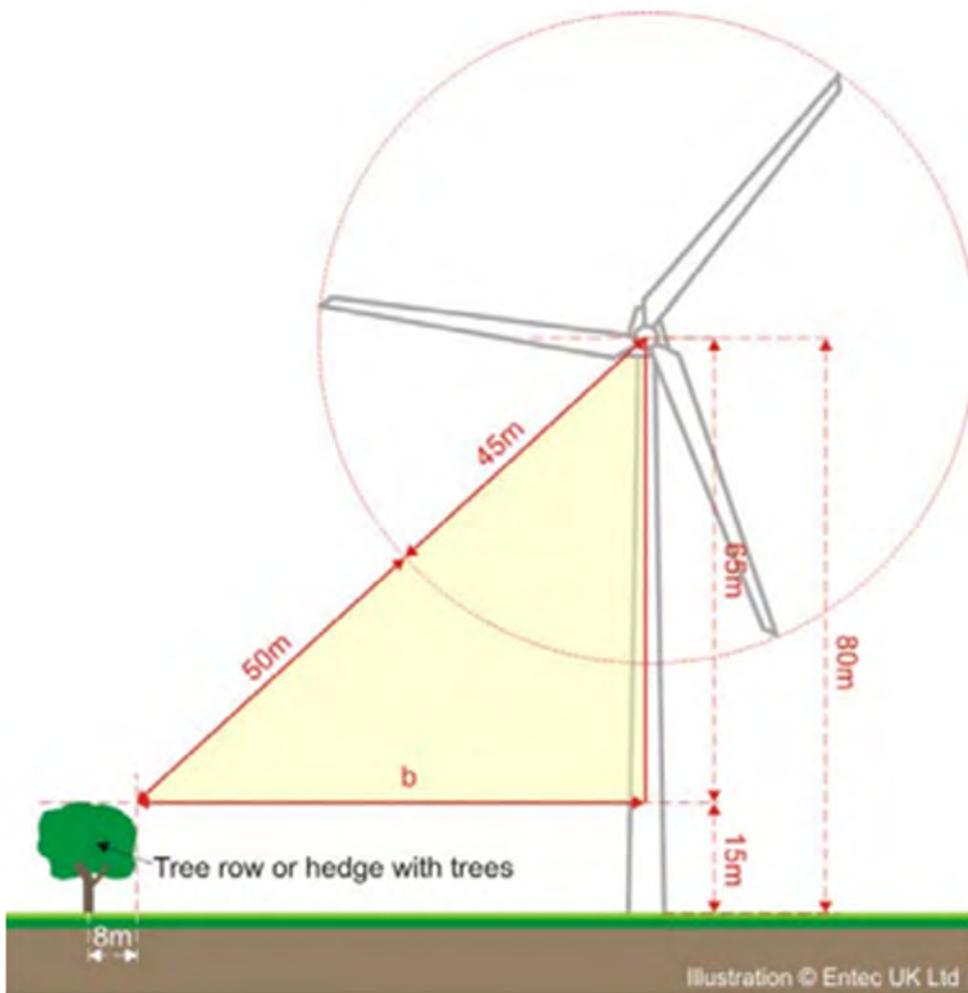


Figure 18: Extract from Technical Information Note TIN051 Bats and onshore wind turbines, showing how buffer distance is determined from top of canopy to blade tip.

As field surveys identified a high diversity and relative abundance of threatened microbats across the development site, further analysis was carried out on each of the 70 turbines to assess the quantum of potential incursion into the required buffer (**Table 34**) and to determine the buffers for the Project.

In applying the buffer formula from TIN051, the following site specific parameters were input for the required variables to use for the formula to obtain the buffer:

- *Turbine name* is a unique identifier for each turbine and the spatial location of each turbine was mapped using GIS so it's position relative to the nearest foraging habitat feature was able to be measured.
- *Distance to foraging habitat* was determined using the measure tool in GIS to measure the distance from the wind turbine to the nearest patch of native vegetation, ground-truthed as part of the PCT mapping for the development footprint.
- *Feature height* is an estimate of the canopy height of the nearest patch of PCT assessed to be potential microbat foraging habitat. This tree height was taken to be a median height of the vegetation community type as defined by Walker and Hopkins, 1990.

This assessment was completed on a turbine that provides a ground clearance of 58m from the blade tip.

Regarding the buffer assessment using the formula in TIN051, the project wind turbine layout achieves a minimum of 36m clearance from top of canopy to blade tip. The assessment shows that:

- 34% of turbines provide a buffer of 30-40m
- 43% of WTGs provide a buffer of 40-50m
- 23% of WTGs provide a buffer of > 50m.

Accordingly, the Project provides an average buffer of 51m from the tip of blades and the closest area of tree canopy.

Table 34: Assessment of buffer from blade tip to top of canopy using TIN051

Turbine Name	Distance to foraging habitat (m)	PCTs and condition in 100m buffer	Feature height (m)	Buffer distance (m)
WP31	21.15	931; 1194-high	23.5	36.42
WP1	22.11	1194- high	23.5	36.60
WP27	22.47	1194-high	23.5	36.67
WP33	22.74	931-high; 1194-mod	23.5	36.72
WP23	23.00	1194-mod	23.5	36.77
WP43	23.00	1194-mod	23.5	36.77
WP61	23.10	1194-mod&high; 927-high	23.5	36.79
WP18	23.17	1194-mod; 934-mod&high	23.5	36.80
WP21	23.58	1194-high	23.5	36.88
WP24	24.78	1194-mod	23.5	37.13
WP11	25.73	931-mod; 934-high	23.5	37.33
WP49	26.72	1194-low&high	23.5	37.55
WP22	26.99	1194; 934-high	23.5	37.61
WP70	28.16	1194-low; 931-high	23.5	37.88
WP16	29.47	1194-mod	23.5	38.20
WP9	30.14	931-mod; 1194-low	23.5	38.37
WP63	30.64	1194-mod	23.5	38.50
WP20	30.97	1194-high; 934-low	23.5	38.58
WP6	31.64	1194-high	23.5	38.76
WP28	31.79	1194-high	23.5	38.80
WP36	33.07	1194-low&mod	23.5	39.14

Turbine Name	Distance to foraging habitat (m)	PCTs and condition in 100m buffer	Feature height (m)	Buffer distance (m)
WP58	33.26	1194-mod	23.5	39.19
WP46	34.70	1194-mod&high	23.5	39.60
WP59	35.13	1194-low&high;934-high	23.5	39.72
WP2	36.10	1194- high	23.5	40.01
WP54	36.15	1194-low,mod&high	23.5	40.02
WP51	36.85	1194-low&mod	23.5	40.24
WP4	23.89	507-mod	20	40.38
WP48	37.74	1194-low&high	23.5	40.51
WP8	38.13	931-mod; 934-low	23.5	40.63
WP30	50.89	931-mod; 934-DNG&mod	28.5	40.66
WP64	38.66	1194-high; 927-high	23.5	40.80
WP57	39.46	1194-mod	23.5	41.05
WP7	39.75	1194-high	23.5	41.15
WP12	42.53	934-mod; 1194-high; 954-high	23.5	42.08
WP34	25.18	1194-mod&high	18.5	42.10
WP5	43.07	1194-mod	23.5	42.27
WP38	43.11	1194-high	23.5	42.28
WP15	43.57	1194-DNG&Mod; 954-High	23.5	42.44
WP65	44.33	1194-high	23.5	42.71
WP66	44.98	931-high;1194-mod	23.5	42.95
WP50	46.07	1194-low,mod&high	23.5	43.35
WP53	38.23	1194-low&high	18.5	45.42
WP68	51.78	1194-low&mod	23.5	45.57

Turbine Name	Distance to foraging habitat (m)	PCTs and condition in 100m buffer	Feature height (m)	Buffer distance (m)
WP13	54.16	954-high	23.5	46.57
WP69	54.66	1194-low	23.5	46.78
WP29	43.46	931-mod; 934-DNG&mod	18.5	47.10
WP62	55.81	1194-low&mod	23.5	47.28
WP3	56.31	1194- high; 934- mod	23.5	47.50
WP19	30.80	934-high	13.5	48.22
WP39	59.15	1194-mod&high	23.5	48.77
WP17	33.47	1194-mod; 934-high	13.5	48.89
WP14	59.73	931-mod; 1194-DNG; 954-high	23.5	49.03
WP60	60.22	1194-low&mod;934-high	23.5	49.26
WP32	51.47	931-high; 1194-DNG&mod	18.5	50.03
WP42	38.57	1194-low&high	13.5	50.29
WP41	39.16	934-high	13.5	50.47
WP10	66.42	931; 1194; 934-mod	23.5	52.24
WP52	68.19	1194-low	23.5	53.13
WP40	35.35	931-low; 934-high	8.5	54.20
WP37	78.76	1194-low&high	18.5	62.96
WP25	93.27	934-low	23.5	67.46
WP56	93.90	1194-mod	23.5	67.85
WP67	113.66	1194-low	23.5	81.05
WP44	95.29	NA		87.53
WP47	169.27	1194-low&high	23.5	123.92
WP35	157.02	NA		128.70

Turbine Name	Distance to foraging habitat (m)	PCTs and condition in 100m buffer	Feature height (m)	Buffer distance (m)
WP55	161.17	NA		131.83
WP26	184.47	NA		149.97
WP45	184.62	NA		150.10

7.3 Transmission line route selection

During the design development phase a wider landscape was reviewed for potential transmission line corridor. Seven potential transmission line routes were identified and to understand visual impact and willingness to reach land agreements. Desktop and field validated vegetation and habitat maps were reviewed and transmission line options assessed for likely impacts to significant biodiversity features, with a focus on minimising impacts to TECs. A desktop assessment was undertaken to identify the potential impacts to native vegetation communities for each of the seven options using the State Vegetation Mapping for the alignments (**Table 35**).

Table 35: Transmission line route selection and estimate of native vegetation impacts.

Transmission line option	Estimated area of PCT impacts
Route 1	105.02
Route 2	127.98
Route 3	118.70
Route 4	126.47
Route 5	127.03
Route 6	178.24
Route 7	138.91

These initial concept transmission line alignments was assessed to result in over 150ha of impact to TECs listed under the BC Act and 55ha of EPBC Act critically endangered TEC.

Following the review of each of these seven options two preferred routes were selected (as highlighted above) and an optimisation consisting of a 200 m corridor was undertaken to adjust the routes to minimise further impact around mapped PCTs.

This was further refined to minimise potential biodiversity impacts resulting in a reduction of impacts to 53ha of impact to BC Act listed TEC and 14ha of impact to EPBC Act listed TECs.

As noted earlier, the current transmission line development footprint considers a conservative ‘worst case’ clearing footprint for the transmission line easement, assessing complete clearing within the easement. Depending on the height of the towers and the topography of the easement, there will be locations where the existing eucalypt forest can be retained, while still maintaining the required safety and operational clearance to the transmission lines, enabling further reductions in impact to be achieved.

Opportunities to carry out ecological restoration works across 90% (111.76 hectares) of the transmission line corridor will be investigated during detailed design. At a minimum, this will include native grass seeding, but where appropriate due to operational and safety constraints, planting with native shrubs and trees will be considered.

7.4 Access roads – construction and operation

Existing road infrastructure was prioritised to provide construction access and operational tracks for the Project. This includes locating primary construction access routes along the existing public access roads Head of Peel Road and Morrisons Gap Road. The alignment of the new sections of access tracks within the wind farm corridor largely follows the existing cleared sections of the site, and the development footprint has considered a very conservative 5m buffer from the centreline of these tracks to give a 10m wide development footprint. This will be investigated in detail during the detailed design, with this footprint to be minimised as much as possible.

In addition to minimising clearing associated with access tracks, it is anticipated that 23.80 hectares of this development footprint will be rehabilitated with native species mixes.

8 Assessment of Impacts

8.1 Impact summary

The approach to impact assessment has included assessment of a worst-case scenario covering direct impacts associated with habitat loss and indirect impacts associated with construction and operation of the project.

Table 36 details the impacts of the optimised Project to biodiversity following the implementation of the measures outlined above to avoid and minimise impacts. A tick has been used to identify where biodiversity impacts are relevant for each proposal phase. These are discussed further in the following sections.

Table 36: Potential impacts to biodiversity

Biodiversity value	Potential impact	Infrastructure type	Proposal phase	
			Construction	Operation
Direct impacts				
Native vegetation and ecosystem credit species habitats	Clearing of 206.70ha of native vegetation, comprised of:	All	✓	
Threatened Ecological Communities	Clearing of 57.43ha of Ribbon Gum-Mountain Gum-Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	Wind farm infrastructure and internal roads	✓	
	Clearing of 13.33ha of White Box Yellow Box Blakely's Red Gum Woodland	Transmission line and access tracks	✓	
Threatened fauna habitat – Species credit species and MNES	Clearing of 61.08ha of habitat for Large-eared Pied Bat	All	✓	
	Clearing of 62.49ha of habitat for Eastern Cave Bat	All	✓	
	Clearing of 30.42ha of habitat for Eastern Pygmy-possum	All	✓	
	Clearing of 50.76ha of habitat for Koala	All	✓	
	Clearing of 0.17ha of habitat for Border Thick-tailed Gecko	Transmission line and access tracks	✓	
	Clearing of 23.12ha of breeding habitat	Wind farm infrastructure	✓	

Biodiversity value	Potential impact	Infrastructure type	Proposal phase	
			Construction	Operation
	for Large Bent-winged Bat			
	Clearing of 23.12ha of breeding habitat for Little Bent-winged Bat	Wind farm infrastructure	✓	
	Clearing of 2.21ha of breeding habitat for Southern Myotis	Wind farm infrastructure	✓	
	Clearing of 25.54ha of habitat for Greater Glider	Wind farm infrastructure	✓	
	Clearing of 25.54ha of habitat for Spotted-tailed Quoll	Wind farm infrastructure	✓	
Indirect impacts				
Threatened fauna	Collision risk for birds and bats	Wind farm infrastructure		✓
Native vegetation, threatened ecological communities and habitat for threatened species	Edge effects and impacts to habitat viability	All lands	✓	✓
	Disturbance of habitats from noise and light	All lands	✓	✓
	Disturbance from weeds, pests and pathogens	Wind farm corridor	✓	✓
	Disturbance from noise and light	Transmission line corridor	✓	
	Fauna injury/mortality	All lands	✓	✓
Prescribed impacts				
Native vegetation, threatened ecological communities and habitat for threatened species	Loss of habitat connectivity	All	✓	✓
	Impacts to hydrology and water quality	All	✓	
	Impacts to karst, caves, crevices, cliffs and other geological feature of significance	Wind farm corridor	✓	
Threatened fauna and migratory species	Impacts of wind turbine strikes on protected animals	Wind farm corridor		✓
	Impacts to flight paths for raptors and	Wind farm corridor		✓

Biodiversity value	Potential impact	Infrastructure type	Proposal phase	
			Construction	Operation
	resident aerial species			
Other impacts				
Aquatic habitats	Impacts to hydrology and downstream water quality	Access/ transport routes	✓	
	Impacts to fish passage	Access/ transport routes	✓	

8.2 Direct impacts

Direct impacts associated with the development are primarily related to the proposed site clearing works. Site clearing will be carried out for the development footprint.

8.2.1 Clearing of native vegetation

The majority of the impacts to vegetation within the development footprint will be to exotic grassland and planted vegetation, with a total of 279.75 hectares of clearing of this vegetation type required.

A total of 206.70 hectares of native vegetation will be cleared from within the development footprint. This includes:

- 19.59ha for wind farm infrastructure;
- 65.99ha for internal roads;
- 85.75ha for the transmission line;
- 18.32ha for the transmission line access tracks; and
- 17.00ha for the transport haul route.

As described in Section 3 of this BDAR in detail, the condition of the native vegetation is highly variable and patchy, with the majority being derived native grassland, low or moderate condition.

The 206.70 hectares of native vegetation which is contained in the development footprint represents 0.95% of the approximately 21,540 ha of native vegetation contained within the study area.

To mitigate impacts to native vegetation as a result of temporary impacts, site rehabilitation and ecological restoration works will be completed in areas such as batters for access tracks, temporary construction laydown areas and trenching for underground cabling. A Biodiversity Management Plan for the site will also look at opportunities for revegetation and restoration plans to buffer areas of important habitat, such as the adjacent Ben Halls Gap Nature Reserve and to provide for biodiversity corridors through the development footprint.

Estimates of areas to be subject to rehabilitation works through seeding or planting with native species, includes a total of 271 hectares and includes:

- 10.60 hectares within the wind farm infrastructure development footprint;
- 89.02 hectares for internal access roads development footprint;
- 119.05 hectares for the transmission line development footprint;
- 23.80 hectares for the transmission line access tracks development footprint; and
- 28.10 hectares for the transport haul route development footprint.

These rehabilitation works will contribute towards minimising the impacts to native vegetation and fauna habitats within the development footprint. During detailed design, opportunities to include trees and shrubs in the rehabilitation species mix will be considered where site constraints regarding safety and operation permit. Based on these current estimates for areas to be subject to rehabilitation, the loss of 206.70 hectares of native vegetation can be compensated by the 271 hectares of restoration.

8.2.2 Impacts to Threatened Ecological Communities

A total of 69.13ha of the vegetation which will be impacted by the development footprint is associated with two threatened ecological communities being White Box Yellow Box Blakely's Red Gum Woodland and Ribbon Gum-Mountain Gum-Snow Gum open forest or woodland (**Table 37**).

To provide some context on the significance of impacts to these TECs, an assessment of the potential extent of these communities in the study area has been carried out. The White Box-Yellow Box-Blakely's Red Gum Woodland TEC occurs within the transmission line corridor, so the assessment of area impacted considered the investigation area for corridor options. This provides a more focused assessment of the impacts for the local landscape which is considered more representative than looking at a bioregional or sub-bioregional scale where percent impacts would be further diluted.

Table 37: Proposal impacts to threatened ecological communities

TEC	Area impacted (ha)	Area in investigation (ha)	% of investigation area impacted
White Box Yellow Box Blakely's Red Gum Woodland	13.33	1,693.6	0.8%
Ribbon Gum-Mountain Gum-Snow Gum open forest or woodland	57.43	1,059ha	5.4%

Based on an estimate of the likely extent of these TECs within the study area, the project is unlikely to result in a significant impact to these TECs, as there are substantial areas retained in the area for investigation associated with the wind farm and transmission line easement. The estimate of area of TECs for White-Box-Yellow-Box-Blakely's Red Gum extent was derived from the State Vegetation Map for Border Rivers Gwydir / Namoi Region Version 2.0. VIS_ID 4467 (OEH, 2020a), with associated PCTs that comprise the TEC calculated within the transmission line investigation area.

For the area of Ribbon Gum-Mountain Gum-Snow Gum TEC estimated within the wind farm corridor investigation area, a combination of the State Vegetation Map State Vegetation Type Map: Upper Hunter Version 1.0. VIS_ID 4894 (OEH, 2020) and field survey data was used.

Mitigation measures during detailed design to further reduce impacts to these TECs will be investigated. In particular, the current development footprint considers a 'worst case' clearing footprint for the transmission line easement, assessing complete clearing within the easement. Depending on the height of the towers and the topography of the easement, there will be locations where the existing eucalypt forest can be retained, while still maintaining the required safety and operational clearance to the transmission lines.

- State Vegetation Type Map: Border Rivers Gwydir / Namoi Region Version 2.0. VIS_ID 4467 (OEH, 2020a);
- State Vegetation Type Map: Upper Hunter Version 1.0. VIS_ID 4894 (OEH, 2020b);
- Greater Hunter Native Vegetation Mapping Version 4.0. VIS_ID 3855 (DPIE, 2015).

8.2.3 Clearing of habitat for threatened fauna species

Direct impacts to threatened fauna habitat within the development footprint has been calculated using the species polygons developed using the methodology described in **Section 5.5** of this BDAR.

Table 38 presents a summary of estimated impacts to habitat for threatened fauna within the development footprint.

Table 38: Direct impacts to habitat for species credit species

Species	Habitat polygons impacted (ha)					
	Wind farm infrastructure	Internal roads	Transmission line	Access tracks	Transport haul route	TOTAL
Large-eared Pied Bat (foraging and breeding)	13.07	35.86	10.78	0.94	0.43	61.08
Eastern Cave Bat (foraging and breeding)	13.14	37.19	10.78	0.94	0.43	62.48
Large Bent-winged Bat (breeding)	3.59	16.97	2.47	0.09	0.00	23.12
Little Bent-winged Bat (breeding)	3.59	16.97	2.47	0.09	0.00	23.12
Southern Myotis	0.61	1.49	0.00	0.00	0.12	2.21
Koala	11.35	25.46	10.02	1.10	2.83	50.76
Eastern Pygmy-possum	7.04	15.32	6.16	0.47	1.43	30.42
Squirrel Glider	6.76	13.30	3.45	0.17	2.52	26.20
Border Thick-tailed Gecko	0	0	0.06	0.11	0	0.17

Species	Habitat polygons impacted (ha)					
	Wind farm infrastructure	Internal roads	Transmission line	Access tracks	Transport haul route	TOTAL
Booroolong Frog	0	0	0.39	1.20	0	1.59

In addition to the habitat mapped for species credit species, a number of threatened fauna were directly observed on site. These species are ecosystem credits and their habitat is predicted in the BAM by the presence of vegetation types. These species and the area impacted include:

- Spotted-tailed Quoll - 25.54ha
- Greater-broad Nosed Bat - 70.03ha
- Little Pied Bat - 5.67ha
- Eastern False Pipistrelle - 70.03ha
- Eastern Coastal Freetail Bat - 17.86ha
- Grey-headed Flying-fox - 80.67ha

8.3 Indirect impacts

This section details potential indirect impacts associated with the construction and operation of the proposal following the implementation of proposed avoidance and minimisation measures. The likely extent and nature of these impacts is discussed in further detail below in relation to each element of the proposal.

8.3.1 Collision and barotrauma risk (microchiropteran bats)

The project has the potential to cause indirect impacts to the identified threatened microbats recorded within the development footprint. Impacts to loss of breeding and foraging habitat are addressed as part of indirect impacts, however there are also potential operational phase impacts associated with blade strike and barotrauma. The assessment has confirmed that the project is not likely to result in any significant or serious and irreversible impacts to threatened microbats due to potential indirect impacts associated with collision risk or barotrauma.

There are no known maternity roost sites for threatened bats within the development footprint. However there is a known winter roost for Large Bent-winged Bat at Timor Caves, approximately 5.2km from the development footprint and the nearest wind turbine (WP23). The project is also located within 150-280km to the south and east of four known maternity roosts for Large-eared Pied Bat, which are known to disperse around 200km from these maternity roosts. As no maternity roosts will be impacted, the project is not considered to result in an impact to the lifecycle or population dynamics of threatened microbat species.

The assessment of bat activity at canopy height and rotor swept height indicates that there is a relatively low potential for microbats to forage in areas subject to collision risk with blades. Based on the data obtained on this site, it is considered likely that the species are more likely to forage directly above the canopy or closer to the ground. There is limited published data on the heights that microbats will fly and forage. It is generally understood that they will fly above the canopy while foraging. A study by Mills and Pernay (2017) recorded very low levels of Eastern Bent-wing Bats flying at 100m above ground level, only where there was a relatively higher call detection at ground level. In sites where there were lower calls detected at ground level, Mills and Pernay (2017) did not record any Eastern Bent-wing bats flying at the 100m height range.

The spacing of wind turbines will also allow for substantial locations for migrating and foraging bats to pass through the landscape, with spacing ranging from 300m to over 500m between turbines. The layout also retains areas of preferred foraging habitat in steeper areas of terrain, with more densely vegetated gullies. The layout of the turbines are on areas of more elevated terrain, providing increased clearance from the

An Operational Bird and Bat Management Plan will be prepared prior to construction to assess any bat mortality and to continually assess the assumptions of this impact assessment and enable adaptive management measures to be implemented if required to reduce measured impacts. The plan will include methods for monitoring bat mortality, acceptable thresholds for mortality and adaptive management regimes if thresholds are exceeded.

8.3.2 Collision risk (birds)

The SEARs and the BAM require an impact assessment to migratory species and any resident raptors that may be subject to indirect impacts associated with blade strike during the operational phase of the project. The results of the bird utilisation survey and the Collision Risk Model (**Appendix D**) indicate that there are no migratory bird species at risk of collision with turbines during the operation of the wind farm. Three resident raptors were identified, including Wedge-tailed Eagle, Nankeen Kestrel and Brown Goshawk.

Using additional site based information from field surveys, as well as literature reviews, population estimates were able to be obtained for Wedge-tailed Eagle and Nankeen Kestrel to inform a more detailed assessment of the significance of impacts to these species. Based on this assessment it is considered unlikely that the project will have a significant impact on the population of resident raptors.

Cherriman (2007) provided an overview of studies that have investigated the size of Wedge-tailed Eagle territories in temperate regions. Territory sizes in studies near Perth (Cherriman 2007); at two other sites in the south-east of Western Australia (Ridpath and Brooker 1987); near Canberra in south-eastern Australia (Leopold and Wolfe 1970); and, in South Australia (Rowe et al. 2017) were all between 31 km² and 42 km². Foster and Wallis (2010) studied the species west of Melbourne and recorded nearest-neighbour distances averaged 4.7 kilometres. In a study in western NSW, Sharp et al. (2001) found the mean distance to nearest neighbour between Wedge-tailed Eagle nests was in the order of 1 pair per 3–9 km². They noted this was considerably higher than that noted in other semi-arid zone studies (~1 pair per 40–48 km²).

Using a conservative mean Wedge-tailed Eagle territory size of 30 km², the average diameter of a territory would be slightly greater than 12 kilometres. As a consequence, we have based the modelling exercise for Wedge-tailed Eagles on the assumption that the 26 kilometre linear array of the proposed wind farm may intersect with three territories, occupied by six adult birds.

Cherriman (2013) reported that breeding productivity (number of chicks fledged) was 0.73 young per pair, across 15 occupied territory-years. Debus et al. (2007) recorded very similar results with 10 young produced in 12 pair-years, equating to 0.8 young fledged per pair per year. On the basis of those studies, we have conservatively assumed that, on average, three pairs will be accompanied by a total of three flying juveniles, bringing the average site-population of Wedge-tailed Eagles to a total of 9.

During field investigations of the site, field staff documented one instance each in which three, four and five Wedge-tailed Eagles were observed simultaneously.

Informed assumptions were able to be developed and employed for the potential site-population sizes of Nankeen Kestrels and Wedge-tailed Eagles and this permitted the model to provide projections expressed as average numbers of potential collisions per annum for those two species. Depending upon avoidance capacity and all other assumptions used for Nankeen Kestrels the model returned a likely range of between 0.07 and 0.36 collisions for that species per annum.

Under the same caveats for Wedge-tailed Eagles, the likely range was between 0.98 and 5.86 collisions per annum.

Collision risks to birds will be mitigated under the Operational Bird and Bat Management Plan.

8.3.3 Disturbance of habitats from noise and light

Habitats within and adjacent to the development footprint are likely to be subject to some increased disturbance from noise and light, primarily during the construction phase of the project. Noise and light impacts during operation will be negligible, with limited impacts to native fauna from the operation of the wind turbines. There may be some minor impacts associated with lighting of access tracks, site offices and other ancillary sites during operation, however these can be mitigated through lighting design measures.

The majority of the threatened fauna that have been identified to be potentially impacted by the project are nocturnal, so measures to manage noise and light from construction at night will be implemented. Aviation hazard lighting is not expected to have an impact on nocturnal fauna using the habitats within and adjacent to the development footprint. Considering the high elevation of the turbines and implementation of shields, any light spill is unlikely to occur below the tree canopy impacting on the behaviour of any terrestrial or arboreal fauna.

8.3.4 Disturbance from weeds, pests and pathogens

There is the potential for weeds and pathogens to be introduced and spread during construction as a result of machinery movements and increased foot traffic.

Works associated with the proposed road upgrades on the haul route are considered low risk as these will be limited to the road corridor where lands are already subject to disturbance from adjacent transport activities.

Pathogens, including Root Rot *Phytophthora cinnamomic*, Myrtle Rust *Austropuccinia psidii* and Chytrid Fungus *Batrachochytrium dendrobatidis*, have the potential to be introduced to the site during construction and, if so, terrestrial and aquatic habitats within the development site could be impacted. Mitigation measures to control the spread of weeds, pests and pathogens will be detailed in a Biodiversity Management Plan.

8.4 Waterway crossings

A desktop assessment was carried out to identify and map aquatic habitat values and potentially occurring threatened aquatic species for the development footprint. The assessment incorporated the review of relevant spatial datasets and documentation as outlined in Section 1.6 of this document, and was supported by general observations of aquatic values during fieldwork.

There is no suitable habitat for any threatened aquatic species within the development footprint and any indirect impacts are not considered likely to result in any impacts to potential habitat downstream.

Streams identified for the study area were classified according to the Strahler (1952) stream ordering system. Riparian buffers were identified and mapped for each stream in accordance with Appendix 3 of the BAM. The majority of the streams within the development footprint for the turbines, internal roads, transmission line and access tracks are first order streams being located high in the catchment. There is limited value for any aquatic threatened species within these environments and no targeted surveys for aquatic species were required under the BAM.

There are 15 locations that require upgrades of creek crossings along the transport haul route. In these locations there is an existing crossing structure that is likely to require upgrading to allow for the safe transport of turbine infrastructure, raising the vertical clearance of the crossing to allow clearance of long elements such as turbine blades.

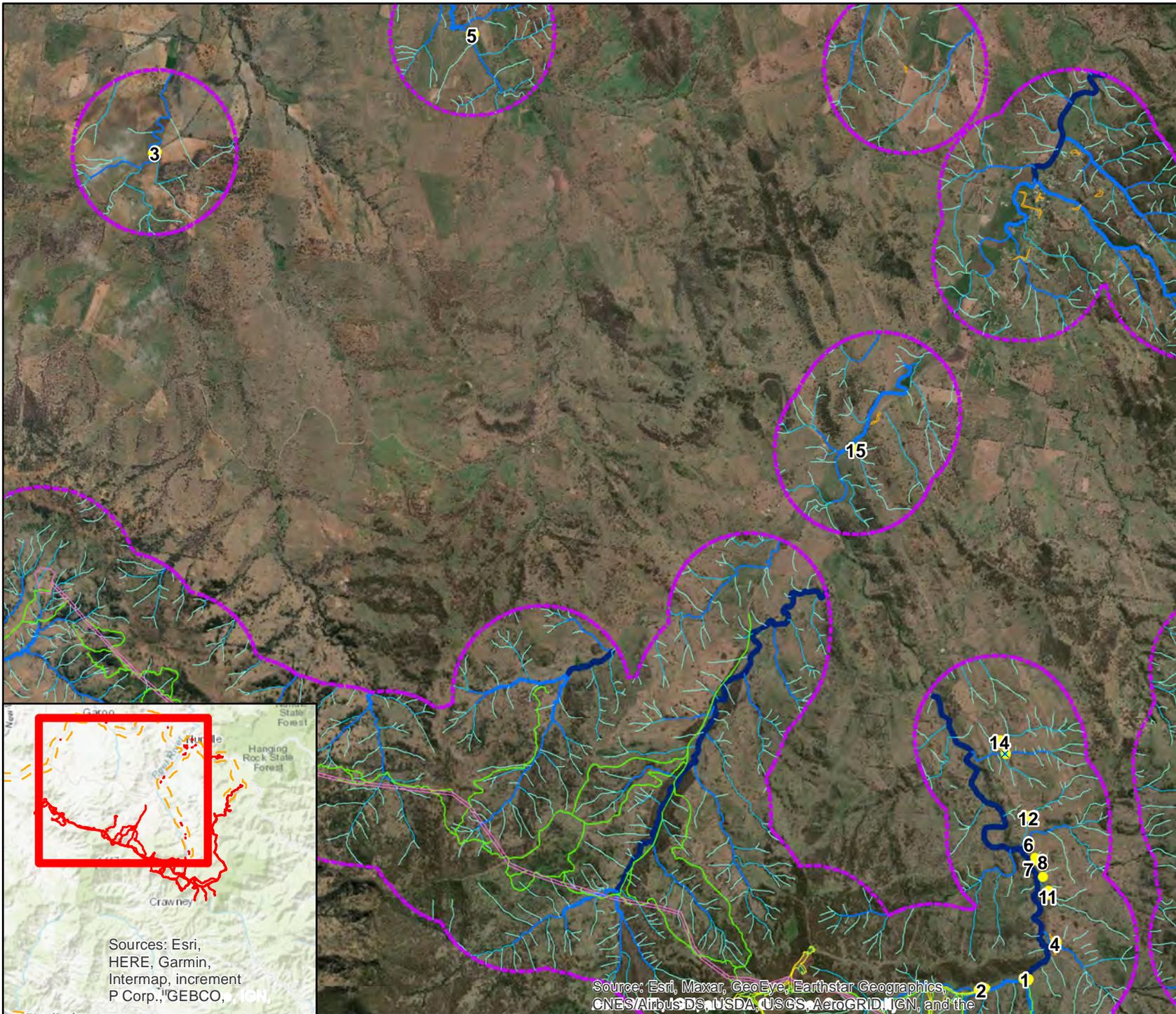
Where there is an existing bridge that has been identified for upgrades, the works will generally include additional strengthening to accommodate additional weight or widening. This may involve new foundations, piers and carriageway with these works resulting in minimal impacts to the existing waterway channel. A similar approach will be adopted for any existing culverts that are required to be strengthened.

Where there is an existing causeway, additional assessment will be required during detailed design to determine if any upgrade works are required. If the causeway crossing is suitable for the transport requirements no works will be completed. If added vertical clearance is required a culvert will be the likely crossing structure. A summary of the existing crossing locations which may potentially require upgrades subject to further assessment, and the type of fish habitat for each crossing is provided in **Table 39**.

Table 39: Assessment of fish habitat class at waterway crossings

Site number	Crossing location and existing structure type	Stream order	Fish habitat class
1	Woodleys Creek 2 Causeway	4	Class 2
2	Woodleys Creek 1 Causeway	3	Class 2
3	Goonoo Goonoo Creek crossing, Lindsay's Gap Road, Garoo Bridge	3	Class 2
4	Head of Peel Bridge	3	Class 2
5	Middlebrook Creek crossing, Lindsay's Gap Road, Garoo Bridge	3	Class 2

Site number	Crossing location and existing structure type	Stream order	Fish habitat class
6	Wardens Brook, Head of Peel Road, Nundle Causeway	3	Class 2
7	Tributary of the Peel River, Head of Peel Road, Nundle Causeway	1	Class 3
8	Tributary of the Peel River, Head of Peel Road, Nundle Causeway	1	Class 3
9	Tributary of the Peel River, Head of Peel Road, Nundle Causeway	1	Class 3
10	Tributary of the Peel River, Head of Peel Road, Nundle Causeway	1	Class 3
11	Tributary of the Peel River, Head of Peel Road, Nundle Causeway	2	Class 3
12	Tributary of the Peel River, Head of Peel Road, Nundle Causeway	2	Class 3
13	Tributary of the Peel River, Head of Peel Road, Nundle Causeway	3	Class 3
14	Tributary of the Peel River, Head of Peel Road, Nundle Causeway	2	Class 3
15	Tributary of the Peel River, Head of Peel Road, Nundle Causeway	2	Class 3



	Waterway crossing locations
	Transport route (port to site)
	Wind farm infrastructure
	Transmission line and switching
	Internal roads
	Transmission line access tracks
	Landscape assessment buffer (study area)

Streams

Strahler stream order

	1
	2
	3
	4
	5

D1	16/10/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

0.0 0.375 0.75 1.5 2.25 3 3.75 4.5

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

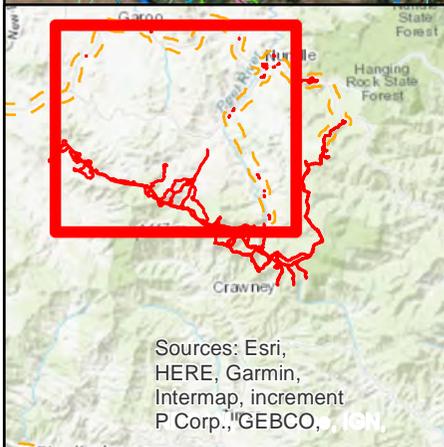
Job Title
Hills of Gold Wind Farm

Drawing Title
Waterway crossing locations

Scale at A4 1:100,000	Drawing Status Final
---------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No 019
----------------------------	--------------------------



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

I:\270335\270335-00 Hills of Gold\Work\mxd\Design\GIS\Figures\Draft\BOAR_June2020\Draft\Figures_revised.mxd

8.5 Cumulative impacts

An assessment of proposed and current wind farm projects within a 200km buffer of the project site has been carried out to provide a summary of potential cumulative impacts to biodiversity (**Table 40**). The summary chapters for biodiversity from each of these projects EIS or the scoping report was reviewed to gain an understanding of the main biodiversity impact and how these may contribute to cumulative impacts when considering the development of the Hills of Gold Project.

Table 40: Cumulative impacts from wind farms in the region.

Project, description and location	Potential biodiversity impacts	Relevance to Hills of Gold
Kyoto Energy Park 47km away 42 wind turbines, solar photovoltaic array and mini hydro plant EIS chapter reviewed.	<ul style="list-style-type: none"> - No threatened flora - 5.9 ha of impact to White Box-Yellow Box-Blakelys Red Gum TEC - Seven threatened fauna species, comprised of birds and microbats with lower terrestrial fauna diversity than the Hills of Gold project. - Potential Koala habitat, but no records or sign of activity during field surveys - Wedge-tailed Eagle and Nankeen Kestrel identified in collision risk. 	<p>A test of significance under the now repealed <i>Threatened Species Conservation Act 1997</i> found that the project is unlikely to have a significant impact on threatened species and communities.</p> <p>An additional 5.9ha of impact to the TEC is not considered to substantially contribute to the impact assessment for impacts to this TEC for the Hills of Gold Project.</p>
Bowmans Creek Wind Farm 59 km away Desktop assessment from request for SEARs	<ul style="list-style-type: none"> - Nine PCTs mapped as being potentially impacted, with five of these being TECs 	<p>The Bowmans Creek windfarm is in a different soil landscape than the Hills of Gold Project and there is no PCTs that are common to both.</p>
Winterbourne Wind Farm 75km away Field assessment from request for SEARs	<ul style="list-style-type: none"> - Two threatened fauna species, Scarlet Robin and Spotted-tailed Quoll - Two TECs, New England Peppermint woodland and Box Gum woodland - Five non-threatened raptors at risk of blade strike, 	<p>The Winterbourne windfarm is in a different soil landscape than the Hills of Gold Project and there are few PCTs that are common to both.</p> <p>Potential impacts to Wedge-tailed Eagle as a results of collision risk, however unlikely to be significant with a similar outcome as assessed for this Hills of Gold project</p>

Project, description and location	Potential biodiversity impacts	Relevance to Hills of Gold
Liverpool Range Wind Farm 116km away	- Key impacts are to Box Gum Woodland, woodland birds, forest owls and microchiropteran bats	Assessment of collision risk for microbats determined that species unlikely to be significantly impacted by blade strike due to foraging heights within or below canopy.

8.6 MNES Significant impact assessment

A detailed assessment against the EPBC Act *Significant Impact Guideline 1.1 – MNES* is included in this section of the BDAR. The outcomes of this assessment indicate that the project has the potential to result in a significant impact to one TEC and three threatened fauna species, summarised in **Table 41**.

The following sections describe the significant impact assessment for all MNES species known or considered likely to occur in the development footprint.

Table 41: Summary of MNES assessed to have a significant impact under the EPBC Act guidelines.

TEC and EPBC Status	Extent and nature of significant impact
White Box Yellow Box Blakely's Red Gum Woodland Critically Endangered	<p>The project will result in the direct impact and loss of up to 13.33ha of this TEC within the transmission line corridor.</p> <p>Any impacts to this TEC are considered significant, as it is listed as critically endangered.</p> <p>Measures to avoid and minimise impacts to this TEC have been considered as part of the design, particularly in the selection of the preferred transmission line route.</p> <p>Additional mitigation measures to avoid impacts to the TEC will be considered and implemented where practicable during future design phases and any residual impacts will be offset. The current development footprint considers a 'worst case' clearing footprint for the transmission line easement, assessing complete clearing within the easement. Depending on the height of the towers and the topography of the easement, there will be locations where the existing eucalypt forest can be retained, while still maintaining the required safety and operational clearance to the transmission lines. This presents opportunities to further minimise the extent of clearing of this TEC during detailed design.</p> <p>As well as minimising impacts through design, site restoration and rehabilitation will utilise a species planting list drawn from this TEC where appropriate.</p>
Koala Vulnerable	<p>Given the scale of native vegetation removal required for the proposed works (> 20 hectares), the presence of Koala within the study area, and the contiguous nature of the study area with surrounding National Parks and State Forests, the EPBC Act referral guidelines classifies the vegetation within the study area as critical to the survival of the species. The referral guidelines, which are applicable to all project types, states that the proposed works has the potential for a significant impact on the species, due to the removal of greater than 20 hectares of habitat.</p> <p>The removal of 50.76 hectares of native vegetation known to support Koala may impact the species due to the removal of habitat. The federal conservation aim for the Koala includes increased vegetation recovery in regions containing fragmented Koala populations. The current population in the area is not considered to be fragmented, and the areas of habitat impacted as part of the Project are small, isolated patches or areas of edge habitat adjacent to larger contiguous areas of Koala habitat. These impacts are not considered likely to result in a long term reduction in the size of the Koala population in the region.</p>

TEC and EPBC Status	Extent and nature of significant impact
	<p>Measures to avoid and minimise impacts to critical Koala habitat have been considered during the design, especially as part of the design refinements for the wind farm resulting in a reduction of the proposed turbines from 97 to 70 and workshops to site infrastructure within cleared areas where practicable.</p> <p>Additional measures will be explored during detailed design phases to reinstate koala habitat in suitable areas as part of revegetation and landscaping works for rehabilitation of areas subject to temporary impacts.</p>
<p>Large-eared Pied Bat Vulnerable</p>	<p>The proposed works would require the removal of 60.08ha hectares of Large-eared Pied Bat habitat that likely forms a combination of roosting, breeding and foraging habitat for the species. Within this 60.08 ha of combined habitat, a total area of 23.56 ha has been mapped a breeding habitat. This habitat is defined as eucalypt forest that is within 100m of the mapped steep cliffs providing potential roosting habitat.</p> <p>From the information available, it is likely that Large-eared Pied Bat are breeding within the study area and the project avoids any direct impacts to breeding and roost sites associated with steep cliffs. The impacted breeding habitat is defined as eucalypt forest surrounding these cliffs within a 100m buffer.</p> <p>Impacts will be avoided, mitigated or offset where residual impacts would occur.</p>
<p>Spotted-tailed Quoll Vulnerable</p>	<p>In consideration of the above significant impact criteria, the proposed activity is likely to significantly impact habitat of the Spotted-tailed Quoll within the study area and wider locality.:</p> <p>The Spotted-tailed Quoll habitat within the study area is considered to be important habitat, as there is direct evidence of occupancy by the species. 25.54 hectares of this habitat is proposed to be removed as part of the project, which is likely to adversely impact Spotted-tailed Quoll habitat within the locality.</p> <p>The removal of Spotted-tailed Quoll habitat from the study area would contribute to the threats currently impacting the species (i.e. habitat loss). Impacts will be avoided, mitigated or offset where residual impacts would occur.</p>

8.6.1 Koala

Koala is listed as Vulnerable under the Commonwealth EPBC Act. It occurs from north-east Queensland to South Australia, including parts of NSW. A rapid decline in the number of individuals has been seen since European settlement, primarily due to a reduction in available good quality vegetation with appropriate canopy species suitable for supporting the species (DECC 2008).

The study area is located within the Northern Tablelands Koala Management Area (KMA), and the project will require the removal of a total of 186.73 hectares of native vegetation within the development footprint. Of this, 50.76 hectares is considered to be Koala habitat, encompassing 11 PCTs.

Potential impacts of the proposed works include removal of documented Koala feed trees within the Northern Tablelands KMA located within the study area,

including Snow Gum, Mountain Gum, Mountain Ribbon Gum, Yellow Box and Messmate (OEH 2018).

Within 10 kilometres of the development footprint, the species has been recorded seven times (EES 2020), with an additional two individuals recorded within the development footprint during the current field assessment (consisting of a mother and joey, Biosis 2019). The closest previous records of Koala occur within Ben Halls Gap Nature Reserve, which is east of, and contiguous with, the study area. Hanging Rock State Forest, Nundle State Forest, and Tomalla State Forest and Nature Reserve all lie within 20 kilometres of the study area, and contain scattered Koala records throughout (EES 2020). For the purposes of this assessment the definition of “the population” encapsulates all contiguous areas of Koala habitat into a singular spatial unit.

A detailed assessment of impacts to Koala against the significant impact guidelines is provided in **Table 42**.

Table 42: EPBC Act significant impact assessment for Koala

Criteria	Assessment response
<p>Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population?</p>	<p>The Commonwealth Species Profile and Threats Database (SPRAT) currently states that there is a data deficiency in regards to the delineation of sub-populations throughout the listed Koala's range (DAWE 2020a). Therefore, it is currently difficult to specify important populations and such a proposition must be assessed on a case by case basis, using the information available for a particular location. The extent of a sub-population is likely to be defined by significant natural or anthropogenic barriers.</p> <p>The development footprint lies approximately 100 kilometres south east of Gunnedah, a known Koala hot-spot. In Gunnedah, local records of Koala were particularly high from the 1970s to the 1990s, but began declining rapidly after multiple heat waves hit the area around 2009 (Gunnedah Shire Council 2015). Since then further impacts to Koalas such as clearing of land and vehicle strikes have further contributed to the decline of the Koala population. It is likely that the Gunnedah population would be considered an ‘important population’ of the species. Conversely, Koala records nearby the current study area are much less concentrated, and little is known about the abundance, distribution or movement patterns of Koalas in the broader area. It is unlikely that Koalas inhabiting the development footprint would be considered part of an ‘important population’ of Koalas.</p> <p>Regardless, Koalas are known to breed in the locality of the development footprint (recent record of mum and joey, Biosis 2019), and the locality is likely to be used by the species. The proposed works require impacts to 50.76 hectares of native vegetation identified as potential Koala habitat. These impacts will reduce the availability of resources within the locality.</p> <p>Given the proposed impacts occur on the edge of an extensive reserve system (greater than 3000 hectares), it is unlikely that the overall size of the existing population will diminish as a result of the works. Impacts to Koala habitats impacted within the development footprint are also to largely fragmented patches located within a matrix of agricultural land. There are no large, intact areas of Koala habitat proposed to be impacted and the project will not cause any permanent barriers to Koala movement within or through the development footprint. Overall, it is unlikely that</p>

Criteria	Assessment response
	the proposed works will lead to a long-term decrease in the size of an important population.
Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?	<p>Koalas occurring in and nearby the development footprint are not considered to form part of an 'important population' of Koalas.</p> <p>The proposed works require impacts to 50.76 hectares of native vegetation identified as potential Koala habitat. These impacts will reduce the availability of resources within the locality. Whilst impacts to these areas may restrict the expansion of the existing Koala population, given the proposed impacts occur on the edge of an extensive reserve system (greater than 3,000 hectares), it is unlikely that the overall size of the existing population will diminish as a result of the works. Overall, it is unlikely that the proposed works will significantly reduce the area of occupancy of an important population.</p>
Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?	<p>Koalas occurring in and nearby the development footprint are not considered to form part of an 'important population' of Koalas.</p> <p>Within the locality of the development footprint, Koala records are scattered throughout the landscape, mostly to the north and east. Koala have been recorded within the wider study area, with previous records also occurring within Ben Halls Gap Nature Reserve, Hanging Rock State Forest, Nundle State Forest, and Tomalla State Forest and Nature Reserve, all laying within 20 kilometres of the study area (EES 2020). To the west of the development footprint however, land is largely cleared for farming, and large gaps occur between areas of native vegetation. It is likely that the development footprint falls at the western edge of the local Koala population, with Koalas mostly inhabiting the nearby nature reserves to the east.</p> <p>The proposed works require removal of 50.76 hectares of potential Koala habitat, however this habitat occurs at the western fringes of Ben Halls Gap Nature Reserve. While removal of this vegetation will reduce resources for Koala in the area, it is unlikely to fragment the local population, which most likely occurs largely east of the development footprint. Overall, it is unlikely that the proposed works will result in the fragmentation of the current existing population into two or more populations.</p>
Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?	<p>Table 4 of the EPBC Act referral guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) (DoE 2014) includes a habitat assessment tool for assessing habitat critical to the survival of the Koala. Impact areas that score five or more are considered to include critical habitat for the species.</p> <p>The area of the proposed works returned a score of 8, and therefore constitutes critical habitat to the survival of Koala. This score was based on the following criteria:</p> <ul style="list-style-type: none"> - Evidence of one or more Koalas within 2 kilometres of the edge of the impact area within the last 5 years (2 points). - Has forest, woodland or shrubland with emerging trees with two or more known koala food tree species (2 points). - Area is part of a contiguous landscape \geq 1000 hectares (2 points).

Criteria	Assessment response
	<ul style="list-style-type: none"> - Evidence of infrequent or irregular Koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for Koala occurrence (1 point). - Uncertain whether the habitat is important for achieving the interim recovery objectives for the relevant context (1 point). <p>The EPBC Act referral guidelines for Koala include assessment criteria under Section 7 for determining whether a proposed action including impacts to critical koala habitat requires an EPBC referral (see Figure 2: assessing adverse effects on habitat critical to the survival of the Koala). As the development footprint contains habitat classed as critical, and the impact to vegetation is more than 20 hectares, the guidelines state that the impact to Koala is most likely to be significant for the purposes of the EPBC Act.</p> <p>Given the patchy spatial arrangement of native vegetation removal required for the proposed works, the presence of Koala within the study area, the limited barriers to movement and corridors from the project and the contiguous nature of the development footprint with surrounding National Parks and State Forests, this assessment considers the proposed works unlikely to adversely affect habitat critical to the survival of the species. Regardless of this assessment, design of the proposal has sought to avoid, mitigate and where necessary offset impacts.</p>
Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?	<p>Koalas occurring in and nearby the development footprint are not considered to form part of an ‘important population’ of Koalas.</p> <p>The 50.76 hectares of vegetation being removed occurs on the fringes of native vegetation along the western side of Ben Halls Gap Nature Reserve. While Koalas are known to breed in the locality (recent record of mum and joey, Biosis 2019), it is also likely that such behaviour occurs throughout the reserve system to the north and east of the development footprint. While the removal of vegetation as part of the proposed works will reduce habitat (including breeding habitat) for Koala in the local area, the local Koalas are not considered an important population and the abundance of habitat available within the nearby reserve system would likely continue to support the breeding and population growth of the species in this area. Overall, it is unlikely that the proposed works will disrupt the population or breeding cycle of an important population of Koala.</p>
Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	<p>The proposed works will remove 50.76 hectares of potential Koala habitat from the study area. This includes removal of native trees identified as feed trees for Koala within the Northern Tablelands KMA (OEH 2018). As Koala are known to utilise the development footprint, the removal of this habitat will decrease the availability of habitat for the species within the locality. However, due to the abundance of habitat available to Koala within the nearby reserve system to the north and east, the project would not impact on the ability of the locality to continue to support the species. Overall, it is unlikely that the proposed works would cause the species to decline.</p>
Is there a real chance or a possibility that the action will result in invasive species that are	<p>Invasive species such as the European Fox <i>Vulpes vulpes</i> that may predate Koala are considered established within the region. Invasive weeds species are not known to directly harm populations of Koala but do have potential to reduce quality of habitat in the adjoining bushland and therefore increase potential to harm the population of Koala. Management measures would be prepared, implemented and audited to avoid and minimise the</p>

Criteria	Assessment response
harmful to a vulnerable species becoming established in the vulnerable species' habitat?	<p>environmental risks associated with weeds, pests and pathogens. As a minimum, these would include:</p> <ul style="list-style-type: none"> - Completion of a site weed assessment and development of a Weed Management Plan. The Weed Management Plan would sit as a sub-plan to the Environmental Management Strategy (EMS) - Implementation of appropriate weed control and weed disposal in accordance with Biosecurity protocols. - Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. - Appropriate disposal of any weed material.
Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?	<p>The proposed action will result in removal of potential habitat for Koalas within the development footprint. This impact is not likely to result in the introduction of diseases that may cause the species to decline.</p>
Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?	<p>There is no accepted or adopted national recovery plan for Koala. However, the approved conservation advice (Commonwealth of Australia 2012) gives priority to the following conservation actions:</p> <ul style="list-style-type: none"> - Develop and implement a development planning protocol to be used in areas of koala populations to prevent loss of important habitat, Koala populations or connectivity options. - Development plans should explicitly address ways to mitigate risk of vehicle strike when development occurs adjacent to, or within, Koala habitat. - Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. - Identify populations of high conservation priority. - Investigate formal conservation arrangements, management agreements and covenants on private land, and for Crown and private land investigate and/or secure inclusion in reserve tenure if possible. - Manage any other known, potential or emerging threats such as a Bell Miner Associated Dieback or Myrtle rust. - Develop and implement options of vegetation recovery and re-connection in regions containing fragmented Koala populations, including inland regions in which Koala populations were diminished by drought and coastal regions where development pressures have isolated Koala populations.

Criteria	Assessment response
	<ul style="list-style-type: none"> - Develop and implement a management plan to control the adverse impacts of predation on Koalas by dogs in urban, peri-urban and rural environments. - Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions.

8.6.2 Large-eared Pied Bat

The Large-eared Pied Bat is a medium-sized insectivorous bat measuring a total length of approximately 100 millimetres and weighing 7–12 grams (Hoye and Dwyer 1995). The species is listed as Vulnerable under the BC Act and the EPBC Act. The species' current distribution is poorly known. Records exist from Shoalwater Bay, north of Rockhampton, Queensland, through to the vicinity of Ulladulla, NSW in the south (Hoye 2005). Despite the large range, it has been suggested that the species is far more restricted within the species' range than previously thought (DECC 2007). Much of the known distribution is within NSW. Available records suggest that the largest concentrations of populations appear to be in the sandstone escarpments of the Sydney basin and the north-west slopes (Coolah Tops, Mt Kaputar, Warrumbungle National Park and Pilliga Nature Reserve. Although the species is widely distributed, it is uncommon and patchy within this area (DERM 2011).

The species requires a combination of sandstone cliff/escarpment to provide roosting habitat that is adjacent to higher fertility sites, particularly box gum woodlands or river/rainforest corridors which are used for foraging (TSSC 2012). Almost all records have been found within several kilometres of cliff lines or rocky terrain (Hoye 2005). Roosting has also been observed in disused mine shafts, caves, overhangs and disused Fairy Martin *Hirundo ariel* nests (Hoye and Dwyer 1995).

Known breeding locations are extremely limited within NSW. Five locations are known to have been used for breeding within NSW, including:

- A mine tunnel at Copeton which was used for breeding until flooded by dam waters in 1976 (Dwyer 1966).
- A sandstone cave near Coonabarabran, NSW (Pennay 2008).
- Capture of lactating females adjacent to sandstone cliffs in Ulan, NSW (Fly By Night 2005).
- Observations of small groups of females in a disused gold mine near Barraba, NSW (DERM 2011).
- Anecdotal observations of small groups of females and young bats in the sandstone Pilliga region, NSW (DERM 2011).

The maternity site at Barraba lies approximately 150 kilometres north of the current study area, while the maternity site at Coonabarabran lies approximately 185 kilometres west. Post-lactating females have also been recorded approximately 16 kilometres south west of the study area near Murrurundi.

The structure of maternity roosts appears to be very specific (arch caves with dome roofs). Caves need to be high and deep enough to allow juvenile bats to learn to fly safely inside and have indentations in the roof. Roosting bats cluster in these indentations, presumably to allow the capture of heat. These physical characteristics are very uncommon in the landscape and their scarcity presumably poses an important limiting factor in the distribution of the Large-eared pied bat (Pennay 2008). No maternity roosts were identified within or adjacent to the development footprint or the 1,500m landscape buffer study area, as part of the desktop and field investigations completed for this project.

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

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

To date, there have been no genetic studies undertaken on the Large-eared Pied Bat. Movement of this species between areas has not been recorded and its dispersal ability and habits are not known (DERM 2011). Thus, it is difficult to define 'populations' of the species.

The closest previous records of Large-eared Pied Bat occur approximately 16 kilometres south west of the study area, nearby Murrurundi (EES 2020). These sightings recorded post-lactating females, indicating that breeding of the species likely occurs within the locality. The species was also recorded in 10 different locations on an ultrasonic acoustic device within the study area during the current assessment, likely using vegetation within the development footprint for foraging. Further previous records of the species lie 30 kilometres north west of the study area, near Quirindi. As the morphology of the species suggests that individuals do not disperse over large distances like similar species (DERM 2011), for the purposes of this assessment individuals occurring within the development footprint and nearby in Murrurundi and Quirindi are considered to make up the local population.

The proposed works will likely result in the loss of 61.08 hectares of potential Large-eared Pied Bat habitat in the form of vegetation communities that are associated with the species foraging requirements, nearby caves, cliffs and rocky areas. The project will not result in any direct impacts to roosting caves or cliffs being mapped and protected by a 100m buffer. This habitat has the potential to contribute to local breeding habitat for this species and across the study area there is 23.56ha of impact to vegetation within this 100m buffer. This breeding habitat is wholly contained within the 61.08ha of potential foraging habitat. This impact to the 100m buffer around mapped cliffs is a result of earthworks required for the

internal roads network, with the majority of wind turbines being located outside this 100m buffer. Opportunities to carry out native planting as part of site rehabilitation works on earthworks batters will minimise some of the impacts associated with vegetation clearing within the 100m buffer area to roosting habitats.

It should be noted that although impacts to microbats via blunt force trauma or barotrauma from wind turbines is one of the environmental risks associated with wind farms, Large-eared Pied Bat forage for small flying insects below the forest canopy (OEH 2017), and are considered unlikely to be at risk of turbine strike due to the unlikelihood of the species foraging nearby the turbines. The main impact for this species associated with the project is loss of potential foraging habitat only, with breeding and roost sites being protected.

A detailed assessment of impacts to Large-eared Pied Bat against the significant impact guidelines is provided in **Table 43**.

Table 43: EPBC Act significant impact assessment for Large-eared Pied Bat

Criteria	Assessment response
<p>Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population?</p>	<p>Information about the size, distribution and interactions of Large-eared Pied Bat populations is largely unknown. No populations have been defined as 'important populations' for the species. The largest concentration of records for this species appears to be in the sandstone escarpments of the Sydney basin, and northwest slopes of NSW. Important populations are likely to occur at the edge of the species range, for example in the sandstone escarpments of Morton National Park at the southern end of its range (DERM 2011).</p> <p>The local population, defined from nearby records, does not occur at the edge of the species' range in NSW, however it does occur at the eastern edge of the species range in the regional area. While the species has been recorded abundantly within the Pilliga to the west of the study area, no records of the species occur from the development footprint east to the coast. Due to the very few known breeding locations of the species, the record of nearby post-lactating females, and the occurrence of the development footprint at the edge of the regional occurrence of individuals, it is likely that the local population of Large-eared Pied Bat is an important population.</p> <p>The species is known to roost in sandstone caves and travel down to nearby fertile wooded valleys to forage. The proposed works are likely to result in direct impact (via removal) of approximately 61.08 hectares of Large-eared Pied Bat habitat in the form of vegetation associated with the species that occurs nearby caves, cliffs and rocky areas. This habitat is considered to be predominantly potential foraging habitat for the species.</p> <p>Of this 61.08ha, a buffer of 23.56ha of native vegetation has been mapped around potential roost or breeding sites associated with steep cliffs in the development footprint. There will be some impacts to the buffering vegetation around roosting and breeding sites, but no direct impacts to these steep cliffs. Where impacts to this 60.18ha of foraging habitat is within areas subject to temporary impacts as a result of earthworks for internal roads, site rehabilitation works will reduce the severity of this loss by reestablishing native vegetation cover.</p> <p>From the information available, it is likely that Large-eared Pied Bat are breeding within the locality of the development footprint. The project will</p>

Criteria	Assessment response
	not result in any direct impacts to breeding or roosting habitats, with appropriate buffers provided to these areas. As such, the project is not considered likely to cause a long-term decrease in population size.
Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?	As above, it is likely that Large-eared Pied Bat are breeding within the locality of the development footprint, due to the abundance of rocky escarpment and caves, and nearby records of post-lactating females. Due to the rarity of such sites in the landscape, it is considered that the destruction of a maternity roost site for this species would lead to a reduction in the area of occupancy of the current important population, through removal of critical habitat and interruption to the breeding cycle. However, as the project will not directly impact any known maternity roosts a reduction in the area of occupancy for Large-eared Pied Bat is unlikely.
Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?	The native vegetation to be removed and land proposed to be removed as part of the proposed project lies on the western edge of Ben Halls Gap Nature Reserve. Land to the west of the development footprint contains large cleared areas with scattered remnant vegetation. The removal of 61.08 hectares of potential Large-eared Pied Bat foraging habitat from the development footprint is unlikely to fragment the existing local population of Large-eared Pied Bat, as the species is mobile and would still be able to use habitat located in the Nature Reserve to the east, and on nearby farmland.
Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?	<p>Habitat critical to the survival of the species is defined as (DERM 2011):</p> <ul style="list-style-type: none"> - Maternity roosts. - Sandstone cliffs and fertile wooded valley habitat within close proximity of each other. <p>The current project proposes the removal of 61.08 hectares of potential Large-eared Pied Bat foraging habitat, consisting of wooded habitat adjacent to cliffs. There will be no direct impacts to cave, cliffs or roosting habitat and there are no know maternity roosts impacted by the project. The majority of the impacts to Little-eared Pied Bat habitat will be to foraging habitat and there will be no direct impacts to any caves or potential breeding habitat. The removal of this potential foraging habitat is not considered to adversely affect habitat critical to the survival of Large-eared Pied Bat.</p>
Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?	As above, there is potential for Large-eared Pied Bat are breeding within the locality of the development footprint, due to the abundance of rocky escarpment and caves, and nearby records of post-lactating females. The project will not result in any direct impacts to this habitat type and disruption to the breeding cycle is unlikely.
Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or	<p>The proposed works will likely result in the removal of 61.08 hectares of potential Large-eared Pied Bat foraging habitat in the form of wooded areas nearby cliffs, and potential caves that provide roosting and breeding habitat.</p> <p>Wooded areas nearby cliffs are considered critical to the survival of the species. It is considered likely that Large-eared Pied Bat are breeding within the locality of the development footprint, however any potential maternity roosts will not be directly impacted. The loss of 61.08 hectares</p>

Criteria	Assessment response
quality of habitat to the extent that the species is likely to decline?	of potential foraging habitat does not result in a substantial reduction in foraging habitat for this species given the availability of this habitat type in adjacent areas, including protected area reserves.
Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	<p>There is potential for the introduction of weeds, pests or pathogens as a result of the proposed works, via movement of vehicles and plant, and increase in foot traffic. However, management measures would be prepared, implemented and audited to avoid and minimise the environmental risks associated with weeds, pests and pathogens. As a minimum, these would include:</p> <ul style="list-style-type: none"> - Completion of a site weed assessment and development of a Weed Management Plan. The Weed Management Plan would sit as a sub-plan to the EMS. - Implementation of appropriate weed control and weed disposal in accordance with Biosecurity protocols. - Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. - Appropriate disposal of any weed material. - Implementation of appropriate hygiene protocols where there are potential or known pathogen risks.
Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?	<p>The IUCN Species Survival Commission released a statement on 19 June 2020 stating that there is a credible risk of human-to-bat transmission of SARS-Cov-2, a virus currently circulating the globe and causing a pandemic of the illness Covid-19 (IUCN SSC 2020). However, introduction of this disease to Large-eared Pied Bats within the development footprint as a result of the proposed works is unlikely for the following reasons:</p> <ul style="list-style-type: none"> - The project will implement measures to minimise the risk of Covid-19 spread among the workforce as required. - No contact or sharing of closed areas between humans and bats is expected as a result of the proposed works. - If further microbat trapping or survey is undertaken by an ecologist as part of the proposed project, the recommendations provided by the IUCN will be followed, including the wearing of a face mask by the ecologist, and avoidance of handling of any microbats. <p>The transmission of SARS-Cov-2 is considered unlikely as a result of the proposed works.</p>
Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?	<p>The following recovery objectives have been specified within the National recovery plan for the Large-eared Pied Bat:</p> <ul style="list-style-type: none"> - Identify priority roost and maternity sites for protection. - Implement conservation and management strategies for priority sites. - Educate the community and industry to understand and participate in the conservation of the Large-eared Pied Bat.

Criteria	Assessment response
	<ul style="list-style-type: none"> - Research the Large-eared Pied Bat to augment biological and ecological data to enable conservation management. - Determine the meta-population dynamics throughout the distribution of the Large-eared Pied Bat. <p>One of the recovery actions stated under these objectives is the protection of known roosts and associated foraging habitats and management of threats. As approximately 61.08 hectares of potential Large-eared Pied Bat foraging habitat is proposed to be removed as part of the project. The project will not impact on any priority roost sites or maternity sites, so it is unlikely that the project will substantially interfere with the recovery of Large-eared Pied Bat.</p>

8.6.3 Spotted-tailed Quoll

The Spotted-tailed Quoll is listed as Endangered under the EPBC Act. The Spotted-tailed Quoll is a nocturnal, cat-sized, carnivorous marsupial with reddish-brown fur and distinctive white spots over its back and tail (OEH 2019).

The species was previously widely distributed from south-east Queensland, eastern NSW, Victoria, south-east South Australia and Tasmania (Jones 2001). The subspecies' mainland range is now considered to have reduced by 50–90% (Jones 2001). However, detailed distribution records and abundance estimates are generally lacking due to the scale and intensity of surveying that is required to detect the species across its entire range (DAWE 2016).

The Spotted-tailed Quoll has a preference for mature wet forest habitat, especially in areas with rainfall 600 mm/year (McKay 2008). Unlogged forest or forest that has been less disturbed by timber harvesting is also preferable. The Spot-tailed Quoll is predominantly nocturnal and rests during the day in dens (Jones 2001). Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves (OEH 2019). Individuals also require an abundance of food, such as birds and small mammals, and large areas of relatively intact vegetation through which to forage (DAWE 2020c). This subspecies is moderately arboreal and approximately 11% of travelling is done in trees (Jones 2001). The Spotted-tailed Quoll occupy large home ranges, with females occupying 200 – 500 hectares, while males can occupy from 500 to over 4000 hectares (OEH 2019).

The Spotted-tailed Quoll has previously been recorded within and adjacent to the development footprint, including during the current assessment. In 2019 a roadkill individual was located within the Ben Halls Gap State Forest adjacent the study area, and another individual was recorded on a camera trap within the study area. Hanging Rock State Forest, Nundle State Forest, and Tomalla State Forest and Nature Reserve all lie within 20 kilometres of the development footprint and contain scattered previous Spotted-tailed Quoll records throughout (EES 2020). For the purposes of this assessment the definition of “the local population” encapsulates all contiguous areas of this Spotted-tailed Quoll habitat into a singular spatial unit.

The local population of Spotted-tailed Quolls occurring within and nearby the development footprint is not considered to be an ‘important population’ of the species. There are currently 10 populations within NSW that are defined as ‘important populations’ of the species, with the closest populations to the study area occurring approximately 40 kilometres south east in Barrington Tops, and 80 kilometres north east in Walcha (DAWE 2016).

Potential Spotted-Quoll habitat occurs throughout the development footprint in the form of eucalypt woodland, rocky outcrops, caves, logs and tree hollows. Approximately 25.54 hectares of Spotted-tailed Quoll habitat will be removed as part of the proposed works. This habitat is comprised of the PCTs identified in Bionet, assessed as having high and moderate condition levels.

A detailed assessment of impacts to Spotted-tailed Quoll against the significant impact guidelines is provided in **Table 44**.

Table 44: EPBC Act significant impact assessment for Spotted-tailed Quoll

Criteria	Assessment response
Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population?	<p>The local population of Spotted-tailed Quolls occurring within and nearby the development footprint is not considered to be an ‘important population’ of the species.</p> <p>Habitat within the development footprint is known to be used by Spotted-tailed Quoll. The removal of 25.54 hectares of potential Spotted-tailed Quoll habitat from the study area, including potential den sites, is unlikely to limit the habitat available to the local population.</p> <p>As the population is not considered to be an ‘important population’ under the EPBC Act this impact is not considered to be significant.</p>
Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?	<p>As above, habitat within the study area is known to be used by Spotted-tailed Quoll. The removal of 25.54 hectares of potential Spotted-tailed Quoll habitat from the study area, is unlikely to reduce the area of occupancy of the local population, as they will still be able to move through the relatively narrow linear development footprint.</p> <p>Spotted-tailed Quoll requires large home ranges, with female home ranges generally not overlapping. 25.54 hectares of habitat is not considered substantial, and the loss of this area is unlikely to limit individuals such that inadequate land is available to them, and they are unable to persist.</p> <p>As the population is not considered to be an ‘important population’ under the EPBC Act this impact is not considered to be significant.</p>
Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?	<p>As the development footprint occurs on the western edge of Ben Halls Gap Nature Reserve, habitat in the form of eucalypt woodland and rocky outcrops is proposed to be removed mostly along the edges of remnant vegetation. Clearing in this spatial arrangement it will not cause novel fragmentation that would split the local population into two or more populations.</p> <p>Further, as noted above, the local population is not considered to be an ‘important population’ under the EPBC Act.</p>
Is there a real chance or a possibility that the action will adversely affect	<p>Habitat that is critical to the survival of the Spotted-tailed Quoll includes large patches of forest with adequate denning resources and relatively high densities of medium-sized mammalian prey (DAWE 2016). However, the threshold densities of these critical components required to support quoll populations are unknown. Consequently it is currently not possible to</p>

Criteria	Assessment response
habitat critical to the survival of a species?	<p>define (or map) habitat critical to the survival of the Spotted-tailed Quoll. The Recovery Plan states that given the threatened status of the Spotted-tailed Quoll, all habitats within its current distribution that are known to be occupied are considered important (DAWE 2016).</p> <p>25.54 hectares of Spotted-tailed Quoll habitat is proposed to be removed as part of the project, including intact vegetation. Den sites, including rocky outcrops and large tree hollows will be retained. It is unlikely that the proposed works will adversely affect Spotted-tailed Quoll habitat, through direct removal of vegetation. Accordingly, design of the proposal has sought to avoid, mitigate and where necessary offset impacts.</p>
Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?	<p>Potential Spotted-tailed Quoll breeding habitat has the potential to be removed from the study area as part of the proposed works, including rocky outcrops, tree hollows and logs. Due to the reserve system directly adjacent the study area, encompassing Ben Halls Gap Nature Reserve, Hanging Rock State Forest, Nundle State Forest, and Tomalla State Forest and Nature Reserve, it is likely that adequate den sites are located within the locality such that the breeding cycle of the local population will not be interrupted by the proposed works.</p>
Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	<p>Approximately 25.54 hectares of Spotted-tailed Quoll habitat is proposed to be removed from the development footprint as part of the proposed works. However, records of the species are scattered throughout the locality, and encompass the nearby reserve system, including the adjacent Ben Halls Gap Nature Reserve. While the proposed works would result in a reduction of habitat available to the local population, it is considered that there is adequate habitat available in surrounding farmland and nature reserves that the species is not likely to decline.</p>
Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	<p>There is potential for the introduction of weeds, pests or pathogens as a result of the proposed works, via movement of vehicles and plant, and increase in foot traffic. However, management measures would be prepared, implemented and audited to avoid and minimise the environmental risks associated with weeds, pests and pathogens. As a minimum, these would include:</p> <ul style="list-style-type: none"> - Completion of a site weed assessment and development of a Weed Management Plan. The Weed Management Plan would sit as a sub-plan to the EMS. - Implementation of appropriate weed control and weed disposal in accordance with Biosecurity protocols. - Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. - Implementation of appropriate hygiene protocols where there are potential or known pathogen risks. - Appropriate disposal of any weed material.

Criteria	Assessment response
<p>Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?</p>	<p>The proposed action will result in removal of potential habitat for Spotted-tailed Quoll within the development footprint. This impact is not likely to result in the introduction of diseases that may cause the species to decline.</p>
<p>Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?</p>	<p>The main threats to Spotted-tailed Quoll include habitat loss and fragmentation, poison baiting, predation by invasive species, deliberate killing, road mortality, poor burning regimes and climate change, among others. The National Recovery Plan for the Spotted-tailed Quoll lists the following management objectives:</p> <ul style="list-style-type: none"> - Determine the distribution and status of Spotted-tailed Quoll populations throughout the range, and identify key threats and implement threat abatement management practices. - Investigate key aspects of the biology and ecology of the Spotted-tailed Quoll to acquire targeted information to aid recovery. - Reduce the rate of habitat loss and fragmentation on private land. - Evaluate and manage the risk posed by silvicultural practices. - Determine and manage the threat posed by introduced predators (foxes, cats, wild dogs) and of predator control practices on Spotted-tailed Quoll populations. - Determine and manage the impact of fire regimes on Spotted-tailed Quoll populations. - Reduce deliberate killings of Spotted-tailed Quolls. - Reduce the frequency of Spotted-tailed Quoll road mortality. - Assess the threat Cane Toads pose to Spotted-tailed Quolls and develop threat abatement actions if necessary. - Determine the likely impact of climate change on Spotted-tailed Quoll populations. - Increase community awareness of the Spotted-tailed Quoll and involvement in the Recovery Program. <p>The proposed works would involve the removal of 25.54 hectares of potential Spotted-tailed Quoll habitat. This would directly contribute to the threat of habitat loss for the species, and interfere with the recovery management objective ‘reduce the rate of habitat loss and fragmentation on private land’. It is not considered likely that the proposed works could interfere substantially with the recovery of this species.</p>

8.6.4 Greater Glider

The Greater Glider is listed as Vulnerable under the EPBC Act. It is the largest gliding possum in Australia, with a head and body length of 35 – 46 centimetres, and a tail measuring 45 – 60 centimetres (Menkhorst & Knight 2011). The species is arboreal and nocturnal, and is mostly restricted to eucalypt forests and woodlands. It is typically found in highest abundance in tall, montane and moist eucalypt forests with old trees and abundant hollows. The species favours forests with a diversity of eucalypt species, due to the seasonal variation in its preferred tree species. During the day Greater Glider shelters in tree hollows, particularly those that are in large, old trees (McKay 2008).

The Greater Glider is found throughout eastern Australia, from the Windsor Tableland in north Queensland through to central Victoria. The broad extent of occurrence is unlikely to have changed substantially since European settlement, however the area of occupancy has decreased substantially, mostly due to land clearing (Threatened Species Scientific Committee 2016). This decline is most likely continuing due to further land clearing, fragmentation, fire and forestry activities. The species is considered to be particularly sensitive to forest clearance, logging and fire, and is slow to recover following major disturbance. The species is also considered to be sensitive to fragmentation due to a low dispersal ability, previously showing low persistence in small forest fragments (Threatened Species Scientific Committee 2016).

25 Greater Gliders were recorded within the development footprint during targeted surveys in the current assessment. Previous records of the species are also scattered throughout the adjacent Ben Halls Gap Nature Reserve (EES 2020). As Greater Glider tend to have relatively small home ranges (1 – 4 ha), for the purposes of this assessment, these records throughout the study area and adjacent reserve make up the ‘local population’. Nationally, there are no officially recognised ‘important populations’ of Greater Glider. However in NSW, there are three specific populations listed as Endangered under the BC Act (EES 2020). These are the populations of the Eurobodalla LGA, Mount Gibraltar Reserve, and Seven Mile Beach National Park which are remote from the project. It is not considered that the local population addressed in this assessment makes up an important population of the species.

Approximately 25.54 hectares of Greater Glider habitat is proposed to be removed from the development footprint as a part of the current project. This encompasses high condition eucalypt woodland, on the wind farm and internal roads development footprint.

Table 45: EPBC Act significant impact assessment for Greater Glider

Criteria	Assessment response
Is there a real chance or a possibility that the action will lead to a long-term decrease in the	The local population of Greater Glider addressed in this assessment is not considered to be an important population of the species.

Criteria	Assessment response
size of an important population?	
Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?	The local population of Greater Glider addressed in this assessment is not considered to be an important population of the species.
Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?	The local population of Greater Glider addressed in this assessment is not considered to be an important population of the species.
Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?	<p>Habitat critical to the survival of Greater Glider includes large, mature trees with hollows (for sheltering and breeding), and large remnant vegetation patches. Greater Glider are highly sensitive to fragmentation, and are generally unable to persist in small vegetation patches.</p> <p>The current project proposes the removal of approximately 25.54 hectares of Greater Glider habitat, encompassing eucalypt woodland known to support the species, and the associated hollow-bearing trees throughout. Due to the large number of Greater Glider recorded during the current assessment, this habitat appears to be highly suitable for the species. It is not considered likely that the removal of 25.54 hectares of this habitat would adversely affect habitat critical to the survival of this species. The project footprint avoids areas of higher quality, intact and large patch size vegetation with abundant hollows, which is important habitat for this species.</p>
Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?	The local population of Greater Glider addressed in this assessment is not considered to be an important population of the species.
Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that	The current project proposes the removal of approximately 25.54 hectares of Greater Glider habitat, encompassing eucalypt woodland known to support the species, and the associated hollow-bearing trees throughout. Due to the large number of Greater Glider recorded during the current assessment, this habitat appears to be highly suitable for the species. In some areas this vegetation occurs in small remnant patches within cleared areas. However, Ben Halls Gap Nature Reserve occurs directly east of the study area, and likely provides large areas of suitable habitat to the species. As Greater Glider require relatively small home ranges (1-4 hectares), it is considered that there is adequate habitat within the nearby reserve and retained within the study area to support the local population

Criteria	Assessment response
the species is likely to decline?	of Greater Gliders, and that the proposed works would not cause the species to decline.
Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	<p>Invasive weeds species are not known to directly harm populations of Greater Glider but do have potential to reduce quality of habitat in the adjoining bushland and therefore increase potential to harm the population of the species. Management measures would be prepared, implemented and audited to avoid and minimise the environmental risks associated with weeds, pests and pathogens. As a minimum, these would include:</p> <ul style="list-style-type: none"> - Completion of a site weed assessment and development of a Weed Management Plan. The Weed Management Plan would sit as a sub-plan to the EMS. - Implementation of appropriate weed control and weed disposal in accordance with Biosecurity protocols. - Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. - Appropriate disposal of any weed material at an appropriately licensed facility.
Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?	The proposed action is not likely to result in the introduction of diseases that may cause the species to decline.
Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?	<p>The national conservation advice for Greater Glider lists the primary conservation objectives for the species as:</p> <ul style="list-style-type: none"> Manage threats to secure or increase overall population size. Maintain viable populations at all known localities. <p>While the proposed removal of 25.54 hectares of Greater Glider habitat will not contribute to the recovery of the species, it is not considered likely to substantially interfere with the recovery of the species for the following reasons:</p> <ul style="list-style-type: none"> - Ben Halls Gap Nature Reserve occurs directly east of the development footprint, and likely contains large areas of high quality habitat for the species. This habitat is considered adequate such that the loss of 25.54 hectares of habitat within the study area would not reduce the local population size, or decrease the viability of the local population. There is also large areas of suitable Greater Glider habitat retained within the study area. - As part of the project, pre-clearance assessments would be undertaken and clearing of hollow-bearing trees would be supervised by an ecologist, and any Greater Gliders utilising the habitat being removed from the study area would be captured and relocated. Due to the large

Criteria	Assessment response
	<p>areas of suitable habitat nearby (i.e. within the reserve system), it is likely that displaced individuals would be successfully relocated, assuring that the local population would not decrease in numbers as a result of the proposed works.</p>

8.7 Mitigating and managing impacts

Table 46 identifies proposed measures to further mitigate and manage unavoidable impacts to biodiversity, following all efforts to avoid and minimise undertaken to date.

Table 46: Proposed mitigation measures

ID	Impact	Proposal area	Mitigation measures	Timing	Responsibility
B1	General	Entire development footprint	An Environmental Management Strategy (EMS) will be prepared and implemented, including industry standard measures for the management of soil, surface water and pollutants, weeds, pests and pathogens, as well as site-specific measures and relevant sub-management plans. Relevant sub-plans specific to the management of biodiversity are a Biodiversity Management Plan, Weed Management Plan and Bird and Bat Management Plan.	Pre-construction/ construction	Contractor
B2		Entire development footprint	All site workers would be trained to ensure awareness of requirements of the EMS (B1), relevant sub-plans and statutory responsibilities. Site-specific training would be provided when specific work activities were taking place near areas of identified biodiversity value that are to be protected.	Construction	Contractor
B3	Clearing of native vegetation, threatened ecological communities and habitat for threatened flora and fauna	Entire development footprint	Prepare and implement a biodiversity offset strategy, in accordance with the requirements of the BC Act and the EPBC Act Offsets Policy.	Pre-construction	Proponent
B4	Direct impacts to native vegetation	Entire development footprint	Opportunities to further minimise impacts to native vegetation will continue to be explored during the detailed design. This would include measures to minimise the construction footprint and clearing requirements with a particular focus on the protection of hollow bearing trees and fauna movement corridors.	Pre-construction	Proponent
B5	Impacts to native vegetation, threatened	Entire development footprint	Opportunities to further minimise impacts to native vegetation will continue to be explored during the detailed design. This would include	Pre-construction/ construction	Contractor

ID	Impact	Proposal area	Mitigation measures	Timing	Responsibility
	ecological communities and habitat for threatened species		<p>measures to minimise the construction footprint and clearing requirements with a particular focus on the protection of hollow bearing trees and fauna movement corridors.</p> <p>Upon final design and an understanding of detailed impact, a Biodiversity Management Plan would be prepared and implemented. It would address terrestrial and aquatic matters by including:</p> <ul style="list-style-type: none"> • Plans for the development site and adjoining area showing updated and current extents of native vegetation, flora and fauna habitat, threatened species and threatened ecological communities and measures to minimise impacts to these features. • Plans showing areas to be cleared and areas to be protected, including exclusion zones and protected habitat features, and areas for native vegetation rehabilitation or re-establishment. • Mapping and identification of individual tree hollows and termite mounds and measures to minimise impacts to these features; • Process for communicating biodiversity features to the design team during any turbine micro-siting and design refinements to minimise and avoid impacts. • Pre-clearing protocols, including pre-clearing inspections, establishment of exclusion zones and on-ground identification of specific habitat features to be retained and/ or relocated. • Vegetation clearing protocols, including staged habitat removal and any specified seasonal limits on clearing activities. • Protocols for the salvage and relocation of woody debris, tree hollows and bush rock. • Requirements for temporary fencing to minimise the risk of fauna injury / mortality due to vehicle strike or entrapment in deep excavations. • Proposed temporary measures for maintaining habitat connectivity for koala and other fauna during construction. • Fauna handling and unexpected threatened species finds procedures. 		

ID	Impact	Proposal area	Mitigation measures	Timing	Responsibility
			<ul style="list-style-type: none"> Rehabilitation, revegetation, reuse of soils and other habitat management actions. Weed, pest and pathogen management requirements Monitoring during construction and post-construction Adaptive management measures to be applied if monitoring indicates unexpected adverse impacts. 		
B6	Impacts to threatened flora	Entire development footprint	A pre-clearing survey is to be carried out to confirm the presence/absence of threatened flora within lands that have not been surveyed within and adjacent to the development footprint. As a part of the survey, the size and extent of confirmed threatened flora populations must be determined. The results of the survey are to provide the updated baseline mapping of the vegetation communities and key fauna habitat on site for inclusion in the Biodiversity Management Plan (B5) and inform specific measures for the protection and management of threatened flora. This is to include at a minimum, specific requirements for the clearing process, any proposed translocation opportunities and associated contingency measures.	Pre-construction	Proponent
B7	Impacts to threatened fauna and karst, caves, crevices, cliffs and other geological feature of significance	Entire development footprint	As a part of the Biodiversity Management Plan, opportunities for the salvage and re-use of important habitat features, including tree-hollows and bush rock, are to be identified. The plan is to include detailed procedures for the implementation of these activities.	Pre-construction and construction	Contractor
B8		Entire development footprint	<p>Opportunities to further minimise any impacts to fauna habitat are to be fully explored through detailed design phase including any strategies for habitat restoration augmentation post-work.</p> <p>Habitat avoidance should prioritise the retention of karst and caves offering potential habitat for threatened fauna.</p>	Pre-construction	Proponent
B9	Impacts to National Park estate	Wind farm corridor	<p>An appropriate buffer must be maintained to National Park estate where practicable.</p> <p>Instigating vegetated buffers between the access tracks and wind turbine pads and the National Park estate is to be considered during detailed design. The selection of areas of buffer plantings and species to be</p>	Pre-construction	Proponent

ID	Impact	Proposal area	Mitigation measures	Timing	Responsibility
			planted will be carried out in consultation with the Area Manager, Barrington Tops National Parks and Wildlife Service.		
B10	Edge effects and impacts to habitat viability	Entire development footprint	Restore and rehabilitate all areas within the temporary development footprint. Priority should be given to movement corridors for fauna, significant habitats and threatened ecological communities.	Post-construction	Contractor
B11	Disturbance from weeds, pests and pathogens	Entire development footprint	<p>Management measures would be prepared and implemented to avoid and minimise the environmental risks associated with weeds, pests and pathogens. As a minimum, these would include:</p> <ul style="list-style-type: none"> • Completion of a site weed assessment and development of a Weed Management Plan, as a sub-plan to the EMS. • Implementation of appropriate weed control and weed disposal in accordance with Biosecurity protocols. • Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. • Appropriate disposal of any weed material. • Implementation of appropriate hygiene protocols where there are potential or known pathogen risks. 	Construction	Contractor
B12	Habitat disturbance from light	Entire development footprint	Proposal design and construction to minimise light impacts as much as possible through the use of sensor lighting and/ or directional lighting for more heavily utilised parts of the site.	Pre-construction and construction	Contractor/ Proponent
B13	Impacts of wind turbine strikes on protected animals	Wind farm corridor	Bird and bat activity within the site is generally concentrated around areas of vegetation. Maintain a minimum safe distance of 30m from the turbine blade tip to the adjacent tree canopy to minimise any risk of bird or bat strike.	Pre-construction, post-construction	Proponent
B14		Wind farm corridor	Prepare and implement, an operational Biodiversity Management Plan, as part of the project EMS, detailing ongoing measures for the protection and management of flora and fauna during the operational phase of the proposal. The plan is to identify at a minimum:	Post-construction	Proponent

ID	Impact	Proposal area	Mitigation measures	Timing	Responsibility
			<ul style="list-style-type: none"> • Target species, important habitats and ecological features to be monitored and managed within the site • Specific management measures to be implemented during operations including a proposed schedule for implementation • Requirements for the monitoring of target species, important habitats and ecological features within the site and processes to be implemented to ensure an adaptive management approach • Specific requirements for the monitoring and management of bird and bat mortality from blade strike including any considerations for the timing of species seasonal movements and/ or breeding periods. • Performance objectives and proposed contingency measures. • Roles, responsibilities and reporting requirements 		
B15		Wind farm	<p>Prepare and implement a Bird and Bat Management Plan (BBMP), as a sub-plan to the EMS. The BBMP will include:</p> <ul style="list-style-type: none"> • A description of measures to be implemented on the wind farm site for minimising bird and bat strike • Suitable measures must be identified for the minimisation and management bird and bat strike risks during operation. • Trigger levels for further investigation and mitigation measures to be implemented • An adaptive management plan to be implemented if the monitoring determines threatened or at risk species are subject to adverse impacts. • A detailed monitoring and reporting plan to assess the potential impacts and effectiveness of design and operational measures to mitigate bird and bat strike. <p>For example, the plan may contain the following suggested structure:</p> <p>1 Introduction</p> <p>1.1 Background</p> <p>1.2 Statutory requirements of BBMP</p>	Pre-construction	Proponent

ID	Impact	Proposal area	Mitigation measures	Timing	Responsibility
			1.3 BBMP Objectives 1.4 Consultation 1.5 Site description 2 Baseline bird and bat information 2.1 Bird survey methodology 2.2 Bat survey methodology 2.3 Results 3 Risk assessment 3.1 Species and groups of concern 3.2 Risk assessment methodology 3.3 Risk assessment results 3.4 Conclusions of risk assessment 4 Operational phase surveys 4.1 Monitoring 'at risk' groups 4.2 Bird utilisation surveys 4.3 Bat surveys 4.4 Carcass searches 4.4.1 Turbine selection 4.4.2 Search protocol 4.4.3 Scavenger rates and trials 4.4.4 Detectability (Observer) trials 4.4.5 Incidental carcass protocol 4.4.6 Analysis of results and mortality estimation 4.5 Personnel involved 4.6 Injured bird and bat protocol 4.7 Reporting and review 5 Mitigation measures to reduce risk 6 Trigger – Action – Response Plan		

ID	Impact	Proposal area	Mitigation measures	Timing	Responsibility
B16	Impacts to water quality and hydrology	Entire development footprint	Sections of the Biodiversity Management Plan are to outline measures for the management and monitoring of surface water quality and hydrology during construction, as applicable to the protection of biodiversity values. The plan would also address any requirements for the management of potential acid sulfate soils or contaminated lands during construction so as to minimise impacts to terrestrial and aquatic habitats. The plan would include the implementation of a construction surface water quality monitoring to minimise impacts to surface water quality.	Construction and operation	Contractor/ Proponent
B17		Entire development footprint	Prepare and implement an Erosion and Sediment Control Plan, as a sub-plan within the EMS, outlining measures for the prevention of erosion and sedimentation during construction.		
B18	Impacts to aquatic habitats and fish passage	Access/ transport routes	Proposed waterway crossings associated with access / transport routes are to minimise impacts to aquatic habitat and address Fisheries requirements for maintaining fish passage.	Pre-construction and construction	Contractor/ Proponent
B19	Fauna injury / mortality	Entire development footprint	The Biodiversity Management Plan is to include the following specific requirements to minimise and manage any risk of fauna injury mortality during construction: <ul style="list-style-type: none"> Strategies for fauna management during construction including any identification roles, responsibilities and contingency measures such as temporary stop works and engagement of fauna specialist. Requirements for temporary fencing to minimise the risk of fauna injury / mortality due to vehicle strike or entrapment in deep excavations. Protocols for fauna handling and management of adverse incidents. 	Construction	Contractor
B20	Impacts to habitat connectivity	Entire development footprint	The following opportunities are to be fully explored as a part of the detailed design: <ul style="list-style-type: none"> Opportunities to further minimise the disturbance footprint and clearing within important movement corridors for fauna. Opportunities for post-works restoration of habitat connectivity within important movement corridors for fauna. 	Pre-construction	Proponent

ID	Impact	Proposal area	Mitigation measures	Timing	Responsibility
			<ul style="list-style-type: none"> • Areas subject to temporary disturbance will be rehabilitated using a native species planting schedule as much as practical considering any operational and safety constraints. • The total area exposed and cleared at any one time will be minimised and planned to allow for fauna movement during construction and periods of temporary disturbance 		
B21	Impacts to habitat connectivity	Transmission line	<p>The following measures should be implemented post-construction to minimise impacts to flora and fauna within the transmission line easement:</p> <ul style="list-style-type: none"> • Promote the growth of vegetation under the transmission line to the maximum allowable height to maintain habitat connectivity for fauna. • Understorey vegetation in easements should be managed to maintain composition and quality and to prevent weed invasion. • Install glider poles for glider species in areas where the width of the transmission line easement exceeds minimum requirements for species movement. 	Post-construction	Proponent
B22	Effectiveness of mitigation and management measures	Entire development footprint	Consistent with any specific requirements of the approved Biodiversity Management Plan (B1), a monitoring program would be implemented during construction to assess the effectiveness of mitigation and management measures implemented, to identify any unexpected impacts and appropriate contingency measures necessary for the protection of biodiversity. A register of inspections will be established.	Construction and post-construction	Contractor/ Proponent

9 Impact summary and biodiversity credit report

For residual impacts that cannot be avoided or fully mitigated, offsets will be required. In accordance with Section 6.3 of the BC Act, the following values are subject to assessment and offset under the BOS:

- Impacts of the clearing of native vegetation and the loss of habitat.
- Impacts that are prescribed by the regulations.

A summary of relevant impacts associated with the proposal is presented in **Table 47**.

Table 47: Summary of proposal impacts subject to assessment and offset under the BOS

Relevant matter	Details	Direct impacts (area/ count)
Native vegetation communities and ecosystem credit species habitats.	Direct loss of native vegetation communities associated with site clearing	206.7ha
Threatened ecological communities	Direct loss of Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	57.43ha
	Direct loss of White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	13.33ha
Habitat for threatened fauna species – directly observed, species credit species and MNES fauna	Large-eared Pied Bat*	61.08ha
	Eastern Cave Bat*	62.49ha
	Large Bent-winged Bat*	23.12ha
	Little Bent-winged Bat*	23.12ha
	Southern Myotis*	2.21ha
	Greater-broad Nosed Bat [#]	70.03ha
	Little Pied Bat [#]	5.67ha
	Eastern False Pipistrelle [#]	70.03ha
	Eastern Coastal Freetail Bat [#]	17.86ha
	Grey-headed Flying-fox [#]	80.67ha
	Eastern Pygmy-possum*	30.42ha
	Koala*	50.76ha
	Squirrel Glider [#]	26.20ha
	Greater Glider	25.54ha
	Spotted-tailed Quoll [#]	25.54ha
Booroolong Frog*	1.59ha	
Border Thick-tailed Gecko*	0.17ha	

* Species credit species; # Ecosystem credit species

Offset thresholds for the BOS are detailed in Section 7.1 of the BC Regulation, and include:

- The clearing of native vegetation that exceeds the area-based thresholds for the relevant minimum lot size.
- The clearing of native vegetation, or prescribed impacts to biodiversity within land included on the Biodiversity Values Map (BVM).

Assessment of proposal impacts against the BOS thresholds indicates:

- Clearing impacts associated with the development will exceed the area-based threshold of 2ha relevant to the minimum lot size for the development site.
- Vegetation mapped within the BVM will be directly impacted during clearing works within the wind farm corridor, transmission line and in association with transport / access works.

Under Section 7.3 of the BC Act, offsets may also be required for a development where it is likely to have a significant effect on threatened species or ecological communities, or their habitats. The BAMC offset credit summary reports are included in **Appendix E** and summarised below in **Table 48**.

These offset credits have been calculated using the concept design footprint assessed as part of this EIS. It is a worst-case footprint that will be refined and reduced during future design phases. The calculation of credits has also adopted benchmark vegetation integrity scores when the required number of field-verified BAM plots were not achieved. This method, while being highly conservative, has likely over-estimated several of the the credit calculations which are influenced by vegetation integrity score data.

During the detailed design phase of the project refinements to the BAM Calculator will be required to assess impacts and offsets associated with the final project footprint and vegetation integrity scores and confirm final biodiversity credit requirements. This approach has adopted the consistent assessment of worst-case impacts for this EIS.

A Biodiversity Offset Strategy will be prepared during the detailed design phase that confirms the approach for identifying, creating and retiring the required biodiversity credits. The project proponent has commenced investigations on a number of properties adjacent to the project area where Biodiversity Stewardship Sites can be established. These properties are on similar elevated ridgelines, with similar PCTs and fauna habitats, also being subject to historical impacts associated with farming.

Table 48: Biodiversity offsets required to address residual impacts

Credit class	Relevant matter	Associated TEC	Direct impacts (hectares)	Estimated number of credits
Ecosystem	PCT 84: River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South Bioregion and Nandewar Bioregion		0.17	6
	PCT 433: White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, BBS Bioregion	White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	0.08	4
	PCT 434: White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion		0.02	1
	PCT 450: PCT 450 - Smooth-barked Apple - White Cypress Pine grass shrub woodland on lower slopes and sandy flats, north-western Brigalow Belt South Bioregion		1.5	64
	PCT 486 - River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range		7.55	278
	PCT 490- Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion		3.1	116
	PCT 492: Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion	White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	9.81	371
	PCT 507: Black Sallee - Snow Gum grassy woodland of the New		0.15	5

Credit class	Relevant matter	Associated TEC	Direct impacts (hectares)	Estimated number of credits
	England Tableland Bioregion			
	PCT 510: Blakely's Red Gum - Yellow Box grassy woodland of the New England Tableland Bioregion	White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	0.25	2
	PCT 526 - Mountain Ribbon Gum - Messmate - Broad-leaved Stringybark open forest on granitic soils of the New England Tableland Bioregion		0.5	22
	PCT 538: Rough-barked Apple - Blakely's Red Gum open forest of the Nandewar Bioregion and western New England Tableland Bioregion	White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	0.01	1
	PCT 540 - Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion		69.6	2,610
	PCT 541 - Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion		30.0	1,142
	PCT 591: White Box shrubby open forest on hills mainly in the Nandewar Bioregion		0.65	24
	PCT 599: Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion	White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	3.35	157
	PCT 931 - Messmate - Mountain Gum tall moist forest of the far		5.62	226

Credit class	Relevant matter	Associated TEC	Direct impacts (hectares)	Estimated number of credits
	southern New England Tableland Bioregion			
	PCT 934 - Messmate open forest of the tableland edge of the NSW North Coast Bioregion and New England Tableland Bioregion		15.52	581
	PCT 954 - Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion		1.4	32
	PCT 1192- Snow Gum - Mountain Gum - Mountain Ribbon Gum grassy open forest of the New England Tableland Bioregion	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	1.0	51
	PCT 1194 - Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	56.5	2,321
Species	Large-eared Pied Bat	NA	61.08	3,767
	Little Bent-winged Bat	NA	23.12	1,465
	Large Bent-winged Bat	NA	23.12	1,465
	Eastern Cave Bat	NA	62.49	4,134
	Southern Myotis	NA	2.21	99
	Koala	NA	50.76	2,182
	Eastern Pygmy-possum	NA	30.42	1,307
	Squirrel Glider	NA	26.20	1179
	Booroolong Frog	NA	1.59	77
	Border Thick-tailed Gecko	NA	0.17	8

10 References

- Bureau of Meteorology, 2020. Rainfall and climate data, accessed online 27 September 2020.
- Commonwealth of Australia 2012. Approved conservation advice for *Phascolarctos cinereus* (combined populations of Queensland, New South Wales and the Australian Capital Territory) (koala Northern Designatable Unit), Australian Government Department of the Environment and Energy.
- Commonwealth of Australia 2013. Matters of National Environmental Significance, Significant Impact Criteria Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999, Australian Government Department of the Environment and Energy, Canberra, ACT.
- DAWE 2016. National Recovery Plan for the Spotted-tailed Quoll *Dasyurus maculatus*.
- DAWE 2020a. *Phascolarctos cinereus* (combined populations of Qld, NSW and the ACT) - Koala, accessed 17 September 2020, https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=85104.
- DAWE 2020b. *Litoria booroolongensis* — Booroolong Frog, accessed 17 September 2020, https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1844.
- DAWE 2020c. *Dasyurus maculatus maculatus* (SE mainland population) — Spotted-tailed Quoll, Spotted-tail Quoll, Tiger Quoll, accessed 17 September 2020, https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75184.
- DECC 2007. Terrestrial vertebrate fauna of the Greater Southern Sydney region: Volume 2 Species of conservation concern and priority pest species.
- DECC 2008. Recovery plan for the Koala (*Phascolarctos cinereus*), New South Wales Government Department of Environment and Climate Change.
- DERM 2011. National recovery plan for the Large-eared Pied Bat *Chalinolobus dweyeri*.
- DoE 2014. EPBC Act referral guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory), Department of the Environment, accessed 29 May 2019, Australian Government Department of the Environment and Energy.
- Dwyer 1966. Observations on *Chalinolobus dweyeri* (Chiroptera: Vespertilionidae) in Australia.
- EES 2020. BioNet the website for the Atlas of NSW Wildlife, accessed 8 June 2020, <http://www.bionet.nsw.gov.au/>.
- Fly By Night 2005. Monitoring of the Bat Fauna of Ulan Underground Coal Mine Lease and Rehabilitation Areas of Ulan Open Cut Coal Mine during 2004, Fly By Night Bat Surveys Pty Ltd. Report to Mount King Ecological Surveys.

- Gunnedah Shire Council 2015. Gunnedah Koala Strategy, Gunnedah Shire Council, Gunnedah NSW.
- Hoye 2005. Recovery plan for the large-eared pied bat *Chalinolobus dwyeri*, Fly By Night Bat Surveys Pty Ltd. Brisbane: Queensland Parks and Wildlife Service.
- Hoye and Dwyer 1995. The Mammals of Australia. Large-eared pied bat *Chalinolobus dwyeri*., Reed Books, Chatswood, NSW.
- Hunter 2007. Conservation management of two threatened frog species in south-eastern New South Wales.
- IUCN SSC 2020. IUCN SSC Bat Specialist Group (BSG) Recommended Strategy for Researchers to Reduce the Risk of Transmission of SARS-CoV-2 from Humans to Bats, https://www.iucnbsg.org/uploads/6/5/0/9/6509077/map_recommendations_for_researchers_v._1.0_final.pdf.
- Jones 2001. *Dasyurus maculatus*.
- Mahony 1999.' Review of the decline and disappearance within the Bell Frog group (*Litoria aurea* species group) in Australia' in, Declines and Disappearances of Australian Frogs, Environment Australia, Canberra.
- McKay 2008.' Greater Glider *Petauroides volans*' in, The Mammals of Australia, p 240-242. Reed New Holland. Carlton, Victoria.
- Menkhorst P & Knight F 2011. A field guide to the mammals of Australia, Third, Oxford University Press Australia.
- Mills, D. and Pernay, M. 2017. Landscape utilisation by the threatened eastern bent-wing bat (*Miniopterus schreibersii oceanensis*). A pilot study at Parson's Creek, Adjungbilly, NSW (2015/16 and 2016/17). Ecosystems and Threatened Species, South East. NSW Office of Environment and Heritage
- Mitchell, P.B. 2002 Descriptions for NSW (Mitchell) Landscapes. NSW National Parks and Wildlife Service 2002.
- NSW National Parks and Wildlife Service 2019. Crawney Pass National Park Community Conservation Area Zone 1 Plan of Management
- NSW National Parks and Wildlife Service 2002. Ben Halls Gap National Park Plan of Management
- OEH 2012. National Recovery Plan for Booroolong Frog *Litoria booroolongensis*.
- OEH 2017. Large-eared Pied Bat - profile, accessed 26 March 2020, <https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10157>.
- OEH 2018. A Review of Koala Tree Use Across New South Wales, Office of Environment and Heritage.
- OEH 2019. Spotted-tail Quoll - Profile, New South Wales Government Office of Environment and Heritage, accessed 24 October 2019, <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10207>.

OEH 2020. Saving Our Species - Help Save the Booroolong Frog.

Pennay M 2008. 'A maternity roost of the Large-eared Pied Bat *Chalinolobus dwyeri* (Ryan) (Microchiroptera: Vespertilionidae) in central New South Wales Australia', *Australian Zoologist*, 34, 4: 564–569.

Threatened Species Scientific Committee 2016. Conservation Advice <i>Petauroides volans</i> greater glider.

TSSC 2012. Commonwealth Listing Advice on *Chalinolobus dwyeri* (Large-eared Pied Bat).

Appendix A

Haul route desktop study

Level 4, 108 Wickham Street
Fortitude Valley
QLD 4006
GPO Box 685 Brisbane QLD 4001
Australia
www.arup.com

t +61 7 3023 6000
f +61 7 3023 6023

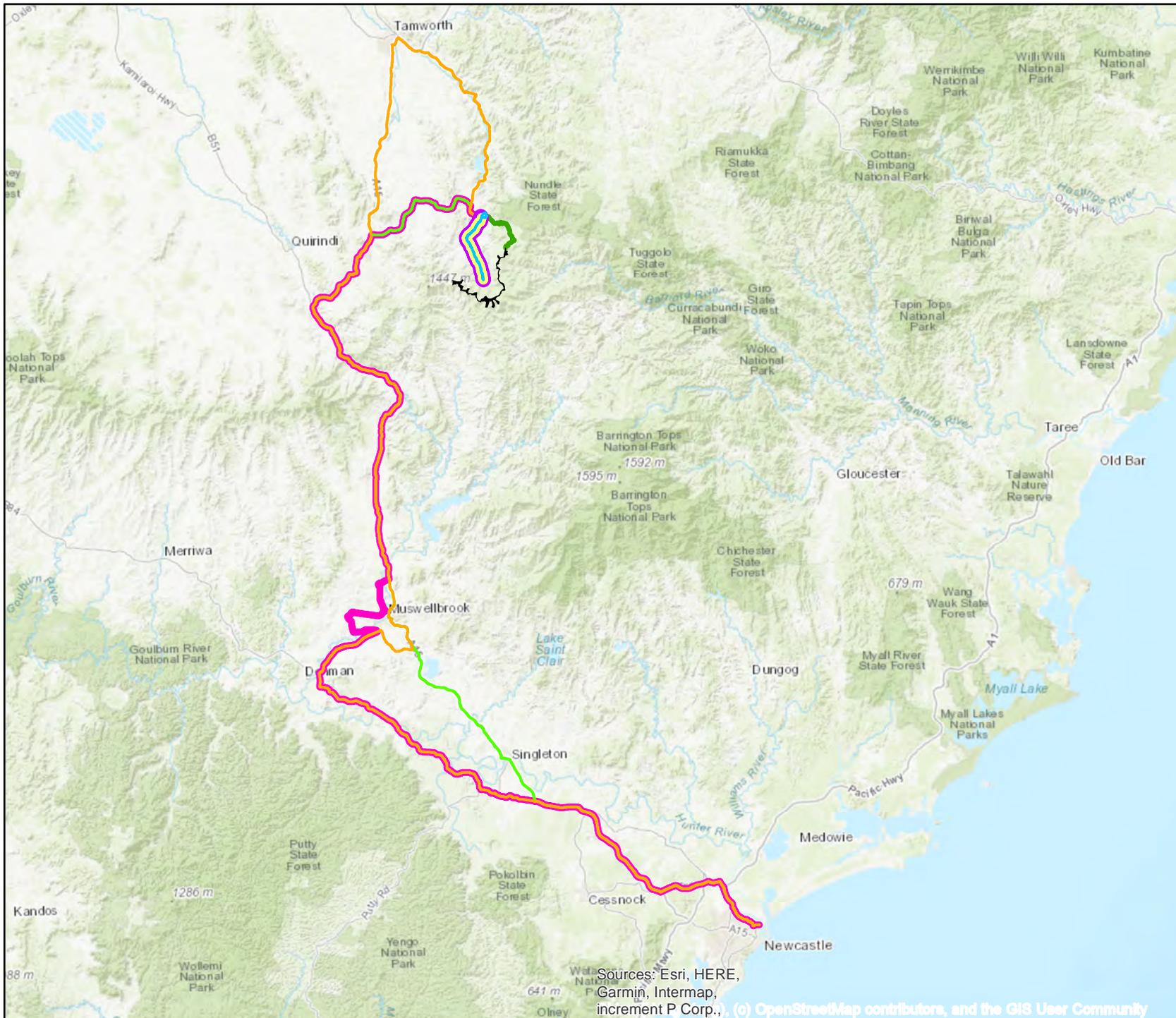
Project title	Hills of Gold Wind Farm	Job number
		273023-00
cc	Wind Energy Partners Biosis	File reference
		HoG_HaulRoute_TN_1.0
Prepared by	Chani Wheeler	Date
		25 August 2020
Subject	Haul route assessment	

1 Introduction

A haul route from the Port of Newcastle to Nundle is proposed for the Hills of Gold Wind Farm development. Figure 1 shows haul route options currently being considered. Some selective clearing of vegetation and increased hardstand may be required in locations along the proposed routes to accommodate the transportation of construction materials to site. A number bridge/culvert upgrades may also be required at the following locations:

- Goonoo Goonoo Creek, Lindsay's Gap Road, Garoo
- Middlebrook Creek, Lindsay's Gap Road, Garoo
- Four separate tributaries of the Peel River, Head of Peel Road, Nundle
- Wardens Brook, Head of Peel Road, Nundle
- Peel River Nundle.

This Technical Note has been prepared to support the assessment of biodiversity impacts associated with the proposed haul routes. It documents the result of a desktop review of constraints at each proposed works area and is intended to inform requirements for additional survey works.



Wind Farm Development Corridor

Haul Route Options

- Newcastle to Nundle - Option 1 - Blades
- Newcastle to Nundle - Option 1 - Remaining Components
- Newcastle to Nundle - Option 2 - Towers
- Nundle to Site - Primary Options - All Components - Morrisons Gap Rd
- Nundle to Site - Secondary Option (a) - All Components - Head of the Peel Rd
- Nundle to Site - Secondary Option (b) - All Components - Head of the Peel Rd
- Nundle to Site - Secondary Option (c) - All Components - Head of the Peel Rd

D1	21/08/2020	CW	MJD	MJD
Issue	Date	By	Chkd	Appd

Kilometers

0 4.5 9 18 27 36 45 54

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023
www.arup.com

Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
Haul route options

Scale at A4 1:1,200,000	Drawing Status Draft
-----------------------------------	--------------------------------

Coordinate System
GDA 1994 MGA Zone 56

Job No 270335-00	Drawing No Figure 1
----------------------------	-------------------------------

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., (c) OpenStreetMap contributors, and the GIS User Community

File Note

273023-00

25 August 2020

2 Method

A review of the following existing datasets and data was carried out:

- Greater Hunter Native Vegetation Mapping v4.0. VIS_ID_3855 (DPIE, 2012)
- State Vegetation Type Map: Border Rivers Gwydir/ Namoi Region v2.0. VIS_ID_4467 (DPIE, 2015)
- Aerial imagery (Google, 2020a)
- Street View imagery (Google, 2020b)

Based on the above information sources, sites were ranked from low to high risk depending on the likely presence of native vegetation communities and potential habitat for threatened species.

3 Results

Table 1: Haul route assessment results and site risk rating

Location	Assessment Results	Risk Rating
<p>Selwyn Street, Mayfield North</p> 	<p>Based on a review of DPIE (2012), River Red Gum/ River Oak grassy riparian woodland of the Hunter Valley is mapped within the northern portion of the works footprint.</p> <p>Review of latest aerial imagery and Street View indicates the site is clear of vegetation.</p> <p>However, based on location of site, there is potential for marine plants where surface waters are saline. There is also potential for Green and Golden Bell Frog where bulrushes/ sedges are present.</p> <p>Survey of site recommended to confirm marine plants and potential habitat for Green and Golden Bell Frog.</p>	<p>Moderate</p>

File Note

273023-00

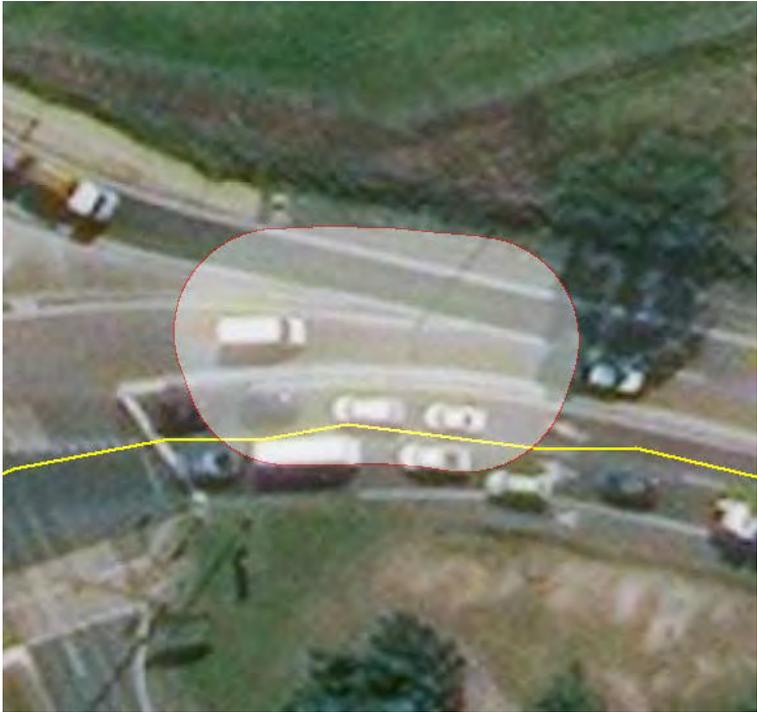
25 August 2020

Location	Assessment Results	Risk Rating
<p>George Street, Tighes Hill</p> 	<p>No native vegetation is mapped for the area (DPIE, 2012). Based on aerial imagery and street view, the site supports maintained lawns. Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Industrial Drive, Mayfield West</p> 	<p>No native vegetation is mapped for the site (DPIE, 2012). Based on aerial imagery and street view, the site supports existing road hardstand and some grassed verges. Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Hunter Expressway, adjacent to Buchanan Road, Buchanan</p>  An aerial photograph showing a multi-lane road (Hunter Expressway) with a landscaped median. A red oval highlights a section of the median, and a yellow line runs parallel to the road. The surrounding area is green with some trees and a road intersection visible.	<p>No native vegetation is mapped for the area (DPIE, 2012). Based on aerial imagery and street view, the site supports road hardstand and landscaped median.</p> <p>Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr New England Highway and Golden Highway & Mitchell Line of Rd, Whittingham</p> 	<p>No native vegetation is mapped for the area (DPIE, 2012). Based on aerial imagery and street view, the site supports existing road hardstand and grassed verges. Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr of Golden Highway & Mitchell Line of Rd and Putty Road, Mount Thorley</p> 	<p>No native vegetation is mapped for the site (DPIE, 2012). Based on aerial imagery and street view, site is within and adjacent to rail corridor. The site appears to support grassland with some regenerating woodland.</p> <p>No disturbance of vegetation is likely as the site is situated on a rail bridge and the extent of likely blade overhang will be elevated above the ground.</p> <p>No survey required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Mount Thorley Road exit lane, adjacent to Putty Highway, Mount Thorley</p> 	<p>No native vegetation is mapped for the site (DPIE, 2012). Based on review of aerial imagery and street view, site is dominated by road hardstand and exotic grassland.</p> <p>Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Golden Highway, Pagan and Pringle Streets, Jerry Plains</p> 	<p>No native vegetation is mapped for the site (DPIE, 2012). Based on review of aerial imagery and street view, site is dominated by maintained road verges with scattered remnant native and exotic landscape trees.</p> <p>Survey required to confirm native trees within proposed clearing footprints, presence of habitat features and any requirements under the BAM.</p>	<p>Moderate</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Golden Highway and Denman Road, Denman</p>  An aerial photograph showing a road intersection. A pink line outlines a specific area at the intersection. Two irregular shapes within this area are highlighted in pink, representing the site of interest. The surrounding area includes a road, grassy fields, and some trees.	<p>No native vegetation is mapped for the site (DPIE, 2012). Based on review of aerial imagery and street view, site is dominated by maintained road verges and pasture dominated by exotic grasses. Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Denman Road and Bengalla Road, Muswellbrook</p> 	<p>No native vegetation is mapped for the site (DPIE, 2012). However, review of aerial imagery and street view indicates potential presence of regenerating Eucalypt woodland immediately east of Bengalla Road. Other areas appear to be dominated by exotic grassland.</p> <p>Survey to confirm presence and extent of native vegetation within the works footprint.</p>	<p>Moderate</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Bengalla Road and Wybong Road, Castle Rock</p> 	<p>No native vegetation is mapped for the site (DPIE, 2012). Review of latest aerial imagery and street view indicates the site lacks woody vegetation and is dominated by grassed road verges. Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Wybong Road and Kayuga Road, Muswellbrook</p>  An aerial photograph showing a road intersection. A pink line outlines a specific area, and a red line highlights a portion of it. The area is mostly green, suggesting grass or pasture, with some trees and a road hardstand visible.	<p>No native vegetation is mapped for the site (DPIE, 2012). Review of latest aerial imagery and street view indicates the site is dominated by exotic pasture and road hardstand. Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Invermein Street and Stair Street, Kayuga</p> 	<p>No native vegetation is mapped for the site (DPIE, 2012). Review of latest aerial imagery and street view indicates the site is dominated by exotic pasture. Although some regenerating Eucalypts appear to be located on the northern periphery of proposed works. Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Stair Street, Kayuga</p> 	<p>No native vegetation is mapped for the site (DPIE, 2012). Review of latest aerial imagery and street view indicates the site is dominated by exotic pasture. Although there are a couple of scattered regenerating Eucalypts on the north-western periphery of proposed works, adjacent to the carpark. Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Stair Street and New England Highway, Aberdeen</p>  An aerial photograph showing a road intersection. A pink shaded area highlights a specific location at the intersection. A yellow line runs vertically through the intersection, and a pink line runs horizontally across it. The surrounding area is green, likely grass or pasture.	<p>No native vegetation is mapped for the site (DPIE, 2012). Review of latest aerial imagery and street view indicates the site is dominated by exotic pasture. Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr New England Highway and Lindsays Gap Road, Wallabadah</p> 	<p>No native vegetation is mapped for the site (DPIE, 2015). Review of latest aerial imagery and street view indicates the site is dominated by exotic pasture. However some scattered Eucalypt trees are located on the periphery of proposed works. Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Goonoo Goonoo Creek crossing, Lindsay's Gap Road, Garoo</p> 	<p>Review of DPIE (2015) indicates riparian vegetation is mapped as PCT 84-River Oak- Rough-barked Apple- Red Gum- Box riparian tall woodland (wetland of the Brigalow Belt South and Nandewar Bioregions).</p> <p>Review of the latest aerial imagery suggests the footprint largely lacks woody vegetation.</p> <p>Proposed works at the site are likely to include bridge upgrade or bypass. Survey of site required to confirm extent of native vegetation and potential habitat for threatened species within proposed footprint.</p>	<p>High</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Middlebrook Creek crossing, Lindsay's Gap Road, Garoo</p>  <p>The image is an aerial photograph showing a creek crossing a road. A yellow line indicates the road's path, and a semi-transparent rectangular box highlights a specific area of the creek crossing. The surrounding landscape is green and appears to be a mix of grassland and woodland.</p>	<p>Review of DPIE (2015) indicates the presence of the following native vegetation communities within the proposed footprint:</p> <ul style="list-style-type: none"> • PCT 84- River Oak- Rough-barked Apple- Red Gum- Box riparian tall woodland (wetland of the Brigalow Belt South and Nandewar Bioregions. • Candidate Native Grasslands <p>Proposed works at the site are likely to include creek crossing upgrade. Survey of site required to confirm extent of native vegetation and potential habitat for threatened species within the works footprint.</p>	<p>High</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Lindsay's Gap Road and Nundle Road, Nundle</p> 	<p>Review of DPIE (2015) indicates site supports Candidate Native Grasslands.</p> <p>Review of latest aerial imagery and street view indicates recent road works and a lack of native vegetation.</p> <p>Survey of footprint required to confirm extent of any native grasslands.</p>	<p>Moderate</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Oakenville Street, Herron Street, Innes Street and Jenkins Street, Nundle</p> 	<p>No native vegetation is mapped for the site (DPIE, 2015). Based on the review of aerial imagery and street view, lands within the works footprint is dominated by maintained road verges with scattered remnant native and exotic landscape trees.</p> <p>Site survey is recommended to confirm native trees, presence of habitat features and any requirements under the BAM.</p>	<p>Moderate</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Gill Street and Point Street, Nundle</p> 	<p>No native vegetation is mapped for the site (DPIE, 2015). Review of latest aerial imagery and Streetview indicates the footprint is dominated by maintained road verges with some scattered landscape shrubs. Survey not required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr River Road and Happy Valley Road, Nundle</p>  An aerial photograph showing a road intersection. A red outline highlights a specific area, likely the work footprint, which includes a road and surrounding grasslands. The area is semi-transparent, allowing the underlying terrain and buildings to be visible.	<p>No native vegetation is mapped for the site (DPIE, 2015).</p> <p>Review of latest aerial imagery and Streetview indicates site supports grasslands with scattered Eucalypt regen.</p> <p>Site survey recommended to confirm presence and extent of native vegetation in works footprint.</p>	<p>Moderate</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Oakenvill Street and Old Hanging Rock Road, Nundle</p>  An aerial photograph showing a road intersection. A red line traces a path along the road, and a semi-transparent grey area highlights a specific section of the road and its immediate surroundings. The surrounding landscape is a mix of green grass and trees.	<p>Review of DPIE (2015) indicates riparian vegetation is mapped as PCT 84-River Oak- Rough-barked Apple- Red Gum- Box riparian tall woodland (wetland of the Brigalow Belt South and Nandewar Bioregions).</p> <p>Review of aerial imagery and Streetview indicates the site is dominated by exotic pasture with some scattered Eucalypt and Casuarina spp. trees.</p> <p>Survey recommended to confirm extent of vegetation.</p>	<p>Moderate</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr of Happy Valley Road and Old Hanging Rock Road, Nundle</p> 	<p>Review of DPIE (2015) indicates presence of candidate native grasslands. Based on review of latest aerial imagery and Streetview lands immediately adjacent to the road appear to support exotic grasses and forbs. Although some regenerating Eucalypts are observed and native grasses may still be present in areas further from the road. Survey recommended to confirm the extent of native vegetation.</p>	<p>Moderate</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Hanging Rock State Forest, Barry Road, Nundle</p> 	<p>Review of DPIE (2015) indicates the following native vegetation communities are present within the proposed works footprint:</p> <ul style="list-style-type: none"> • PCT 492- Silvertop Stringybark – Yellow Box- Apple Box- Rough-barked Apple shrub grass open forest mainly on southern lopes of the Liverpool Range, Brigalow Belt South Bioregion • PCT526- Mountain Gum- Messmate- Broad-leaved Stringybark open forest on granitic soils of the New England Tablelands Bioregion • PCT 541- Silvertop Stringybark- Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tablelands and NSW North Coast Bioregion • PCT 563- White-box- Silvertop Stringybark ± White Cypress Pine grass shrub open forest of the southern Nandewar Bioregion and New England Tablelands Bioregion • PCT 486- River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range • Candidate Native Grasslands <p>Survey of works footprints required to confirm native vegetation communities and map extent including any important habitat features.</p>	<p>High</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Morrison's Gap Road, Nundle</p> 	<p>Review of DPIE (2015) indicates the following native vegetation communities are present within the proposed works footprint:</p> <ul style="list-style-type: none"> • PCT 494- Snow Gum- Mountain Gum- Silver Wattle tall open forest of the Liverpool Range, Brigalow belt South Bioregion • PCT1194- Snow Gum- Mountain Gum- Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tablelands Bioregion • PCT526- Mountain Gum- Messmate- Broad-leaved Stringybark open forest on granitic soils of the New England Tablelands Bioregion • Candidate Native Grasslands <p>Survey of works footprints required to confirm native vegetation communities and map extent including any important habitat features.</p>	<p>High</p>

File Note

273023-00

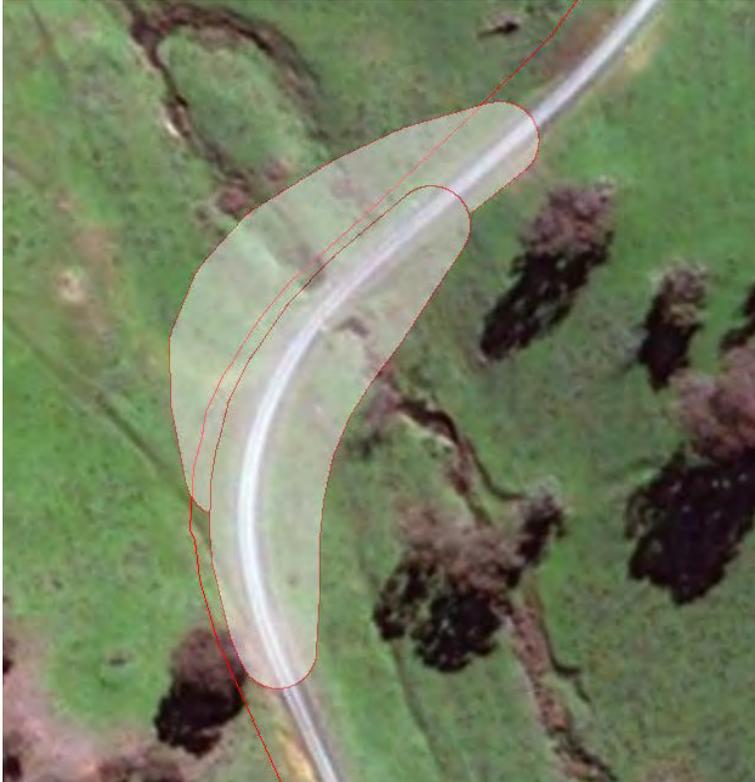
25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Crawney Road and Head of Peel Road, Nundle</p> 	<p>Review of DPIE (2015) and latest aerial imagery indicates native vegetation is limited to scattered Eucalypt trees.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Tributary of the Peel River, Head of Peel Road, Nundle- heading south</p> 	<p>Review of DPIE (2015) indicates the site may support Candidate Native Grasslands with adjacent PCT 599- Blakely's Red Gum- Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion.</p> <p>Review of aerial imagery suggests works will not impact woody vegetation. Survey of site recommended to confirm extent of native vegetation communities relative to the works footprint.</p>	<p>Moderate</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Tributaries of the Peel River, Head of Peel Road, Nundle- heading south</p>  An aerial photograph showing a river system with a red-shaded buffer zone along the banks. The river flows from the top left towards the bottom right. The surrounding area is green, indicating vegetation. The red shading follows the course of the river and its tributaries, highlighting the area of interest for the assessment.	<p>Review of DPIE (2015) indicates the site may support Candidate Native Grasslands.</p> <p>Survey of works footprint recommended to confirm extent of native grasslands and habitat for threatened species where relevant.</p>	<p>Moderate.</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Tributary of the Peel River, Head of Peel Road, Nundle- heading south</p>  An aerial photograph showing a tributary of the Peel River. A red outline highlights a specific area of the riverbank and the river itself. The surrounding landscape is green, suggesting grasslands or agricultural land. There is a small pond or wetland area visible to the right of the river.	<p>Review of DPIE (2015) indicates the site may support Candidate Native Grasslands.</p> <p>Survey of works footprint recommended to confirm extent of native grasslands and habitat for threatened species where relevant.</p>	<p>Moderate</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Wardens Brook, Head of Peel Road, Nundle- heading south</p>  An aerial photograph showing a road and surrounding greenery. A semi-transparent, light-colored polygon highlights a specific area along the road, likely indicating the site of interest for the assessment.	<p>Review of DPIE (2015) indicates the site may support Candidate Native Grasslands.</p> <p>Survey of works footprint recommended to confirm extent of native grasslands and habitat for threatened species where relevant.</p>	<p>Moderate</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Peel River, Head of Peel River, Nundle- heading south</p> 	<p>Review of DPIE (2015) indicates the site supports PCT 486- River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range and Candidate Native Grasslands.</p> <p>Survey of works footprint recommended to confirm extent of native vegetation communities.</p>	<p>High</p>
<p>Alternative route to Nundle via Tamworth</p>		

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Goonoo Goonoo Rd/ New England Highway and Wilburtree Street, South Tam worth</p> 	<p>Review of DPIE (2015) indicates the site is dominated by non-native vegetation. Based on a review of aerial imagery the works footprint includes disturbed road hardstand and verges only.</p> <p>No survey required.</p>	<p>Low</p>

File Note

273023-00

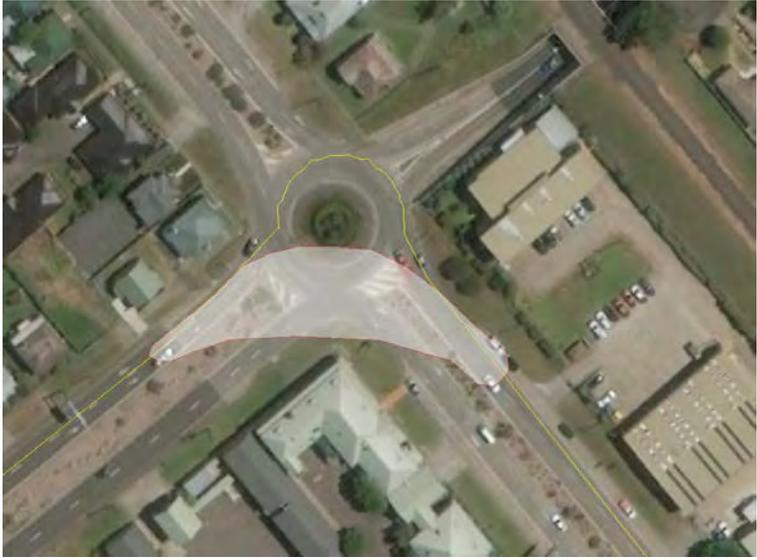
25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Goonoo Goonoo Rd/ New England Highway and Vera Street, South Tamworth</p> 	<p>Review of DPIE (2015) indicates the site is dominated by non-native vegetation. Based on a review of aerial imagery the works footprint includes disturbed road hardstand and verges only.</p> <p>No survey required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Scott Rd/ New England Highway and Marius Street/ New England Highway, Tamworth</p> 	<p>Review of DPIE (2015) indicates the site is dominated by non-native vegetation. Based on a review of aerial imagery the works footprint includes disturbed road hardstand and verges only.</p> <p>No survey required.</p>	<p>Low</p>

File Note

273023-00

25 August 2020

Location	Assessment Results	Risk Rating
<p>Cnr Nundle Road and Ogunbil Road, Dungowan</p> 	<p>Review of DPIE (2015) indicates the site is dominated by non-native vegetation. Based on a review of aerial imagery the works footprint includes disturbed road hardstand and verges only.</p> <p>No survey required.</p>	<p>Low</p>

4 Summary

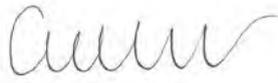
Based on the assessment, 19 sites were identified as having a low risk of biodiversity impacts and do not require further field survey. A total of 12 sites were identified as moderate risk and five sites as high risk. Further survey of these sites is recommended to confirm the presence and extent of any native vegetation communities and habitat for threatened species.

File Note

273023-00

25 August 2020

DOCUMENT CHECKING (not mandatory for File Note)

	Prepared by	Checked by	Approved by
Name	Chani Wheeler	Matt Davis	Matt Davis
Signature			

Appendix B

Detailed PCT descriptions

PCT 84 - River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South Bioregion and Nandewar Bioregion

Vegetation formation: Forested Wetlands

Vegetation class: Eastern Riverine Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 0.18 hectares

Dominant species:

- Canopy: *Angophora floribunda*, *Casuarina.cunninghamiana*
- Shrub: *Salix babylonica*, *Rubus fruticosus*
- Ground: *Eragrostis curvula*, *Melicytus dentatus*, *Plantago lanceolate*, *Plantago lanceolate*, *Ehrharta longiflora*, *Poa labillardieri*, *Poa labillardieri*, *Bromus catharticus*, *Cenchrus clandestinus*, *Dactylis glomerate*, *Phalaris aquatica*, *Galium aparine*, *Foeniculum vulgare*, *Galium aparine*, *Foeniculum vulgare*, *Lolium perene*, *Brassica rapa*, *Bidens pilosa*, *Vicia sativa*



PCT 433 - White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, BBS Bioregion

Vegetation formation: Grassy Woodlands

Vegetation class: Western Slopes Grassy Woodlands

Conservation status:

- EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- BC Act: White Box Yellow Box Blakely's Red Gum Woodland

Extent within development footprint: 0.08 hectares

Dominant species:

- Canopy: *Eucalyptus albens*
- Shrub: *Geijera parviflora*
- Ground: *Eragrostis cilianensis*, *Eragrostis cilianensis*, *Hyparrhenia hirta*, *Medicago polymorpha*, *Themeda triandra*, *Themeda triandra*, *Themeda triandra*, *Themeda triandra*, *Austrostipa scabra*, *Dianella longifolia*



PCT 434 - White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion

Vegetation formation:Grassy Woodlands

Vegetation class: Western Slopes Grassy Woodlands

Conservation status:

- EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- BC Act: White Box Yellow Box Blakely's Red Gum Woodland

Extent within development footprint: 0.02 hectares

Dominant species:

- Canopy: *Eucalyptus albens*, *Angophora floribunda*
- Shrub: *Oleiria viscosa*
- Ground: *Urtica incisa*, *Medicago polymorpha*, *Malva neglecta*, *Bromus catharticus*, *Lolium perenne*

PCT 450 - Smooth-barked Apple - White Cypress Pine grass shrub woodland on lower slopes and sandy flats, north-western Brigalow Belt South Bioregio

Vegetation formation: Dry Sclerophyll Forest (Shrubby sub-formation)

Vegetation class: Yetman Dry Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: N

Extent within development footprint: 1.47 hectares

Dominant species:

- Canopy: *Eucalyptus laevopinea*, *Angophora leiocarpa*

PCT 486 - River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range

Vegetation formation: Forested Wetlands

Vegetation class: Eastern Riverine Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 0.02 hectares

Dominant species:

- Canopy: *Angophora floribunda*, *Eucalyptus viminalis*, *Casuarina cunninghamiana*, *Eucalyptus nortoni*, *Eucalyptus laevopinia*
- Shrub: Eucalypt saplings, *Bursaria spinosa*, *Acacia implexa*, *Olearia viscosa*, *Ligustrum sinense*, *Melicytus dentatus*, *Notelaea microcarpa* var *microcarpa*
- Ground: *Poa sieberiana*, *Verbena bonariensis*, *Plantago lanceolata*, *Bromus catharticus*, *Ehrharta longiflora*, *Microlaena stipoides*, *Rytidosperma racemosum*, *Lolium perene*, *Lomandra multiflora*, *Bothriochloa decipiens*, *Cenchrus clandestinus*, *Bothriochloa decipiens*, *Poa labillardieri*, *Cerastium glomeratum*



PCT 490 - Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion

Vegetation formation: Grassy Woodlands

Vegetation class: New England Grassy Woodlands

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 3.14 hectares

Dominant species:

- Canopy: *Eucalyptus laevopinia*, *Eucalyptus dalrympleana*,
Eucalyptus.mannifera
- Shrub: *Lomatia arborescens*, *Acacia melanoxylon*,
- Ground: *Poa sieberiana*, *Lomandra longifolia*, *Microlaena stipoides*,
Pteridium esculentum



PCT 492 – Silvertop Stringybark – Yellow Box – Apple Box – Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion

Vegetation formation: Grassy Woodlands

Vegetation class: New England Grassy Woodlands

Conservation status:

- EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- BC Act: White Box Yellow Box Blakely's Red Gum Woodland

Extent within development footprint: 9.83 hectares

Dominant species:

- Canopy: *Eucalyptus albens*, *Eucalyptus blakelyi*, *Eucalyptus melliodora*
- Shrub: *Olearia viscidum*, *Cassinea laevis*, *Acacia melanoxylon*, *Acacia implexa*, *Acacia paradoxa*
- Ground: *Themeda triandra*, *Aristida racemosa*, *Bothriochloa decipiens*, *Hardenbergia violaceae*,



PCT 507 - Black Sallee - Snow Gum grassy woodland of the New England Tableland Bioregion

Vegetation formation: Grassy Woodlands

Vegetation class: Tableland Clay Grassy Woodland

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 0.15 hectares

Dominant species:

- Canopy: *Eucalyptus stellulata*
- Shrub:
- Ground: *Poa sieberiana*, *Cenchrus clandestinus*

PCT 510 - Blakely's Red Gum - Yellow Box grassy woodland of the New England Tableland Bioregion

Vegetation formation: Grassy Woodlands

Vegetation class: New England Grassy Woodlands

Conservation status:

- EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- BC Act: White Box Yellow Box Blakely's Red Gum Woodland

Extent within development footprint: 0.05 hectares

Dominant species:

- Canopy: *Eucalyptus melliodora*, *Eucalyptus blakelyi*
- Shrub: *Prunus cerasifera*
- Ground: *Lolium multiflorum*, *Lamium amplexicaule*, *Bromus catharticus*, *Plantago lanceolata*, *Hypochaeris radicata*, *Taraxicum officinale*, *Chloris truncata*



PCT 526 - Mountain Ribbon Gum - Messmate - Broad-leaved Stringybark open forest on granitic soils of the New England Tableland Bioregion

Vegetation formation: Dry Sclerophyll Forests (Shrub/grass sub-formation)

Vegetation class: New England Dry Sclerophyll Forests

Conservation status:

- EPBC Act: not listed
- BC Act: Not listed

Extent within development footprint: 0.50 hectares

Dominant species:

- Canopy: *Eucalyptus obliqua*, *Eucalyptus viminalis*, *Eucalyptus dalrympleana*, *Eucalyptus mannifera*
- Shrub: *Acacia melanoxylon*, *Melicytus dentata*, *Lomatia arborescens*, *Coprosma quadrifida*, *Bursaria spinosa spinosa*, *Banksia integrifolia subsp. monticola*
- Ground: *Smilax glyciphylla*, *Poa sieberiana*, *Dicksonia antarctica*, *Microlaena stipoides*, *Lomandra longifolia*, *Urtica incisa*, *Pteridium esculentum*



PCT 538 - Rough-barked Apple - Blakely's Red Gum open forest of the Nandewar Bioregion and western New England Tableland Bioregion

Vegetation formation: Dry Sclerophyll Forests (Shrubby sub-formation)

Vegetation class: Northern Tableland Dry Sclerophyll Forests

Conservation status:

- EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- BC Act: White Box Yellow Box Blakely's Red Gum Woodland

Extent within development footprint: 0.00002 hectares

Dominant species:

- Canopy: *Eucalyptus blakelyi*
- Shrub:
- Ground: *Eragrostis pilosa*, *Verbena bonariensis*, *Eragrostis curvula*, *Dichelachne micrantha*, *Poa labillardieri*, *Lomandra filiformis subsp coriacea*



PCT 540 - Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion

Vegetation formation: Dry Sclerophyll Forests (Shrub/grass formation)

Vegetation class: New England Dry Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 69.63 hectares

Dominant species:

- Canopy: *Angophora floribunda*, *Eucalyptus dalrympleana*, *Eucalyptus laevopinia*, *Eucalyptus nortonii*, *Eucalyptus viminalis*, *Eucalyptus obliqua*, *Eucalyptus pauciflora*, *Eucalyptus nobilis*
- Shrub: *Dodonaea viscosa*, *Melicytus dentatus*, *Bursaria spinosa*, *Cassinia laevis*, *Coprosma quadrifida*, *Acacia melanoxydon*, *Notelaea microcarpa* var *microcarpa*, *Olearia viscosa*, *Acacia paradoxa*, *Banksia integrifolia* subsp. *monticola*, *Acacia implexa*, *Rubus fruticosus*
- Ground: *Lolium perenne*, *Bromus catharticus*, *Dactylis glomerata*, *Pandorea pandorana*, *Phytolacca octandra*, *Geranium potentilloides*, *Aristida ramosa*, *Chloris ventricosa*, *Rytidosperma laeve*, *Sigesbeckia orientalis*, *Bothriochloa decipiens*, *Bothriochloa macra*, *Lomandra multiflora multiflora*, *Carthamus lanatus*, *Urtica incisa*, *Cenchrus clandestinus*, *Cyperus ihotskyanus*, *Dichondra repens*, *Geranium solanderi*, *Lomandra longifolia*, *Microlaena stipoides*, *Poa sieberiana*, *Oxalis perennans*, *Rytidosperma racemosum*, *Pteridium esculentum*, *Austrostipa scabra*, *Lomandra filiformis* subsp. *coriacea*, *Cymbopogon refractus*, *Cerastium glomeratum*, *Echinopogon mckiei*, *Elymus scabra*, *Marrubium vulgare*, *Medicago polymorpha*, *Poa labillardieri*, *Paspalum dilatatum*, *Pimelea* spp, *Carex inversa*, *Pteridium esculentum*, *Verbena bonariensis*, *Xanthium occidentale*, *Cymbonotus lawsonianus*, *Cirsium vulgare*, *Juncus flavidus*, *Onopordum acanthium*, *Panicum effusum*, *Themeda triandra*, *Dichelachne micrantha*,



PCT 541 - Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion

Vegetation formation: Dry Sclerophyll Forests (Shrub/grass formation)

Vegetation class: New England Dry Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 29.99 hectares

Dominant species:

- Canopy: *Angophora floribunda*, *Eucalyptus albens*, *Eucalyptus blakelyi*, *Eucalyptus laevopinia*, *Eucalyptus nortoni*, *Eucalyptus viminalis*, *Eucalyptus dalrympleana*
- Shrub: *Schinus molle*, *Allocasuarina littoralis*, *Bursaria spinosa*, *Cassinia laevis*, *Meliccytus dentatus*, *Notelaea microcarpa var microcarpa*, *Olearia viscidula*, *Rosa rubiginosa*, *Acacia dealbata*, *Acacia melanoxylon*, *Acacia implexa*, *Acacia paradoxa*, *Rubus fruticosus*
- Ground: *Malva neglecta*, *Eragrostis curvula*, *Microlaena stipoides*, *Lolium perenne*, *Pandorea pandorana*, *Plantago lanceolata*, *Cirsium vulgare*, *Paspalum dilatatum*, *Dactylis glomerata*, *Phytolacca octandra*, *Sporobolus africanus*, *Themeda triandra*, *Aristida ramosa*, *Chloris ventricosa*, *Rytidosperma laeve*, *Austrostipa scabra*, *Bothriochloa decipiens*, *Bromus catharticus*, *Carthamus lanatus*, *Urtica incisa*, *Galium aparine*, *Lomandra multiflora multiflora*, *Lomandra longifolia*, *Oxalis perennans*, *Geranium potentilloides*, *Plantago lanceolata*, *Poa labillardieri*, *Poa sieberiana*, *Rytidosperma racemosum*, *Austrostipa scabra*, *Sigesbeckia orientalis*, *Sporobolus africanus*, *Swainsona galegifolia*, *Urtica incisa*, *Vicia sativa*, *Cymbopogon refractus*, *Cerastium glomeratum*, *Imperata cylindrica*, *Lomandra filiformis subsp coriacea*, *Marrubium vulgare*, *Medicago polymorpha*, *Pimelea spp*, *Carex inversa*, *Solanum nigrum*, *Pteridium esculentum*, *Trifolium repens*, *Bidens pilosa*, *Hardenbergia violaceae*, *Dianella longifolia*, *Cymbonotus lawsonianus*, *Echinopogon ovatus*, *Eleocharis spp*, *Panicum effusum*, *Plantago lanceolata*, *Solanum chenopodioides*, *Sonchus asper*



PCT 591 - White Box shrubby open forest on hills mainly in the Nandewar Bioregion

Vegetation formation: Dry Sclerophyll Forests (Shrub/grass formation)

Vegetation class: North-west Slopes Dry Sclerophyll Woodlands

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 0.65 hectares

Dominant species:

- Canopy: *Callitris glaucophylla*, *Eucalyptus nortonii*, *Angophora floribunda*, *Eucalyptus laevopinia*
- Shrub: *Olearia viscosa*, *Bursaria spinosa spinosa*, *Notelaea microcarpa var microcarpa*, *Acacia paradoxa*, *Cassinia laevis*
- Ground: *Lomandra multiflora multiflora*, *Aristida ramosa*, *Lomandra filiformis subsp coriacea*, *Medicago polymorpha*



PCT 599 - Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion

Vegetation formation:

Vegetation class:

Conservation status:

- EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- BC Act: White Box Yellow Box Blakely's Red Gum Woodland

Extent within development footprint: 3.34 hectares

Dominant species:

- Canopy: *Angophora floribunda*, *Eucalyptus albens*, *Eucalyptus blakelyi*, *Eucalyptus melliodora*, *Eucalyptus nortonii*
- Shrub: *Acacia implexa*, *Schinus molle*, *Acacia melanoxylon*, *Brachychiton populnea*, *Geijera parviflora*, *Notelaea microcarpa var microcarpa*, *Olearia viscidum*, *Bursaria spinosa spinosa*, *Melicytus dentatus*, *Cassinia laevis*, *Rubus fruticosus*,
- Ground: *Dactylis glomerata*, *Eragrostis curvula*, *Ehrharta longiflora*, *Lomandra multiflora multiflora*, *Eustrephus latifolius*, *Paspalum dilatatum*, *Plantago lanceolata*, *Rytidosperma racemosum*, *Themeda triandra*, *Dichelachne micrantha*, *Amaranthus retroflexus*, *Aristida ramosa*, *Bothriochloa decipiens*, *Bidens pilosa*, *Bromus catharticus*, *Chloris ventricosa*, *Cymbopogon refractus*, *Geranium solanderi*, *Malva neglecta*, *Microlaena stipoides*, *Onopordum acanthium*, *Onopordum acanthium*, *Plantago lanceolata*, *Poa labillardieri*, *Urtica incisa*, *Vicia sativa*, *Asperula conferta*, *Lomandra filiformis subsp coriacea*, *Rytidosperma laeve*, *Dianella longifolia*, *Phalaris aquatica*, *Avena fatua*, *Medicago polymorpha*, *Trifolium pratense*, *Soliva sessilis*, *Taraxicum officinale*, *Lolium perenne*, *Lomandra multiflora multiflora*, *Bothriochloa decipiens*, *Austrostipa scabra*, *Galium aparine*, *Cerastium glomeratum*, *Digitaria ciliaris*, *Sonchus asper*, *Wurmbea dioica*



PCT 931 - Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion

Vegetation formation: Wet Sclerophyll Forests (Shrubby sub-formation)

Vegetation class: Northern Escarpment Wet Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 5.57 hectares

Dominant species:

- Canopy: *Eucalyptus obliqua*, *Eucalyptus viminalis*, *Eucalyptus dalrympleana*, *Eucalyptus pauciflora*
- Shrub: *Acacia melanoxylon*, *Lomatia arborescens*, *Melicetyus dentatus*, *Leptospermum polygalifolium*
- Ground: *Microlaena stipoides*, *Poa sieberiana*, *Urtica incisa*, *Pteridium esculentum*



PCT 934 - Messmate open forest of the tableland edge of the NSW North Coast Bioregion and New England Tableland Bioregion

Vegetation formation: Wet Sclerophyll Forests (Shrubby sub-formation)

Vegetation class: Northern Escarpment Wet Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 15.56 hectares

Recorded species:

- Canopy: *Acacia melanoxylon*, *Eucalyptus blakelyi*, *Eucalyptus laevopinea*, *Eucalyptus nobilis*, *Eucalyptus obliqua*, *Eucalyptus pauciflora*
- Shrub: *Cassinia laevis*, *Coprosma quadrifida*, *Daviesia ulicifolia*, *Lomatia arborescens*, *Meliccytus dentatus*, *Acacia implexa*, *Asperula conferta*, *Austrocynoglossum latifolium*, *Rubus fruticosus*, *Rubus parvifolius*
- Ground: *Smilax australis*, *Asperula conferta*, *Austrocynoglossum latifolium*, *Bidens pilosa*, *Bidens subalternans*, *Bidens tripartite*, *Brachycome spathulata*, *Calochlaena dubia*, *Carthamus lanatus*, *Cenchrus clandestinus*, *Cotula australis*, *Crassula sieberiana*, *Cymbonotus lawsonianus*, *Cynoglossum latifolia*, *Desmodium spp.*, *Desmodium varians*, *Dichondra repens*, *Dysphania pumilio*, *Echinopogon mckiei*, *Ehrharta calycina*, *Einadia nutans*, *Einadia trigonos*, *Eustrephus latifolius*, *Galium gaudichaudii*, *Galium leiocarpum*, *Geranium potentilloides*, *Geranium solanderi* var. *solanderi*, *Geranium spp.*, *Glycine microphylla*, *Glycine tabacina*, *Gonocarpus teucroides*, *Hydrocotyle laxiflora*, *Hydrocotyle laxiflora*, *Hypericum gramineum*, *Leucopogon hookeri*, *Lobelia concolor*, *Lobelia spp.*, *Lomandra filiformis*, *Lomandra longifolia*, *Mentha diemenica*, *Microlaena stipoides*, *Oxalis perennans*, *Plantago debilis*, *Poa labillardierei*, *Poa sieberiana* var. *sieberiana*, *Pratia concolor*, *Pratia purpurascens*, *Pseuderanthemum variabile*, *Pteridium esculentum*, *Rumex brownie*, *Rytidosperma carphoides*, *Rytidosperma laeve*, *Scutellaria humilis*, *Senecio hispidulus*, *Senecio minimus*, *Senecio prenanthoides*, *Sigesbeckia orientalis*, *Smilax australis*, *Solanum aviculare*, *Solanum chenopodioides*, *Solanum prinophyllum*, *Stellaria pungens*, *Swainsona galegifolia*, *Urtica incisa*, *Veronica plebeian*, *Viola betonicifolia*, *Wahlenbergia gracilis*



PCT 954 - Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion

Vegetation formation: Wet Sclerophyll Forests (Grassy sub-formation)

Vegetation class: Northern Escarpment Wet Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 1.41 hectares

Species recorded:

- Canopy: *Eucalyptus laevopinea*
- Shrub: *Bursaria spinosa subsp. spinosa*, *Cassinia laevis*, *Acacia implexa*
- Ground: *Acaena novae-zelandiae*, *Ajuga australis*, *Aristida ramosa*, *Asperula conferta*, *Asperula scoparia*, *Asplenium flabellifolium*, *Bidens pilosa*, *Bidens subalternans*, *Bothriochloa decipiens*, *Carex incomitata*, *Cheilanthes sieberi subsp. sieberi*, *Crassula sieberiana*, *Cymbonotus lawsonianus*, *Daucus glochidiatus*, *Desmodium varians*, *Dichondra repens*, *Dysphania pumilio*, *Echinopogon mckiei*, *Einadia nutans*, *Einadia trigonos*, *Galium leptogonium*, *Geranium solanderi var. solanderi*, *Glycine microphylla*, *Lepidosperma laterale*, *Lomandra filiformis subsp. flavior*, *Microlaena stipoides*, *Oxalis perennans*, *Plantago debilis*, *Poa labillardierei*, *Pratia concolor*, *Rubus parvifolius*, *Rumex brownie*, *Rytidosperma penicillatum*, *Scutellaria humilis*, *Senecio hispidulus*, *Senecio prenanthoides*, *Senecio quadridentatus*, *Sigesbeckia orientalis*, *Solanum chenopodioides*, *Solenogyne gunnii*, *Stellaria pungens*, *Veronica calycina*, *Viola betonicifolia*, *Wahlenbergia stricta subsp. stricta*

PCT 1192 - Snow Gum - Mountain Gum - Mountain Ribbon Gum grassy open forest of the New England Tableland Bioregion

Vegetation formation: Grassy Woodlands

Vegetation class: Tableland Clay Grassy Woodlands

Conservation status:

- EPBC Act: Not listed
- BC Act: Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion

Extent within development footprint: 1.02 hectares

Species recorded:

- Canopy : *E.pauciflora*, *E.dalrympleana*
- Shrub: none
- Ground: *Poa sieberiana*, *Carthamus lanatus*, *Cenchrus clandestinus*

PCT 1194 - Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion

Vegetation formation: Wet Sclerophyll Forests (Grassy sub-formation)

Vegetation class: Northern Tableland Wet Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion

Extent within development footprint:

Species recorded:

- Canopy: *Acacia melanoxylon*, *Eucalyptus nobilis*, *Eucalyptus pauciflora*, *Eucalyptus viminalis*, *Eucalyptus dalrympleana*, *Eucalyptus laevopinia*
- Shrub: *Acacia melanoxylon*, *Bursaria spinosa*, *Coprosma quadrifida*, *Daviesia genistifolia*, *Lomatia arborescens*, *Melicytus dentatus*, *Olearia spp.*
- Ground: *Smilax australis*, *Acaena novae-zelandiae*, *Ammobium alatum*, *Arthropodium milleflorus*, *Asperula conferta*, *Austrocynoglossum latifolius*, *Austrostipa scabra*, *Bidens pilosa*, *Billardiera mutabilis*, *Brachycome spathulata*, *Brachyscome aculeata*, *Brachyscome sieberi*, *Carex incomitata*, *Carex inversa*, *Cenchrus clandestina*, *Chrysocephalum apiculatus*, *Coprosma quadrifida*, *Cotula australis*, *Cymbonotus lawsonianus*, *Daucus glochidiatus*, *Desmodium gunnii*, *Desmodium varians*, *Dianella caerulea*, *Dichondra repens*, *Dysphania pumilio*, *Echinopogon mckiei*, *Echinopogon ovatus*, *Einadia nutans*, *Einadia trigonos*, *Entolasia marginate*, *Epilobium billardioreanum subsp. cinereum*, *Euchiton japonicus*, *Euchiton sphaericus*, *Euchiton spp.*, *Eustrephus latifolius*, *Galium ciliare*, *Galium gaudichaudii*, *Galium leptogonium*, *Geitonoplesium cymosum*, *Geranium potentilloides*, *Geranium solanderi*, var. *solanderi*, *Glycine clandestine*, *Glycine microphylla*, *Glycine tabacina*, *Gonocarpus micranthus*, *Gonocarpus teucrioides*, *Hardenbergia violacea*, *Hibbertia spp.*, *Hydrocotyle laxiflora.*, *Hypericum gramineum*, *Juncus flavidus*, *Lobelia concolor Lobelia spp.*, *Lomandra filiformis subsp. flavior*, *Lomatia arborescens*, *Mentha diemenica*, *Microlaena stipoides*, *Mentha diemenica*, *Microlaena stipoides*, *Poa sieberiana var. sieberiana*, *Pratia concolor*, *Pratia purpurascens*, *Pteridium esculentum*, *Rubus fruticosus sp. agg.*, *Rubus parvifolius*, *Rumex brownii*, *Senecio madagascariensis*, *Senecio prenanthoides*, *Senecio tenuiflorus*, *Sigesbeckia orientalis*, *Smilax australis*, *Solanum chenopodioides*, *Solanum prinophyllum*, *Stellaria pungens*, *Swainsona galegifolia*, *Thysanotus tuberosus*, *Urtica incisa*, *Veronica calycina*, *Veronica plebeian*, *Viola betonicifolia*, *Viola hederacea*, *Wahlenbergia gracilis*, *Wahlenbergia stricta*



PCT 1604 - Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Vegetation formation: Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 0.10 hectares

Species recorded:

- Canopy: *Corymbia maculate*, *Eucalyptus mollucanna*, *Eucalyptus crebra*
- Shrub: *Acacia implexa*,
- Ground: *Sonchus oleraceus*, *Lysimachia arvensis*, *Lamium amplexicaule*, *Plantago lanceolata*, *Galenia pubescens* var *pubescens*, *Eremophila debilis*



PCT 1691 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter

Vegetation formation: Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 0.03 hectares

Species recorded:

- Canopy: *Eucalyptus tereticornis*, *Eucalyptus crebra*
- Shrub: *Lycium ferocissimum*
- Ground: *Avena fatua*, *Brassica fruticulosa*, *Bromus catharticus*, *Lolium perenne*, *Galenia pubescens var pubescens*, *Malva neglecta*



Appendix C

Threatened species habitat suitability assessment

C1

Table 49: Consideration of species requiring further assessment

Bam candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
Species name	Common name	Credit class	Species geographic constraints	Species associated with site PCT?	Native vegetation cover required	Required patch size	Requires further assessment	Habitat constraints	Suitable habitat	Habitat assessment	Likelihood of occurrence
Frogs											
Litoria booroolongensis	Booroolong Frog	Species		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses.;1 Adults occur on or near cobble banks and other rock structures within stream margins.;2 Shelter under rocks or amongst vegetation near the ground on the stream edge.;3 Sometimes bask in the sun on exposed rocks near flowing water during summer.;4 Breeding occurs in spring and early summer and tadpoles metamorphose in late summer to early autumn.;5 Eggs are laid in submerged rock crevices and tadpoles grow in slow-flowing connected or isolated pools.;6	Marginal habitat supported by a number of minor waterbodies within the wind farm development corridor. Low quality potential habitat present where transmission line corridor crosses Wombramurra Creek	Moderate
Litoria daviesae	Davies' Tree Frog	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes	Other; Streams or swamps or within 250 m of waterbodies	Davies' Tree Frog occurs in permanent, slow-flowing small streams above 400 m elevation, mostly in the headwaters of eastern-flowing streams (although it does occur in the headwaters of the western-flowing Peel River).;1 On the tablelands, riparian habitat may be montane heath or dry open forest with fringing tea tree, tussocks and ferns.	Marginal habitat supported by a number of minor waterbodies within the wind farm development corridor. Habitats degraded on transmission line corridor	Moderate

									Escarpment habitat is typically rainforest and wet sclerophyll with a rainforest understorey.;2 Breeding occurs in spring and early summer. Daytime calling is common during the breeding season. At night, males can be found calling from perched positions on trees and shrubs 0.5 - 1.5 m above streams.;3 The species has rarely been observed away from the riparian zone, implying a reliance on that zone for breeding and foraging. However, nothing is known of habitat use outside the breeding season.;4		
Litoria subglandulosa	Glandular Frog	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes		Glandular Frogs may be found along streams in rainforest, moist and dry eucalypt forest or in subalpine swamps.;1 Breeding occurs in summer, and possibly in spring.;2	Marginal habitat supported by a number of minor waterbodies within the wind farm development corridor. Habitats degraded on transmission line corridor. Species records associated with large areas on intact vegetation to the east of the project site, with no records within 100kms of the project site.	Low
Mixophyes balbus	Stuttering Frog	Species		Yes	Variegated - 31-70% habitat retained	5 - 24 ha	Yes		Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range.;1 Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor.;2 Feed on insects and smaller frogs.;3 Breed in streams during summer after heavy rain.;4 Eggs are laid on rock shelves or shallow riffles in small, flowing streams.;5 As the tadpoles grow they move to deep permanent pools and	Marginal habitat supported by a number of minor waterbodies within the wind farm development corridor. Habitats degraded on transmission line corridor. Species records associated with large areas on intact vegetation to the east of the project site, with no records within	Low

										take approximately 12 months to metamorphose.;6	100kms of the project site.	
Birds												
Anthochaera phrygia	Regent Honeyeater	Species/Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Other; As per mapped areas	The Regent Honeyeater is a flagship threatened woodland bird whose conservation will benefit a large suite of other threatened and declining woodland fauna. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes.;1 Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. Birds are occasionally seen on the south coast.;2 In the last 10 years Regent Honeyeaters have been recorded in urban areas around Albury where woodlands tree species such as Mugga Ironbark and Yellow Box were planted 20 years ago.;3 The Regent Honeyeater is a generalist forager, although it feeds mainly on the nectar from a relatively small number of eucalypts that produce high volumes of nectar. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. Other tree species may be regionally important. For example the Lower Hunter Spotted Gum forests have recently been demonstrated to support regular breeding events.	Potential forage habitat supported across the development footprint. Project site does not occur within mapped Important Areas for the species	Moderate	

									<p>Flowering of associated species such as Thin-leaved Stringybark <i>Eucalyptus eugenioides</i> and other Stringybark species, and Broad-leaved Ironbark <i>E. fibrosa</i> can also contribute important nectar flows at times. Nectar and fruit from the mistletoes <i>Amyema miquelii</i>, <i>A. pendula</i> and <i>A. cambagei</i> are also utilised. When nectar is scarce lerp and honeydew can comprise a large proportion of the diet. Insects make up about 15% of the total diet and are important components of the diet of nestlings. ;4 Colour-banding of Regent Honeyeater has shown that the species can undertake large-scale nomadic movements in the order of hundreds of kilometres. However, the exact nature of these movements is still poorly understood. It is likely that movements are dependent on spatial and temporal flowering and other resource patterns. To successfully manage the recovery of this species a full understanding of the habitats used in the non-breeding season is critical.;5 There are three known key breeding areas, two of them in NSW - Capertee Valley and Bundarra-Barraba regions. The species breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria.;6 An open cup-shaped nest is constructed of bark, grass, twigs and wool by the</p>	
--	--	--	--	--	--	--	--	--	--	--

									female. Two or three eggs are laid and incubated by the female for 14 days. Nestlings are brooded and fed by both parents at an average rate of 23 times per hour and fledge after 16 days. Fledglings fed by both parents 29 times per hour.;7]		
Artamus cyanopterus cyanopterus	Dusky Woodswallow	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland.;1 Primarily eats invertebrates, mainly insects, which are captured whilst hovering or sallying above the canopy or over water. Also frequently hovers, sallies and pounces under the canopy, primarily over leaf litter and dead timber. Also occasionally take nectar, fruit and seed. ;2 Depending on location and local climatic conditions (primarily temperature and rainfall), the dusky woodswallow can be resident year round or migratory. In NSW, after breeding, birds migrate to the north of the state and to southeastern Queensland, while Tasmanian birds migrate to southeastern NSW after breeding. Migrants generally depart between March and May, heading south to breed again in spring. There is some evidence of site fidelity for breeding. Although dusky woodswallows generally breed as solitary pairs or occasionally in small flocks, large	Potential forage habitat supported across the development footprint	Moderate

									flocks may form around abundant food sources in winter. Large flocks may also form before migration, which is often undertaken with other species. ;3 Nest is an open, cup-shape, made of twigs, grass, fibrous rootlets and occasionally casuarina needles, and may be lined with grass, rootlets or infrequently horsehair, occasionally unlined. Nest sites vary greatly, but generally occur in shrubs or low trees, living or dead, horizontal or upright forks in branches, spouts, hollow stumps or logs, behind loose bark or in a hollow in the top of a wooden fence post. Nest sites may be exposed or well concealed by foliage. ;4		
Burhinus grallarius	Bush Stone-curlew	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	No	Fallen/standing dead timber including logs; Null	Inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber.;1 Largely nocturnal, being especially active on moonlit nights.;2 Feed on insects and small vertebrates, such as frogs, lizards and snakes.;3 Nest on the ground in a scrape or small bare patch.;4 Two eggs are laid in spring and early summer.;5	Species occurs at altitudes much lower than the development footprint with the highest elevation record of the species within over 120kms of the project site at an altitude of 500 metres (approx.). The lowest point of the project site occurs along the transmission line at an altitude of 750 metres (approx.) and as such the development footprint does not support habitat for the species. Two records of the species occurs at an elevation of approximately 1000 metres, one near Armidale over 120kms from the project site, and the other in	Negligible

											Washpool NP, over 270kms from the project site. When these records are compared to the remainder of the 1350 species' records in BioNet, these occurrences are considered to be a vagrants.	
Callocephalon fimbriatum	Gang-gang Cockatoo	Species/Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	No	Hollow bearing trees; Eucalypt tree species with hollows greater than 9 cm diameter	In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. ;1 In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas.;2 May also occur in sub-alpine Snow Gum (Eucalyptus pauciflora) woodland and occasionally in temperate rainforests.;3 Favours old growth forest and woodland attributes for nesting and roosting. Nests are located in hollows that are 10 cm in diameter or larger and at least 9 m above the ground in eucalypts.;4	Of the 16,000 records of the species in ebird (and >600 in BioNet), none occur north of Muswellbrook NSW, except occasional records along coast just south of Coffs Harbour. As such the development footprint does not support habitat for the species.	Negligible	
Calyptorhynchus lathami	Glossy Black-Cockatoo	Species/Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Forage: Presence of Allocasuarina and casuarina species Breeding: Hollow bearing trees; Living or	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (Allocasuarina littoralis) and Forest Sheoak (A. torulosa) are important foods.;1 Inland populations feed on a wide range of sheoaks, including Drooping Sheoak, Allocasuarina diminuta, and A. gymnathera. Belah is also utilised and	Marginal potential forage habitat supported across the development footprint, very few Casuarina spp or Allocasuarina spp. have been recorded during floristic surveys of fauna habitat assessments. Breeding	Moderate	

								dead tree with hollows greater than 15cm diameter and greater than 5m above ground.	may be a critical food source for some populations.;2 In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, but also recorded in open woodlands dominated by Belah (Casuarina cristata).;3 Feeds almost exclusively on the seeds of several species of she-oak (Casuarina and Allocasuarina species), shredding the cones with the massive bill.;4 Dependent on large hollow-bearing eucalypts for nest sites. A single egg is laid between March and May.;5	habitat potentially present in the form of hollow trees.	
Chthonicola sagittata	Speckled Warbler	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies.;1 Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.;2 Large, relatively undisturbed remnants are required for the species to persist in an area.;3 The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees.;4 Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding.;5 The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside.;6 A clutch of 3-4 eggs is laid, between August and January,	Potential forage habitat supported across the development footprint	Moderate

									and both parents feed the nestlings. The eggs are a glossy red-brown, giving rise to the unusual folk names 'Blood Tit' and 'Chocolatebird'.;7 Some cooperative breeding occurs. The species may act as host to the Black-eared Cuckoo.;8 Speckled Warblers often join mixed species feeding flocks in winter, with other species such as Yellow-rumped, Buff-rumped, Brown and Striated Thornbills.;9		
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (Eucalyptus camaldulensis) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.;1 Sedentary, considered to be resident in many locations throughout its range; present in all seasons or year-round at many sites; territorial year-round, though some birds may disperse locally after breeding.;2 Gregarious and usually observed in pairs or small groups of 8 to 12 birds; terrestrial and arboreal in	Potential forage habitat supported across the development footprint	Moderate

									<p>about equal proportions; active, noisy and conspicuous while foraging on trunks and branches of trees and amongst fallen timber; spend much more time foraging on the ground and fallen logs than other treecreepers.</p> <p>;3 When foraging in trees and on the ground, they peck and probe for insects, mostly ants, amongst the litter, tussocks and fallen timber, and along trunks and lateral branches; up to 80% of the diet is comprised of ants; other invertebrates (including spiders, insects larvae, moths, beetles, flies, hemipteran bugs, cockroaches, termites and lacewings) make up the remaining percentage; nectar from Mugga Ironbark (Eucalyptus sideroxylon) and paperbarks, and sap from an unidentified eucalypt are also eaten, along with lizards and food scraps; young birds are fed ants, insect larvae, moths, crane flies, spiders and butterfly and moth larvae.;4 Hollows in standing dead or live trees and tree stumps are essential for nesting.</p> <p>;5 The species breeds in pairs or cooperatively in territories which range in size from 1.1 to 10.7 ha (mean = 4.4 ha). Each group is composed of a breeding pair with retained male offspring and, rarely, retained female offspring. Often in pairs or cooperatively breeding groups of two to five birds.</p> <p>;6 </p>		
Daphoenositta chrysoptera	Varied Sittella	Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes		Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia	Potential forage habitat supported across the development footprint	Moderate

									woodland.;1 Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy.;2 Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.;3 Generation length is estimated to be 5 years.;4		
Glossopsitta pusilla	Little Lorikeet	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity.;1 Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species.;2 Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards;3 Gregarious, travelling and feeding in small flocks (<10), though often with other lorikeets. Flocks numbering hundreds are still occasionally observed and may have been the norm in past centuries.;4 Roosts in treetops, often distant from feeding areas.;5 Nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including	Potential forage habitat supported across the development footprint	Moderate

									species like Allocaeusuarina.6 Nesting season extends from May to September. In years when flowering is prolific, Little Lorikeet pairs can breed twice, producing 3-4 young per attempt. However, the survival rate of fledglings is unknown.;7		
Grantiella picta	Painted Honeyeater	Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes		Inhabits Boree/ Weeping Myall (Acacia pendula), Brigalow (A. harpophylla) and Box-Gum Woodlands and Box-Ironbark Forests.;1 A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.2 Insects and nectar from mistletoe or eucalypts are occasionally eaten.;3 Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.;4	Potential forage habitat supported across the development footprint	Moderate
Haliaeetus leucogaster	White-bellied Sea-Eagle	Species/Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	No	Waterbodies; Within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines; Living or dead mature trees within suitable vegetation within 1km of a rivers,	Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea.;1 Occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. ;2 Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest). ;3 Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent	Project site does not occur within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines. Where Peel River occurs within 1km of the development footprint it is a minor watercourse.	Negligible

								lakes, large dams or creeks, wetlands and coastlines	eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts'. Nests are large structures built from sticks and lined with leaves or grass. ;4 Feed mainly on fish and freshwater turtles, but also waterbirds, reptiles, mammals and carrion.;5 Hunts its prey from a perch or whilst in flight (by circling slowly, or by sailing along 10–20 m above the shore). Prey is usually carried to a feeding platform or (if small) consumed in flight, but some items are eaten on the ground.;6 May be solitary, or live in pairs or small family groups consisting of a pair of adults and dependent young. ;7 Typically lays two eggs between June and September with young birds remaining in the nest for 65-70 days.;8		
Hamirostra melanosternon	Black-breasted Buzzard	Species/Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Waterbodies; Land within 40 m of riparian woodland on inland watercourses/waterholes containing dead or dying eucalypts	Lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat.;1 Also hunts over grasslands and sparsely timbered woodlands.;2 Not a powerful hunter, despite its size, mostly taking reptiles, small mammals, birds, including nestlings, and carrion.;3 Also specialises in feeding on large eggs, including those of emus, which it cracks on a rock.;4 Breeds from August to October near water in a tall tree. The stick nest is large and flat and lined with green leaves. Normally two eggs are laid.;5	Riparian habitats are degraded within the development footprint.	Negligible
Hieraaetus morphnoides	Little Eagle	Species/Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes	Other; Nest trees - live (occasional	Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and	Potential forage and breeding habitat	Moderate

								y dead) large old trees within vegetation.	riparian woodlands of interior NSW are also used.;1 Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.;2 Lays two or three eggs during spring, and young fledge in early summer.;3 Preys on birds, reptiles and mammals, occasionally adding large insects and carrion.;4	supported across the development footprint	
Lathamus discolor	Swift Parrot	Species/Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Other; As per mapped areas	Migrates to the Australian south-east mainland between February and October.;1 On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations.;2 Favoured feed trees include winter flowering species such as Swamp Mahogany Eucalyptus robusta, Spotted Gum Corymbia maculata, Red Bloodwood C. gummifera, Forest Red Gum E. tereticornis, Mugga Ironbark E. sideroxylon, and White Box E. albens;3 Commonly used lerp infested trees include Inland Grey Box E. microcarpa, Grey Box E. moluccana, Blackbutt E. pilularis, and Yellow Box E. melliodora;4 Return to some foraging sites on a cyclic basis depending on food availability.;5 Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum Eucalyptus globulus;6	Potential forage habitat supported across the development footprint. Project site does not occur within mapped Important Areas for the species	Moderate

Lophoictinia isura	Square-tailed Kite	Species/Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes	Other; Nest trees	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses.;1 In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland.;2 Is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage.;3 Appears to occupy large hunting ranges of more than 100km2.;4 Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.;5	Potential forage and breeding habitat supported across the development footprint	Moderate
Melanodryas cucullata	Hooded Robin (south-eastern form)	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas.;1 Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.;2 Often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey.;3 Territories range from around 10 ha during the breeding season, to 30 ha in the non-breeding season.;4 May breed any time between July and November, often rearing several broods.;5 The nest is a small, neat cup of bark and grasses bound with webs, in a tree fork or crevice, from less than 1 m to 5 m above the ground.;6 The nest is	Potential forage habitat supported across the development footprint	Moderate

									defended by both sexes with displays of injury-feigning, tumbling across the ground.;7 A clutch of two to three is laid and incubated for fourteen days by the female. Two females often cooperate in brooding.;8		
Ninox connivens	Barking Owl	Species/Ecosystem		Yes	Fragmented - 11-30 % habitat retained	25 - 100 ha	Yes	Hollow bearing trees; Living or dead trees with hollows greater than 20 cm diameter and greater than 4m above the ground.	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey found on these fertile riparian soils.;1 Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. During nesting season, the male perches in a nearby tree overlooking the hollow entrance.;2 Preferentially hunts small arboreal mammals such as Squirrel Gliders and Common Ringtail Possums, but when loss of tree hollows decreases these prey populations the owl becomes more reliant on birds, invertebrates and terrestrial mammals such as rodents and rabbits. Can catch bats and moths on the wing, but typically hunts by sallying from a tall perch.;3 Requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats.;4 Two or three eggs are laid in hollows of large, old trees. Living eucalypts are preferred though	Potential forage and breeding habitat supported across the development footprint	Moderate

									<p>dead trees are also used. Nest sites are used repeatedly over years by a pair, but they may switch sites if disturbed by predators (e.g. goannas).;5 Nesting occurs during mid-winter and spring, being variable between pairs and among years. As a rule of thumb, laying occurs during August and fledging in November. The female incubates for 5 weeks, roosts outside the hollow when chicks are 4 weeks old, then fledging occurs 2-3 weeks later. Young are dependent on their parents for several months.;6 Territorial pairs respond strongly to recordings of Barking Owl calls from up to 6 km away, though humans rarely hear this response farther than 1.5 km. Because disturbance reduces the pair's foraging time, and can pull the female off her eggs even on cold nights, recordings should not be broadcast unnecessarily nor during the nesting season.;7 </p>		
Ninox strenua	Powerful Owl	Species/Ecosystem	Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes	Hollow bearing trees; Living or dead trees with hollow greater than 20cm diameter	<p>The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest.;1 The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine Syncarpia glomulifera, Black She-oak Allocasuarina littoralis, Blackwood Acacia melanoxylon, Rough-barked Apple Angophora</p>	Potential forage and breeding habitat supported across the development footprint	Moderate	

									<p>floribunda, Cherry Ballart Exocarpus cupressiformis and a number of eucalypt species. ;2 The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. There may be marked regional differences in the prey taken by Powerful Owls. For example in southern NSW, Ringtail Possum make up the bulk of prey in the lowland or coastal habitat. At higher elevations, such as the tableland forests, the Greater Glider may constitute almost all of the prey for a pair of Powerful Owls. Flying foxes are important prey in some areas; birds comprise about 10-50% of the diet depending on the availability of preferred mammals. As most prey species require hollows and a shrub layer, these are important habitat components for the owl. ;3 Pairs of Powerful Owls demonstrate high fidelity to a large territory, the size of which varies with habitat quality and thus prey densities. In good habitats a mere 400 can support a pair; where hollow trees and prey have been depleted the owls need up to 4000 ha.;4 Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. While the female and young are in the nest hollow the male Powerful Owl roosts nearby (10-200 m) guarding them, often choosing a dense "grove" of trees that provide concealment from other birds that harass him.;5 Powerful Owls are monogamous and mate for life. Nesting occurs from late autumn to</p>	
--	--	--	--	--	--	--	--	--	---	--

									mid-winter, but is slightly earlier in north-eastern NSW (late summer - mid autumn). Clutches consist of two dull white eggs and incubation lasts approximately 38 days.;		
Pachycephala olivacea	Olive Whistler	Ecosystem		Yes	Variegated - 31-70% habitat retained	25 - 100 ha	Yes		Mostly inhabit wet forests above about 500m. During the winter months they may move to lower altitudes.;	Potential forage habitat supported across the development footprint	Moderate
Petroica boodang	Scarlet Robin	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs.;	Potential forage habitat supported across the development footprint	Moderate

									<p>approached.;7 Birds forage from low perches, fence-posts or on the ground, from where they pounce on small insects and other invertebrates which are taken from the ground, or off tree trunks and logs; they sometimes forage in the shrub or canopy layer.;8 Scarlet Robin pairs defend a breeding territory and mainly breed between the months of July and January; they may raise two or three broods in each season.;9 This species' nest is an open cup made of plant fibres and cobwebs and is built in the fork of tree usually more than 2 metres above the ground; nests are often found in a dead branch in a live tree, or in a dead tree or shrub.;10 Eggs are pale greenish-, bluish- or brownish-white, spotted with brown; clutch size ranges from one to four.;11 Birds usually occur singly or in pairs, occasionally in small family parties; pairs stay together year-round.;12 In autumn and winter, the Scarlet Robin joins mixed flocks of other small insectivorous birds which forage through dry forests and woodlands.;13 </p>		
Petroica phoenicea	Flame Robin	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		<p>Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes.;1 Prefers clearings or areas with open understoreys.;2 The ground layer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense.;3 Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgeland at high altitudes.;4 In winter, birds migrate to drier more open habitats in the lowlands (i.e. valleys below the ranges, and to the</p>	Potential forage habitat supported across the development footprint	Moderate

									western slopes and plains).;5 Often occurs in recently burnt areas; however, habitat becomes unsuitable as vegetation closes up following regeneration.;6 In winter lives in dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees.;7 In winter, occasionally seen in heathland or other shrublands in coastal areas.;8 Birds forage from low perches, from which they sally or pounce onto small invertebrates which they take from the ground or off tree trunks, logs and other coarse woody debris.;9 Flying insects are often taken in the air and sometimes glean for invertebrates from foliage and bark.;10 In their autumn and winter habitats, birds often sally from fence-posts or thistles and other prominent perches in open habitats.;11 Occur singly, in pairs, or in flocks of up to 40 birds or more; in the non-breeding season they will join up with other insectivorous birds in mixed feeding flocks.;12 Breeds in spring to late summer.;13 Nests are often near the ground and are built in sheltered sites, such as shallow cavities in trees, stumps or banks.;14 Builds an open cup nest made of plant materials and spider webs.;15 Eggs are oval in shape and are pale bluish- or greenish-white and marked with brownish blotches; clutch size is three or four eggs.;16		
Stagonopleura guttata	Diamond Firetail	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum Eucalyptus pauciflora Woodlands.;1 Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from	Potential forage habitat supported across the development footprint	Moderate

									other communities.;2 Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.;3 Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season).;4 Usually encountered in flocks of between 5 to 40 birds, occasionally more.;5 Groups separate into small colonies to breed, between August and January.;6 Nests are globular structures built either in the shrubby understorey, or higher up, especially under hawk's or raven's nests.;7 Birds roost in dense shrubs or in smaller nests built especially for roosting.;8 Appears to be sedentary, though some populations move locally, especially those in the south.;9 Has been recorded in some towns and near farm houses.;10		
Tyto novaehollandiae	Masked Owl	Species/Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes	Hollow bearing trees; Living or dead trees with hollows greater than 20cm diameter.	Lives in dry eucalypt forests and woodlands from sea level to 1100 m.;1 A forest owl, but often hunts along the edges of forests, including roadsides.;2 The typical diet consists of tree-dwelling and ground mammals, especially rats.;3 Pairs have a large home-range of 500 to 1000 hectares.;4 Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.;5	Potential forage and breeding habitat supported across the development footprint	Moderate
Tyto tenebricosa	Sooty Owl	Species/Ecosystem		Yes	Intact - over 70% natural habitat retained	> 100 ha	Yes	Caves;Caves or clifflines/ledges Hollow bearing trees; Living or	Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests.;1 Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the	Potential forage and breeding habitat supported across the development footprint	Moderate

									dead trees with hollows greater than 20cm diameter.	Common Ringtail Possum (Pseudocheirus peregrinus) or Sugar Glider (Petaurus breviceps);2 Nests in very large tree-hollows.;3		
Mammals												
Aepyprymnus rufescens	Rufous Bettong	Species		Yes	Variegated - 31-70% habitat retained	< 5 ha	Yes			Rufous Bettongs inhabit a variety of forests from tall, moist eucalypt forest to open woodland, with a tussock grass understorey. A dense cover of tall native grasses is the preferred shelter.;1 They sleep during the day in cone-shaped nests constructed of grass in a shallow depression at the base of a tussock or fallen log.;2 At night they feed on grasses, herbs, seeds, flowers, roots, tubers, fungi and occasionally insects.;3	Marginal potential habitat occurs within the wind farm development corridor, habitats within the transmission line corridor are degraded	Moderate
Cercartetus nanus	Eastern Pygmy-possum	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes			Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest.;1 Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable.;2 Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests.;3 Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (Pseudocheirus peregrinus) dreys or thickets of	Potential habitat is present within the development footprint.	Moderate

									vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.;4 Appear to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares.;5 Young can be born whenever food sources are available, however most births occur between late spring and early autumn.;6 Agile climbers, but can be caught on the ground in traps, pitfalls or postholes; generally nocturnal.;7 Frequently spends time in torpor especially in winter, with body curled, ears folded and internal temperature close to the surroundings.;8		
Chalinolobus dwyeri	Large-eared Pied Bat	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes		Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (Petrochelidon ariel), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years.;1 Found in well-timbered areas containing gullies.;2 The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest	Habitat occurs within and adjacent to the development footprint	Recorded by survey

									canopy.;3 Likely to hibernate through the coolest months.;4 It is uncertain whether mating occurs early in winter or in spring.;5		
Dasyurus maculatus	Spotted-tailed Quoll	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.;1 Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites.;2 Mostly nocturnal, although will hunt during the day; spends most of the time on the ground, although also an excellent climber and will hunt possums and gliders in tree hollows and prey on roosting birds.;3 Use communal 'latrine sites', often on flat rocks among boulder fields, rocky cliff-faces or along rocky stream beds or banks. Such sites may be visited by multiple individuals and can be recognised by the accumulation of the sometimes characteristic 'twisty-shaped' faeces deposited by animals.;4 A generalist predator with a preference for medium-sized (500g-5kg) mammals. Consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits, reptiles and insects. Also eats carrion and takes domestic fowl.;5 Females occupy home ranges of 200-500 hectares, while males occupy very large home ranges from 500 to over 4000 hectares. Are known to traverse their home ranges along densely vegetated creeklines.;6 Average litter size is five; both sexes mature at about one	Habitat occurs within and adjacent to the development footprint	Recorded by survey

									year of age. Life expectancy in the wild is about 3-4 years.;7]		
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Ecosystem		Yes	Variegated - 31-70% habitat retained	5 - 24 ha	Yes		Prefers moist habitats, with trees taller than 20 m.;1 Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.;2 Hunts beetles, moths, weevils and other flying insects above or just below the tree canopy.;3 Hibernates in winter.;4 Females are pregnant in late spring to early summer.;5]	Habitat occurs within and adjacent to the development footprint	Recorded by survey
Macropus parma	Parma Wallaby	Species		Yes	Variegated - 31-70% habitat retained	5 - 24 ha	Yes		Preferred habitat is moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas, rainforest margins and occasionally drier eucalypt forest.;1 Typically feed at night on grasses and herbs in more open eucalypt forest and the edges of nearby grassy areas.;2 During the day they shelter in dense cover.;3]	Potential habitat occurs in higher condition areas connected to Ben Halls Gap Nature Reserve. Potential habitats within the transmission line corridor are degraded	Moderate
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range.;1 Roost mainly in tree hollows but will also roost under bark or in man-made structures.;2 Usually solitary but also recorded roosting communally, probably insectivorous.;3]	Habitat occurs within and adjacent to the development footprint	Recorded by survey
Miniopterus australis	Little Bent-winged Bat	Species/Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Caves; Cave, tunnel, mine, culvert or other structure known or suspected to be used	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas.;1 Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small	Habitat occurs within and adjacent to the development footprint	Recorded by survey

								for breeding including species records in BioNet with microhabitat code 'IC – in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature.	insects beneath the canopy of densely vegetated habitats.;2 They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters.;3 In NSW the largest maternity colony is in close association with a large maternity colony of Eastern Bentwing-bats (Miniopterus schreibersii) and appears to depend on the large colony to provide the high temperatures needed to rear its young.;4 Maternity colonies form in spring and birthing occurs in early summer. Males and juveniles disperse in summer.;5 Only five nursery sites /maternity colonies are known in Australia.;6		
Miniopterus orianae oceanensis	Large Bent-winged Bat	Species/Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Caves; Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records with microhabitat code "IC - in cave;" observation type code "E nest-roost;" with	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.;1 Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.;2 Maternity caves have very specific temperature and humidity regimes.;3 At other times of the year, populations disperse within about 300 km range of maternity caves.;4 Cold caves are used for hibernation in southern Australia.;5 Breeding or roosting colonies can number from 100 to 150,000 individuals.;6 Hunt in forested areas, catching moths and other flying insects above the tree tops.;7	Habitat occurs within and adjacent to the development footprint	Recorded by survey

								numbers of individuals >500			
Myotis macropus	Southern Myotis	Species		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage.;1 Forage over streams and pools catching insects and small fish by raking their feet across the water surface.;2 In NSW females have one young each year usually in November or December.;3	Habitat occurs within and adjacent to the development footprint	Recorded by survey
Nyctophilus corbeni	Corben's Long-eared Bat	Ecosystem		Yes	Fragmented - 11-30 % habitat retained	5 - 24 ha	Yes		Inhabits a variety of vegetation types, including mallee, bullocke Allocasuarina leuhmanni and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland.;1 Roosts in tree hollows, crevices, and under loose bark.;2 Slow flying agile bat, utilising the understorey to hunt non-flying prey - especially caterpillars and beetles - and will even hunt on the ground.;3 Mating takes place in autumn with one or two young born in late spring to early summer.;4	Potential habitat is present within the development footprint	Moderate
Petauroides volans	Greater Glider	Ecosystem		Yes	Variegated - 31-70% habitat retained	5 - 24 ha	Yes			Habitat occurs within and adjacent to the development footprint	Recorded by survey
Petaurus australis	Yellow-bellied Glider	Ecosystem		Yes	Variegated - 31-70% habitat retained	25 - 100 ha	Yes		Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils.;1 Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall	Habitat occurs within and adjacent to the development footprint	Moderate

									montane forests in the south.;2 Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein.;3 Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar.;4 Live in small family groups of two - six individuals and are nocturnal.;5 Den, often in family groups, in hollows of large trees.;6 Very mobile and occupy large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources.;7		
Petaurus norfolcensis	Squirrel Glider	Species		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas.;1 Prefers mixed species stands with a shrub or Acacia midstorey.;2 Live in family groups of a single adult male one or more adult females and offspring.;3 Require abundant tree hollows for refuge and nest sites.;4 Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.;5	Potential habitat is present within the development footprint	Moderate
Petrogale penicillata	Brush-tailed Rock-wallaby	Species		Yes	Fragmented - 11-30 % habitat retained	5 - 24 ha	Yes		Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north.;1 Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night when foraging.;2 Browse on vegetation in and adjacent to rocky areas eating	Potential habitat is present within the development footprint	Moderate

									grasses and forbs as well as the foliage and fruits of shrubs and trees.;3 Highly territorial and have strong site fidelity with an average home range size of about 15 ha. Males tend to have larger home ranges than females.;4 The home range consists of a refuge area and a foraging range linked by habitually used commuting routes.;5 Females settle in or near their mother's range, while males mainly disperse between female groups within colonies, and less commonly between colonies.;6 Dominant males associate and breed with multiple females.;7 Breeding occurs throughout the year with a peak in births between February and May, especially in the southern parts of the range and at higher altitudes.;8		
Phascogale tapoatafa	Brush-tailed Phascogale	Species		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter.;1 Also inhabit heath, swamps, rainforest and wet sclerophyll forest.;2 Agile climber foraging preferentially in rough barked trees of 25 cm DBH or greater.;3 Feeds mostly on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates.;4 Females have exclusive territories of approximately 20 - 40 ha, while males have overlapping territories often greater than 100 ha.;5 Nest and shelter in tree hollows with entrances 2.5 - 4 cm wide and use many different hollows over a short time span.;6 Mating occurs May - July; males die soon after the mating season whereas females can live for up to three years but generally only produce one litter.;7	Potential habitat is present within the development footprint. However, BioNet notes the species occurrences in the following IBRA subregions relevant to the project site. Walcha Plateau IBRA - Known to occur, but a geographic restriction exists stating "East of the Tia River". This river's headwaters occurs >50kms north-east of the study area. Nearest record of the species is 56kms east. Tomala IBRA - species known, with no geographic restrictions	Negligible

										listed. However, only records of the species comprise an inaccurate record (10kms) noted as Mount Royal SF (or NP) from 1991, one more low accuracy (10kms) in similar location (but in Barrington Tops IBRA), one further single record in the IBRA from 1974, and >66kms from the study area. Peel IBRA - Species predicted to occur (ie not known), no geographic restrictions listed. Species never recorded in IBRA.	
Phascolarctos cinereus	Koala	Species/Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Other; Areas identified via survey as important habitat (see comments)	Inhabit eucalypt woodlands and forests.;1 Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.;2 Inactive for most of the day, feeding and moving mostly at night.;3 Spend most of their time in trees, but will descend and traverse open ground to move between trees.;4 Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size.;5 Generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery.;6 Females breed at two years of age and produce one young per year.;7	Habitat occurs within and adjacent to the development footprint	Recorded by survey

Phoniscus papuensis	Golden-tipped Bat	Ecosystem		Yes	Variegated - 31-70% habitat retained	< 5 ha	Yes		Found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m. Also recorded in tall open forest, <i>Casuarina</i> -dominated riparian forest and coastal <i>Melaleuca</i> forests.;1 Bats will fly up to two kilometres from roosts to forage in rainforest and sclerophyll forest on mid and upper-slopes.;2 Roost mainly in rainforest gullies on small first- and second-order streams in usually abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests modified with an access hole on the underside. Bats may also roost under thick moss on tree trunks, in tree hollows, dense foliage and epiphytes.;3 Bats will use multiple roost and change roosts regularly.;4 Bats roost individually or in small colonies which can contain up to approximately 20 bats of both males and females or just a single sex.;5 Maternity roosts may occur away from water sources with one maternity roost found 450m upslope of the nearest water course in a broken bough.;6 Specialist feeder on small web-building spiders.;7 There is one breeding cycle per year.;8	Potential habitat is present within the development footprint	Moderate
Pteropus poliocephalus	Grey-headed Flying-fox	Species/Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Other; Breeding camps	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.;1 Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.;2 Individual camps may have tens of thousands of animals and are used for mating, and for giving birth	Potential forage habitat supported across the development footprint	Recorded by survey

									and rearing young.;3 Annual mating commences in January and conception occurs in April or May; a single young is born in October or November.;4 Site fidelity to camps is high; some camps have been used for over a century.;5 Can travel up to 50 km from the camp to forage; commuting distances are more often <20 km.;6 Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines.;7 Also forage in cultivated gardens and fruit crops.;8		
Saccolaimus flaviventris	Yellow-bellied Sheath-tail-bat	Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes		Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.;1 When foraging for insects, flies high and fast over the forest canopy, but lower in more open country.;2 Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.;3 Breeding has been recorded from December to mid-March, when a single young is born.;4 Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn.;5	Habitat occurs within and adjacent to the development footprint	Recorded by survey
Scoteanax rueppellii	Greater Broad-nosed Bat	Ecosystem		Yes	Variegated - 31-70% habitat retained	5 - 24 ha	Yes		Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest.;1 Although this species usually roosts in tree hollows, it has also been found in buildings.;2 Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m.;3 Open woodland	Habitat occurs within and adjacent to the development footprint	Recorded by survey

									habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species.;4 Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young.;5		
Thylogale stigmatica	Red-legged Pademelon	Ecosystem		Yes	Fragmented - 11-30 % habitat retained	5 - 24 ha	Yes		Inhabits forest with a dense understorey and ground cover, including rainforest, moist eucalypt forest and vine scrub.;1 Wet gullies with dense, shrubby ground cover provide shelter from predators.;2 In NSW, rarely found outside forested habitat.;3 They disperse from dense shelter areas to feed from late afternoon to early morning, favouring native grasses and herbs on the edge of the forest.;4 Also known to feed on fruits, young seedling leaves and stems, fungi and ferns.;5	Potential forage habitat supported across the development footprint	Moderate
Vespadelus troughtoni	Eastern Cave Bat	Species		Yes	Fragmented - 11-30 % habitat retained	5 - 24 ha	Yes	Caves; Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres	Very little is known about the biology of this uncommon species.;1 A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals.;2 Occasionally found along cliff-lines in wet eucalypt forest and rainforest.;3 Little is understood of its feeding or breeding requirements or behaviour.;4	Habitat occurs within and adjacent to the development footprint	Recorded by survey

									of old mines, tunnels, old buildings or sheds."			
Reptiles												
Hoplocephalus bitorquatus	Pale-headed Snake	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	No			The Pale-headed Snake is a highly cryptic species that can spend weeks at a time hidden in tree hollows.;1 Found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest.;2 In drier environments, it appears to favour habitats close to riparian areas.;3 Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees.;4 The main prey is tree frogs although lizards and small mammals are also taken.;5 The Pale-headed Snake is relatively unusual amongst elapid snakes in that it is well adapted to climbing trees.;6	Species known only to occur at altitudes much lower than the development footprint, within highest elevation BioNet records including 550m elevation (approx.) north of Bindarri NP (>200kms from the project site), 390m elevation (approx.) west of Kwiambal NP (>150kms from the project site) and 375m elevation (approx.) west of Gunnedah (>100kms from the project site). The lowest point of the project site occurs along the transmission line at an altitude of 750 metres (approx.) and as such the development footprint does not support habitat for the species.	Negligible
Uvidicolus sphyrurus	Border Thick-tailed Gecko	Species		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes			As implied by another of its common names (Granite Thick-tailed Gecko), this species often occurs on steep rocky or scree slopes, especially granite. Recent records from basalt and metasediment slopes and flats	Species distribution is north of the project site and has never been recorded (or predicted to occur in) Tomala or Walcha Plateau IBRA	Low

									indicate its habitat selection is broader than formerly thought and may have extended into areas that were cleared for agriculture.;1 Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter. Occupied sites often have a dense tree canopy that helps create a sparse understorey.;2 These Geckos are active at night and shelter by day under rock slabs, in or under logs, and under the bark of standing trees.	subregions. Peel IBRA has records 20-25kms north of the site across cleared land, which are at the southern extent of the species' occurrence. Peel IBRA abuts parts of the wind farm development corridor and includes the western 60% of the transmission line corridor.	
Plants											
<i>Acacia atrox</i>	Myall Creek Wattle	Species	N/A	N/A	N/A	N/A	Yes	N/A	Species grows in soils ranging from deep black clay over basalt to shallow red stony loams on the upper slope and crest of a low hill. Currently known from two populations near Delungra and Gurley. There individuals grow in a partly cleared paddock of box woodland with a native grassy understorey.	Known populations more than 200km north/ northwest of the study area. No records within proximity to the site. Potential habitat in PCT599 is marginal and unlikely to support the species.	Unlikely
<i>Eucalyptus nicholii</i>	Narrow-leaved Black Peppermint	Species	N/A	N/A	N/A	N/A	Yes	N/A	Typically grows in dry grassy woodland, on shallow soils of slopes and ridges- prefers infertile soils derived from granite or metasedimentary rock. The species occurs from Nundle to north of Tenterfield being most common in the central portions of its range.	Potential habitat within grassy woodland and dry sclerophyll forests within the site	Possible
<i>Chiloglottis platyptera</i>	Barrington Tops Ant Orchid	Species	N/A	N/A	N/A	N/A	Yes	N/A	Grows in moist areas in tall open Eucalypt forest with a grassy understorey and also around rainforest edges; generally on rich brown loam soils. Known to occur within the area including at Ben Halls Gap Nature Reserve.	Potential habitat within grassy woodland and open forests within the site.	Likely

<i>Dichanthium setosum</i>	Bluegrass	Species	N/A	N/A	N/A	N/A	Yes	N/A	Found in heavy basaltic black soil and red-brown loams with clay subsoil. Often in moderately disturbed areas including cleared woodland, grassy roadside remnants and high disturbed pasture; associated with species including <i>Eucalyptus albens</i> , <i>E.melanophloia</i> , <i>E.melliodora</i> , <i>E.viminalis</i> , <i>Myoporum debile</i> , <i>Aristida ramosa</i> , <i>Themeda triandra</i> , <i>Poa sieberiana</i> , <i>Bothriochloa ambigua</i> , <i>Medicago minima</i> .	Potential habitat within dry sclerophyll forests, derived native grassland and forested wetlands within the site.	Possible
<i>Digitaria porrecta</i>	Finger Panic Grass	Species	N/A	N/A	N/A	N/A	Yes	N/A	Occurs in native grassland, woodland or open forest with a grassy understorey on richer soils. Typically associated with <i>E.albens</i> , <i>Acacia pendula</i> <i>Austrostipa aristiglumis</i> , <i>Enteropogon acicularis</i> , <i>Cyperus bifax</i> , <i>Hibiscus trionum</i> and <i>Neptunia gracilis</i> .	Habitat within box woodland marginal for the species. No other suitable habitat within the site.	Unlikely
<i>Homoranthus prolixus</i>	Granite Homoranthus	Species	N/A	N/A	N/A	N/A	Yes	On or near granite outcrops and slabs or within 100m	Grows in heath patches, in skeletal soil among crevices of granite outcrops within the Ironbark Nature Reserve (east of Barraba) and neighbouring properties. The species has not been recorded in a survey of other granitic outcrop areas in the region.	No suitable habitat within the site	Unlikely
<i>Monotaxis macrophylla</i>	Large-leafed Monotaxis	Species	N/A	N/A	N/A	N/A	Yes	N/A	Found in coastal heath, arid shrubland, forests and montane heath from sea level to 1300m altitude, subject to regular fire.	No suitable habitat within the site	Unlikely
<i>Picris evae</i>	Hawkweed	Species	N/A	N/A	N/A	N/A	Yes	N/A	Occurs within open Eucalypt forest including a canopy of <i>E.melliodora</i> , <i>E.crebra</i> , <i>E.populnea</i> , <i>E.albens</i> , <i>Angophora subvelutina</i> , <i>Allocasuarina torulosa</i> , <i>Cunninghamiana</i> with a <i>Dichanthium</i> grassy understorey. Recorded north of Inverell and at Oxley Park Tamworth.	Open Eucalypt woodland within site does not support <i>Dichanthium</i> spp. dominated ground layer and is marginal for the species.	Unlikely

<i>Polygala linariifolia</i>	Native Milkwort	Species	N/A	N/A	N/A	N/A	Yes	N/A	Sandy soils in dry eucalypt forest and woodland with a sparse understorey. The species has been recorded from the Inverell and Torrington districts growing in dark sandy loam on granite in shrubby forest of <i>Eucalyptus caleyi</i> , <i>Eucalyptus dealbata</i> and <i>Callitris</i> , and in yellow podsolic soil on granite in layered open forest	Potential habitat within PCT 1194	Possible.
<i>Pterostylis elegans</i>	Elegant Greenhood	Species	N/A	N/A	N/A	N/A	Yes	N/A	Known to occur on red-brown loams at elevations between 950m and 1200m. Found among grass and shrubs in tall open Eucalypt forest.	Suitable habitat in open forest within the site.	Possible
<i>Commersonia procumbens</i>	Commersonia procumbens	Species	N/A	N/A	N/A	N/A	Yes	Piliga sandstone	Grows in sandy sites, often along roadsides. The species is often found as a pioneer species of disturbed habitats. It has been recorded colonising disturbed areas such as roadsides, the edges of quarries and gravel stockpiles and a recently cleared easement under power lines.	No PCTs known to be associated with the species occur within the site	Unlikely
<i>Tasmannia glaucifolia</i>	Fragrant Pepperbush	Species	N/A	N/A	N/A	N/A	Yes	N/A	Usually grows in or near Antarctic Beech <i>Nothofagus moorei</i> rainforest along streams in mountain areas at altitudes of between 1200 and 1500 m altitude. Also occurs in tall scrub, on seepage lines in tall eucalypt forest and in grassy woodland.	Eucalypt forest within PCT 934, 931 and 927 offers marginal habitat for the species.	Possible
<i>Tasmannia purpurascens</i>	Broad-leaved Pepperbush	Species	N/A	N/A	N/A	N/A	Yes	N/A	Grows in tall, moist eucalypt forest, sub-alpine woodland and cool temperate rainforest. Has been observed growing on cleared land, logged forest and graded fire trails.	Suitable habitat within open woodland and forest within the site (PCT 934, 931, 927 and 1194)	Likely
<i>Thesium australe</i>	Austral Toadflax	Species	N/A	N/A	N/A	N/A	Yes	N/A	It occurs in shrubland, grassland or woodland, often on damp sites. Vegetation types include open grassy heath dominated by <i>Leptospermum myrtifolium</i> , <i>Hakea microcarpa</i> , <i>Callistemon sieberi</i> , <i>Grevillea</i>	Suitable habitat within open woodland, Eucalypt forest and derived native grasslands.	Possible

									lanigera, Epacris microphylla and Poa spp., Kangaroo Grass grassland surrounded by Eucalyptus woodland; and grassland dominated by Cymbopogon refractus.		
<i>Tylophora linearis</i>	Tylophora linearis	Species	N/A	N/A	N/A	N/A	Yes	N/A	Grows in dry scrub and open forest. Records from low altitude (300-400m) sedimentary flats and dry woodlands of <i>E.fribosa</i> , <i>E.sideroxylon</i> , <i>E.albens</i> , <i>Callitris endlicheri</i> , <i>Callitris glaucophylla</i> and <i>Allocasuarina luehmannii</i> .	Associated PCTs within the development site occur at higher altitudes than recorded for the species.	Unlikely
<i>Asterolasia sp. 'Dungowan Creek'</i>	Dungowan Starbush	Species	N/A	N/A	N/A	N/A	Yes	N/A	In the vicinity of Dungowan Dam the Dungowan Starbush grows in rocky alluvial soil along a creekbank dominated by <i>Casuarina cunninghamiana</i> with or without <i>Eucalyptus viminalis</i> . Recent populations have been found growing near (100-150m) major drainage lines on lower and mid slopes in open forest in moderately deep brown loamy soils. Overstorey trees at these locations were dominated by <i>Eucalyptus obliqua</i> and <i>E. nobilis</i> with or without <i>E. radiata ssp. sejuncta</i> .	Marginal habitat within PCT 934.	Possible.
<i>Homopholis belsonii</i>	Belson's Panic	Species	N/A	N/A	N/A	N/A	Yes	N/A	Grows in dry woodland (e.g. Belah) often on poor soils. Found mostly on heavy texture cracking soils derived from basalt or alluvials between 00-520m altitude.	Site lacks suitable habitat.	Unlikely
<i>Euphrasia arguta</i>	Euphrasia arguta	Species	N/A	N/A	N/A	N/A	Yes	N/A	Plants from the Nundle area have been recorded in Eucalypt forest with a mixed grass and shrub understorey. Also know to occur in highly disturbance areas including road edges	Suitable habitat within the study area	Likely

* Conservation advice taken from BioNet and Commonwealth SPRAT databases.

Appendix D

Collision Risk Model Report



Hills of Gold Wind Farm Bird Collision Risk Assessment

Prepared for Arup Group Pty Ltd

30 September 2020

Biosis offices

NEW SOUTH WALES

Albury

Phone: (02) 6069 9200

Email: albury@biosis.com.au

Newcastle

Phone: (02) 4911 4040

Email: newcastle@biosis.com.au

Sydney

Phone: (02) 9101 8700

Email: sydney@biosis.com.au

Western Sydney

Phone: (02) 9101 8700

Email: sydney@biosis.com.au

Wollongong

Phone: (02) 4201 1090

Email: wollongong@biosis.com.au

VICTORIA

Ballarat

Phone: (03) 5304 4250

Email: ballarat@biosis.com.au

Melbourne

Phone: (03) 8686 4800

Email: melbourne@biosis.com.au

Wangaratta

Phone: (03) 5718 6900

Email: wangaratta@biosis.com.au

Document information

Report to: Arup Group Pty Ltd

Prepared by: Ian Smales

Biosis project no.: 30695

File name: 30695.HoG.WF.CRM.DFT01.20200930.docx

Citation: Biosis 2020. Hills of Gold Wind Farm – Bird Collision Risk Assessment.

Document control

Version	Internal reviewer	Date issued
Draft version 01	Callan Wharfe	30/09/2020

Acknowledgements

Biosis acknowledges the contribution of the following people and organisations in undertaking this study:

- Arup Group – Matt Davis

© Biosis Pty Ltd

This document is and shall remain the property of Biosis Pty Ltd. The document may only be used for the purposes for which it was commissioned and in accordance with the Terms of the Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Disclaimer:

Biosis Pty Ltd has completed this assessment in accordance with the relevant federal, state and local legislation and current industry best practice. The company accepts no liability for any damages or loss incurred as a result of reliance placed upon the report content or for any purpose other than that for which it was intended.

Contents

1. Introduction	1
1.1 Background to quantitative risk modelling.....	1
1.2 Turbine collision risk model	2
1.2.1 Overview of the model	2
1.2.2 Avoidance rate.....	3
1.2.3 Result metrics – number of flights at risk vs number of collisions	4
2. Preliminary evaluation of turbine options	5
3. Model inputs and assumptions	6
3.1 Wind farm and turbine parameters	6
3.2 Bird species data.....	6
3.2.1 Estimating site-populations for raptors	7
4. Model results	9
4.1 Raptors.....	9
4.2 Other species.....	9
5. Conclusion	11
References	12
Appendix 1	13

1. Introduction

This document presents a collision risk assessment for birds at the proposed Hills of Gold Wind Farm, near Nundle New South Wales (NSW).

Biosis Pty Ltd has conducted a range of ecological assessments for the project. These surveys have included seasonal bird utilisation surveys at 21 sites across the wind farm study area. The data collected during those surveys forms the basis of the collision risk model presented in this report.

A background to risk modelling is provided in Section 1.1, and a description of the Biosis collision risk model can be found in Smales et al. (2013), provided in Appendix 1.

The risk modelling for Hills of Gold Wind Farm followed a three-stage approach, as detailed in this report. In the first stage, a brief evaluation was made of three different models of turbine that are under consideration for the project. The object of this stage was to ascertain which turbine might represent a 'worst-case' collision risk. This turbine was then used for subsequent stages of modelling with the intention that if either of the other two turbines are chosen for operational use by the project, the potential collision risk they pose will be lower than that presented herein.

In the second stage, the collision risk model was run to obtain results expressed as the probable annual number of flights at risk of collision (see Section 1.2.3) for all species that were recorded flying at rotor-swept height for the 'worst-case' turbine.

In the third stage, a likely size of the site-population was estimated for species of raptors and those values were incorporated into the model to obtain results expressed as the probable annual number of collisions (see Section 1.2.3) for those species.

1.1 Background to quantitative risk modelling

Collisions of birds and bats with wind turbines have been documented to occur at various frequencies around the world. Quantitative modelling to estimate the number of collision mortalities of threatened and non-threatened taxa is widely used as part of environmental impact assessments for proposed wind energy facilities (Masden & Cook 2016).

The impact of any collisions on the viability of threatened and non-threatened fauna populations is more important than determination of simple numbers of mortalities, and population models can be used in combination with results of collision risk models to evaluate such impacts, but population modelling would be a separate exercise to the collision risk modelling presented here.

Modelling of collision risk is reliant on empirical data for flights by species at the wind farm site. There is no practicable method to obtain species-specific flight data for bats that are likely to utilise the site and bat-call data does not provide information about the number of flights by bats. The modelling presented here is therefore confined to diurnal birds.

Mathematical modelling of risk is intended to provide an articulated, transparent and replicable evaluation of what may occur in the real world. The rationale behind projections is explicitly stated in the mathematics of a model, which means that the logical consistency of the predictions can be easily evaluated. The explicit nature of inputs and rigour entailed in modelling means that the process is replicable and consistent and it is open to analysis, criticism or modification when new information becomes available. Modelling is designed as a mechanism to evaluate uncertainties – if there was no uncertainty there would be no need to use a model. As a consequence of

uncertainty in various parameters, some assumptions are required and while it is necessary to include some assumptions and arbitrary choices when deciding on the structure and parameters of a model, these choices are explicit. To the extent feasible, assumptions are informed by the best available information.

Models are also valuable for their heuristic capacities as they focus attention on important processes and parameters entailed in risk (Brook et al. 2002). Their very nature facilitates incorporation of information as it is learnt (Burgman 2005) and refinements should thus be expected of any model.

Most factors related to the layout, dimensions and geometry of turbines are known. The risk modelling detailed here entails the use of informed assumptions related particularly to the flights of birds. The bird utilisation data collected from the site provides an empirical basis for extrapolations required for use in the model. We consider the assumptions and values used are reasonable and they are informed by available information about the ecology of relevant species. As a consequence, we consider the results of modelling detailed here provide a basis for evaluation of probable effects of the proposed Hills of Gold Wind Farm on relevant species of birds.

The only alternative to a quantitative modelling approach is one of qualitative subjective judgement. All the benefits of using mathematical modelling outlined above are difficult, if not impossible to achieve with a purely qualitative assessment.

1.2 Turbine collision risk model

The risk of birds colliding with turbines at the proposed Hills of Gold Wind Farm has been assessed using the Biosis Pty. Ltd. Deterministic Collision Risk Model. The model was first developed in 2002 and has been refined over time to incorporate new data and knowledge, and has been applied at a wide range of proposed wind farm sites in Australia. A full description of the model (Smales *et al.* 2013) is provided in Appendix 1.

1.2.1 Overview of the model

The collision risk model takes account of bird flights that occur within the height zone that will be occupied by turbines. Data for the number of flights and their heights was documented by a regime of fixed-time point counts at locations representative of future turbine locations across the site. The model uses the empirical sample of flight data for each species and extrapolates that to determine a potential number of such flights that might occur over an entire 12-month period. This factor takes into account what is known about seasonal presence of particular species that may be migratory or may be present only for part of the year for other reasons.

In the model, the turbine is decomposed into its static and dynamic components. The entire turbine (including the tower, nacelle and the rotor *when stationary*) represents the static component. The dynamic component is the volume swept by the leading edge of the rotor blades in the time it takes the species of interest to pass across the depth of the swept disk.

Since the turbine tower below rotor swept height is always a static component and poses minimal collision risk, the model takes this into account by dividing flights into those below turbine rotor height, and those within the height zone swept by turbine rotors and allocating different risk rates to these height classes.

The risk assessment accounts for a combination of variables that are specific to the proposed wind farm and to data for birds from the vicinity of the farm. They include the following:

- The numbers flights of each species below rotor height, and for which just the lower portion of turbine towers present a collision risk.
- The numbers of flights at heights within the zone swept by turbine rotors, and for which the upper portion of towers, nacelles and rotors present a collision risk.
- The numbers of bird movements-at-risk, as recorded during timed point counts, extrapolated to determine an estimated number of movements-at-risk the species makes in an entire year. Account is taken of the portion of the year that birds are within proximity of the site and that they may thus be at risk.
- The mean area (m^2 per turbine), of tower, nacelle and stationary rotor blades of a wind generator that present a risk to birds. Thus, the mean area presented by a turbine is between the maximum (where the direction of the bird is perpendicular to the plane of the rotor sweep) and the minimum (where the direction of the bird is parallel to the plane of the rotor sweep). The mean presented area is determined from turbine specifications supplied to Biosis for specific make and model of a turbine. It represents the average area presented to an incoming flight from any direction.
- The additional area (m^2 per turbine) presented by the movement of rotors during the potential flight of a bird through a turbine. This information is determined via a calculation involving species-specific, independent parameters of flight speed and body length and supplied turbine specifications.
- The model assumes that all turbines in the site represent equal risk.
- A calculation of the average number of turbines a bird is likely to encounter in a given flight through the site. This is based on the scattered configuration of turbines in the landscape and the total number of turbines proposed for the project.

1.2.2 Avoidance rate

Results are provided for various avoidance rates. Avoidance rate is the capacity for a bird to avoid a collision, whether that occurs due to a cognitive response on the part of a bird or not. Thus at the extremes of the rates applied, a 0.90 avoidance rate equates to one flight in 10 in which a bird takes no action to avoid a turbine and a 0.99 avoidance rate equates to one flight in 100 in which it does not avoid a turbine. Based on experience with a wide range of bird species, it is certain that virtually all species have high capacity to avoid collision with the static components of turbines. Avoidance rate for these components is thus consistently considered to be 0.999 in the modelling. Various avoidance rates are modelled for the dynamic turbine components because it is not certain how adept various species may be at evading collision with the moving rotor. For this reason, results are provided for 0.90, 0.95, 0.98 and 0.99 avoidance rates for the dynamic components (moving rotor) of turbines.

It should be noted that internationally there is very little empirical evidence for the actual avoidance rate for any bird species and for this reason it is prudent to provide a range of estimates that are considered to be reasonable. The evidence that is available suggests that avoidance capacity is species-specific and that the great majority of birds have very high avoidance capability that is higher than 0.98. Nonetheless, the avoidance rate of some large raptors in Australia appears to be between 0.93 and 0.95 (Smales et al. 2013; Smales 2017).

1.2.3 Result metrics – number of flights at risk vs number of collisions

Generally, the model's results are expressed as the number of flights at risk of collision per annum for each species. This is a relative measure that permits us to compare risk rates associated with various turbines or turbine configurations. It does not necessarily equate to the number of collisions that might occur because we do not know how many individual birds of each species use the site and may thus be at risk. The difference between flights at risk of collision and number of actual collisions can be simply explained by way of an example. If there are just two individuals of a given species occupying the wind farm, they may make multiple flights that could result in collisions, however the maximum number of fatalities that could occur is two. As can be seen from this example, the number of actual collisions can be no greater than the number of flights at risk, and if the site-population is small but the birds fly actively within the site, the number of collisions will always be considerably lower than the number of flights at risk.

In cases where a good estimate of the site-population for particular species can be made, the model permits that to be incorporated to provide results expressed as an annual estimate of collisions.

Existing knowledge of the population dynamics for most of the species at the Hills of Gold site, is not sufficient to allow an estimate to be made for their site-populations. However, for two resident raptors, an estimate of their possible site-populations has been made and the model has been run to provide a projection of results for them as an annual estimate of collisions.

The model cannot forecast the frequency of collisions around the predicted annual average and it is important to recognize that the number of any actual collisions that might occur can be expected to vary from year to year in a distribution around the average.

All results are provided to two significant figures, however they represent annual 'average' results and, of course actual bird fatalities will always be measured in numbers of individuals and the average results of modelling must represent a distribution that can be expected to vary from year-to-year around the mean.

2. Preliminary evaluation of turbine options

An array of 70 wind turbines is proposed for the Hills of Gold Wind Farm. At present the project is considering options for three different models of turbine (Vestas 5.6, GE 5.5, SGRE 6). The three turbines differ in various aspects that may affect the collision risk they pose to birds in flight. The differences include rotor-swept area, rotor-sweep height above the ground and rotor speed. As a consequence, the risk to various species of birds will differ between them in response to the documented data for flight heights.

The Biosis turbine collision risk model was initially applied to a single species (Wedge-tailed Eagle) for each of the three turbines with a view to providing a preliminary consideration of how they might differ and to determine which turbine might represent a 'worst-case' collision risk. Wedge-tailed Eagle was chosen for this purpose because it had the greatest number of flights recorded at the site that were within rotor-swept height for all three turbines. An avoidance rate of 0.95 was used (see below and Appendix 1). The size of the population of Wedge-tailed Eagles at risk for the project was determined as set out under *Raptor populations at-risk*, below.

Results of the preliminary assessment of the three turbines are shown in Table 1.

Table 1 Comparison of three turbine models for a configuration of 70 of each turbine. Results show projected annual collision mortalities of Wedge-tailed Eagles at 0.95 avoidance rate.

Turbine model	Projected annual collision mortalities of Wedge-tailed Eagles at 0.95 avoidance rate
Vestas 5.6	3.71
GE 5.5	2.90
SGRE 6	3.23

On the basis of the preliminary evaluation it was determined that the Vestas 5.6 turbine represents the likely 'worst-case' collision risk for birds at the proposed Hills of Gold Wind Farm. While it has a slightly smaller rotor-swept area than the SGRE 6 turbine, it has a greater rotor speed and that can factor significantly in collision risk for birds.

3. Model inputs and assumptions

The Biosis collision risk model requires a range of numeric inputs, to quantify the number of turbines, key dimensions of turbines, and to estimate bird utilisation characteristics, including the number of flights within and outside of rotor swept height for species to be included in the model.

3.1 Wind farm and turbine parameters

The collision risk model requires input values for 36 turbine parameters that include number and layout of turbines and multiple aspects of turbine dimensions and geometry.

Following the results of the preliminary evaluation, the collision risk model was run for the Vestas 5.6 turbine.

Key parameters used in this modelling are:

- Number of turbines: 70
- Turbine type: based on Vestas 5.6
- Turbine tower height: 139 m
- Rotor diameter: 162 m
- Rotational speed: 12.1 rpm

The rotor-swept area is 17331.5 m². The 162 metres diameter blades have a length of 81 metres, resulting in rotor swept height between 58 and 220 metres above the ground.

The landscape configuration of the proposed Hills of Gold Wind Farm is essentially a linear row of turbines. This is different from most wind energy facilities in Australia in which turbines are scattered across a site. In the more usual scattered or 'clustered' array, a bird has a high probability of encountering multiple turbines in a given flight. The configuration of Hills of Gold turbines is such that a bird is likely to encounter multiple turbines only in the rare event that it flies directly along the row of turbines. The collision risk model has a built-in function to account for this difference whereby the turbine array can have any setting from 100% of turbines fully clustered to 0% in which turbines are entirely linearly configured. Given the slight sinuosity of the ridge-top array, this factor was set to 5%.

3.2 Bird species data

Following the results of the preliminary evaluation, the collision risk model was run for all species for which there were any flights recorded at rotor-swept height for the Vestas 5.6 turbine. That included all flights documented from between 58 and 220 metres above the ground.

A total of 51 species of birds were recorded during investigations of the Hills of Gold site. While all of them may have capacity to fly at rotor swept height, 18 species were recorded doing so, and thus have data available for use in the model. They are listed in Table 3, below.

White-breasted Woodswallow is the only one of the modelled species that is known to be present seasonally as its population migrates to inland and northern Australia during the winter. It was modelled as being present at the site for nine months per annum.

With the exception of two species of raptors (Section 3.2.1), it is not feasible to estimate the site-population sizes of the species modelled. As a consequence, model results for those 16 species are expressed as the

number of flights at risk of collision per annum. The resident raptors, Nankeen Kestrel and Wedge-tailed Eagle, tend to occupy territories that remain stable over periods of several years and, because they are apex predators they occur at relatively low densities. In light of published studies for those species, Biosis undertook a process to estimate the sizes of their potential populations for the site. For those two species it was thus possible to run the model to provide results expressed as annual estimate of collisions.

3.2.1 Estimating site-populations for raptors

Information was collated from published sources to ascertain the likely number of Wedge-tailed Eagles and Nankeen Kestrels that might occupy the site and thus be at some risk of turbine collision. Brown Goshawk was recorded once only and is not considered further. There are a number of relevant studies of Wedge-tailed Eagle, but less for Nankeen Kestrel. Information for the latter was drawn from data collated in Marchant and Higgins (1993). The population dynamics of neither species has been studied at the Hills of Gold Wind Farm site.

The first item of information relates to average home-range size or documented spacing between home-ranges and to the number of birds that might occupy a given home-range. The second requires an understanding of the likely number of flying birds that might occupy a given territory. For the two species in question, published data indicates that they function as territorial pairs that usually attempt to raise one brood per annum. For the purposes of considering collision risk, the number of birds occupying a territory thus includes the adult pair and the average number of their offspring that fledge.

Wedge-tailed Eagle

Cherriman (2007) provided an overview of studies, including his own, that have investigated the size of Wedge-tailed Eagle territories in temperate regions. Territory sizes in studies near Perth (Cherriman 2007); at two other sites in the south-east of Western Australia (Ridpath and Brooker 1987); near Canberra in south-eastern Australia (Leopold and Wolfe 1970); and, in South Australia (Rowe et al. 2017) were all between 31 km² and 42 km². Foster and Wallis (2010) studied the species west of Melbourne and recorded nearest-neighbour distances averaged 4.7 kilometres. In a study in western NSW, Sharp et al. (2001) found the mean distance to nearest neighbour between Wedge-tailed Eagle nests was in the order of 1 pair per 3–9 km². They noted this was considerably higher than that noted in other semi-arid zone studies (~1 pair per 40–48 km²).

Using a conservative mean Wedge-tailed Eagle territory size of 30 km², the average diameter of a territory would be slightly greater than 12 kilometres. As a consequence, we have based the modelling exercise for Wedge-tailed Eagles on the assumption that the 26 kilometre linear array of the proposed wind farm may intersect with three territories, occupied by six adult birds.

Cherriman (2013) reported that breeding productivity (number of chicks fledged) was 0.73 young per pair, across 15 occupied territory-years. Debus et al. (2007) recorded very similar results with 10 young produced in 12 pair-years, equating to 0.8 young fledged per pair per year. On the basis of those studies, we have conservatively assumed that, on average, three pairs will be accompanied by a total of three flying juveniles, bringing the average site-population of Wedge-tailed Eagles to a total of 9. Hence we have modelled for this number of birds as being at potential risk of collision.

During field investigations of the site, Biosis staff documented one instance each in which three, four and five Wedge-tailed Eagles were observed simultaneously.

Nankeen Kestrel

Near Armidale, NSW, one pair of Nankeen Kestrels occupied at least 200 hectares (2 km²) (Genelly 1978) and active nests were recorded approximately 1 kilometre apart (Baker-Gabb 1985). Near Mildura, Victoria, 12 pairs were documented from an area with a 10 kilometre radius (i.e. approx. 314 km²), and 25 nests averaged

1-3.6 kilometre apart equating to 1 pair per 5.4 km² (Baker-Gabb 1984). At Millewa, Victoria, Campbell (1986) reported an average of 1 active pair per 5.3 km² [all references in Marchant and Higgins (1993)].

Using a conservative mean Nankeen Kestrel territory size of 5.3 km², the average diameter of a territory would be approximately 2.6 kilometre . As a consequence, we have based the modelling exercise for Nankeen Kestrels on the assumption that the 26 kilometre linear array of the proposed wind farm may intersect with 10 territories, occupied by 20 adult birds.

Baker-Gabb (1984) reported a mean number of 1.3 fledglings per territorial pair. On the basis of that study, we have assumed that, on average, 10 pairs will be accompanied by a total of 13 flying juveniles, bringing the average site-population of Nankeen Kestrels to a total of 33 and we have modelled for this number of birds as being at potential risk of collision.

4. Model results

4.1 Raptors

Collision risk model results for Nankeen Kestrel and Wedge-tailed Eagle are shown in Table 2. As discussed earlier, informed assumptions have been made for the possible site-population sizes of these two species, and results for them are provided here expressed as projected numbers of annual average collisions. Results are provided for four potential avoidance rates.

Experience with these two species at wind energy facilities in south-eastern Australia demonstrates that both Nankeen Kestrels and Wedge-tailed Eagles collide with wind turbines (Moloney et al. 2019). For Wedge-tailed Eagles there is some published empirical data (Smales et al. 2013) and more recent unpublished data for actual mortalities available to validate the outputs of the Biosis collision risk model. That evidence suggests that the model's projections accurately equate to avoidance capacity of between 0.90 and 0.95. As with any forward-projection modelling, the accuracy of the results presented here for the proposed Hills of Gold Wind Farm, will depend upon the precision of all assumptions used for the modelling process.

Table 2 Collision risk model results for 70 x Vestas 5.6 turbines for two raptors at Hills of Gold Wind Farm site

Common name	Scientific name	Dynamic rotor avoidance rate			
		0.90	0.95	0.98	0.99
Nankeen Kestrel	<i>Falco cenchroides</i>	0.36	0.20	0.10	0.07
Wedge-tailed Eagle	<i>Aquila audax</i>	5.86	3.71	1.77	0.98

4.2 Other species

Collision risk model results for all 18 species of birds that were documented flying within rotor-swept height of the Vestas 5.6 turbines as proposed for Hills of Gold Wind Farm, are shown in Table 3. As discussed earlier in the report, information about the possible site-population sizes of 16 of these species is not available, and results for them are provided here expressed as projected numbers of annual flights that may be at risk of turbine collisions. Results are provided for four potential avoidance rates.

Fewer than 20 flights were recorded during the total of all point count field observations for the species shaded grey in Table 3. In cases such as these where the sample size of flights is low, it is possible that the model results may be less reliable than they are for species that were recorded more frequently. If the low number of observations for those species indicates that they occur relatively infrequently, or make few flights, that may still indicate that their risk is relatively low. We include them here for completeness, but under the caveat that the model's estimates for them may be less certain than the results for species with a greater number of records.

Table 3 Results for 70 x Vestas 5.6 turbines for 18 species of birds recorded within RSH at Hills of Gold Wind Farm site

Common name	Scientific name	Dynamic rotor avoidance rate			
		0.90	0.95	0.98	0.99
Brown Goshawk	<i>Accipiter fasciatus</i>	0.24	0.12	0.05	0.03
Galah	<i>Cacatua roseicapilla</i>	0.34	0.17	0.07	0.04
Nankeen Kestrel	<i>Falco cenchroides</i>	0.36	0.20	0.10	0.07
White-browed Treecreeper	<i>Climacteris affinis</i>	1.08	0.54	0.22	0.11
Australian Magpie	<i>Gymnorhina tibicen</i>	1.07	0.61	0.33	0.24
Yellow-tailed Black-Cockatoo	<i>Calyptorhynchus funereus</i>	3.27	1.64	0.67	0.34
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	0.73	0.38	0.16	0.09
Red Wattlebird	<i>Anthochaera carunculata</i>	0.59	0.38	0.25	0.21
Spotted Pardalote	<i>Pardalotus punctatus</i>	1.03	0.52	0.21	0.11
Common Starling	<i>Sturnus vulgaris</i>	0.30	0.16	0.08	0.05
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	0.52	0.26	0.11	0.06
Crimson Rosella	<i>Platycercus elegans</i>	0.62	0.35	0.20	0.14
Little Wattlebird	<i>Anthochaera chrysoptera</i>	1.70	0.87	0.36	0.20
Pied Currawong	<i>Strepera graculina</i>	1.99	1.02	0.43	0.24
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>	1.67	0.84	0.35	0.18
Australian Raven	<i>Corvus coronoides</i>	4.02	2.04	0.86	0.46
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	3.95	2.01	0.84	0.45
Wedge-tailed Eagle	<i>Aquila audax</i>	9.46	4.78	1.97	1.03

5. Conclusion

A total of 51 species of birds were recorded during investigations of the Hills of Gold site. While all of them may have capacity to fly at rotor-swept height, 18 species were recorded doing so and the Biosis turbine collision risk model was run for them. The modelling was undertaken for 70 x Vestas 5.6 turbines after preliminary assessment suggested that this turbine is likely to represent a greater collision risk than two other types of turbines under consideration for operational use by the project.

None of the species involved are listed within any category of threat status under New South Wales or Commonwealth legislation.

Informed assumptions were able to be developed and employed for the potential site-population sizes of Nankeen Kestrels and Wedge-tailed Eagles and this permitted the model to provide projections expressed as average numbers of potential collisions per annum for those two species. Depending upon avoidance capacity and all other assumptions used for Nankeen Kestrels the model returned a likely range of between 0.36 and 0.07 collisions for that species per annum. Under the same caveats for Wedge-tailed Eagles, the likely range was between 5.86 and 0.98 collisions per annum. Empirical evidence from some wind farms in south-eastern Australia suggest that avoidance capacity for this species at those sites has been between 0.90 and 0.95.

For 16 other species, of birds collision risk modelling provided results expressed as average numbers of their flights that might be at risk of turbine collisions. For nine of those species the model indicates that they might make between one and four flights per annum that would be at some risk of collision assuming their collision avoidance capacity was no greater than 0.90. This is considered to be a very low avoidance rate and most birds appear to avoid turbine collisions at a significantly higher rate than that. On the basis of the bird utilization data collected for these birds at the site, and other assumptions entailed in the modelling, it is reasonable to conclude that the number of actual collisions that might occur per annum for all of these species would be lower than the number of their flights-at-risk.

References

- Brook, B.W., Burgman, M.A., Akçakaya, H.R., O'Grady, J.J., Frankham, R., 2002. Critiques of PVA ask the wrong questions: throwing the heuristic baby out with the numerical bath water. *Conservation Biology* 16, 262-263.
- Burgman, M. 2005. *Risks & Decisions for Conservation & Environmental Management*. Cambridge University Press. Cambridge.
- Cherriman, S. C. 2007. Territory size and diet throughout the year of the Wedge-tailed Eagle *Aquila audax* in the Perth region, Western Australia. B.Sc. (Hons) Thesis, Curtin University, Western Australia.
- Cherriman, S. C. 2013. Nest-site characteristics and breeding productivity of Wedge-tailed Eagles (*Aquila audax*) near Perth, Western Australia. *Amytornis Western Australian Journal of Ornithology* 5: 23-28.
- Debus, S.J.S., Hatfield, T.S., Ley, A.J. and Rose, A.B. 2007. Breeding biology and diet of the Wedge-tailed Eagle *Aquila audax* in the New England region of New South Wales. *Australian Ornithology* 24: 93-120.
- Foster, A. and Wallis, R. 2010. Nest-site characteristics of the Wedge-tailed Eagle *Aquila audax* in Southern Victoria *Corella* 34(2):36-44.
- Leopold, A. S. and Wolfe, T. O. 1970. Food habits of nesting wedge-tailed eagles, *Aquila audax*, in south-eastern Australia. *CSIRO Wildlife Research* 15: 1-17.
- Marchant, S. and Higgins, P.J. (editors) 1993. *Handbook of Australian, New Zealand & Antarctic Birds*. Volume 2, Raptors to lapwings. Melbourne, Oxford University Press.
- Masden, E.A. & Cook, A.S.C.P. 2016. Avian collision risk models for wind energy impact assessments. *Environmental Impact Assessment Review* 56: 43-49.
- Moloney, P.D., Lumsden, L.F. and Smales, I. 2019. Investigation of existing post-construction mortality monitoring at Victorian wind farms to assess its utility in estimating mortality rates. Arthur Rylah Institute for Environmental Research Technical Report Series No. 302. Department of Environment, Land, Water and Planning, Heidelberg, Victoria.
- Ridpath, M. G. and Brooker, M. G. 1987. Sites and spacing as determinants of wedge-tailed eagle breeding in Arid Western Australia. *Emu* 87: 143-149.
- Rowe, E., Brinsley, R. and Dennis, T. 2017. A review of Wedge-tailed Eagle population stability in the Fleurieu Peninsula region of South Australia in 2017. *South Australian Ornithologist* 43 (1 - 2): 27-37.
- Sharp, A., Norton, M. and Marks, A. 2001. Breeding activity, nest site selection and nest spacing of Wedge-tailed Eagles (*Aquila audax*) in western New South Wales. *Emu* 101: 323-328.
- Smales, I., Muir, S., Meredith, C. & Baird, R. 2013. A description of the Biosis Model to assess risk of bird collisions with wind turbines. *Wind Energy and Wildlife Conservation* 37(1): 59-65.
- Smales, I. 2017. Modelling of collision risk and populations. in M. Perrow (ed) *Wildlife and Wind Farms: conflicts and solutions*. Pelagic Publishing. UK.

Appendix 1



A Description of the Biosis Model to Assess Risk of Bird Collisions With Wind Turbines

IAN SMALES,¹ *Biosis Propriety Limited 38, Bertie Street, Port Melbourne, Vic. 3027, Australia*

STUART MUIR, *Symbolix Propriety Limited, 1A/14 Akuna Drive, Williamstown North, Vic. 3016, Australia*

CHARLES MEREDITH, *Biosis Propriety Limited 38, Bertie Street, Port Melbourne, Vic. 3027, Australia*

ROBERT BAIRD, *Biosis Propriety Limited 38, Bertie Street, Port Melbourne, Vic. 3027, Australia*

ABSTRACT We describe the model of Biosis Propriety Limited for quantifying potential risk to birds of collisions with wind turbines. The description follows the sequence of the model's processes from input parameters, through modules of the model itself. Aspects of the model that differentiate it from similar models are the primary focus of the description. These include its capacity to evaluate risk for multi-directional flights by its calculation of a mean presented area of a turbine; its use of bird flight data to determine annual flux of movements; a mathematical solution to a typical number of turbines that might be encountered in a given bird flight; capacity to assess wind-farm configurations ranging from turbines scattered in the landscape to linear rows of turbines; and the option of assigning different avoidance rates to structural elements of turbines that pose more or less risk. We also integrate estimates of the population of birds at risk with data for numbers of their flights to predict a number of individual birds that are at risk of collision. Our model has been widely applied in assessments of potential wind-energy developments in Australia. We provide a case history of the model's application to 2 eagle species and its performance relative to empirical experience of collisions by those species. © 2013 The Wildlife Society.

KEY WORDS bird, collision, model, risk, turbine, wind energy.

A number of mathematical models have been developed for the purposes of either describing the interaction of a bird with a wind turbine or to predict the risks of bird collisions with turbines (Tucker 1996a, b; Podolsky 2003, 2005; Bolker et al. 2006; Band et al. 2007). Tucker (1996a, b) and Band et al. (2007) detailed their models in the peer-reviewed literature. The collision risk model developed by Biosis Propriety Limited has been widely used to assess wind-energy developments in Australia since 2002, but it has not previously been described in detail. Given high levels of interest in effects of wind turbines on fauna, we believe it is important for the model to be accessible.

Our model provides a predicted number of collisions between turbines and a local or migrating population of birds. It has the potential to be modified to accommodate Monte-Carlo simulation, although at its core it uses a deterministic approach. It is modular by design, and allows various customizations, depending upon the unique configuration of the wind facility and characteristics of the taxa modeled.

The initial calculation involves species-specific parameters for speed and size of birds and specifications of the turbine, including its dimensions and rotational speed of its blades. Using these parameters, we derive the mean area of turbine

presented to a bird in flight. This allows the model to accommodate flight approaches from any potential direction. Alternatively, unidirectional flights can be modeled by using the relevant turbine surface area presented to birds approaching from a given direction.

Data for bird flights are collected at the wind-farm site according to a specific and consistent field methodology. These data are used to determine the flux (density) of bird flights. When combined with turbine specifications, this yields the probability of collision during a single flight-turbine interaction. The density flux approach has not been used for this application previously.

The number of movements at risk of collision with one turbine is then scaled according to a typical number of turbines that a bird might encounter in a given flight. This is further refined by a metric for the capacity of the particular species to avoid collisions. Where a population census or estimate is available for the number of birds that may be at risk, a further deduction is used to attribute the number of flights-at-risk to individuals, and hence provide a final model output as the number of individuals at risk of collisions. The ability to transform from flights-at-risk to individuals-at-risk has been uniquely developed and applied as a routine component of our model.

DESCRIPTION OF THE MODEL

The model requires data for input parameters and, using these, functions in a sequence of modules (Fig. 1).

Published: 18 March 2013

¹E-mail: ismales@biosis.com.au

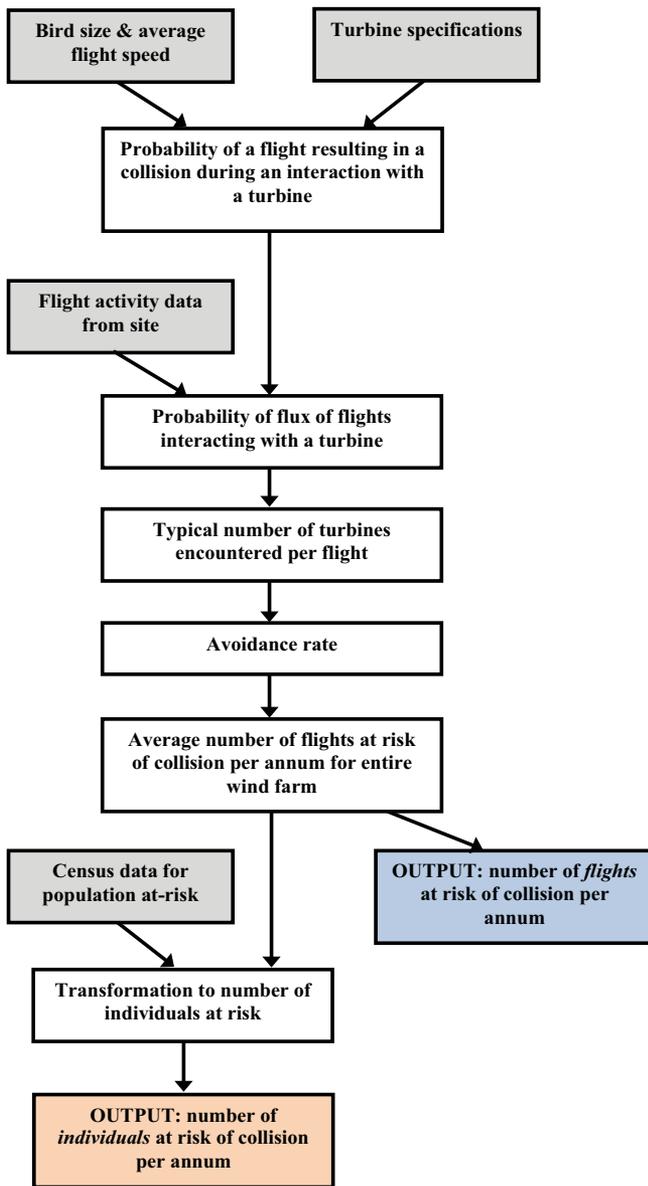


Figure 1. Overview of the collision risk model that quantifies risk to birds of colliding with wind turbines, showing input parameters (gray boxes), modules, and sequence.

Model Inputs

Turbine parameters.—The primary risk faced by a flying bird, whether it may strike or be struck by a turbine, is that the machine presents a potential obstacle in its path. Ultimately this equates to the surface area of the turbine presented to the bird from whatever its angle of approach. Other models, such as probably Band et al. (2007), use individualistic representations of birds. Our model uses a projection of the presented area onto all possible flight angles. For this reason, multiple dimensions of turbine components and rotor speed for the particular type of turbine are used as input values to the risk model. Turbine specifications are as provided by the machine’s manufacturer.

The modeled wind turbine consists of 2 fundamental components representing potentially different risks. We refer

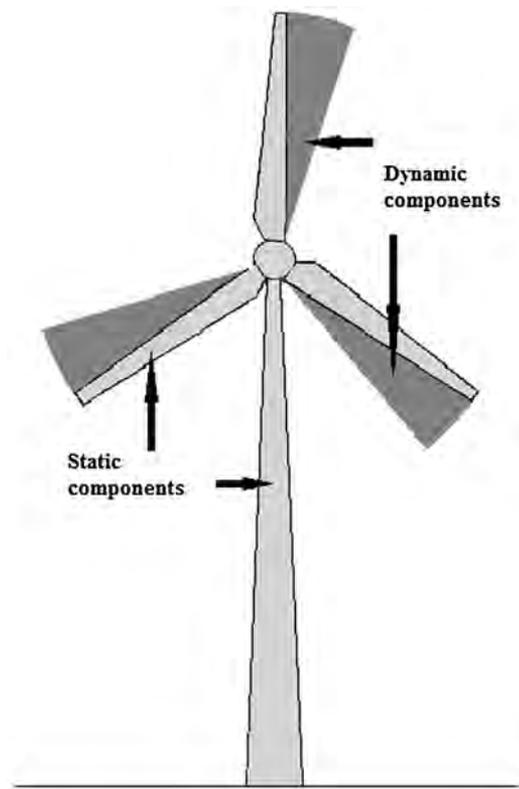


Figure 2. Schematic indication of the static and dynamic components of a wind turbine that may be encountered by a flying bird. The dynamic component is the area swept by rotor blades during the time that a bird of a particular species would take to pass through the rotor-swept zone.

to these as the static and dynamic components (Fig. 2). The static areas of a turbine include all surfaces of the entire machine comprising a tower, which in current turbines is a simple taper with known base and top diameters; a rectangular nacelle housing the generator; a hemi-spherical hub; and rotor blades that taper in 2 planes. The dynamic component is the area swept by the leading edges of rotor blades during the time that a bird would take to pass through the rotor-swept zone.

Size and flight speed of birds.—For each taxon, the model requires values for the total length of the bird in flight, from bill tip to tip of the tail or outstretched legs, and the average speed of the species’ flights. We obtained bird lengths either from museum specimens or from standard ornithological texts.

Accurate determinations of bird flight speeds can be complex and difficult to obtain (Videler 2005, Pennycuik 2008) and published data are not available for most species. However, published radar studies (e.g., Bruderer 1995, Bruderer and Boldt 2001) provide ranges of flight speeds for a variety of species, including congenics with similar morphologies and ecological traits to a number of species we have assessed. Use of radar to collect bird flight data at the wind-farm site may provide flight speeds for species of interest. We consider that average ground speed (as opposed to air speed) is appropriate for modeling of multidirectional movements of birds.

Bird flight data.—The model requires data from the wind-farm site for the number of flights made by species of interest within a measured time and volume of airspace. Movement data may be obtained from fixed-time point counts using a methodology adapted from Reynolds et al. (1980), incorporating an effective detection range (Buckland et al. 1993). It may be collected by human observers or by using horizontal and vertical radar combined with call recording or visual species identification (e.g., Gauthreaux and Belser 2003, Desholm et al. 2006). Data represent the number of flights that birds make within a cylinder of airspace that is centered horizontally on the observer and the height of which is the maximum reached by rotor blades of the turbines. The data collection regime is designed with the aim of providing a representative sample of flight activity across the local range of diel, seasonal, and other environmental variables.

Model Modules

Probability of a single flight interacting with a turbine.—In some situations, such as during highly directional migratory passage, the presented area of turbines is determined from the angle of the birds' flight relative to the compass orientation of turbines. However, for the great majority of species (including temporary or permanent residents at an on-shore wind farm) this does not apply, and flights can be expected to approach turbines from any direction. For this situation, all dimensions of the turbine contribute to the area with which a flying bird might collide and the model uses a simple integration to determine a mean presented area. This represents a substantial advance over other collision risk models that depend on the assumption of a specific angle of approach as a bird encounters a turbine (e.g., Tucker 1996a, b; Bolker et al. 2006; Band et al. 2007).

We calculate the area presented by the static components of a turbine using a conservative assumption that none of them overlap or obscure any others. The area of each component is calculated individually, and these are then summed to determine a total static area for the turbine. Static areas are calculated from the simple length \times width dimensions of all components visible by line of sight. These are then projected onto an arbitrary approach direction (effectively scaling by the cosine of the approach angle). For example, viewed directly from one side, only the side panel of the nacelle is visible. However, approached from 45° to the turbine, both the front and side panels are visible, and are thus scaled by $\cos(45) \rho 1/\sqrt{2}$ to match that particular angle of view.

We calculate the dynamic area, swept during the movement of blades, from the dimensions of the stationary blades and the distance they travel at their average speed during the time taken by a bird to fly through the rotor-swept area. We assume that all flights involve forward movement, so the swept-area is derived from the length and speed of the particular species of bird, in combination with the thickness of the sweeping blade.

Each rotor blade is tapered in 2 planes. Thus the thickness of the blades, used to determine the time taken for a bird to cross through the swept area, is actually a function of the

point in the rotor radius at which an individual bird's flight intersects the swept area. This presents a complication that we overcome by defining an effective blade, which is a simple rectangular cross-section that sweeps out precisely the same volume of space as the physical blade. In doing so, we calculate a constant thickness of blade that accounts for the fact that the thinner tips actually sweep far more space than the thicker base of the blade. This ensures also that our flux calculation is not compromised by introduction of a spatial variation at odds with other aspects of the model.

A further input parameter is the percentage of time per annum when rotors are not turning due to inappropriate wind speeds and routine turbine maintenance. Prior to commissioning of a wind farm, wind speed data are usually gathered and the expected percentage of downtime due to inappropriate wind speeds is determined. During downtime periods the rotor simply stops turning; and so risks associated with dynamic components only are reduced by this percentage of time, while all static components of the turbine remain as potential obstacles to flying birds.

Combining all presented areas of the turbine.—Modeling for multidirectional bird movements requires no dependence on approach angles nor on complexities of interactions between flight direction and wind direction. We thus reduce the turbine to its mean presented area. This is solved by the equation

$$\frac{1}{\pi} \int_0^{\pi} A(\theta) d\theta$$

where A is the presented area of the turbine as a function of approach angle θ . We solve this numerically using a trapezoidal integrator (Press et al. 1992).

Probability of multiple flights interacting with a turbine.—Because counts of bird flights have been made across the wind-farm site and there is no obligatory relationship between point-count locations and particular sites proposed for turbines, we combine the data collected from all point counts. This provides a measure of flight activity, which is assumed to be constant across the site. Thus the field data reduce to a single ratio value for the subject species, which is the sum of all flights documented during all counts divided by the total time of observations. This equates to a maximum likelihood estimation of the mean of an assumed Poisson distribution.

To calculate a number of flights at risk of collision, we first reduce documented bird movements (M) to a measure of flux (F) using the equation

$$F = \frac{M}{T_{\text{obs}} A_{\text{obs}}}$$

where T_{obs} is the combined total time of all point counts and A_{obs} is the area of the vertical plane dissecting the observation cylinder. This flux is a measure of bird movements per time per square meter of vertical airspace. The third dimension, volume of airspace, is redundant (or tacit) due to the

assumption that, unless involved in a collision, flight paths do not end arbitrarily in space.

We next multiply activity measure by the number of minutes in which the species is active during the 24-hour diel period, T , and the total presented area of the turbine, A . For year-round resident species, the “active minutes” are calculated for the entire year, while for seasonal or migratory species, they are calculated for the portion of the year that the species is present at the site. This then gives a measure of risk to the bird movements, $M_{\text{risk}} = \text{FTA}$.

Because the flight data are a measure of movements by the species in question and do not discriminate the number of individuals making the movements, the measure (M_{risk}) quantifies the total movements-at-risk for the species and does not reflect risk to individual birds.

To determine a risk rate from total of recorded movements-at-risk, it is necessary to extrapolate to a total number of expected bird movements per annum, M_{yearly} . We calculate this from the flight data, extrapolating the movements to a yearly total through the equation

$$M_{\text{yearly}} = M \frac{T_{\text{yearly}}}{T_{\text{obs}}}$$

We then deduce a probability of flights at risk of collision as $M_{\text{risk}}/M_{\text{yearly}}$. Note that T_{year} is the total time in a year, and not the diel activity period of the species, which has already been factored into the calculation of movements at risk.

The resultant value is now a probability of flights being at risk of collision with a single turbine. To this point, no account is taken of the bird’s own ability to avert a collision. This is modified later through use of an avoidance factor.

Estimating number of turbines encountered per flight.—Every turbine is presumed to represent some risk for birds, so the total number of turbines proposed for the wind farm is an input to the model. Turbine layout of modern wind farms is primarily determined by the wind resource and turbines are micro-sited accordingly. Consequently, the machines are usually scattered on the landscape. Older wind farms had turbines arrayed in rows, and occasional modern facilities may be linear where they follow a single topographic feature.

To account for the number of turbines with which a single flight might interact, it would be necessary either to know precisely the route of every flight or to make informed assumptions about flight paths. The manner in which turbines are arrayed in the landscape is important to ascertain a typical number of turbines that a bird might encounter in a given flight. This number differs according to whether turbines are in a scattered array or a single row, and these require different calculations.

For a row of turbines, the likely number of encounters can be visualized by considering a row of N turbines in plan view and a flight path at angle Φ to the row. A flight directly along the line of turbines (Φ') will interact with all N turbines. As the angle of flight relative to the row increases toward 90° , flight paths have potential to interact with fewer turbines until an angle (Φ'') is reached at which the path has potential to interact with a maximum of one turbine.

For a single row of turbines, we define the piecewise smooth function, which gives the number of turbines for a given angle of crossing with,

$$n_{\text{interaction}} = \begin{cases} N, & \text{if } \theta \leq \phi' \\ \cot(\theta), & \text{if } \phi' < \theta \leq \phi'' \\ 1, & \text{if } \phi'' < \theta \leq \frac{\pi}{2} \end{cases}$$

This gives us an expected number of interactions as

$$\langle n_{\text{interaction}} \rangle = \frac{2}{\pi} \left[N \arctan\left(\frac{1}{N}\right) + \frac{\pi}{4} - \ln\left(\sqrt{2} \sin\left(\arctan\left(\frac{1}{N}\right)\right)\right) \right]$$

For scattered turbine arrays it is not realistic to assume that a bird will encounter all turbines in the wind farm in a given flight. We assume each flight has potential to cross between any 2 points on the outer edges of the farm. Given the size of most on-shore wind farms, this is a reasonable assumption for typical species of concern, such as raptors. When multiple flight paths are drawn randomly across the plan view of a wind farm, some paths may be circuitous and have potential to encounter many turbines, while others will pass through a small portion of the site and have potential to encounter relatively few turbines.

To deduce an average number of turbines likely to be encountered by any flight we use a topological, non-affine mapping technique. This spatial transformation can be illustrated as follows: if we were to throw a lasso around the perimeter of the site and shorten it to its minimum, we would find that all the turbines had collected in a circle. A straight flight path through this “lassoed” site is mathematically equivalent to a random walk across the unconstrained layout. The average of all flight paths crossing the center of this remapped farm will intersect with \sqrt{N} turbines (where N is the total no. of turbines in the wind farm). This value is used in the model for the number of turbines that might be encountered per flight within a scattered turbine array.

For arrays that are neither entirely scattered nor linear, the model employs a simple weighted average of the values for fully scattered and entirely linear arrays.

Application of turbine avoidance capacity.—Birds have substantial ability to avoid obstacles; therefore, it is necessary to incorporate this capacity into the model. In common with other workers (Percival et al. 1999), we use “avoidance” in specific reference to behavior on the part of a bird that averts a potential collision with a turbine. The “avoidance rate” equates to the proportion of flights that might otherwise have involved interaction with a turbine but where the bird alters course and the flight does not result in a collision. For the purposes of the model it is of no consequence whether or not this is a result of a cognitive response by the bird to the presence of the turbine.

Turbine avoidance remains little-studied for any species, and empirical information about actual avoidance can be obtained for a given site only by studying the responses of birds in the presence of operational turbines (Chamberlain et al. 2006). One recent investigation has compared flight behaviors of 2 species of eagles in the presence of turbines at

2 operating wind farms with their behaviors at a site without turbines (Hull and Muir 2013).

Avoidance rate is incorporated into the model by scaling the movements at risk by $(1 - v)$, where v is a measure of the bird's ability to avoid objects. In this scenario, $v = 0$ corresponds to a blind, non-responsive projectile, and $v = 1$ represents a perfectly responsive bird able to avoid any object.

A novel feature of our model is its capacity to apply different avoidance values to the static and dynamic portions of a turbine. As noted by Martin (2011), birds are known to collide with both stationary and moving parts of turbines. This aspect of our model allows for differences in capacity of birds to detect and avoid the large, static components of modern turbines relative to their capacity to detect and avoid the small and fast-moving leading edges of rotor blades.

Size of population at risk.—When information about the size of the population at-risk is available, this can be factored directly into our model to provide results in the form of an expected number of individuals at risk of collision per annum. This is an important consideration because an input measured in terms of bird movements cannot provide an output in terms of individual birds. This aspect appears to have been largely overlooked by other workers, although Chamberlain et al. (2006) alluded to the use of a number of flights only, without incorporation of the number of individuals, as a potential issue in evaluation of collision estimates provided by the Band model (Band et al. 2007).

To deduce a predicted number of individual birds that are at risk of collision, a valid estimate is required of the number of individuals that may interact with turbines at the wind farm in the course of a year. If it is not feasible to obtain this for a species, then the output of the collision risk model will necessarily be the number of flights-at-risk per annum. Although this metric is not predictive of the number of individuals that might collide, it permits risk to be compared for various designs of a wind farm or between one facility and another. In rare cases, such as where there is a single migration passage through the site per annum, the number of movements may equate with the number of individual birds that are at risk. The great majority of risk modeling we have undertaken has been for raptors that are year-round residents. Due to their territoriality and relatively low densities, our studies at wind-farm sites have been able to ascertain the number of individuals using a site per annum, including both resident adults and juveniles, with a high level of confidence. For some other species, such as cranes (Gruidae), we have undertaken home-range studies to determine numbers present during the breeding season, and we have obtained local census data to estimate numbers of individuals that might encounter turbines during non-breeding seasons.

Given a population estimate, the number of flights at risk is attributed equally to the relevant number of individuals through the simple relation $M_{\text{individuals}} = \text{Yearly Movements} / \text{Population}$. We can then attribute individual mortality through

$$\text{mortality} = \text{Population} \left(1 - \frac{\text{Movements At Risk}}{\text{Yearly Movements}} \right)^{M_{\text{individuals}}}$$

MODEL VALIDATION

The model we describe here has been used to assess potential turbine collision risk for numerous species of birds for 23 commercial-scale wind farms proposed in Australia and one in Fiji. Eleven of these facilities have subsequently been built and are now operational. The model's projections have been used by regulatory authorities in determination of approval or modification to wind-farm designs for a range of species of concern. These include taxa as diverse as the orange-bellied parrot (*Neophema chrysogaster*), wedge-tailed eagle (*Aquila audax*), brolga (*Grus rubicunda*), and the large and readily observable Pacific fruit-bat (*Pteropus tonganus*) in Fiji.

The model's performance can be validated only when it can be compared with post-construction mortality data that are sufficient to permit calculation of an actual annual mortality rate and a 95% confidence interval for that rate. Conditions of regulatory approval for most wind farms that have been built to-date in Australia have varied considerably between state jurisdictions and over time. Generally they have not required rigorous investigation or public reporting of avian collisions that occur during operation. We have thus had limited opportunity to validate our model against empirical information for actual collisions. However, where these are available, we can compare the model's predicted average estimates with the measured confidence interval for actual mortalities to assess its predictive capacity. We present one such case study below.

Comparing the Model's Predictions With Empirical Data—A Case History

Substantial investigations have been undertaken at Bluff Point and Studland Bay wind farms in northwestern Tasmania entailing a number of studies of wedge-tailed eagle and white-bellied sea-eagle (*Haliaeetus leucogaster*). These have included utilization surveys designed to measure eagle activity before and after development of the wind farm; collision monitoring; eagle breeding success; eagle behaviors and movements relative to turbines and observers; and investigations and trials aimed at reduction of collisions (Hull et al. 2013). Commissioning of turbines began at Bluff Point Wind Farm in 2002 and at Studland Bay Wind Farm in 2007. Bluff Point Wind Farm consisted of 37 Vestas V66 turbines in a scattered array on an area of 1,524 ha. Studland Bay Wind Farm was situated 3 km south of Bluff Point and comprised 25 Vesta V90 turbines in a scattered array over an area of 1,410 ha. Both wind farms were close to the coast of northwestern Tasmania and resident white-bellied sea-eagles and Tasmanian subspecies of wedge-tailed eagle (*A. a. fleayi*) occurred at both sites.

Monitoring Eagle Flights

Movement data for both species were collected during point counts at Bluff Point Wind Farm site in 3 years prior to construction of turbines and in 4 years after they commenced operating. At Studland Bay, they were collected in 6 years prior to turbine construction and in 3 years after turbines commenced operation. As prescribed by regulatory authorities, point counts were undertaken in the austral autumn and spring. Ten replicate point counts were made in each season

at 18 locations per wind farm. There were 545 point counts undertaken at Bluff Point between 1999 and 2007 and 854 point counts at Studland Bay between 1999 and 2009.

Collision Risk Model Results

We used the model to estimate risk based on movement data collected prior to construction for populations of 6 wedge-tailed eagles and 4 white-bellied sea-eagles at-risk per annum at each of the 2 wind farms.

State regulatory authorities have required that the collision risk model be re-run with the accumulated sum of eagle movement data obtained during the entire period of both pre-construction and operation of the 2 wind farms spanning the period from 1999 to 2009 (Table 1). We modeled static avoidance rate at 99% in all cases.

Documented Eagle Collisions

Carcass monitoring surveys were conducted at the Bluff Point and Studland Bay wind farms since they commenced operating. Fences to exclude mammalian scavengers were maintained at 27% of turbines across the 2 sites. All turbines, both fenced and unfenced, were searched routinely within a 100-m radius of the tower base. Search frequency was initially informed by trials to determine rates of loss to scavengers and of observers' capacity to detect carcasses. Since 2007, searches were carried out twice weekly during periods that may have represented higher risk to the species (i.e., eagle display period Jun–Aug, inclusive; and eagle fledging period mid-Dec–Feb, inclusive) and fortnightly outside these periods (Hull et al. 2013). Assessment of the extent of undetected eagle collisions (Hydro Tasmania 2012; Hull et al. 2013) concluded that it is unlikely that significant numbers of eagle carcasses were missed because they are conspicuous; the search zone around turbines was adequate to detect eagle carcasses where they will fall after colliding with turbines (Hull and Muir 2010); personnel on site had capacity to detect carcasses that may have been moved from the formal search zones; eagle carcasses in vegetation were found not to decompose readily and, even when scavenged, remains were identifiable; avian scavengers did not remove all evidence of carcasses and, although mammalian scavengers could remove carcasses, this was controlled at the subset of fenced turbines; survey intensity was informed by predetermined scavenger removal rates; and, although a small number of eagles survived collision with a turbine, in all documented cases such birds were unable to fly and are likely to have been detected because

Table 1. Modeled mean annual turbine collision estimates for 2 eagle species based on movement data collected over the span of pre-construction and operation of 2 wind farms in northwestern Tasmania, Australia, from 1999 to 2009. Estimates are shown for 4 potential dynamic avoidance rates. Static avoidance rate was modeled at 99% in all cases

Dynamic avoidance rate (%)	White-bellied sea-eagle		Wedge-tailed eagle	
	Bluff Point	Studland Bay	Bluff Point	Studland Bay
90	0.9	0.8	2.7	1.9
95	0.5	0.4	1.5	1.1
98	0.2	0.2	0.7	0.5
99	0.1	0.1	0.4	0.3

both scavenger exclusion and farm fences prevented them from leaving the site.

Comparison of Collision Risk Model Estimates With Actual Mortality Rates

Given constraints of statistically low collision numbers, the model's estimates of annual collisions, based on the combined total of movement data from pre-construction and operation of the 2 wind farms from 1999 until 2009 (Table 1), compare well with actual mortality of the 2 eagle species at both wind farms (Table 2). The model's estimate of the number of wedge-tailed eagle collisions per annum at Bluff Point at a 95% avoidance rate was 1.5, which is the same as the mean number of documented mortalities per annum. Estimates provided for this case by model iterations for 90% and 95% avoidance rates fell within the 95% confidence interval of measured mortality rates. The model's estimates for number of collisions at a 95% avoidance rate for white-bellied sea-eagles at Bluff Point (0.5) and for wedge-tailed eagles at Studland Bay (1.1; Table 1) also closely approximated the mean numbers of documented mortalities per annum for the 2 species (0.4 and 1.0, respectively; Table 2). For those cases, the model's estimates for the range of avoidance rates between 90% and 99% fell within the 95% confidence interval of measured mortality rates. No white-bellied sea-eagle collisions have yet been reported from Studland Bay so, to date, the model's estimates are higher than actual experience for that species there.

MANAGEMENT IMPLICATIONS

We consider that there are 2 different, although not mutually exclusive, applications for modeling of bird collision risks at prospective wind farms. These are to provide projections of long-term effects of a particular wind-energy facility on key bird species; and to determine relative risks for key species that are associated with different wind-farm sites, different portions of large wind farms, and different types of turbines and/or turbine configurations.

In many respects, we consider the latter use of collision risk modeling is the most important contribution it offers. This application provides a tool for planning of wind farms to avoid, reduce, or mitigate potential risks to birds. The model we describe here has now been used in such an iterative manner for a number of prospective sites to evaluate relative risks to key species posed by different types, sizes, numbers, and layouts of turbines.

The integration in our model of data for numbers of bird flights with numbers of birds in the population at-risk is key to the accurate prediction of potential numbers of collisions. This aspect appears not to have been adequately considered previously but has real implications to the appropriate determination of actual risks posed by a wind farm. Our model's use of bird flight data to determine annual flux of movements; a mathematical solution to the typical number of turbines that might be encountered in a bird flight; capacity to assess wind-farm configurations ranging from turbines scattered in the landscape to linear rows of turbines; and the option of assigning different avoidance rates to components

Table 2. Average annual mortality rate and variance for 2 eagle species based on carcasses detected at 2 wind farms in northwestern Tasmania, Australia

Wind farm	White-bellied sea-eagle		Wedge-tailed eagle	
	Mean annual mortality	Annual variance (95% CI)	Mean annual mortality	Annual variance (95% CI)
Bluff Point 2002–2012	0.4	0.1–1.0	1.5	0.8–2.6
Studland Bay 2007–2012	0.0	0.0–0.7	1.0	0.3–2.2

of turbines that pose more or less risk, all represent refinements designed to improve the predictive capacity of turbine collision risk modeling.

In the cases outlined here, where long-term mortality data sets have permitted validation of the model's collision estimates at given avoidance rates, the two have closely approximated each other. We will seek further opportunities to compare the results of our model with empirical mortality information from operating wind farms, with a view to wider application of the model.

ACKNOWLEDGMENTS

C. Hull and E. Stark have been constant sources of ideas and valued discussions. C. Hull also facilitated our access to information about Bluff Point and Studland Bay wind farms and provided critical review of 2 drafts of the paper. M. McCarthy provided comment on early incarnations of the model. R. Brereton offered important inputs and S. Allie assisted to improve the model in relation to predicting risk to individual birds. Two early reviews of the model by T. Pople, H. Possingham, L. Joseph, and T. Regan of the Ecology Centre University of Queensland offered ideas for improvements to the model. Assessments of numerous wind-farm sites have been the foundation of development of the model and we are grateful to various wind-energy companies for involvement in their projects.

The model described here is the property of Biosis Propriety Limited, an environmental consultancy business incorporated in Australia. It is used commercially by Biosis Propriety Limited.

LITERATURE CITED

Band, W., M. Madders, and D. P. Whitfield. 2007. Developing field and analytical methods to assess avian collision risk at wind farms. Pages 259–275 in M. De Lucas, G. Janss, and M. Ferrer, editors. *Birds and wind farms risk assessment and mitigation*. Servicios Informativos Ambientales/Quercus, Madrid, Spain.

Bolker, E. D., J. J. Hatch, and C. Zara. 2006. Modeling bird passage through a windfarm. University of Massachusetts Boston, Boston, Massachusetts, USA. <<http://www.cs.umb.edu/~eb/windfarm/paper072706.pdf>>. Accessed 10 Nov 2012.

Bruderer, B. 1995. The study of bird migration by radar part 2: major achievements. *Naturwissenschaften* 84:45–54.

Bruderer, B., and A. Boldt. 2001. Flight characteristics of birds: 1. radar measurements of speed. *Ibis* 143:178–204.

Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. *Distance sampling: estimating abundance of biological populations*. Chapman and Hall, London, England, United Kingdom.

Chamberlain, D. E., M. R. Rehfish, A. D. Fox, M. Desholm, and S. J. Anthony. 2006. The effect of avoidance rates on bird mortality predictions made by wind farm turbine collision risk models. *Ibis* 148:198–202.

Desholm, M., A. D. Fox, D. L. Beasley, and J. Kahlert. 2006. Remote techniques for counting and estimating the number of bird–wind turbine collisions at sea: a review. *Ibis* 148:76–89.

Gauthreaux, S. A., and C. G. Belser. 2003. Radar ornithology and biological conservation. *The Auk* 120:266–277.

Hull, C. L., and S. Muir. 2010. Search areas for monitoring bird and bat carcasses at wind farms using a Monte-Carlo model. *Australasian Journal of Environmental Management* 17:77–87.

Hull, C. L., and S. C. Muir. 2013. Behavior and turbine avoidance rates of eagles at two wind farms in Tasmania, Australia. *Wildlife Society Bulletin* 37:49–58.

Hull, C. L., C. Sims, E. Stark, and S. Muir. 2013. Results and analysis of eagle studies from Bluff Point and Studland Bay Wind Farms 2002–2012. *Wind and Wildlife*. Proceedings of the Conference on Wind and Wildlife, 9 October 2012, Melbourne, Australia. Springer, Dordrecht, The Netherlands, in press.

Hydro Tasmania. 2012. Bluff Point Wind Farm and Studland Bay Wind Farm Annual Environmental Performance Report 2011. Hydro Tasmania. <<http://www.hydro.com.au/system/files/documents/wind-environment/2011-AEPR-BPWF-SBWF.pdf>>. Accessed 10 Nov 2012.

Martin, G. R. 2011. Understanding bird collisions with man-made objects: a sensory ecology approach. *Ibis* 153:239–254.

Pennycuik, C. J. 2008. *Modeling the flying bird*. Academic Press, Elsevier, Oxford, England, United Kingdom.

Percival, S. M., B. Band, and T. Leeming. 1999. Assessing the ornithological effects of wind farms: developing a standard methodology. Proceedings of the 21st British Wind Energy Association Conference, Cambridge, England, United Kingdom.

Podolsky, R. 2003. Avian risk of collision (ARC) model. NWCC Biological Significance Workshop, 17–18 November 2003, Washington, D.C. National Wind Coordinating Committee, Washington, D.C., USA.

Podolsky, R. 2005. Application of risk assessment tools: avian risk of collision model. Proceedings of the Onshore Wildlife Interactions with Wind Developments: Research Meeting V, 3–4 November 2004, Lansdowne, Virginia. Prepared for the Wildlife Subcommittee of the National Wind Coordinating Committee. RESOLVE, Washington, D.C., USA.

Press, W. H., S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery. 1992. *Numerical recipes in Fortran 77: the art of scientific computing*. Second edition. Cambridge University Press, New York, New York, USA.

Reynolds, R. T., J. M. Scott, and R. A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. *Condor* 82:309–313.

Tucker, V. A. 1996a. A mathematical model of bird collisions with wind turbine rotors. *Journal of Solar Energy Engineering* 118:253–262.

Tucker, V. A. 1996b. Using a collision model to design safer wind turbine rotors for birds. *Journal of Solar Energy Engineering* 118:263–269.

Videler, J. J. 2005. *Avian flight*. Oxford University Press, Oxford, England, United Kingdom.

Associate Editor: Smallwood.

Appendix E

Offset credit summary reports

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00020779/BAAS18090/20/00020780	Hills of Gold Wind Farm	20/08/2020
Assessor Name	Report Created	BAM Data version *
Chani S Wheeler	16/10/2020	30
Assessor Number	BAM Case Status	Date Finalised
BAAS19077	Open	To be finalised
Assessment Revision	Assessment Type	
1	Major Projects	

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAIL	Ecosystem credits
Black Sallee - Snow Gum grassy woodland of the New England Tableland Bioregion								
	16 507_Moderate	60.0	0.15	0.25	High Sensitivity to Potential Gain	2.00		5
							Subtotal	5

Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion								
30	599_Low	90.7	1.8	0.25	High Sensitivity to Potential Gain	2.00	TRUE	79
31	599_DNG	59.9	0.06	0.25	Moderate Sensitivity to Potential Gain	1.75	TRUE	2
32	599_High	99.9	0.39	0.25	High Sensitivity to Potential Gain	2.00	TRUE	19
33	599_Moderate	99.9	1.1	0.25	High Sensitivity to Potential Gain	2.00	TRUE	57
							Subtotal	157
Blakely's Red Gum - Yellow Box grassy woodland of the New England Tableland Bioregion								
17	510_Low	99.8	0.05	0.25	High Sensitivity to Potential Gain	2.00	TRUE	2
							Subtotal	2
Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion								
34	931_Low	28.4	0.22	0.25	High Sensitivity to Potential Gain	2.00		3
35	931_High	92.8	4	0.25	High Sensitivity to Potential Gain	2.00		185
36	931_Moderate	56.2	1.4	0.25	High Sensitivity to Potential Gain	2.00		38
							Subtotal	226
Messmate open forest of the tableland edge of the NSW North Coast Bioregion and New England Tableland Bioregion								
37	934_Moderate	78.5	3.2	0.25	High Sensitivity to Potential Gain	2.00		127
38	934_High	93.6	7	0.25	High Sensitivity to Potential Gain	2.00		329
39	934_Low	50.0	0.62	0.25	High Sensitivity to Potential Gain	2.00		15
40	934_DNG	53.9	4.7	0.25	Moderate Sensitivity to Potential Gain	1.75		110
							Subtotal	581

Mountain Ribbon Gum - Messmate - Broad-leaved Stringybark open forest on granitic soils of the New England Tableland Bioregion								
18	526_High	99.6	0.35	0.25	High Sensitivity to Potential Gain	1.75		15
19	526_Moderate	99.6	0.15	0.25	High Sensitivity to Potential Gain	1.75		7
							Subtotal	22
Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion								
41	954_High	51.1	1.4	0.25	High Sensitivity to Potential Gain	1.75		32
							Subtotal	32
River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South Bioregion and Nandewar Bioregion								
1	84_Low	99.1	0.08	0.25	High Sensitivity to Potential Gain	1.50		3
2	84_Moderate	99.1	0.09	0.25	High Sensitivity to Potential Gain	1.50		3
							Subtotal	6
River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range								
7	486_DNG	52.9	0.14	0.25		1.00		2
8	486_High	99.1	0.71	0.25	High Sensitivity to Potential Gain	1.50		26
9	486_Low	99.1	1	0.25	High Sensitivity to Potential Gain	1.50		39
10	486_Moderate	99.1	5.7	0.25	High Sensitivity to Potential Gain	1.50		211
							Subtotal	278
Rough-barked Apple - Blakely's Red Gum open forest of the Nandewar Bioregion and western New England Tableland Bioregion								
20	538_Low	99.1	0.01	0.25	High Sensitivity to Potential Gain	2.00	TRUE	1
							Subtotal	1

Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion									
11	490_Low	98.3	3.1	0.25	High Sensitivity to Potential Gain	1.50			116
								Subtotal	116
Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion									
21	540_High	95.6	13.8	0.25	High Sensitivity to Potential Gain	1.75			578
22	540_Moderate	98.2	28.1	0.25	High Sensitivity to Potential Gain	1.75			1207
23	540_Low	92.3	16.2	0.25	High Sensitivity to Potential Gain	1.75			654
24	540_DNG	47.4	11.5	0.25		1.25			171
								Subtotal	2610
Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion									
25	541_DNG	48.0	5.7	0.25		1.25			86
26	541_High	99.4	12.9	0.25	High Sensitivity to Potential Gain	1.75			561
27	541_Low	99.4	2.8	0.25	High Sensitivity to Potential Gain	1.75			121
28	541_Moderate	99.4	8.6	0.25	High Sensitivity to Potential Gain	1.75			374
								Subtotal	1142
Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion									
12	492_Moderate	89.5	0.77	0.25	High Sensitivity to Potential Gain	2.00	TRUE		34
13	492_Low	88.6	5.3	0.25	High Sensitivity to Potential Gain	2.00	TRUE		233

BAM Credit Summary Report

14	492_DNG	53.1	2.8	0.25		1.50	TRUE	57
15	492_High	99.8	0.94	0.25	High Sensitivity to Potential Gain	2.00	TRUE	47
							Subtotal	371
Smooth-barked Apple - White Cypress Pine grass shrub woodland on lower slopes and sandy flats, north-western Brigalow Belt South Bioregion								
6	450_High	99.6	1.5	0.25	High Sensitivity to Potential Gain	1.75		64
							Subtotal	64
Snow Gum - Mountain Gum - Mountain Ribbon Gum grassy open forest of the New England Tableland Bioregion								
42	1192_Low	99.5	1	0.25	High Sensitivity to Potential Gain	2.00		51
							Subtotal	51
Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion								
43	1194_DNG	35.2	6	0.25	Moderate Sensitivity to Potential Gain	1.75		92
44	1194_Low	81.2	4.8	0.25	High Sensitivity to Potential Gain	2.00		194
45	1194_High	84.2	21.9	0.25	High Sensitivity to Potential Gain	2.00		921
46	1194_Moderate	93.7	23.8	0.25	High Sensitivity to Potential Gain	2.00		1114
							Subtotal	2321
White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion								
5	434_Low	99.9	0.02	0.25	High Sensitivity to Potential Gain	2.00	TRUE	1
							Subtotal	1
White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, BBS Bioregion								
3	433_Low	99.9	0.01	0.25	High Sensitivity to Potential Gain	2.00	TRUE	1

BAM Credit Summary Report

4	433_Moderate	99.9	0.07	0.25	High Sensitivity to Potential Gain	2.00	TRUE	3
							Subtotal	4
White Box shrubby open forest on hills mainly in the Nandewar Bioregion								
29	591_Moderate	99.4	0.65	0.25	High Sensitivity to Potential Gain	1.50		24
							Subtotal	24
							Total	8014

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Potential SAIL	Species credits	
<i>Cercartetus nanus / Eastern Pygmy-possum (Fauna)</i>							
450_High	99.6	0.89	0.25	2	False	44	
526_High	99.6	0.35	0.25	2	False	17	
599_High	99.9	0.39	0.25	2	False	19	
931_High	92.8	3.4	0.25	2	False	156	
934_High	93.6	5	0.25	2	False	234	
954_High	51.1	1.4	0.25	2	False	36	
1194_High	84.2	19	0.25	2	False	801	
						Subtotal	1307
<i>Chalinolobus dwyeri / Large-eared Pied Bat (Fauna)</i>							
450_High	99.6	1.5	0.25	3	True	110	
507_Moderate	60.0	0.15	0.25	3	True	7	

BAM Credit Summary Report

526_High	99.6	0.35	0.25	3 True	26
526_Moderate	99.6	0.09	0.25	3 True	7
599_High	99.9	0.07	0.25	3 True	5
599_Moderate	99.9	0.09	0.25	3 True	7
934_Moderate	78.5	2.2	0.25	3 True	129
934_High	93.6	7	0.25	3 True	494
1194_High	84.2	21.4	0.25	3 True	1354
1194_Moderate	93.7	23.2	0.25	3 True	1628
				Subtotal	3767
<i>Litoria booroolongensis / Booroolong Frog (Fauna)</i>					
84_Moderate	99.1	0.07	0.25	2 False	3
486_High	99.1	0.18	0.25	2 False	9
486_Moderate	99.1	0.88	0.25	2 False	44
540_High	95.6	0.36	0.25	2 False	17
541_High	99.4	0.07	0.25	2 False	3
541_Moderate	99.4	0.03	0.25	2 False	1
				Subtotal	77
<i>Miniopterus australis / Little Bent-winged Bat (Fauna)</i>					
540_Moderate	98.2	1.3	0.25	3 True	93
540_Low	92.3	2.4	0.25	3 True	168
540_DNG	47.4	0.48	0.25	3 True	17

BAM Credit Summary Report

931_Low	28.4	0.06	0.25	3 True	1
931_High	92.8	0.1	0.25	3 True	7
931_Moderate	56.2	0.45	0.25	3 True	19
934_Moderate	78.5	0.01	0.25	3 True	1
934_High	93.6	1.8	0.25	3 True	127
934_Low	50.0	0.04	0.25	3 True	1
954_High	51.1	0.49	0.25	3 True	19
1192_Low	99.5	0.99	0.25	3 True	74
1194_DNG	35.2	1.1	0.25	3 True	30
1194_Low	81.2	1.5	0.25	3 True	89
1194_High	84.2	7.2	0.25	3 True	453
1194_Moderate	93.7	5.2	0.25	3 True	366
				Subtotal	1465
<i>Miniopterus orianae oceanensis / Large Bent-winged Bat (Fauna)</i>					
540_Moderate	98.2	1.3	0.25	3 True	93
540_Low	92.3	2.4	0.25	3 True	168
540_DNG	47.4	0.48	0.25	3 True	17
931_Low	28.4	0.06	0.25	3 True	1
931_High	92.8	0.1	0.25	3 True	7
931_Moderate	56.2	0.45	0.25	3 True	19
934_Moderate	78.5	0.01	0.25	3 True	1

BAM Credit Summary Report

934_High	93.6	1.8	0.25	3 True	127
934_Low	50.0	0.04	0.25	3 True	1
954_High	51.1	0.49	0.25	3 True	19
1192_Low	99.5	0.99	0.25	3 True	74
1194_DNG	35.2	1.1	0.25	3 True	30
1194_Low	81.2	1.5	0.25	3 True	89
1194_High	84.2	7.2	0.25	3 True	453
1194_Moderate	93.7	5.2	0.25	3 True	366
				Subtotal	1465
<i>Myotis macropus / Southern Myotis (Fauna)</i>					
1194_High	84.2	0.06	0.25	2 False	3
1194_Moderate	93.7	2	0.25	2 False	96
				Subtotal	99
<i>Petaurus norfolcensis / Squirrel Glider (Fauna)</i>					
84_Moderate	99.1	0.05	0.25	2 False	2
433_Moderate	99.9	0.07	0.25	2 False	3
526_High	99.6	0.35	0.25	2 False	17
526_Moderate	99.6	0.14	0.25	2 False	7
591_Moderate	99.4	0.65	0.25	2 False	32
599_High	99.9	0.39	0.25	2 False	19
599_Moderate	99.9	0.68	0.25	2 False	34

BAM Credit Summary Report

1194_High	84.2	11.4	0.25	2	False	482
1194_Moderate	93.7	12.4	0.25	2	False	583
					Subtotal	1179
<i>Phascolarctos cinereus / Koala (Fauna)</i>						
84_Moderate	99.1	0.09	0.25	2	False	4
433_Moderate	99.9	0.07	0.25	2	False	3
450_High	99.6	1.5	0.25	2	False	73
507_Moderate	60.0	0.15	0.25	2	False	5
526_High	99.6	0.35	0.25	2	False	17
526_Moderate	99.6	0.14	0.25	2	False	7
591_Moderate	99.4	0.65	0.25	2	False	32
599_High	99.9	0.39	0.25	2	False	19
599_Moderate	99.9	0.79	0.25	2	False	39
931_High	92.8	3.4	0.25	2	False	156
931_Moderate	56.2	1.2	0.25	2	False	33
934_Moderate	78.5	2.2	0.25	2	False	84
934_High	93.6	6.4	0.25	2	False	299
1194_High	84.2	21.3	0.25	2	False	898
1194_Moderate	93.7	11	0.25	2	False	513
					Subtotal	2182

BAM Credit Summary Report

<i>Uvidicolus sphyrurus / Border Thick-tailed Gecko (Fauna)</i>							
599_High	99.9	0.07	0.25	2	False		3
599_Moderate	99.9	0.11	0.25	2	False		5
						Subtotal	8
<i>Vespadelus troughtoni / Eastern Cave Bat (Fauna)</i>							
450_High	99.6	1.5	0.25	3	True		110
507_Moderate	60.0	0.15	0.25	3	True		7
526_High	99.6	0.35	0.25	3	True		26
526_Moderate	99.6	0.09	0.25	3	True		7
599_High	99.9	0.07	0.25	3	True		5
599_Moderate	99.9	0.09	0.25	3	True		7
931_High	92.8	3.7	0.25	3	True		255
931_Moderate	56.2	1.4	0.25	3	True		58
934_Moderate	78.5	2.2	0.25	3	True		129
934_High	93.6	7	0.25	3	True		494
954_High	51.1	1.4	0.25	3	True		54
1194_High	84.2	21.4	0.25	3	True		1354
1194_Moderate	93.7	23.2	0.25	3	True		1628
						Subtotal	4134

Proposal Details

Assessment Id 00020779/BAAS18090/20/00021863	Proposal Name Hills of Gold Wind Farm	BAM data last updated * 20/08/2020
Assessor Name Chani S Wheeler	Report Created 16/10/2020	BAM Data version * 30
Assessor Number BAAS19077	BAM Case Status Open	Date Finalised To be finalised
Assessment Revision 0	Assessment Type Major Projects	

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAIL	Ecosystem credits
Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter								
1	1604_Low	99.7	0.1	0.25	High Sensitivity to Potential Gain	2.00		5
							Subtotal	5

BAM Credit Summary Report

Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter							
2	1691_Low	99.7	0.03	0.25	High Sensitivity to Potential Gain	2.00	1
						Subtotal	1
						Total	6

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Potential SAll	Species credits	
Myotis macropus / Southern Myotis (Fauna)							
1604_Low	99.7	0.1	0.25	2	False	5	
1691_Low	99.7	0.01	0.25	2	False	1	
						Subtotal	6