7 IMPACTS, MANAGEMENT AND MITIGATION

This section provides a summary of potential environmental and social impacts of the Project and the measures that will be implemented to mitigate and manage residual impacts. The issues have been prioritised in accordance with the SEARs, the risk assessment and outcomes of the SEP.

7.1 LANDSCAPE AND VISUAL

A Landscape and Visual Impact Assessment (LVIA) was undertaken for the Project by Green Bean Design Pty Ltd (GBD) and is included in full in **Appendix H**.

The LVIA has been prepared in accordance with the Visual Bulletin and the SEARs.

A summary of the LVIA is presented below including key impact assessment findings, as well as management measures committed to by the Proponent.

7.1.1 Background

A visual primary study area has been defined within a 4.4 km and 3 km offset from the WTGs as shown in **Figure 28**. The 4.4 km and 3 km visual offsets are in accordance with the blue and black lines illustrated in the Visual Bulletin (DPE, 2016b) as Figure 2 and Figure 5, respectively.

An analysis of the landscape within 4.4 km of the WTGs did not identify any key public viewpoints (such as dedicated lookouts, public spaces or recreational areas); however, the LVIA extends to a broader study area in excess of 12 km which includes public viewpoints and lookouts beyond the Project Boundary.

Feedback from community consultation activities as described in **Section 5**, has been comprehensively considered in the LVIA with turbine locations responding to an iterative process of reviews against the Bulletin's performance objectives.

To support the community consultation process, GBD prepared a number of figures to illustrate the results of preliminary site work. The figures outline landscape characteristics associated with Scenic Quality Areas (SQAs). The landscape characteristics are generally defined by land use, land cover and topography and are shown in **Appendix H**.

Each landscape area was photographed and described for the purpose of the community information sessions and were used to inform the community about the approach to landscape analysis and processes involved in the determination of scenic quality. Notable observations or comments made during face-to-face meetings, information sessions and as provided in the feedback form were incorporated in the LVIA.

7.1.2 Methodology

Overview

The methodology employed for the LVIA has incorporated the key steps and analysis set out in the Visual Bulletin and generally includes introductory sections as well as:

- A visual baseline study which establishes existing landscape and visual conditions and considers:
    - Sensitive Land Use Designations;
    - Landscape Character Type;

  - Key Landscape Features;
  - Scenic Quality Classes;
  - Viewpoint Inventory and sensitivity levels;
  - Visibility distance zones;
  - Wind Resource Categories;
  - Wind Turbine Locations and Heights (Optional Scenarios);
  - Other Wind Farm Projects;
- Zones of visual influence which identifies the overall extent of wind turbine visibility beyond the Project;
- Visual influence zones which establish the relative landscape significance against which the potential impacts of WTGs are assessed utilising Table 8 of the Visual Bulletin;
- Visual performance evaluation which considers the Project against the following visual performance objectives:
  - Visual Magnitude;
  - Landscape Scenic Integrity;
  - Key Feature Disruption;
  - Multiple Wind Turbine Effects;
  - Shadow Flicker and Blade Glint;
  - Aviation Hazard Lighting; and
- Impact mitigation options to avoid or minimise visual and lighting impacts.

Visual Baseline Study

Visual assessment requires an evaluation of the Project and its various components, turbines and ancillary facilities against the visual performance objectives, using a combination of desktop and field evaluations.

Visual performance objectives are used as a framework for evaluation that enables potential impacts and management options to be considered objectively, against the varying levels of landscape significance established by the baseline study.

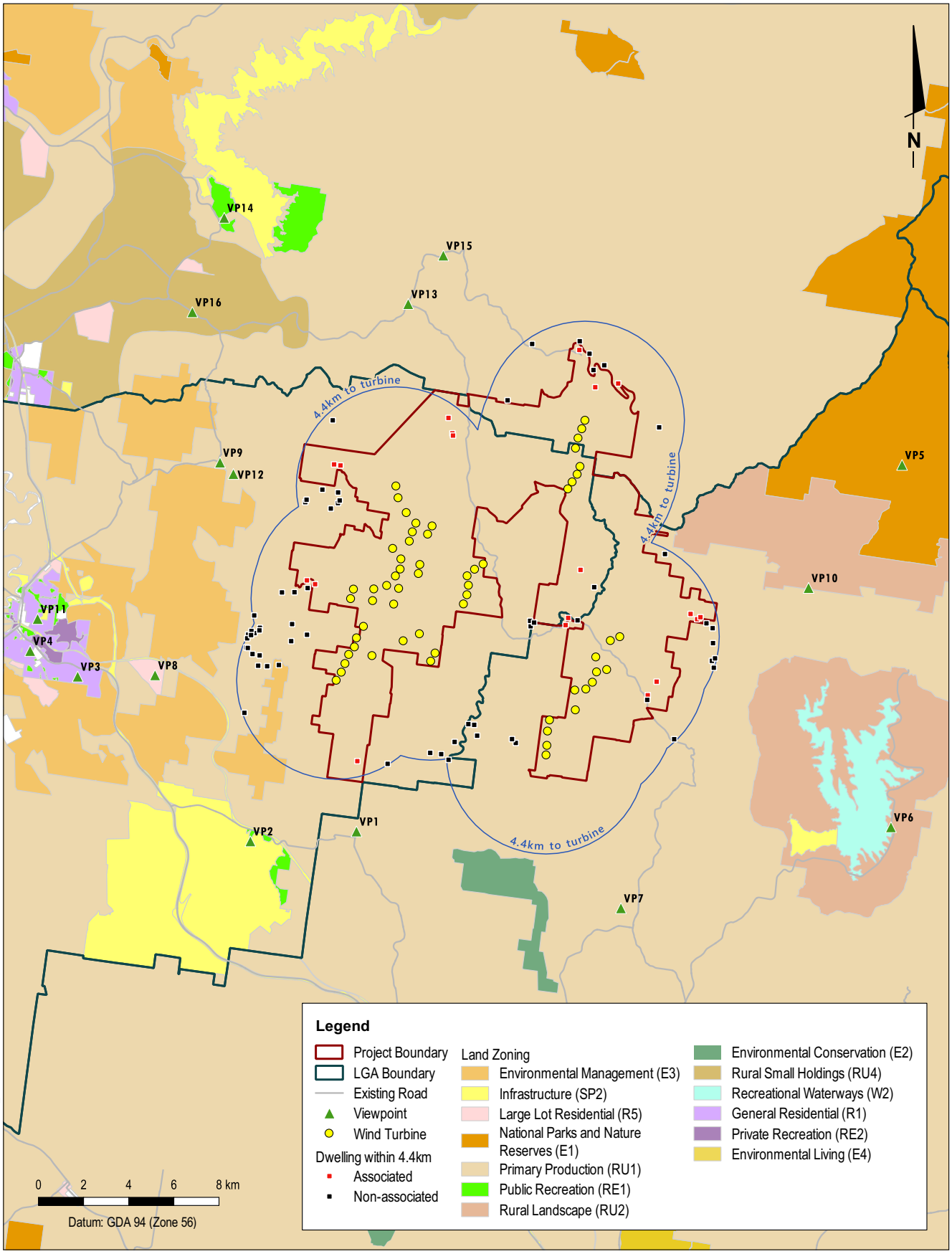
Visual Magnitude

Visual magnitude is a key visual parameter in the preliminary assessment tool. The respective threshold lines on the graph at Figure 5 of the Visual Bulletin (reproduced as **Figure 29**) indicate where turbines may potentially have significant visual magnitude impacts based on their relative height and their distance from viewpoints.

For the visual assessment, an additional threshold distance line has been added to the visual magnitude graph which identifies potentially high visual magnitude impacts, to allow more detailed assessment as part of this EIS.

The black and blue lines in Figure 5 of the Visual Bulletin (see **Figure 29**) are not determinative of acceptability but instead provide a basis for the assessment. The assessment of potential impacts relating to visual magnitude is a key factor as it is acknowledged that WTGs are very large structures that will be visible in the landscape.

Source: Land Zoning © MSC LEP 2009, UHSC LEP ZOX



Bowmans Creek Wind Farm | Fig28_Visual Assessment Locations | 23.03.2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Visual Assessment Locations

FIGURE 28

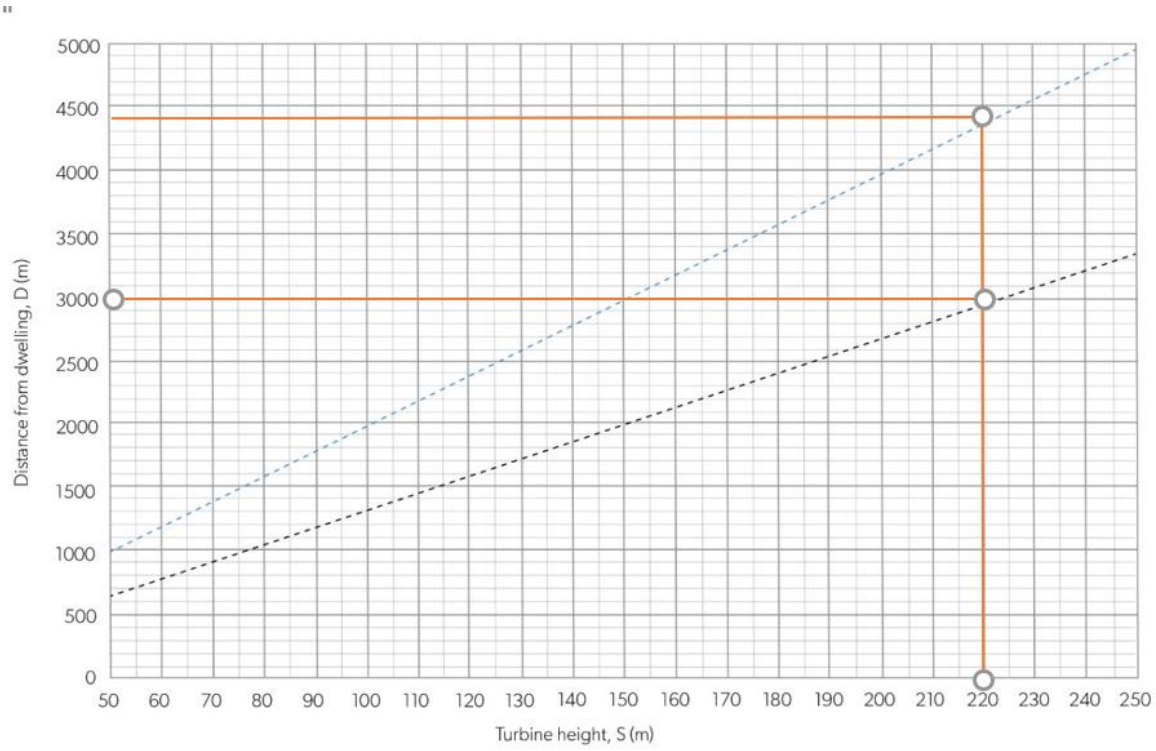


Figure 29
Visual Bulletin Figure 5 Visual Magnitude Thresholds

Landscape Scenic Integrity

The landscape scenic integrity criterion assesses the extent to which the current landscape character and scenic quality of the visual catchment would be maintained given a proposed landscape alteration, such as a wind energy project. The purpose of this performance objective is to determine the impacts on the broader landscape of a region. The baseline study inputs, including the identification of the scenic quality class determine the visual influence zone. Other baseline study inputs such as the "landscape character type" and "landscape character options" also provide the context for determining the integrity of the existing landscape. For wind energy projects:

- In the high scenic quality class, they should not cause more than a low level modification of the visual catchment, where turbines may be visible and are unlikely to be missed by casual observers, but lack sufficient size or contrast to compete with major landscape elements;
- In the moderate scenic quality class, they should not cause significant modification of the visual catchment. Turbines may be visually apparent and could become a major element in the landscape; and
- In the low scenic quality class, they may result in significant modification of the visual catchment. Turbines may be visually apparent and a major element in the landscape.

Landscape Scenic Integrity

The Bulletin notes that the key features disruption parameter describes proposed wind turbines that are likely to disrupt or interrupt the central line of sight and/or the central focal viewing field surrounding it, when seen from a viewpoint looking toward the identified key features of a landscape.

Identification of these key landscape features will also be informed by community consultation undertaken. Examples include visually prominent mountain peaks, large rock outcrops, waterfalls, rivers or creeks, distinctive stands of vegetation and distinctive cultural buildings.

Multiple Wind Turbine Effects

The “multiple wind turbine effect” is the other key visual parameter utilised in the preliminary assessment tool. For the visual assessment, the effects of multiple wind turbines visible from individual viewpoints as part of the Project, as well as the cumulative landscape and visual impacts must be considered having regard to existing and approved wind energy projects located within 8 km of the Project.

Depending on the viewer sensitivity level, the location of the proposed turbines should avoid, where possible, views to turbines of one or more wind energy projects, within the effective horizontal views of two or more 60° sectors (from Level 1 viewpoints), or in three or more 60° sectors (from Level 2 viewpoints).

Multiple Wind Turbine Tool (MWTT) diagrams have been generated through GIS analysis and presented in the Performance Objective assessment for each non-associated dwelling within 4.4 km of wind turbine locations. Each MWTT diagram includes a separate visibility rose to illustrate the number of 60° sectors occupied by wind turbines (see **Appendix H**).

7.1.3 Impact Assessment

Visual Baseline Study

The visual baseline study established the existing landscape and visual conditions in accordance with the Visual Bulletin.

SLUDs

Sensitive Land Use Designations (SLUDs) were defined and include consideration of applicable land use zones and primary nature of the land use (e.g agricultural, industrial, rural residential), including identification of sensitive land use designations, particularly considering any sites listed at the National and State level.

SLUDS identified in the vicinity of the Project are shown on **Figure 28** and generally include: National and state (National parks, National Reserve System reserves and State heritage register sites) and LEP Zones (RU1, R1, R5, RE2, E1, E2, E3 and W2). All land with the Project Boundary is designated RU1 as described in **Section 4.3.6**.

Scenic Quality Classes

Scenic Quality Areas (SQA) "frames of reference" were determined (i.e. high, moderate and low) to identify those landform, vegetation, waterform and/or cultural features that may be considered to be scenically outstanding or of high quality for the area. SQAs are listed in **Table 16**.

Table 16
Visual Scenic Quality Areas

Type	Description	Landscape Character Options	Scenic Quality Assessment
1	Prominent hills and mountains	• Naturally evolving, *Natural Appearing*, Cultural (minor)	Moderate
2	Low undulating hills	• Natural Appearing, *Pastoral*, Cultural (minor)	Moderate
3	River flood plain	• Natural Appearing, *Pastoral*, *Agricultural*, Cultural (minor)	Moderate
4	Mining activities	• Industrial modification, Power generation	Low
5	Township-urban	• Cultural, Urban/Rural villages	Low to Moderate
6	Rural properties	• Cultural, Urban/Rural villages	Moderate
7	Water body	• Naturally appearing, *Cultural*, Power generation and transmission	Moderate to High
8	Power generation	• Large scale built form, *Industrial modification*, Power generation	Moderate
9	Ridgelines timbered	• Natural Appearing, *Pastoral*, Cultural (minor)	Moderate
10	Hills and ridges (pasture)	• Natural Appearing, *Pastoral*, Cultural (minor)	Moderate

Landscape Character Types and Features

Landscape character types and key landscape features associated with the SQAs were identified in consideration of land use, land cover and topography. A landscape analysis identified ten landscape areas within and surrounding the Project Boundary as described in **Table 16**. Landscape character options were selected to assist in the description of the existing landscape character type and used during the performance evaluation phase to assess to what extent the existing landscape character may potentially be modified by the Project.

A viewpoint inventory and sensitivity map illustrating public and private viewpoints of Level 1 to Level 3 sensitivity is presented in **Appendix H**. Sensitivity levels were applied in accordance with the Visual Bulletin's Table 5 as Level 1 (High), Level 2 (Moderate), or Level 3 (Low).

Visibility distance zones for relevant “distances of view” were applied to the visual analysis of the Project in accordance with the Bulletin's Table 6 and are noted for each viewpoint in **Table 17**.

A review has not identified any other wind farm projects within 8 km of the Project (the closest approved but not constructed at 35 km to the north-west) and as such, no cumulative assessment is required.

Zones of Visual Influence

Zone of Visual Influence (ZVI) diagrams were prepared to identify theoretical areas of the landscape from which a defined number of wind turbines (or portions of turbines) could be visible within the viewshed. They are useful for providing an overview as to the extent to which the project may be visible from surrounding view locations. The methodology adopted for the ZVI is a geometric assessment where the visibility of the Project is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain. Calculations were made to determine the visibility of the wind turbines. The calculations take into account the terrain relief and earth curvature which is very conservative as, the:

- Screening effects of any structures and vegetation above ground level are not considered in any way. Therefore, the wind turbines may not be visible at many of the locations indicated on the ZVI diagrams due to the local presence of trees or other screening materials; and
- Number of turbines visible is also affected by the weather conditions at the time. Inclement or cloudy weather tends to mask the visibility of the Project.

The most extensive and continuous area of visibility toward the project turbines would generally occur where the tips of the wind turbine rotor blades are visible above surrounding ridgelines or vegetation; however, views toward the tips and upper portions of the wind turbine rotors are likely to become less noticeable at reasonably short distances from the wind farm due to the screening influence of topography and dense tree cover. Views toward tip of blade are visually negligible from medium to longer distance receiver locations.

The ZVI diagrams for “tip” and ”hub" height cover similar extents of landscape surrounding the Project and extend toward isolated pockets of rural landscape beyond 12 km of the nearest wind turbine (see **Appendix H**). The number and distribution of turbines visible between tip and hub height is influenced by ridgelines and surrounding hills for several areas between the 5 km to 10 km distance offsets.

The ZVI diagrams illustrate areas of landscape which are likely to offer views toward the wind turbines and demonstrate that most views generally occur within private property and across tracts of unoccupied rural landscape. The ZVI diagrams also illustrate a number of discrete pockets within portions of the 5 km to 10 km distance offset from which the wind turbines would not be visible, although this band of the viewshed also represents areas from which a greater number of turbines would also be visible.

The ZVI diagrams illustrate that the influence of surrounding landform begins to disperse visibility from beyond 5 km, although opportunities to view turbines from elevated, but moderately distant and generally unoccupied areas occur from areas beyond 5 km. GBD notes that when viewed from distances of around or greater than 10 km, WTGs will generally be less distinct from other distant elements within the same field of view, and the majority of land within the viewshed comprises rural agricultural land and areas of dense timber growth.

Visual Influence Zones

Three zones of visual influence (low, moderate and high) and were established for the Project Boundary from dwellings and key public viewpoints. This establishes the relative landscape significance against which the potential impacts of wind turbines may be assessed. The visual influence zones are determined utilising information from the baseline study and Table 8 of the Visual Bulletin considering viewer sensitivity level, visibility distance zones and SQAs described in **Table 16**.

Each visual influence zone has a corresponding set of visual performance objectives that provide guidance by establishing different visual objectives and levels of landscape protection for the assessment and determination of the Project.

Visual influence zones are generated through the matrix in Visual Bulletin's Table 8 and include:

- Visual Influence Zone (VIZ) 1 is associated with those areas with the highest level of visual significance;
- VIZ2 would have combinations resulting in a moderate VIZ rating; and
- VIZ3 is associated with those landscapes with the lowest level of combined significance.

All representative view locations and relevant dwellings were ascribed to visual influence zone VIZ2, with the exception of four non-Associated dwellings which were within 2 km of a proposed WTG (G15-3, P22-1, P22-4 and S17-2) as shown on **Figure 6**.

Visual Performance Evaluation to 4.4 km (Blue Line)

Table 17 lists non-Associated landholders where screening (between the blue line and the black line) will be offered to the landowner with an impact summary for each. The following is correct for all locations (except where stated):

- Overall wind turbine visibility will not cause any significant modification to the visual catchment;
- The visible wind turbines will not result in the removal or visual alteration of key landscape features;
- Visible wind turbines within 8 km of the view location are compliant with the Multiple Wind Turbine Effects performance objectives; and
- Ancillary electrical infrastructure will not be visible from the dwellings.

The visual performance objectives are summarised in **Table 18** for all non-associated dwellings out to 4.4 km from the WTGs locations where impacts do not entirely meet the visual performance objectives, residual impacts are predicted and therefore additional mitigation is committed to by the Proponent.

Detailed assessments for all assessed locations are provided in **Appendix H**.

Dwellings are shown on **Figure 6** and listed in **Appendix E.**

Table 17
Visual Performance Evaluation to 4.4 km where Screening will be Offered

ID	Impact Summary
D18-3 (D18-2 and E18-1)	• Turbine (T) 66 is located 4.17 km (Far Middleground) from dwelling D18-3. • The MWTT diagram illustrates 3 wind turbines would be visible (discounting vegetative screening) within the blue line with additional wind turbines extending up to 8 km beyond the blue line north-east to south-east of the dwelling. • Lightly scattered tree cover around and beyond the dwellings may offer some filtering of views toward wind turbines from the dwellings. • Whilst wind turbines may be visible the potential for visual impact is not significant and largely mitigated by distance. The Bulletin acknowledges that wind turbines are very large structures that will be visible in the landscape. • Wind turbines are located beyond the black line at Far Middleground, therefore no mitigation measures are proposed below the black line.
D21-2	• T66 is located 4.31 km (Far Middleground) from dwelling D21-1. • The MWTT diagram indicates that 1 wind turbines would be visible (discounting vegetative screening) within the blue line with additional wind turbines extending up to 8 km beyond the blue line north-east of the dwelling. • Scattered tree cover around the dwelling may present some filtering toward distant views of wind turbine hubs and blades. • Whilst wind turbines may be visible the potential for visual impact is not significant and largely mitigated by distance. • Wind turbines are located beyond the black line at Far Middleground, therefore no mitigation measures are proposed below the black line.
E17-3 (E17-1, E17-2 and E17-5	• T68 is located 4.09 km (Far Middleground) from dwelling E17-3. • The MWTT diagram indicates that 1 wind turbines would be visible (discounting vegetative screening) within the blue line with additional wind turbines extending up to 8 km beyond the blue line north-east of the dwelling. • Scattered tree cover around the dwellings may present some filtering toward distant views of wind turbine hubs and blades. • Whilst wind turbines may be visible the potential for visual impact is not significant and largely mitigated by distance. • Wind turbines are located beyond the black line at Far Middleground, therefore no mitigation measures are proposed below the black line.
E17-4	• T66 is located 4.27 km (Far Middleground) from dwelling E17-4. • The MWTT diagram indicates that 3 wind turbines would be visible (discounting vegetative screening) within the blue line with additional wind turbines extending up to 8 km beyond the blue line north-east of the dwelling. • Tree cover beyond the dwelling may present some filtering toward distant views of wind turbine hubs and blades.

ID	Impact Summary
	• Whilst wind turbines may be visible the potential for visual impact is not significant and largely mitigated by distance. • Wind turbines are located beyond the black line at Far Middleground, therefore no mitigation measures are proposed below the black line.
E17-6	• T60 is located 4.33 km (Far Middleground) from dwelling E17-6. • The MWTT diagram indicates that 1 wind turbine would be visible (discounting vegetative screening) within the blue line with additional wind turbines extending up to 8 km beyond the blue line north-east of the dwelling. • Tree cover beyond the dwelling may present some filtering toward distant views of wind turbine hubs and blades. • Whilst wind turbines may be visible the potential for visual impact is not significant and largely mitigated by distance. • Wind turbines are located beyond the black line at Far Middleground, therefore no mitigation measures are proposed below the black line.
E19-1 (and E18-2)	• T66 is located 3.12 km (Near Middleground) from dwelling E19-1. • The MWTT diagram illustrates 6 wind turbines would be visible (discounting vegetative screening) within the blue line with additional wind turbines extending up to 8 km beyond the blue line north-east to east of the dwelling. • Individual tree cover around and beyond the dwellings may offer some filtering of views toward wind turbines from the dwellings. • Whilst wind turbines may be visible the potential for visual impact is not significant and largely mitigated by distance. • Wind turbines are located beyond the black line at Near Middleground, therefore no mitigation measures are proposed below the black line. • Wind turbines will be visible along a ridgeline landform along the skyline. Some minor screening/filtering of views would be provided by tree cover. Additional spot planting of specimen trees may provide some potential for screening/filtering of views toward wind turbines.
F16-1	• T60 is located 2.49 km (Near Middleground) from dwelling F16-1. • The MWTT diagram illustrates 2 wind turbines would be visible (discounting vegetative screening) within the black line with an additional 10 wind turbines extending up to the blue line south-east to east of the dwelling. • Tree cover beyond the dwelling may offer some filtering of views toward wind turbines from the dwelling and at various locations from the surrounding curtilage. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent.

ID	Impact Summary
	• Overall wind turbine visibility will not cause any significant modification to the visual catchment. The wind turbines (and specifically Turbines 60 and 61) will be visually apparent and become a major element in the landscape but will not dominate the existing visual catchment which extends to hills and ridgelines without wind turbines north north-east to south-west of the dwelling. • See additional mitigation in **Table 18.**
F16-2	• T60 is located 3.05 km (Near Middleground) from dwelling F16-2. • The MWTT diagram illustrates 4 wind turbines would be visible (discounting vegetative screening) beyond the black line with additional wind turbines extending beyond the blue line east to north-east of the dwellings. • Tree cover beyond the dwellings may offer some filtering of views toward wind turbines from the dwelling and at various locations from the surrounding curtilage. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent.
F17-1	• T60 is located 2.83 km (Near Middleground) from dwelling F17-1. • The MWTT diagram illustrates 4 wind turbines would be visible (discounting vegetative screening) below the black line with an additional 3 wind turbines extending beyond the blue line south-east of the dwelling. • Tree cover beyond the dwelling may offer some filtering of views toward wind turbines from the dwelling and at various locations from the surrounding curtilage. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent. The Bulletin acknowledges that wind turbines are very large structures that will be visible in the landscape. • See additional mitigation in **Table 18.**
F18-1	• T68 is located 2.58 km (Near Middleground) from dwelling F18-1. • The MWTT diagram illustrates 6 wind turbines would be visible (discounting vegetative screening) within the black line with an additional 6 wind turbines extending to the blue line east to north-east of the dwelling. • The dwelling and curtilage lacks any significant tree cover therefore views toward wind turbines would be open and direct.

ID	Impact Summary
	• Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. Whilst the wind turbines do not impart a significant vertical dominance over the dwelling or surrounding curtilage, they will be visible along a sloping ridgeline landform. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent. • See additional mitigation in **Table 18.**
F19-1	• T66 is located 2.63 km (Near Middleground) from dwelling F19-1. • The MWTT diagram illustrates 3 wind turbines would be visible (discounting vegetative screening) within the black line with an additional 5 wind turbines extending to the blue line east to north-east of the dwelling. The MWTT diagram illustrates that wind turbines beyond the blue line will not be visible from this dwelling. • The dwelling and curtilage lack any significant tree cover therefore views toward wind turbines would be open and direct. • Wind turbines within single 60-degree sector are not considered to dominate the available viewshed. Whilst the wind turbines do not impart a significant vertical dominance over the dwelling or surrounding curtilage, they will be visible along a sloping ridgeline landform. • Wind turbines within the single 60-degree sector are not considered to dominate the available viewshed. Whilst the wind turbines do not impart a significant vertical dominance over the dwelling or surrounding curtilage, they will be visible along a sloping ridgeline landform. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent. • Wind turbines will be visible along a ridgeline landform along the skyline. • See additional mitigation in **Table 18.**
G12-1 (and G11-1)	• T57 is located at 4.08 km (Far Middleground) from the dwelling G12-1. • The MWTT diagram illustrates the 2 wind turbines (blades only) will be visible beyond the blue line. • The general extent of landform and tree cover provides screening toward most wind turbines beyond the blue line.
G15-3	• T60 is located 1.96 km (Near Foreground) from dwelling G15-3. • The MWTT diagram illustrates 5 wind turbines would be visible (discounting vegetative screening) within the black line with an additional 14 wind turbines extending up to the blue line east to south south-east of the dwelling. • Tree cover beyond the dwelling will offer some filtering and screening of views toward wind turbines from the dwelling and the surrounding curtilage. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage.

ID	Impact Summary
	• Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent. • Visible wind turbines within 8 km of the view location are restricted to one 60-degree sector through tree screening beyond the dwelling. The Multiple Wind Turbine Effect is compliant with the VIZ1 performance objective. • See additional mitigation in **Table 18**.
G17-1	• T64 is located 2.04 km (Near Middleground) from dwelling G17-1. • The MWTT diagram illustrates 8 wind turbines would be visible (discounting vegetative screening) within the black line with an additional 4 wind turbines extending to the blue line south-east to north-east of the dwelling. • The dwelling curtilage lacks significant tree cover therefore views toward wind turbines would be open and direct. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. Whilst the wind turbines do not impart a significant vertical dominance over the dwelling or surrounding curtilage, they will be visible along a sloping ridgeline landform. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent. • Overall wind turbine visibility will not cause any significant modification to the visual catchment. The wind turbines will be visually apparent and become a major element in the landscape. • Tree planting beyond the dwelling will separate and reduce the extent of horizontal views. • See additional mitigation in **Table 18**.
H8-1	• T57 is located 4.03 km (Far Middleground) from dwelling H8-1. • The MWTT diagram illustrates 1 wind turbine would be visible (discounting vegetative screening) between the black and blue line with additional wind turbines extending beyond the blue line south to south-east of the dwelling. • The dwelling curtilage includes some tree cover with views toward the wind turbine partially screened or filtered from the dwelling and curtilage. • The wind turbine within one 60-degree sector is not considered to dominate the available viewshed. • Whilst the wind turbine may be visible the potential for visual impact is not significant and partially mitigated by distance and extent.
H11-2	• T57 is located 3.26 km (Near Middleground) from dwelling H11-2. • The MWTT diagram illustrates 6 wind turbines would be visible (discounting vegetative screening) between the black and blue line with an additional 20 wind turbines extending beyond the blue line east to south of the dwelling. • Tree cover beyond the dwelling may offer some filtering of views toward wind turbines south-east to south south-east from the dwelling and at various locations from the surrounding curtilage.

ID	Impact Summary
	• Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent. • Photomontage analysis: • Some potential for screening/filtering of views toward wind turbines south-east to south of the dwelling would be provided by tree cover beyond the dwelling.
H12-1	• T51 is located 3.02 km (Near Middleground) from dwelling H12-1. • The MWTT diagram illustrates 14 wind turbines would be visible (discounting vegetative screening) between the black and blue line with an additional 9 wind turbines extending beyond the blue line east to south of the dwelling. • Landform and tree cover beyond the dwelling may offer some filtering of views toward wind turbines east to south south-east from the dwelling and at various locations from the surrounding curtilage. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent. • See additional mitigation in **Table 18**.
H12-3 (H11-1, and H12-2)	• T57 is located 2.57 km (Near Middleground) from dwelling H12-3 and would be visible to blade only. • The MWTT diagram illustrates 2 visible wind turbines below (and on) the black line and 6 wind turbines visible (discounting vegetative screening) south-east of the dwelling. • Landform and partial tree cover beyond the dwellings may offer some filtering of views toward wind turbines south-east from the dwelling and at various locations from the surrounding curtilage. • Wind turbines within one 60-degree sector are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent. • See additional mitigation in **Table 18**.

ID	Impact Summary
K23-1	• T66 is located 4.35 km (Far Middleground) from dwelling K23-1. • The MWTT diagram illustrates no wind turbines will be visible below the black or blue lines. Distant views (in excess of 4 km) will extend toward wind turbines to the east and north north-east of the dwelling. • Landform and tree cover beyond the dwelling will offer screening of views toward wind turbines north from the dwelling from various locations from the dwelling curtilage. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent. The Bulletin acknowledges that wind turbines are very large structures that will be visible in the landscape.
L23-1	• T33 is located 4.07 km (Far Middleground) from dwelling L23-1. • The MWTT diagram illustrates that 1 wind turbine will be visible between the black and blue lines. Distant views (in excess of 4km) will extend toward wind turbines beyond the blue line to the east of the dwelling. • Landform and tree cover beyond the dwelling will offer screening of views toward wind turbines north from the dwelling from various locations from the dwelling curtilage. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent.
M23-2	• T33 is located 4.15 km (Far Middleground) from dwelling M23-2. • The MWTT diagram illustrates that 1 wind turbine (blade only) will be visible between the black and blue lines. Distant views (in excess of 4 km) will extend toward wind turbines beyond the blue line to the east of the dwelling. • Landform and tree cover beyond the dwelling will offer screening of views toward wind turbines north from the dwelling from various locations from the dwelling curtilage. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent. • Views toward the majority of wind turbines will be screened by extensive tree cover beyond the dwelling. • Overall wind turbine visibility will not cause any significant modification to the visual catchment with wind turbines not becoming a major element in the landscape or dominating the existing visual catchment due to distance and extent within existing view.

ID	Impact Summary
N21-1 (and N21-2)	• T33 is located 3.25 km (Near Middleground) from dwelling N21-1. • The MWTT diagram illustrates that 2 wind turbines will be visible between the black and blue lines south-east of the dwelling and 1 wind turbine north-west of the dwelling. Distant views (in excess of 4km) will extend toward wind turbines (largely blade only) beyond the blue line to the north-west of the dwelling. • Landform and tree cover beyond the dwelling will offer screening of views toward wind turbines from the dwellings from various locations from the dwelling curtilages. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent.
N22-1	• T33 is located 3.73 km (Near Middleground) from dwelling N22-1. • The MWTT diagram illustrates that 6 wind turbines will be visible between the black and blue lines east and north-west of the dwelling. Distant views (in excess of 4 km) will extend toward 3 wind turbines (hub and blade only) beyond the blue line to the north-west of the dwelling. • Landform and tree cover beyond the dwelling will offer screening of views toward wind turbines from the dwellings from various locations from the dwelling curtilages. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent.
O22-1	• T23 is located 3.12 km (Near Middleground) from dwelling N22-1. • The MWTT diagram illustrates that 6 wind turbines will be visible between the black and blue lines east and north-west of the dwelling. Distant views (in excess of 5 km) will extend toward 3 wind turbines (hub and blade only) beyond the blue line to the north and north-west of the dwelling. • Landform and tree cover beyond the dwelling will offer screening of views toward wind turbines from the dwellings from various locations from the dwelling curtilages. • Wind turbines within three 60-degree sectors however given distance the wind turbines within 3 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent. • Views toward the majority of wind turbines will be screened by extensive tree cover beyond the dwelling.

ID	Impact Summary
	• Wind turbines occur within three 60-degree sectors. The theoretical extent of wind turbine visibility includes wind turbine tip of blades in the third 60 degree sector that are likely to be screened by tree cover on hills and slopes over 5km from the dwelling.
P7-1	• T17 is located 3.52 km (Near Middleground) from dwelling P7-1. • The MWTT diagram illustrates that 5 wind turbines will be visible between the black and blue lines east and north-west of the dwelling. Distant views (in excess of 5 km) will extend toward 7 wind turbines (hub and blade only) beyond the blue line to the north and north-west of the dwelling. • Landform beyond the dwelling will offer partial screening of views toward wind turbines from the dwelling from various locations within the dwelling curtilage. • Wind turbines within two 60-degree sectors are not considered to dominate the available viewshed. The wind turbines do not impart a vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by distance and extent.
P22-1 (and P22-4)	• T23 is located 1.38 km (Far Foreground) from dwelling P22-1. • The MWTT diagram illustrates 4 wind turbines would be visible (discounting vegetative screening) below the black line to the east of the dwelling. An additional 6 wind turbines are located beyond the blue and purple (8km) lines north-west of the dwelling. • The dwelling and curtilage include mature tree cover which also extends to hills and slopes beyond the dwelling. Tree cover and undulating landform will provide some degree of potential screening toward the wind turbines. There is a greater degree of screening toward wind turbines 24 and 25 with existing tree cover generally restricting views to upper portions of rotor blades. • Wind turbines within two 60-degree sectors, the second 60-degree sector includes a view toward 1 wind turbine out toward the 8km line which is likely to be screened through tree cover. • See additional mitigation in **Table 18**.
Q5-1	• T12 is located 4.11 km (Far Middleground) from dwelling Q5-1. • The MWTT diagram illustrates that no wind turbines will be visible from the dwelling. • Lack of wind turbine visibility will not cause any modification to the visual catchment. • The wind turbines will not become a major element in the landscape from this view location. • Lack of wind turbine visibility will disrupt views from the dwelling.

ID	Impact Summary
Q17-3 (Q17-1 and Q17-2)	• T8 is located 3.13 km (Near Middleground) from dwelling Q17-3. • The MWTT diagram illustrates that no wind turbines would be visible (discounting vegetative screening) below the black line. A total of 6 wind turbines are located between the black and the blue lines north-west of the dwelling and 9 wind turbines between the black and blue line to the south-east of the dwelling. A further 11 wind turbines extend beyond the blue line with views partially restricted by landform and vegetation to the south and north-west of the dwellings. • Curtilage areas include a small number of specimen mature trees which also extend alongside a creek meandering between the dwellings. Tree cover and a gently undulating landform to the south-east of dwelling Q17-1 may provide some degree of filtering views toward some wind turbines. • Wind turbines within four 60-degree sectors are not considered to dominate the available viewshed. • Wind turbines occur within four 60-degree sectors. Views toward wind turbines within the third and fourth 60-degree sectors are marginal and are not considered to significantly increase the modification of the visual catchment. One 60-degree sector to the south of the dwellings includes views toward 3 wind turbines (with 2 wind turbines visible to blades only beyond the blue line). A second 60-degree sector includes views toward 2 wind turbines beyond the blue line.
S4-1	• T12 is located 3.51 km (Near Middleground) from dwelling S4-1. • The MWTT diagram illustrates that no wind turbines would be visible below the black line. A total of 3 wind turbines are located between the black and the blue lines south of the dwelling. A further 5 wind turbines extend beyond the blue line with views partially restricted by landform and vegetation to the south of the dwelling. • A small number of mature trees extend alongside a creek south of the dwelling. • Wind turbines within one 60-degree sector are not considered to dominate the available viewshed.
S17-2	• T9 is located 1.71 km (Far Foreground) from dwelling S17-2. • The MWTT diagram illustrates 6 wind turbines would be visible (discounting vegetative screening) below the black line with an additional 2 wind turbines between the black and the blue line south of the dwelling. The MWTT diagram also illustrates visible wind turbines west north-west of the dwelling beyond the blue line. • Tree cover around and beyond the dwelling follows a creek line to the east, north and west of the dwelling / curtilage and provides some degree of screening and / or filtering of views toward wind turbines. The level of screening is variable within and beyond the curtilage; however, views toward wind turbines from the dwelling have some degree of screening.

ID	Impact Summary
	• Wind turbines within three 60-degree sectors are not considered to dominate the available viewshed. Whilst the wind turbines do not impart a significant vertical dominance over the dwelling or surrounding curtilage. • Whilst wind turbines may be visible the potential for visual impact is not significant and partially mitigated by existing tree cover. • Wind turbines occur within three 60-degree sectors; however, the second 60-degree sector includes views toward 2 wind turbines at blade only beyond the black line. Wind turbines within the third 60-degree sector to the west and north-west of the dwelling are located beyond the blue line and subject to significant tree screening from the dwelling and immediate curtilage. • See additional mitigation in **Table 18**.
T5-1	• T12 is located 2.95 km (Near Middleground) from dwelling T5-1. • The MWTT diagram illustrates that 1 wind turbine would be visible below the black line. A total of 3 wind turbines are located between the black and the blue lines south of the dwelling. A further 3 wind turbines extend beyond the blue line with views partially restricted by landform and vegetation to the south of the dwelling. • A small number of mature trees extend alongside a creek south of the dwelling. • Wind turbines within one 60-degree sector are not considered to dominate the available viewshed. • Visibility toward 5 wind turbines below the blue line with some partial screening/filtering of views toward 3 turbines through tree cover. • See additional mitigation in **Table 18**.
T6-2	• T12 is located 2.58 km (Near Middleground) from dwelling T6-2. • The MWTT diagram illustrates that 1 wind turbine would be visible below the black line. A total of 3 wind turbines are located between the black and the blue lines south south-west of the dwelling. A further 4 wind turbines extend beyond the blue line with views partially restricted by landform and vegetation to the south south-west of the dwelling. • A small number of mature trees extend alongside a creek south of the dwelling. • Wind turbines within one 60-degree sector are not considered to dominate the available viewshed. • The location of 4 wind turbines below the black line within a very narrow horizontal field of view. Foreground visual mitigation works would provide potential screening/filtering of views toward wind turbines. • See additional mitigation in **Table 18**.

ID	Impact Summary
T6-9	• T12 is located 2.26 km (Near Middleground) from dwelling T6-9. • The MWTT diagram illustrates that 2 wind turbines would be visible below the black line. A total of 3 wind turbines are located between the black and the blue lines south south-west of the dwelling. A further 2 wind turbines extend beyond the blue line with views partially restricted by landform and vegetation to the south south-west of the dwelling. • A small number of mature trees extend alongside a creek south of the dwelling but do not provide any significant degree of screening. • Wind turbines within one 60-degree sector are not considered to dominate the available viewshed. • Views toward the 6 wind turbines south of the dwelling including 2 wind turbines below the black line. The foreground tree illustrates the potential for visual mitigation planting works to screen/filter views toward the wind turbines. • See additional mitigation in **Table 18**.
T15-1	• T10 is located 2.47 km (Near Middleground) from dwelling T15-1. • The MWTT diagram illustrates that 2 wind turbines would be visible below the black line. • A total of 4 wind turbines are located between the black and the blue lines south of the dwelling. A further 2 wind turbines extend beyond the blue line with views partially restricted by landform and vegetation to the south south-west of the dwelling. • Views toward wind turbines north and west of the dwelling are marginal and largely screened by landform. Therefore, wind turbines within three 60-degree sector are not considered to dominate the available viewshed. • See additional mitigation in **Table 18**.
V20-1	• T7 is located 2.25 km (Near Middleground) from dwelling V20-1. • The MWTT diagram illustrates that 5 wind turbines would be visible below the black line. • A total of 4 wind turbines are located between the black and the blue lines south of the dwelling. A further 4 wind turbines extend south to south-west beyond the blue line. • Views toward wind turbines from the dwelling and dwelling curtilage are partially screened by semi mature and mature tree planting within and beyond the dwelling curtilage. • See additional mitigation in **Table 18**.
W8-1	• T12 is located 3.31 km (Near Middleground) from dwelling W8-1. • The MWTT diagram illustrates that no wind turbines would be visible below the black line. A total of 6 wind turbines are located between the black and the blue lines west to south-west of the dwelling.

ID	Impact Summary
	• Mature trees to the north through to south-west of the dwellings are likely to provide screening from the dwelling and curtilage. • Wind turbines within one 60-degree sector are not considered to dominate the available viewshed.
W14-1	• T10 is located 4.17 km (Far Middleground) from dwelling W14-1. • The MWTT diagram illustrates that no wind turbines would be visible below the black line. One wind turbine is located between the black and the blue lines south-west of the dwelling. An additional 7 wind turbines extend south-west beyond the blue line. • Mature trees surrounding the dwelling and curtilage are likely to provide visual screening toward all wind turbines. • Wind turbines within one 60-degree sector are not considered to dominate the available viewshed.
W22-1	• T7 is located 4.30 km (Far Middleground) from dwelling W22-1. • The MWTT diagram illustrates that no wind turbines would be visible below the black line. Two wind turbines would be visible (blade only) between the black and the blue lines north-west of the dwelling. An additional four wind turbines extend west to north-west beyond the blue line. • There is no tree cover surrounding the dwelling or curtilage; however, views will be partially screened through topography rising to the north and north-west of the dwelling. • Wind turbines within one 60-degree sector are not considered to dominate the available viewshed.
Y17-1 (and Y17-2)	• T10 is located 4.13 km (Far Middleground) from dwelling Y17-1. • The MWTT diagram illustrates that no wind turbines will be visible from the dwelling or curtilage.
Y18-1	• T10 is located 4.14 km (Far Middleground) from dwelling Y18-1. • The MWTT diagram illustrates that no wind turbines will be visible from the dwelling or curtilage. • The visible wind turbines will not result in the removal or visual alteration of key landscape features, cultural features or focal points including views toward Well Mountain to the north-east of the dwelling.
Y19-5	• T10 is located 4.22 km (Far Middleground) from dwelling Y19-5. • The MWTT diagram illustrates that no wind turbines would be visible below the black line. One wind turbine would be visible between the black and the blue lines north-west of the dwelling. An additional three wind turbines extend west beyond the blue line. • There is no significant tree cover surrounding the dwellings or curtilages; however, views will be partially screened through landform rising to the north and north-west of the dwelling. • Wind turbines within one 60-degree sector are not considered to dominate the available viewshed.

Table 18
Visual Performance Evaluation where Additional Mitigation will be Offered

ID	VIZ	Number of visible turbines below black line	Distance to nearest turbine (km)	Performance objective met Yes (Y) or No (N)**				Performance Objective Notes	Mitigation and Residual Impacts
				Ma	L	F	Mu		
F16-1	2	2	2.50	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives as applicable to a VIZ2	A Near Neighbour Agreement will be offered. If no Agreement reached, T60 and T61 (below the black line) may be removed.
F17-1	2	4	2.83	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives as applicable to a VIZ2	A Near Neighbour Agreement will be offered.
F18-1	2	6	2.58	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives as applicable to a VIZ2	A Near Neighbour Agreement will be offered to the property owner.
F19-1	2	3	2.63	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives as applicable to a VIZ2	A Near Neighbour Agreement will be offered to the property owner.
G15-3	1	5	1.96	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives for VIZ1. Tree screening beyond the dwelling will restrict views toward wind turbines.	A Near Neighbour Agreement will be offered.
G17-1	2	9	2.04km	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives for VIZ1. Tree screening beyond the dwelling will restrict views toward wind turbines.	A Near Neighbour Agreement will be offered.

ID	VIZ	Number of visible turbines below black line	Distance to nearest turbine (km)	Performance objective met Yes (Y) or No (N)**				Performance Objective Notes	Mitigation and Residual Impacts
				Ma	L	F	Mu		
H12-1	2	1	3.02	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives as applicable to a VIZ2	A Near Neighbour Agreement will be offered.
H12-3	2	2	2.57	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives as applicable to a VIZ2	A Near Neighbour Agreement will be offered.
P22-1	1	4	1.38	N*	Y	Y	Y	The Project is compliant with the Bulletin given the location and extent of tree cover beyond the dwelling. Tree cover provides substantial screening to the west of the immediate dwelling curtilage, with tree cover providing partial filtering of views toward wind turbines south of the dwelling.	A Near Neighbour Agreement will be offered. If no Agreement reached, T22 and T23 may be removed.
S17-2	1	6	1.71	N*	Y	Y	Y	The Project is compliant with the Bulletin given the location and extent of tree cover beyond the dwelling. Tree cover provides substantial screening to the west of the immediate dwelling curtilage, with tree cover providing some partial filtering toward wind turbines south of the dwelling.	A Near Neighbour Agreement will be offered. If no Agreement reached, T9 and T10 (below the black line) may be removed and T8 relocated to the south-east.
T5-1	2	1	2.95	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives as applicable to a VIZ2	A Near Neighbour Agreement will be offered.
T6-2	2	2	2.58	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives as applicable to a VIZ2	A Near Neighbour Agreement will be offered.
T6-9	2	2	2.26	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives as applicable to a VIZ2	A Near Neighbour Agreement will be offered.

ID	VIZ	Number of visible turbines below black line	Distance to nearest turbine (km)	Performance objective met Yes (Y) or No (N)**				Performance Objective Notes	Mitigation and Residual Impacts
				Ma	L	F	Mu		
T15-1	2	2	2.47km	Y	Y	Y	Y	The Project is compliant with the Bulletin given the marginal visibility of wind turbines to the west of the dwelling occupying the third 60-degree sector.	A Near Neighbour Agreement will be offered.
V20-1	2	5	2.25km	Y	Y	Y	Y	The Project is compliant with the Bulletin performance objectives as applicable to a VIZ2	A Near Neighbour Agreement will be offered.

*** Ma – Magnitude, L – Landscape Integrity, F – Key Feature Disruption, Mu – Multiple Wind Turbine*

** compliance subject to neighbour agreement*

Visual Performance Evaluation - Scenic Locations / Public View Points

No key public view locations have been identified within 4.4 km of the WTGs. However, the assessment of scenic locations has been undertaken for 16 public view-points and scenic locations to at least 8 km.

Key public view locations beyond 4.4 km from the wind turbine locations which have been assessed as part of this Project are shown on **Figure 28** and assessment findings are summarised in **Table 19**. No mitigation is proposed for any public location.

Photomontages taken from the following locations are provided in **Figure 30** to **Figure 32:**

- Hebden / Scrumlo Road;
- Ruth White Avenue, Muswellbrook; and
- McCully's Gap.

The following is correct for all locations (except where stated):

- Wind turbines will not cause any significant modification to the visual catchment. The wind turbines will not become a major element in the landscape or dominate the existing visual catchment due to distance and extent within existing view; and
- The wind turbines will not become a dominant element in the landscape from this view location.

Table 19
Visual Performance Objectives - Scenic Locations / Public View Points

Location	Assessment
Hebden/ Scrumlo Road	• T66 is located 6.75 km (Far Middleground). • The MWTT diagram illustrates that no wind turbines would be visible below the blue line. The nearest wind turbines would be located toward the 8 km line. • Wind turbines within one 60-degree sector do not dominate the available viewshed.
Lake Liddell Recreation Park	• T66 is located 8.1 km (Near Background). • The MWTT diagram illustrates that no wind turbines would be visible below the blue line and 8 km lines. • Views toward the 330 kv transmission line to the north of the recreation park (between Hebden Road and the railway line) would be largely screened or filtered by tree planning within and beyond the recreation park.
South Muswellbrook	• T66 is located 11.4 km (Near Background). • The MWTT diagram illustrates that no wind turbines would be visible between the blue line and the 8 km threshold line.
Ruth White Avenue, Muswellbrook	• T66 is located 13.6 km (Mid Background). • The MWTT diagram illustrates that no wind turbines would be visible between the blue line and the 8 km threshold line.

Location	Assessment
Mount Royal National Park (Pieris Point Lookout)	• T12 is located 14.2 km (Mid Background). • The MWTT diagram illustrates that no wind turbines would be visible between the blue line and 8 km threshold line.
Lake St Clair	• T7 is located 14.40 km (Mid Background). • The MWTT diagram illustrates that no wind turbines would be from the viewpoint.
Greenlands	• T22 is located 7.5 km (Far Middleground). • The MWTT diagram illustrates that no wind turbines would be visible below the blue line with 2 wind turbines below the 8 km line. • Wind turbines occur within one 60-degree sector and are compliant with the Visual Performance Objective for Multiple Wind Turbine Effects.
Woodlands Ridge	• T66 is located 8.0 km (Near Background). • The MWTT diagram illustrates that no wind turbines would be visible below the blue line or the 8 km line.
McCullys Gap	• T57 is located 7.86 km (Far Middleground). • The MWTT diagram illustrates that 1 wind turbines would be visible below the 8km line. • Wind turbines occur within one 60-degree sector and are compliant with the Visual Performance Objective for Multiple Wind Turbine Effects.
Mount Royal South	• T10 is located 8.65 km (Mid Background). • The MWTT diagram illustrates that no wind turbines would be visible beyond the blue line or the 8 km line.
Muswellbrook, Brook Street	• T66 is located 13.5 km (Mid Background). • The MWTT diagram illustrates that no wind turbines would be visible beyond the blue line or the 8 km line.
McCullys Gap Road (Dolahentys Road)	• T57 is located 7.2 km (Far Middleground). • The MWTT diagram illustrates that no wind turbines would be visible below the blue line. The nearest wind turbines would be located toward the 8 km line • Wind turbines within one 60-degree sector do not dominate the available viewshed.
Rouchel Brook	• T57 is located 8.1 km (Near Background). • The MWTT diagram illustrates that no wind turbines would be visible below the blue line or the 8 km line.
Lake Glenbawn State Park	• T57 is located 13.8 km (Mid Background). • The MWTT diagram illustrates that no wind turbines would be visible beyond the blue line and the 8 km line.
Upper Rouchel	• The MWTT diagram illustrates that no wind turbines would be visible from the viewpoint.
Rochel	• The MWTT diagram illustrates that no wind turbines would be visible from the viewpoint.

Photomontage PM3 Picton Lane, Hebden – October 2020 Conceptual Project Layout

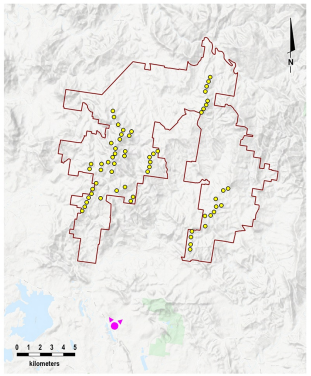
Approximate distance to closest visible wind turbine is 9,290 metres (turbine 22)

Legend

Approximate photo location and indicative view direction toward Bowmans Creek Wind Farm turbines

0m 100m

Aerial location plan



Site layout plan

180° panorama

General Notes

Photos taken at 1pm on 19th June 2020

Coordinates: Easting 317876, Northing 6415654

Elevation: 127m AHD

Camera: Nikon 850 with 50mm prime lens

Original Format - A0 Landscape

220m tip height, 150m hub height and 140m rotor.

This viewpoint has a horizontal view angle of around 82 degrees.

This is a preliminary layout only and is subject to change as detailed planning proceeds.

Closest visible turbine indicated by red line.

Photomontage limitations

A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

The images provided give a reasonable impression of the scale of the turbines and the distance to turbines, but can never be 100% accurate.

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

BOWMANS CREEK WIND FARM

Visual Photomontage Hebden

FIGURE 30

Photomontage PM5 Ruth White Avenue, Muswellbrook – October 2020 Conceptual Project Layout

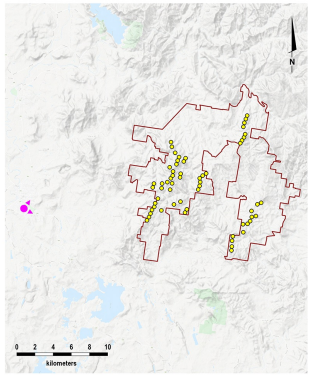
Approximate distance to closest visible wind turbine is 13,600 metres (turbine 66)

Legend

Approximate photo location and indicative view direction toward Bowmans Creek Wind Farm turbines

0m 1000m

Aerial location plan



Site layout plan

145° panorama

General Notes

Photos taken at 3.00pm on 19th June 2020

Coordinates: Easting 301536, Northing 6426879

Elevation: 167m AHD

Camera: Nikon 850 with 50mm prime lens

Original Format - A0 Landscape

220m tip height, 150m hub height and 140m rotor.

This viewpoint has a horizontal view angle of around 79 degrees.

This is a preliminary layout only and is subject to change as detailed planning proceeds.

Closest visible turbine indicated by red line.

Photomontage limitations

A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

The images provided give a reasonable impression of the scale of the turbines and the distance to turbines, but can never be 100% accurate.

Bowmans Creek Wind Farm | Visual Photomontage Ruth White Avenue Muswellbrook | 14 10 2020

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

BOWMANS CREEK WIND FARM

Visual Photomontage Ruth White Avenue Muswellbrook

FIGURE 31

Photomontage PM4 McCullys Gap Road, McCullys Gap – October 2020 Conceptual Project Layout

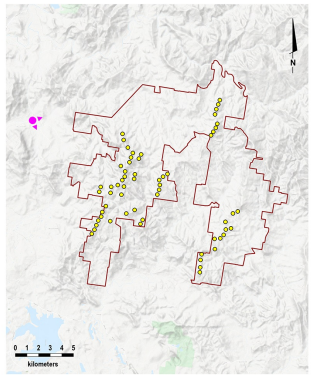
Approximate distance to closest visible wind turbine is 7,840 metres (turbine 57)

Legend

Approximate photo location and indicative view direction toward Bowmans Creek Wind Farm turbines

0m 100m

Aerial location plan



Site layout plan

147° panorama

General Notes

Photos taken at 2.20pm on 19th June 2020

Coordinates: Easting 309958, Northing 6435214

Elevation: 202m AHD

Camera: Nikon 850 with 50mm prime lens

Original Format - A0 Landscape

220m tip height, 150m hub height and 140m rotor.

This viewpoint has a horizontal view angle of around 86 degrees.

This is a preliminary layout only and is subject to change as detailed planning proceeds.

Closest visible turbine indicated by red line.

Photomontage limitations

A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

The images provided give a reasonable impression of the scale of the turbines and the distance to turbines, but can never be 100% accurate.

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

BOWMANS CREEK WIND FARM

Visual Photomontage McCully's Gap

FIGURE 32

7.1.4 Mitigation and Management

The Proponent will employ the following management and mitigation measures for the Project:

- Screening mitigation to non-Associated dwellings as in **Table 17**;
- Additional mitigation to non-Associated dwellings as in **Table 18**;
- During the detail design process, the following will be undertaken where reasonable and feasible:
    - Refinement in the design and layout to assist in the mitigation of bulk and height of proposed structures; and
    - A review of materials and colour finishes for selected components including the use of non-reflective finishes to structures;
- During construction, where reasonable and feasible:
    - Minimise tree removal and protect mature trees (consistent with **Section 7.5**);
    - Avoid temporary light spill beyond the construction site where temporary lighting is required;
    - Progressively rehabilitate disturbed areas; and
- During operations, where reasonable and feasible:
    - Ongoing maintenance and repair of constructed elements;
    - Replacement of damaged or missing constructed elements; and
    - Long term maintenance (and replacement as necessary) of vegetation within the Project site to maintain visual filtering and screening of external views, as and where appropriate.
- Recolouring: white to off white colour (consistent with other Australian wind farms).

Resizing

The Proponent does not propose to re-size key infrastructure elements associated with the Project as these have been designed to address specific technical engineering requirements as well as site specific design and safety parameters.

Replacing larger wind turbines with a 'significantly higher number of smaller wind turbines' is not a valid mitigation measure as it introduces the prospect of non-compliance with a number of performance objectives within the Bulletin including Key Features Disruption and Multiple Wind Turbine Effects.

7.2 NOISE AND VIBRATION

A Noise and Vibration Impact Assessment (NIA) was undertaken for the Project by Sonus Pty Ltd in accordance with the Noise Bulletin and Guidelines and Policies referred to in the SEARs. The NIA is presented in **Appendix I**.

The purpose of the NIA was to determine relevant background levels and conditions, assess environmental impacts during construction and operation of the Project by comparing predicted noise levels at surrounding receivers with relevant criteria.

A summary of the NIA is presented below including key impact assessment findings, as well as management measures committed to by the Proponent.

7.2.1 Background

Monitoring

Background noise monitoring was conducted at four representative locations in the vicinity of the Project (see **Figure 33**) between 28 October 2019 and 16 January 2020. Background noise monitoring was conducted by installing noise loggers at representative locations around the site to record sound levels. This was done to establish a baseline of existing noise levels around the site where turbines are proposed.

Background noise levels ($LA_{90,\ 10\ minute}$) were measured continuously (in 10-minute intervals) at each monitoring location during monitoring periods of at least 6 weeks in accordance with the Noise Guidelines (see **Section 7.2.2**). Onsite monitoring devices (including fixed monitoring masts and portable SODAR devices) were used to measure wind speeds at multiple heights at the time background noise was being measured.

Background Noise

Background noise data for each monitoring location was correlated with the hub height wind speed data to produce a "least squares regression analysis" and line of best fit. The background noise levels at integer wind speeds from cut-in to rated power are provided in **Table 20**.

Table 20
Background Noise Levels at Different Wind Speeds

Dwelling ID	Background Noise Level ($L_{A90\ 10\ minute}$) Integer wind speeds at Hub Height, 140m AGL (dB(A))										
	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s	13m/s
G15-3	25	26	26	27	27	28	29	30	31	33	36
G17-1	25	25	25	26	27	28	29	30	31	32	32
P22-1	24	24	24	25	26	27	29	31	33	35	38
S17-2	24	24	25	26	26	27	28	30	32	34	37

7.2.2 Methodology

Policies and Guidelines

The NIA utilised the following noise guidelines to assess various aspects of the Project:

- WTG noise in accordance with the 'NSW Wind Energy: Noise Assessment Bulletin' (DPE, 2016c) (Noise Bulletin);
- Noise generated by ancillary infrastructure in accordance with the 'NSW Noise Policy for Industry' (EPA, 2017) (NPfI);
- Construction noise under the 'Interim Construction Noise Guideline' (DECC, 2009) (ICNG);
- Traffic noise under the 'NSW Road Noise Policy' (DECCW, 2011) (RN Policy); and
- Vibration under the 'Assessing Vibration: A Technical Guideline' (DEC, 2006) (Assessing Vibration Guideline).

WTG Noise

The predicted equivalent noise level ($LA_{eq10\ minute}$), adjusted for tonality and low frequency noise in accordance with the Noise Bulletin, should not exceed 35 dB(A) or the background noise ($LA_{90\ 10\ minute}$) by more than 5 dB(A), whichever is the greater, at all relevant receivers for wind speed from cut-in to rated power of the WTG generator and each integer wind speed in between.

Ancillary Infrastructure

The NPfI establishes noise trigger levels based on the existing background noise environment (intrusiveness) and the amenity for particular land uses (amenity). The noise trigger levels are the lower values provided by the two methods, which in a rural environment will generally be the intrusiveness noise level.

Construction Noise

The construction of a wind farm comprises activities such as road construction, excavation, foundation construction, electrical infrastructure works and WTG erection. These construction activities require processes such as heavy vehicle movements, crushing and screening, concrete batching, use of mobile plant and equipment (such as loaders, excavators, generators, cranes), and blasting subject to local conditions as described in **Section 3.3.3**. The ICNG provides an emphasis on implementing 'feasible' and 'reasonable' noise reduction measures and does not set mandatory objective criteria all within the framework of a quantitative approach, whereby "management levels" are defined based on the existing Rating Background Level (RBL).

Traffic

The RN Policy applies traffic noise criteria to particular types of project, road category and land use. The most appropriate classification for the traffic associated with the wind farm is considered to be "Local Roads - Existing dwellings affected by additional traffic on existing local roads generated by land use developments".

Vibration

The Assessing Vibration Guideline provides an emphasis on construction activity implementing feasible and practicable vibration reduction measures and establishes goal vibration levels based on human response to continuous, intermittent and impulsive vibration.

Modelling

The predictions of noise from the Project utilise the CONCAWE noise propagation model and SoundPLAN noise modelling software. The assessment has been based on the following:

- Weather category 6 (representing weather conditions conducive to the propagation of noise);
- Atmospheric conditions at 10°C and 80% relative humidity (representing atmospheric conditions with low acoustic absorption rates being conducive to the propagation of noise);
- Wind direction from all noise sources to the particular residence under consideration, even in circumstances where sources are located in opposite directions from the residence (representing conditions which result in higher noise levels than can occur in practice); and
- Maximum barrier attenuation from topography of 2 dB(A) (representing a conservative assessment of any shielding provided by topography – much higher barrier attenuation can occur for WTGs which do not have line of sight to dwellings).

A regression analysis of the noise and wind data was undertaken as described in **Appendix I**.

Modelling assumptions including coordinates for the WTGs, ancillary infrastructure, distance to closest residence, indicative WTG model assessed and Sound Power Levels (SPLs) are described in **Appendix I**. These WTG model and SPLs are indicative only for the purposes of EIS modelling and the final WTG may differ however a worst-case modelling scenario has been applied such that the impacts of the Project at private receivers will be the same or less than the modelled outcome in the weather conditions modelled.

Criteria

WTG Operation

Operational criteria relevant to all non-Associated dwellings are presented in **Table 21**.

Table 21
Project Noise Criteria Non-Associated Dwellings

Dwelling ID	Noise Criteria ($L_{Aeq\ 10\ minute}$) Integer wind speeds at Hub Height, 140m AGL (dB(A))										
	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s	13m/s
G15-3	35	35	35	35	35	35	35	35	36	38	41
G17-1	35	35	35	35	35	35	35	35	36	37	37
P22-1	35	35	35	35	35	35	35	36	38	40	43
S17-2	35	35	35	35	35	35	35	35	37	39	42

The above criteria are applied to all other non-Associated dwellings based on their proximity to the residence in **Table 21**.

The Noise Bulletin enables a less onerous baseline noise criterion to be applied at an associated residence. A suitable criterion is based on the 'World Health Organisation (WHO) Guidelines for Community Noise' (WHO Guidelines) which allows for an outdoor level of 45 dB(A) at the Associated dwellings including inside a bedroom with the windows to the residence open.

Ancillary Infrastructure

The NPfI noise trigger level is 35 dB(A) for ancillary infrastructure.

Construction

The ICNG provides an emphasis on implementing "feasible" and "reasonable" noise reduction measures and establishes "management levels" based on the existing RBL. Relevant criteria are included at **Section 7.2.3**.

The equipment and activities on site will vary throughout the Project, depending on various stages of construction, required processes and specific equipment used. The predicted noise from construction activity is presented as a typical worst-case (highest noise level) scenario for various stages of construction. The predictions are also based on weather conditions that are the most conducive for the propagation of noise. Other weather conditions would result in lower noise levels than those predicted for day-time construction.

Traffic

The RN Policy criteria for "*Local Roads - Existing residences affected by additional traffic on existing local roads generated by land use developments*" are equivalent (LAeq 1hour) noise levels of no greater than 55 dB(A) during the day-time (7 am to 10 pm) and 50 dB(A) during the night-time (10 pm to 7 am). This noise level is to be achieved outside, at a distance of 1 m from the facade of a residence and at a height of 1.5 m.

The RN Policy applies to a permanent change to the environment as it is established for the assessment of changes to the permanent road network. Therefore, its application to transient and fixed term construction activity represents a conservative approach. Indeed, higher construction traffic noise levels than DECCW 2011 could be accommodated without adverse impacts subject to traffic movements being governed under an adequate Construction Management Plan (whereby routes, content and times were clearly articulated to the local community).

Vibration

The Assessing Vibration Guideline provides the vibration criteria based on the core document used as the technical basis for the Technical Guideline, Evaluation of human exposure to vibration in buildings (1-80Hz).

7.2.3 Impact Assessment

Operation

WTG

Figure 33 illustrates the predicted noise level contours at the hub height wind speed corresponding to the WTG maximum sound power levels (wind speed of 10m/s and above). The maximum noise levels generated by the wind turbines complies with the noise criteria at all non-Associated dwellings, excepting P22-1 where the predicted noise exceeds the criteria by 1 dB(A) at a hub height wind speed of 9 m/s.

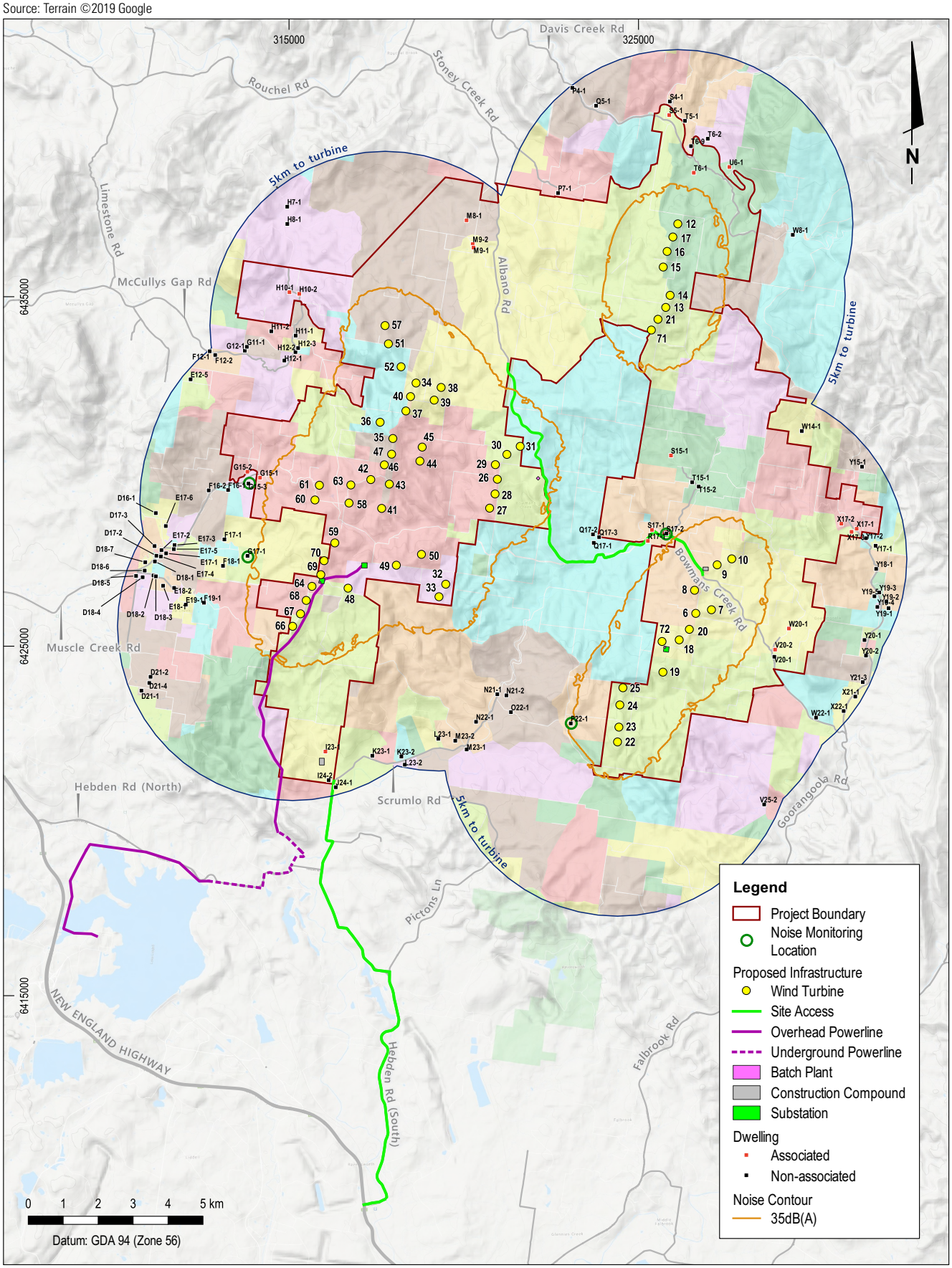
Should an Agreement with P22-1 not be gained, a curtailment strategy (will be implemented where relevant operating turbine(s) will operate in a "sound optimised" mode at the wind speeds where the predictions indicate that the criteria will be exceeded) to achieve compliance with criteria at P22-1.

The noise predictions indicate that the operation of T23 in *Sound Optimised Mode S02* at an integer wind speed of 9 m/s is required to ensure the noise criterion is achieved at P22-1. That is, with T23 operating in *Sound Optimised Mode S02* at integer wind speeds of 9 m/s, the noise level from the Project is predicted to achieve the noise criteria at all dwellings. Additionally, the highest predicted low frequency noise level at any residence is 50 dB(C). This is also predicted at P22-1. A noise level of 50 dB(C) is an order of magnitude lower than the 60 dB(C) level which the Bulletin identifies as an excessive level of low frequency noise at non-Associated dwellings.

Ancillary Infrastructure

The maximum noise levels generated by the substations under conditions most conducive to noise propagation (such as temperature inversions) will readily comply with the criteria established by the SEARs at all dwellings. All predictions were less than 20 dBA at the closest non-associated residence from a substation at any of the potential locations.

Source: Terrain ©2019 Google



Bowmans Creek Wind Farm | Fig33_Predicted Worst Case Noise Contours | 23 03 2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Predicted Worst Case Noise Contours

FIGURE 33

Construction

Construction noise will be generated by construction activities at each turbine location and at the concrete batching plant locations. The closest non-Associated residence is 1.38 km (P4-1) from a proposed turbine location and 2.2 km from the concrete batching plant. The predicted noise levels from construction activities at the closest dwelling is provided in **Table 22**.

The predicted noise level from the closest activity that could occur outside of standard construction hours at the closest dwelling (such as the operation of the batching plant and concrete pouring at WTG sites early in the morning) is provided in **Table 23**.

In accordance with the ICNG, if the noise is "particularly annoying" to nearby residents, a modifying correction factor is to be applied to the measured level. A 5 dB(A) correction factor has conservatively been applied to the noise predictions.

Table 22
Predicted Construction Noise Levels During Standard Hours

Phase	Indicative Equipment	Predicted Noise	Outcome / Action
Site Set-Up and Civil Works	Generator, transport truck, excavator, low loader	43 dB(A) at 1,380 m	Achieves criterion at all non-Associated dwellings.
Road Construction	Mobile crushing and screening plant, dozer, roller, low loader, tipper truck, excavator, scraper, transport truck	49 dB(A) at 1,380 m	Exceeds Management Level at dwellings within 1,800 m of the construction activity. Implement "feasible and reasonable" noise control strategies to minimise noise during construction in accordance with the recommendations below.
Excavation and foundation construction	Excavator, front end loader, mobile crushing and screening plant, truck-mounted concrete pump, concrete mixer truck, mobile crane, transport truck, tipper truck	48 dB(A) at 1,380 m	Exceeds Management Level at dwellings within 1,700 m of the construction activity. Implement "feasible and reasonable" noise control strategies to minimise noise during construction in accordance with the recommendations below.
Electrical Installation	Rock trencher, concrete mixer truck, low loader, tipper truck, mobile crane	49 dB(A) at 1,380 m	Exceeds Management Level at dwellings within 1,800 m of the construction activity. Implement "feasible and reasonable" noise control strategies to minimise noise during construction in accordance with the recommendations below.
WTG Delivery and Erection	Extendable trailer truck, low loader, mobile crane, support crane, grinder, rattle gun	43 dB(A) at 1,380 m	Achieves criterion at all non-associated dwellings

Table 23
Predicted Construction Noise Levels Outside Standard Hours

Phase	Indicative Equipment	Predicted Noise	Outcome / Action
Batching	Front end loader Truck	37 dB(A) at 2,200 m	Exceeds level at dwellings within 2,400 m of the construction activity. Where batching outside of hours is required, there will need to be additional mounding or shielding (which could be provided by natural topography) to all dwellings within 2,400 m. This distance can decrease under other weather conditions.
Concrete Pour	Generator Truck Concrete pump	39 dB(A) at 1,380 m	Exceeds level at dwellings within 1,900 m of the construction activity. Where concrete pouring outside of hours is required, there will need to be additional mounding or shielding (which could be provided by natural topography) to all dwellings within 1,900 m. This distance can decrease under other weather conditions.

Traffic

The closest dwelling is understood to be M23-1 which is set back 20m from the proposed access road. The next closest dwellings are R17-1, S17-2 and V20-1 which are set back approximately 40m from Bowmans Creek Road. Other dwellings are set back 60m or more from any road/track, with the closest in the vicinity of the Project being I23-1, K23-1, S17-1 and W22-1.

It is predicted that for M23-1 (set back 20m from the road side) the 55 dB(A) day time criterion can be achieved for 20 passenger vehicle movements and six heavy vehicle movements in one hour. For the other dwellings located further from the road, the above number of vehicle movements can double for every doubling of the distance between the road and residence. The number of vehicles associated with the Project using the roads will be subject to the final construction approach.

Vibration

The main potential sources of construction vibration will be the rock trenching equipment and roller operation during the road and hardstand construction. The level of vibration at a distance will be subject to the input of the equipment and the local ground conditions. Typically, the distance required to achieve the construction vibration criteria provided in the Assessing Vibration Guideline is in the order of 20 m. At 100 m distance, vibration from these activities is unlikely to be detectable. Based on the separation distances between the construction activities and the nearest dwellings in excess of 100 m, vibration levels are predicted to easily achieve the criteria.

7.2.4 Mitigation and Management

Construction

The Proponent will employ the following management and mitigation measures to the construction of the Project:

- The majority of construction works will be restricted to the hours between 7 am and 6 pm Monday to Friday, and between 8 am and 1 pm on Saturdays;

- Works carried out outside of these hours will only occur where:
  - Works do not cause noise emissions above 35 dB(A) at any non-Associated residents;
  - As requested by Police or other authorities for safety reasons;
  - Other emergency work to protect the asset;
  - Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours (e.g. approval of "Out of Hours Protocol") by relevant regulators.
- All best practice feasible and reasonable work practices will be employed when working outside of standard work hours or when in close proximity to sensitive receivers;
- Fixed noise sources (e.g. crushing and screening plant, concrete batching plant, generators and compressors) will be located at the maximum practicable distance to the nearest dwellings, in consideration of topography to block line of sight;
- Acoustic screens or mounding to be constructed within the Survey Area (and disturbance limits as described in **Section 3.1.3**) to mitigate noise from fixed crushing and screening plant and concrete batching plant operating outside of scheduled hours (where within 2.4 km of a Non-Associated residence with direct line of sight):
  - Locate the acoustic screens or mounding as close as practicable to the noise source. Natural topography can be used in such circumstances subject to consideration and assessment;
  - Construct from mounding using excavated soil from the site or a material with a high density;
  - Construct to a minimum height that blocks direct line of sight between the noise source and any receiver within 2.4 km;
- Provide proprietary acoustic enclosures for site compressors and generators located within 2.4 km of a non-Associated residence;
- Investigate and implement alternative processes where feasible and reasonable;
- Site management will:
  - Centralise site activities and material stores as far from noise-sensitive receivers as possible;
  - Not excessively drop materials to cause peak noise events;
  - Plant known to emit noise strongly in one direction shall be orientated so that the noise is directed away from dwellings, where practicable;
  - Machines that are used intermittently shall be shut down in the intervening periods between works or throttled down to a minimum;
- Equipment selection will ensure:
  - Equipment has Original Equipment Manufacturer mufflers (or better) installed;
  - Be well maintained and fitted with adequately maintained silencers which meet the OEM design specifications;
  - Silencers and enclosures will remain intact, with rotating parts balanced, loose bolts tightened, frictional noise reduced through lubrication and cutting noise reduced by keeping equipment sharp;
  - Use only necessary power to complete the task;
  - Inspect, as part of a monitoring regime, plant and equipment to determine if it is noisier than other similar machines, and rectify as required; and

- Worksite induction training to ensure training in these noise commitments, relevant to job description.

Community consultation will generally occur as described in **Section 5.7** to ensure adequate community awareness and notice of expected construction noise. Additionally, prior to any construction activity occurring in the vicinity of a non-Associated residence where the noise could exceed the ICNG "management levels", or significant construction traffic periods or impacts on local road conditions, the Proponent will:

- Contact the local community potentially affected by the proposed works and inform them of the proposed work;
- Make this contact in a reasonable time before commencement; and
- Provide contact details.

Traffic

Site access will only be via the identified route as indicated in **Section 3.6**.

Construction traffic deliveries will be scheduled such that it is as evenly dispersed, where practicable and within permissible times only as described in **Section 3.2**.

Excessive acceleration of trucks and the use of truck engine brakes will be managed so as not to occur near dwellings adjacent the stipulated site access route.

Vibration

Although not predicted, should construction activities produce higher levels of vibration within 100 m of a non-Associated residence, a monitoring regime will be implemented to ensure compliance with the Assessing Vibration Guideline.

Operations

In accordance with **Table 1** the Proponent will seek to enter into a written agreement with residence P22-1 prior to the commencement of construction to provide appropriate mitigation measures. If an agreement with residence P22-1 cannot be sought, the Noise Bulletin criteria will be achieved by operating WTG T23 in a *Sound Optimised Mode S02* at integer wind speeds of 9m/s.

Given that the noise assessment has been made based on a representative wind turbine generator and the selection may change during the detailed design of the Project, the need for curtailment and the final operating strategy will be determined during a pre-construction noise assessment. The pre-construction noise assessment will consider the final WTG selection and layout, guaranteed sound power levels for the WTG, and final agreements with landowners.

The procurement process will include a requirement for the final WTG to be free of excessive levels of tonality.

Management Plans

The above management and mitigation measures will be included in the Project CEMP or OMP.

7.3 AVIATION SAFETY

7.3.1 Background

An Aviation Impact Assessment (AIA) was prepared for the Project by Aviation Projects and is presented in **Appendix J**. The purpose of the AIA was to identify and assess aviation constraints relevant to the Project in accordance with the SEARs, and relevant NSW legislation and guidelines. A summary of the AIA is presented below including key impact assessment findings, as well as management measures committed to by the Proponent.

7.3.2 Methodology

The methodology used in the AIA considered potential impacts on the following:

- Certified / registered aerodromes;
- ALAs;
- Air routes and Lowest Safe Altitude (LSALT);
- Aviation Facilities;
- Department of Defence;
- Bureau of Meteorology Radars;
- Aerial Agricultural Operations;
- Aerial firefighting; and
- Emergency Services.

The methodology also included an assessment on the requirement for *Hazard Lighting and Marking*. Applicable requirements include the *Civil Aviation Regulations 1988, Civil Aviation Safety Regulations 1998 and* associated Manual of Standards (MOS) and other guidance material.

Guidelines

The AIA followed the 'National Airports Safeguarding Framework Guideline D: Managing Turbine Risk to Aircraft' (DITRDC ,2012) (NASF Guideline D) to meet the following objectives:

- Identify aviation assets and activities within the vicinity of the Project, and identify any aviation constraints to Obstacle Limitation Surfaces (OLS), PAN-OPS surfaces and designated airspace;
- Assess potential impacts on aviation safety, including potential wake / turbulence issues, the need for aviation hazard lighting, considering, defined air traffic routes, aircraft operating heights, approach/departure procedures, radar interference, communication systems and navigation aids; and
- Assess the impact of the WTGs on the safe and efficient aerial application of agricultural fertilisers/pesticides and firefighting.

Aircraft Operations at non-controlled Aerodromes

The Civil Advisory Publication (CAAP) 'CAAP 166-01 v4.2 – Operations in the vicinity of non-controlled aerodromes' (CAAP 166) (CASA, 2019) provides provide guidance, interpretation and explanation on complying with the *Civil Aviation Regulations 1988* (CAR) or Civil Aviation Orders (CAO). CAAP 166 recommends the use of a 'standard' traffic circuit procedure (**Figure 34**) which consists of a series of flight paths known as legs when departing, arrival or when conducting circuit practice.

CAPP 166 also outlines the lateral and vertical separation in the standard aerodrome traffic circuit (**Figure 35**) and states specifically that the aircraft should not execute a turn to fly against the circuit direction unless the aircraft is well outside the circuit area and no traffic conflict exists. This will normally be at least 3 nm from the departure end of the runway, but may be less for aircraft with high climb performance.

Aircraft Landing Areas

CASA has published the 'CAAP 92-1(1) Guidelines for aeroplane landing areas' (CAAP 92-1(1)) (CASA, 1992) as a means to providing guidance to ALA operators. The purpose of CAAP 92-1(1)) is to set out guidelines to determine the suitability of a place for the landing and taking-off of aeroplanes. **Figure 36** (CASA, 1992) shows the physical characteristics of an aeroplane landing area applicable to a single engine and centreline thrust aeroplane not exceeding 2,000 kg during day operations.

Circuit Operations

For the purposes of the aerodromes circuit operations of aircraft landing areas (specifically ALA 1, ALA 2 and ALA 4), the following design parameters were adopted:

- 1 nm upwind to achieve at least 152 m AGL;
- 1 nm abeam the runway for downwind spacing;
- 45° relative position from the threshold for the turn from downwind onto the base leg; and
- Roll out at 1 nm final, not below 152 m AGL.

The analysis of the aerodromes circuit operations for ALA 1, ALA 2 and ALA 4 is based on the recommendations provided in the CASA Advisory Publications (CAAP) 166-01 v4.2.

Rules of Flight

Civil Aviation Regulation 1988 Reg 157 (Low flying) prescribes the minimum height for flight. Generally, aircraft are restricted to a minimum height of 152 m above ground level (AGL) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day. Flight below these heights is permitted during Night Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) (Day or Night).

Aircraft Operator Characteristics

Passenger Transport and Emergency Services

The following aircraft operations are undertaken during the IFR:

- Regular public transport and passenger carrying charter; and
- Aeromedical and other emergency services except when arriving/departing a destination not serviced by an instrument approach.

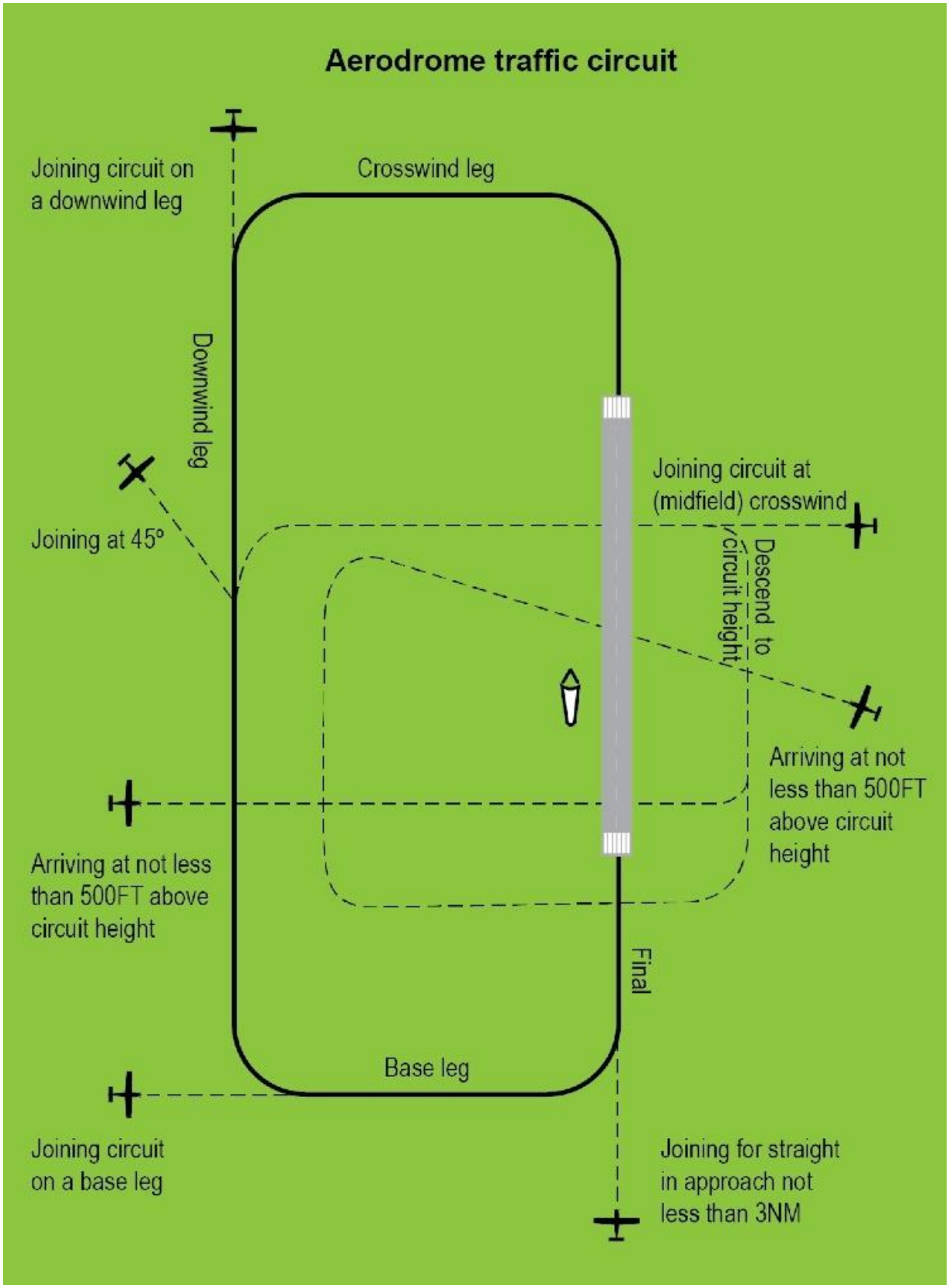


Figure 34
Indicative Aerodrome Standard Traffic Circuit

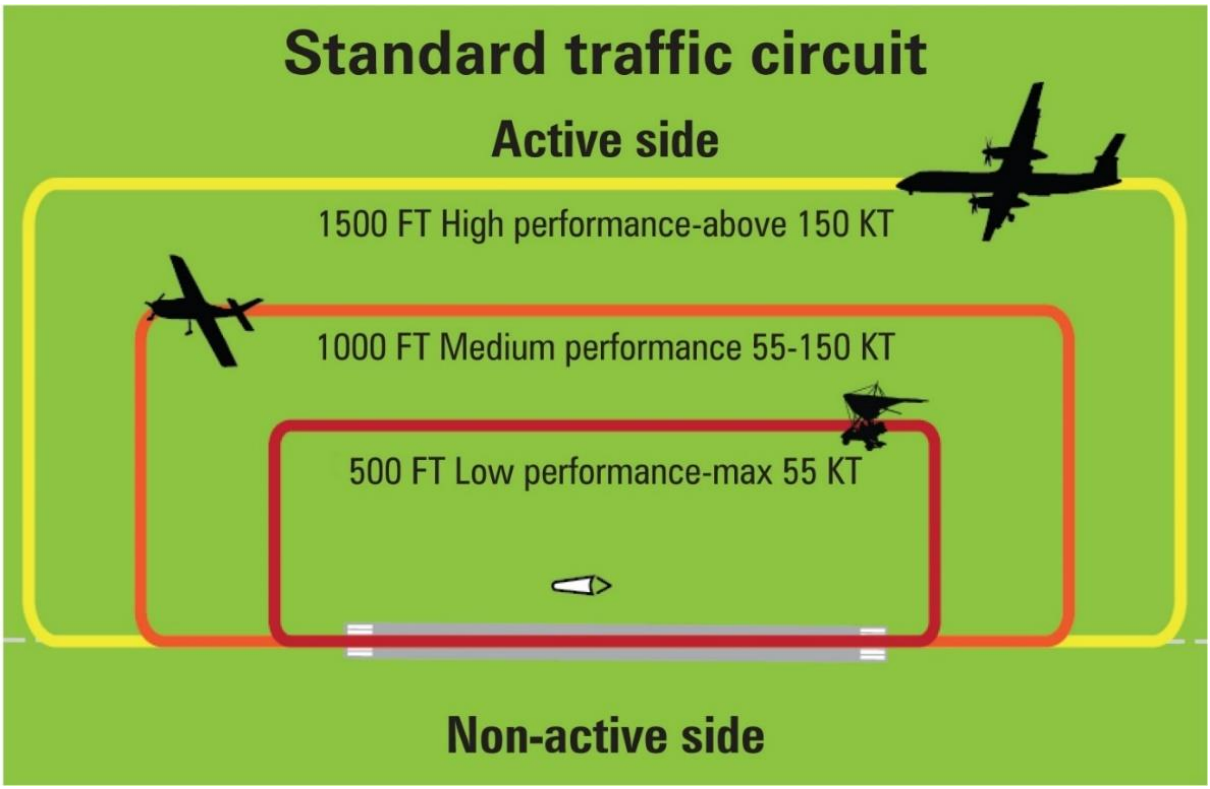


Figure 35
Indicative Traffic Circuit Lateral and Vertical Separation

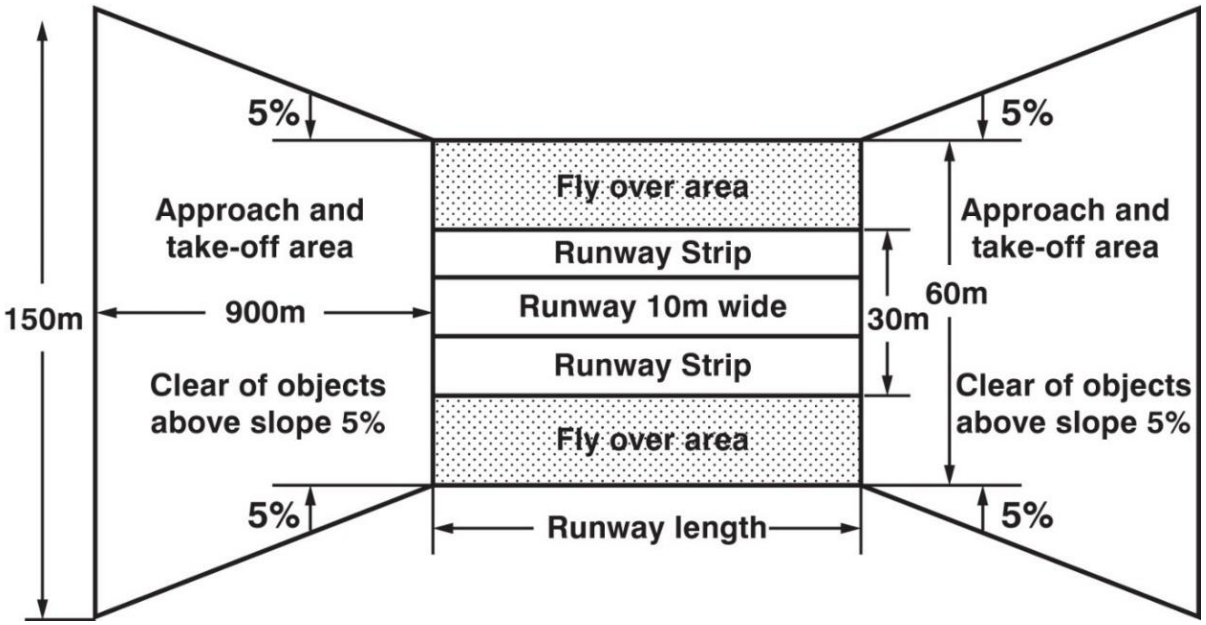


Figure 36
Indicative Single Engine and Centre-Line Thrust Aeroplane Landing Area

Aerial Agriculture

Aerial agricultural operations including such activities as fertiliser, pest and crop spraying are generally conducted under day VFR below 152 m AGL; usually between 18.3 m and 30.5 m AGL.

Due to the nature of the operations conducted, aerial agriculture pilots are subject to rigorous training and assessment requirements in order to obtain and maintain their licence to operate under these conditions. The Aerial Agricultural Association of Australia (AAAA) has a formal risk management program which is recommended for use by its members.

Aerial Firefighting

Aerial firefighting operations (firebombing in particular) are conducted in Day VFR, sometimes below 152 m AGL. Under certain conditions visibility may be reduced/limited by smoke/haze.

Most aerial firefighting organisations have formal risk management programs to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained. For example, pilots require specific training and approvals, additional equipment is installed in the aircraft, and special procedures are developed.

Hazard Lighting and Marking

In considering the need for aviation hazard lighting, the applicable regulatory context was determined and direct consultation with the CASA was undertaken. CASA regulates aviation activities in Australia. Applicable requirements include the *Civil Aviation Regulations 1988* (CAR), CAS Regulations and associated Manual of Standards (MOS) and other guidance material. Relevant provisions are outlined in further detail in **Appendix J**. Further, as Australia is a contracting State to the International Civil Aviation Organisation (ICAO) and signatory to the Chicago Convention on International Civil Aviation (the Convention), and as such has an obligation to implement ICAO's standards and recommended practices (SARPs) as published in the various annexes to the Convention.

Accident Statistics

In response to community concerns in relation to the potential for a VFR aircraft colliding with a WTG, a summary of accidents that involved an aircraft colliding with a WTG, and the relevant factors applicable to this assessment was reviewed by Aviation Projects. The Global Wind Energy Council (2018) states there were 341,320 WTGs operating around the world at the end of 2016. Australia's Clean Energy Council states there were 94 wind farms in Australia at the end of 2018 (ARENA, 2020).

Aviation Projects has researched public sources of information regarding aviation safety occurrences associated with wind farms. Occurrence information published by Australia, Canada, Europe (including Belgium, Denmark, France, Germany, Norway, Sweden and The Netherlands), New Zealand, the United Kingdom and the United States of America was reviewed.

There have been four worldwide that have involved an aircraft colliding with a WTG. None have occurred in Australia or New Zealand. In July 2001 in Palm Springs USA, an aircraft collided with a WTG following an inflight separation of the majority of the right canard and all of the right elevator resulting from a failure of the builder to balance the elevators per the kit manufacturer's instructions. The accident occurred overhead of a wind farm, and the aircraft struck a WTG on its descent.

In February 2017 in Germany, a Diamond DA320-A1 collided with a WTG approximately 20 m above the ground, during the day in good visibility. The mast was grey steel lattice, rather than white, although the blades were painted in white and red bands.

In the third case, (France, 2008), the pilot decided to descend below cloud in an attempt to find the destination aerodrome. The aircraft was in conditions of significantly reduced horizontal visibility in fog where the top of the WTG was obscured by cloud. The WTG became visible too late for avoidance manoeuvring and the aircraft made contact with two WTGs. The aircraft was damaged but landed safely. The fourth fatal accident occurred at night in April 2014 in South Dakota. The aircraft impacted with a WTG in night Instrument Meteorological Conditions (IMC).

There is one additional accident mentioned in a database compiled by an anti-wind farm lobby group, which suggests a Cessna 182 collided with a WTG near Baraboo, Wisconsin on 29 July 2000. The NTSB database records details of an accident involving a Cessna 182 that occurred on 28 July 2000 in the same area, but suggests that the accident was caused by IFR flight into IMC encountered by the pilot and exceeding the design limits of the aircraft. A factor was flight to a destination alternate not performed by the pilot. No mention is made of a WTG or a wind farm.

Wake Turbulence

The NASF Guideline D provides guidance regarding WTG wake turbulence as follows:

> *"Wind farm operators should be aware that turbines may create turbulence which noticeable up to 16 rotor diameters from the turbines. In the case of one of the larger turbine with a diameter of 125 metres, turbulence may be present two kilometres downstream. At this time, the effect of this level of turbulence on aircraft in the vicinity is not known with certainty. However, wind farm operators should be conscious of their duty of care to communicate this risk to aviation operators in the vicinity of the wind farm."*

Consultation

The following consultation occurred as part of the AIA and is discussed further in **Section 5**:

- The draft AIA was provided to DoD, CASA and ASA; and
- Aviation issues were also sought from other stakeholders.

7.3.3 Impact Assessment

Certified / Registered Aerodromes

The Project is located within 30 nautical miles (nm) (55 km) of three registered airports; Cessnock Airport (YCNK), Maitland Airport (YMND) and Scone Airport (YSCO) (shown on **Figure 1**). Cessnock Airport is located 55 km south-east of the closest WTG (T22), Maitland Airport is located 54 km south-east of the closest WTG (T22) and Scone Airport is located 27 km north-west of the closest WTG (T57). Each of these airports were assessed for instrument procedures, PAN-OPS surfaces, circling areas and OLS in relation to the Project. The Project will not penetrate any OLS or PAN-OPS surfaces and is located beyond the required horizontal extent of each airport.

Aircraft Landing Areas and Aerial Agriculture

Due to the nature of aerial agriculture, pilots are subject to rigorous training and assessment requirements in order to obtain and maintain their licence to operate under these conditions. Local aerial operators and private landowners were consulted during the preparation of this EIS to determine the nature of aerial agriculture operations within and surrounding the Project and the locations of any private airstrips.

There were 13 ALAs identified within 40 km of the Project Boundary which are potentially used for aerial agriculture (see **Figure 37)**. Three of these were identified using OzRunways (aeronautical data approved under CASA CASR Part 175), and the remining 10 were identified by the Proponent during stakeholder engagement activities.

An area of interest within a 3 nm radius of an ALA was used to assess potential impacts of proposed developments on aircraft operations at or within the vicinity of the ALA. Four ALAs will be impacted by the Project (ALA 1, ALA 2, ALA 4 and ALA 13) of which three are located on land Associated with the Project (ALA 2, ALA 4 and ALA 13). Mitigation and management for the one ALA on land not Associated with the Project (ALA 1) is discussed in **Section 7.3.4**.

Take-off and landing areas at all identified ALAs will not be impacted by the Project. Circuits associated with ALA 1, ALA 2 and ALA 4 are predicted to be impacted and ALA 13 is predicted to be impacted by wake turbulence. Application of aerial agricultural activities using these ALAs may require additional planning and alteration, subject to a case-by-case assessment following recommendations in **Appendix J**.

Air Routes and LSALT

The 'Manual of Standards 173 Standards Applicable to Instrument Flight Procedure Design' MOS 173 (CASA, 2017) requires that a minimum obstacle clearance of 1,000 ft (30.48 m) below the published LSALT is maintained along each air route.

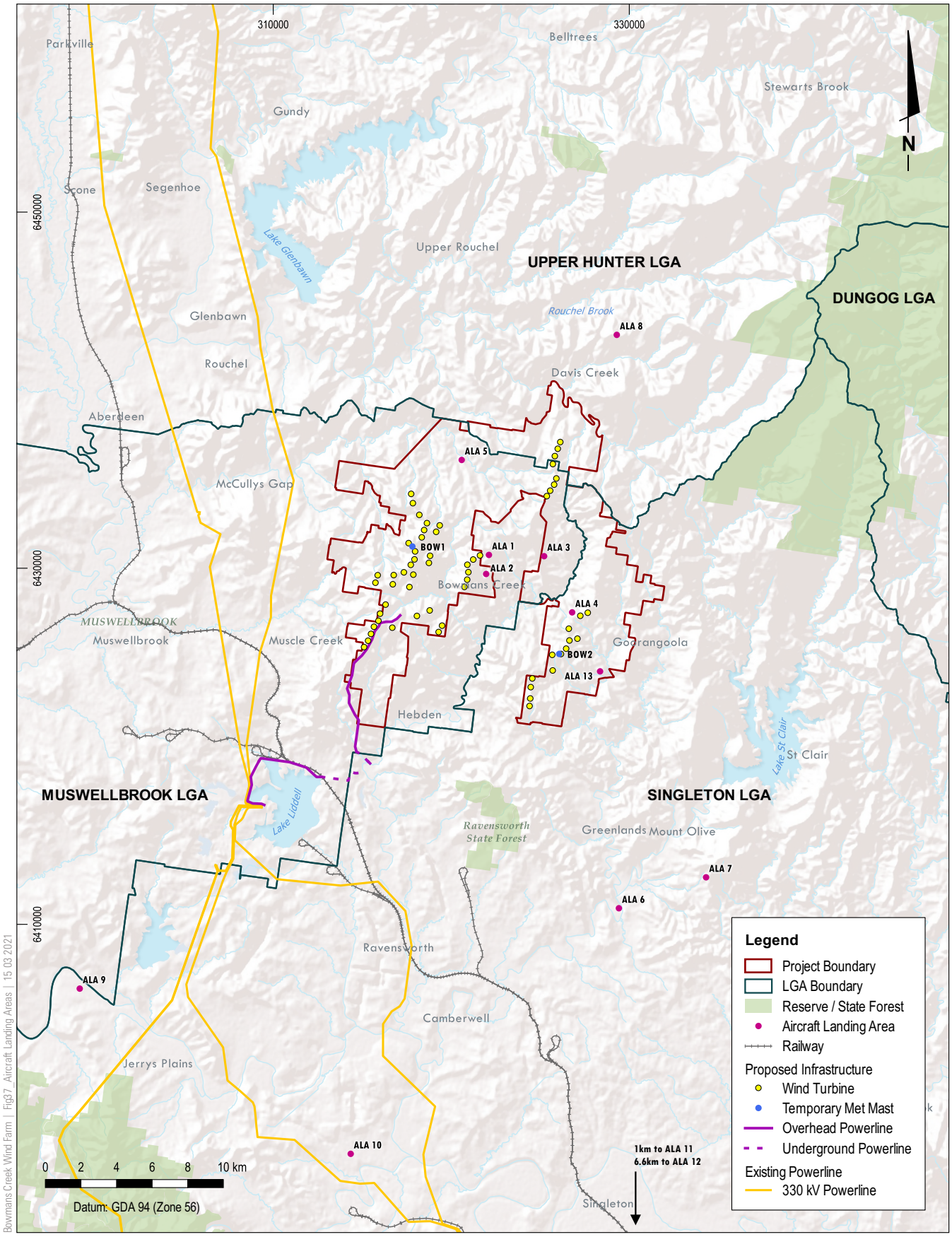
The Project is solely located in the area with a grid LSALT of 6,600 ft altitude above mean sea level (AMSL) (2,012 m AHD) with a MOC surface of 5,600 ft AMSL (1,707 m AHD).

The highest WTG is T46 with a maximum overall height of 911 m AHD (2,988 ft AMSL) and is below the LSALT MOC of 5,600 ft AMSL by 796 m (2,612 ft AMSL). Therefore, the proposed Project will not affect the grid LSALT of 6,600 ft AMSL.

Aviation Facilities

The wind turbines of the Project will not penetrate any protection areas associated with aviation facilities. The closest aviation facility is a Non-Directional radio Beacon (NDB) at Scone Airport located approximately 29 km to the north-east from the Project and will not be impacted.

Source: World Shaded Relief © Esri



Bowmans Creek Wind Farm | Fig37_Aircraft Landing Areas | 15.03.2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Aircraft Landing Areas

FIGURE 37

Defence

Airspace Protection

The Project is located outside controlled airspace (wholly within Class G airspace) but within the Restricted Area R583B and the Danger Area D600 associated with RAAF Base Williamtown military restricted airspace. The specific restrictions of the Restricted Area R583B and Danger Area D600 on the airspace is detailed in the AIA. Further detail is provided in **Appendix J**

All turbines within the Restricted Area R583B and the Danger Area D600 will be within the applicable vertical restriction limits.

Military Operations

There may be some high-speed low-level military jet aircraft and helicopter operations conducted in part of the Project Boundary.

Radar

The following radars were identified in proximity to the Project Boundary:

- Cecil Park Secondary Surveillance Radar (SSR) and Cecil Park Primary Surveillance Radar (PSR) located approximately 175 km south-west;
- Sydney SSR and Sydney PSR located 181 km south; and
- Williamtown tactical air command located 84 km south-east.

The EUROCONTROL guidelines for assessing the potential impact of WTGs on surveillance sensors identifies the PSR and SSR safeguarding and assessments ranges.

The Project Boundary is located in Zone 4 and outside the radar line of sight of Cecil Park PSR/SSR and Sydney PSR/ SSR. The Project will not interfere with the serviceability of these aviation facilities.

It is unlikely that the Project will impact on aviation radars at RAAF Base Williamtown as the Project is located 82 km north-west from the RAAF Base Williamtown. The WTGs are shielded by natural terrain and are outside of the assessment ranges for radar line of sight assessment criteria.

Bureau of Meteorology Radars

With respect to the Bureau of Meteorology (BoM) radars, the closest weather radar is the Newcastle radar located at Lemon Tree Passage (latitude 32.730°S, longitude 152.027 E) 95 km south-east of the Project Boundary (BoM, 2020). This Newcastle radar is a WSR 74 S Band Doppler which operates 24 hours per day. It is unlikely that the Project will impact the radar.

Aerial Firefighting

Aerial firefighting operations (firebombing in particular) are conducted in Day VFR, sometimes below 152 m AGL. Under certain conditions visibility may be reduced/limited by smoke/haze. Most aerial firefighting organisations have formal risk management programs to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained. For example, pilots require specific training and approvals, additional equipment is installed in the aircraft, and special procedures are developed.

Emergency Services

Royal Flying Doctor Service (RFDS) and other emergency services operations are generally conducted under the IFR, except when arriving/departing a destination that is not serviced by instrument approach aids or procedures. Most emergency aviation services organisations have formal risk management programs to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained.

Hazard Lighting and Marking

The AIA concluded that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.

7.3.4 Mitigation and Management

Mitigation and management will be implemented for the Project relevant to potential impacts to aviation in the areas of notifications, construction, operations and review.

Notification and Reporting

"As constructed" details of WTGs and wind monitoring tower coordinates and elevations will be provided promptly to ASA and DoD. Notification to NOTAM will occur in the following circumstances:

- Obstacles above 110 m AGL (including temporary or construction equipment) will be reported until they are incorporated in published operational documents;
- Crane operations required during construction with the following indicative details:
  - The planned operational timeframe and maximum height of the crane; and
  - Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

Notification to local and regional aircraft operations will occur in the following circumstances:

- Prior to construction to consider the potential impact of the wind farm on their operations; and
- Details will be provided to the NSW Regional Airspace and Procedures Advisory Committee for consideration by its members in relation to VFR transit routes in the vicinity of the Project.

Marking of WTGs

The rotor blades, nacelle and towers of the wind turbines will be painted a white colour (unless otherwise agreed by the Secretary), consistent with all wind turbines operational in Australia.

Lighting of WTGs

Aviation Projects confirmed that no mitigation is required in relation to lighting.

However, in response to DoD's late correspondence dated 13 October 2020, should the determining authority require lighting to be installed, WTGs will be obstacle lit in accordance with 'Civil Aviation Safety Regulation 139' and the 'CASA Manual of Standards 139'.

If Light Emitting Diode (LED) lighting is applied, the frequency range of the LED light emitted will be within the range of wavelengths 665 to 930 nanometres to allow for visibility to persons using night vision devices.

Any required lighting would be relevantly shielded and orientated away from sensitive receivers.

Marking of Wind Monitoring Towers

Wind monitoring towers will be marked according to the requirements set out in MOS 139 Chapter 8 Division 10 Obstacle Markings (as modified by the guidance in NASF Guideline D).

Marking of Overhead Transmission Lines and Poles

Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations will be identified in consultation with local aerial agriculture operators and marked in accordance with MOS 139 Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8).

Micro-siting

Micro-siting is described in **Section 3.3.2**.

Aircraft Landing Areas

To facilitate the flight planning of aerial application operators, details of the Project will be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

In the event that pre-existing aerial agricultural activities are affected by the construction and/or operation of the WTGs, the Proponent will implement reasonable measures in consultation with the landowner to mitigate the impacts. This could include:

- Funding the cost difference between pre-development aerial agricultural activities and a suitable alternative; and/or
- Temporarily stopping WTGs during aerial agricultural activities.

The Proponent will consult with the landowner of ALA 1 to address potential impacts on the use of the ALA.

Operations

Local aerial agricultural operators and aerial firefighting operators will be engaged to develop procedures for aircraft operations in the vicinity of the Project.

Review Triggers

The EIS Risk Assessment presented in **Appendix J** will be reviewed and revised if necessary:

- Prior to construction to ensure the regulatory framework has not changed;
- Following any significant changes to the context in which the risk assessment was prepared (including the regulatory framework); and
- Following any near miss, incident or accident associated with operations considered in the risk assessment.

7.4 TRAFFIC AND TRANSPORT

A Traffic and Transport Impact Assessment (TTIA) was undertaken for the Project by Cardno (NSW/ACT) Pty Ltd (Cardno) and is presented in **Appendix K**.

The TTIA provides an assessment of the potential transport impacts during the construction, maintenance, operation and decommissioning phases of the Project. The key objectives of the TTIA were to address the SEARs objectives which included (but is not limited to):

- Review of any previous traffic impact assessments undertaken for the surrounding area;
- Review existing traffic count data and/or undertake traffic counts in areas where data is not available;
- Assess likely Project only and cumulative traffic impacts during the construction, operational and decommissioning phases of the Project (including intersection performance, capacity, safety and site access); and
- Identify necessary mitigation and management measures.

A summary of the TTIA is presented below including key impact assessment findings, as well as management measures committed to by the Proponent.

7.4.1 Background

Road Network

The following section describes the road network surrounding and to be utilised for the Project (see **Figure 38**).

New England Highway

The NEH is a state road (No.09) that varies between one to two lanes of traffic in each direction with segments of physical barrier separation. It is the main road that connects Muswellbrook and Singleton in a north-south direction. It is also a designated TfNSW Restricted Access Vehicle and Higher Mass Limit route. The posted speed limit is 100 km/hour. This will be the road used to bring OSOM haulage vehicles to the local government road access point to the Project.

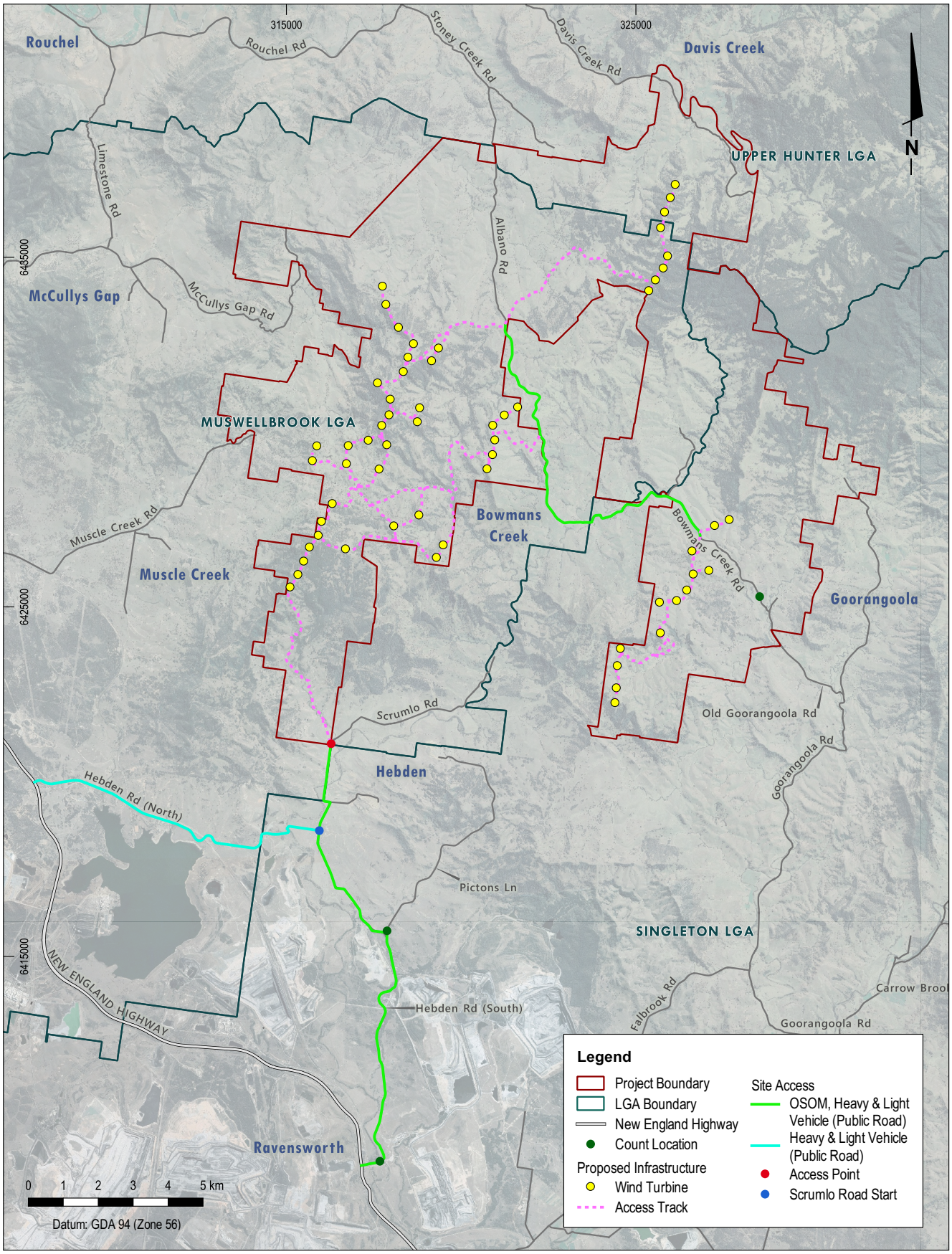
Hebden Road

Hebden Road is 21 km long and intersects with NEH twice, creating a circuit. It is used for access to several large coal mining operations. The most southern intersection with NEH up to Hebden Road / Scrumlo Road intersection has been identified as part of the OSOM haulage route.

Hebden Road is a sealed road that allows for one lane of traffic in each direction but there are a few sections where only one lane of traffic is possible. The majority of the road has clear line markings but there are some sections that are unmarked or where the markings are difficult to see. The road surface is in a relatively good condition and is particularly better between NEH and Pictons Lane. The posted speed limit is 80 km/hour.

On the Hebden Road Haulage Route there is one bridge over the rail lines close to the southern intersection with NEH and a bridge over Stringybark Creek.

Source: Aerial ©2019 Google



Bowmans Creek Wind Farm | Fig38_Site Access and Road Network | 15 03 2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Site Access and Road Network

FIGURE 38

Scrumlo Road

Scrumlo Road has been identified as a Haulage Route 1 and is located at the end of Hebden Road (south). Scrumlo Road will be used in the construction, operational and decommissioning phases. It will provide OSOM and heavy vehicle access to the south-western portion of the Project Boundary. Scrumlo Road is a sealed road with no road line markings. The road surface conditions are in relatively good state. The carriageway width varies along the road where it is suitable for two lanes of traffic (one for each direction) or one lane.

A section of Scrumlo Road is also relied upon by the East Quarry for gravel haulage to market. From Hebden Road / Scrumlo Road intersection to the access track to the East Quarry and Clydsdales Bridge to the end of Haulage Route 1, the carriageway is suitable for two lanes of traffic. However, between the access track to the East Quarry to the Clydsdales Bridge, the carriageway is only suitable for one lane of traffic.

Bowmans Creek Road

Bowmans Creek Road is 8 km long and extends from Old Goorangoola Road to Albano Road. Bowmans Creek Road will be used in the construction, operational and decommissioning phases. It will provide access between the eastern and western parts of the Project. Approximately 6 km of the road is sealed with no road line markings and approximately 2 km is a gravel-like surface. The carriageway is suitable for one lane of traffic at any one time. The gradient of Bowmans Creek Road varies significantly. This creates poor visibility especially around tight bends and on crests. There are also several low-level causeways along the road prone to flooding after heavy rainfall events. There are several narrow cattle grids along the carriageway.

Albano Road

Albano Road is 14 km in length and connects to Bowmans Creek Road and Stoney Creek Road. It is currently an unsealed gravel road and the carriageway width accommodates one lane of traffic in one direction at any time. Vehicle passing occurs within the grassed verge and shoulder area. The gradient of Albano Road varies significantly and there are a greater number of bends in the road. This has created visibility issues when manoeuvring around bends and travelling over crests. There are several narrow cattle grids along the carriageway. A 12 km section of Albano Road will be used in the construction, operational and decommissioning phases. It will provide OSOM and heavy vehicle access between the eastern and western areas of the Project and will most likely be used to access several internal access tracks to the WTGs.

7.4.2 Methodology

Heavy Vehicle Routes

The following restrictions exist on the proposed haulage route:

- NEH, from Pacific Highway, Hexham to John Renshaw Drive, Tarro - vehicles or combinations exceeding 3.5 m wide or 25 m long are not permitted to travel between 8:00 am and sunset on weekends or a state-wide public holiday; and
- Hunter Expressway, from John Renshaw Drive, Buchanan to Magpie Street, Singleton - Vehicles or combinations exceeding 3.2 m wide are not permitted to travel from Monday to Friday from 7:30 am to 9:30 am and from Monday to Friday from 3 pm to 6 pm (except on state-wide public holidays).

Traffic Volumes

SSC provided historical weekly traffic data on Hebden Road, Bowmans Creek Road and Pictons Lane. Additional traffic data was sourced for the NEH from the TfNSW Traffic Classifier Stations 6153 and 6154. Traffic data collection points are shown on **Figure 39**. The data was used to understand the daily variations across one week and determine the AM and PM peak hours based on the highest volume of traffic.

NEH

Project traffic will access the NEH (via Hebden Road) between Stations 6153 and 6154. Traffic data indicates the average weekday traffic volumes to be 9,800 – 16,200 vehicles a day. Traffic has grown between 2017 and 2019 by 2.7% per year. The NEH/Hebden Road (south) intersection turning count data was collected in August 2018 and indicates that the AM and PM peak hours of the intersection to be 5:45 – 6:45 am and 5 am – 6 pm respectively (Puliyapang, 2019).

Hebden Road South

The weekly traffic profile of Hebden Road is relatively consistent across all days of the week. The AM peak in December 2017 was 6 am – 7 am (371 vehicles) and the PM peak occurred at 4 pm – 5 pm (156 vehicles).

Bowmans Creek Road / Albano Road

There is very low traffic volume on Bowmans Creek Road / Albano Road and therefore there is no discernible traffic profile. Based on the profiles, the AM peak in October 2016 was 7 am – 8 am (eight vehicles) and the PM peak occurred at 12 pm – 1 pm (seven vehicles).

Road Condition Assessment

The existing road network conditions and issues have been identified using aerial imagery and observations made during the site visit in 2019.

Swept Path Analysis

Cardno reviewed the OSOM haulage route using AutoCAD 2019 Vehicle Tracking software. The Vehicle Tracking program has a template WTG / blade transporter which has been modified to suit the custom vehicle length proposed to be used by the Proponent.

Swept paths for the WTG delivery from the Hebden Road via NEH to the site entry; as well as from the Newcastle Port to Hebden Road via NEH are presented in **Appendix K**.

7.4.3 Impact Assessment

Overview of Haulage Routes

The delivery of WTG and associated components will most likely largely be from the Port of Newcastle, travelling west via the Hunter Expressway to the NEH as shown on **Figure 1**. The use of the Port is not uncommon, with other wind farms utilising Mayfield Berth 4 for the purpose of WTG and blade storage before transporting to a regional location.

Once at the intersection of Hebden Road / NEH, OSOM vehicles will access the site via the identified site access locations and roads on Hebden Road South, Scrumlo Road and Bowmans Creek/Albano Road as follows:

- Hebden Road (south) between NEH and the intersection with Pictons Lane;
- Hebden Road and Scrumlo Road from the intersection with Pictons Lane to the Site Access location; and
- Bowmans Creek Road/Albano Road connecting the north-western to the south-eastern areas of the Project Boundary.

The access route via Hebden Road (north and south) from NEH will be used by all general construction vehicles (general light and heavy vehicles), operational traffic and decommissioning vehicles as shown on **Figure 38**.

The TTIA study area is based on the transport route from Port of Newcastle to Hebden Road (south) and more closely at Hebden Road (north and south), Scrumlo Road, Bowmans Creek Road and Albano Road.

The TTIA assumed the proposed OSOM vehicle transporter will be supplied by a nominated specialist contractor. The vehicle and its operating procedures will be as per the requirements stipulated within relevant operating manuals.

Road Condition and Safety Assessment

The Road Condition and Safety Assessment was based on the swept path review and documentation, an on-site review of the road condition and safety features of the OSOM route from Newcastle, Hebden Road, Scrumlo Road, Bowmans Creek Road and Albano Road.

The results of the swept path review and associated conceptual conflict points are shown on **Figure 39** in the vicinity of the Project Boundary and tabulated in **Appendix K**.

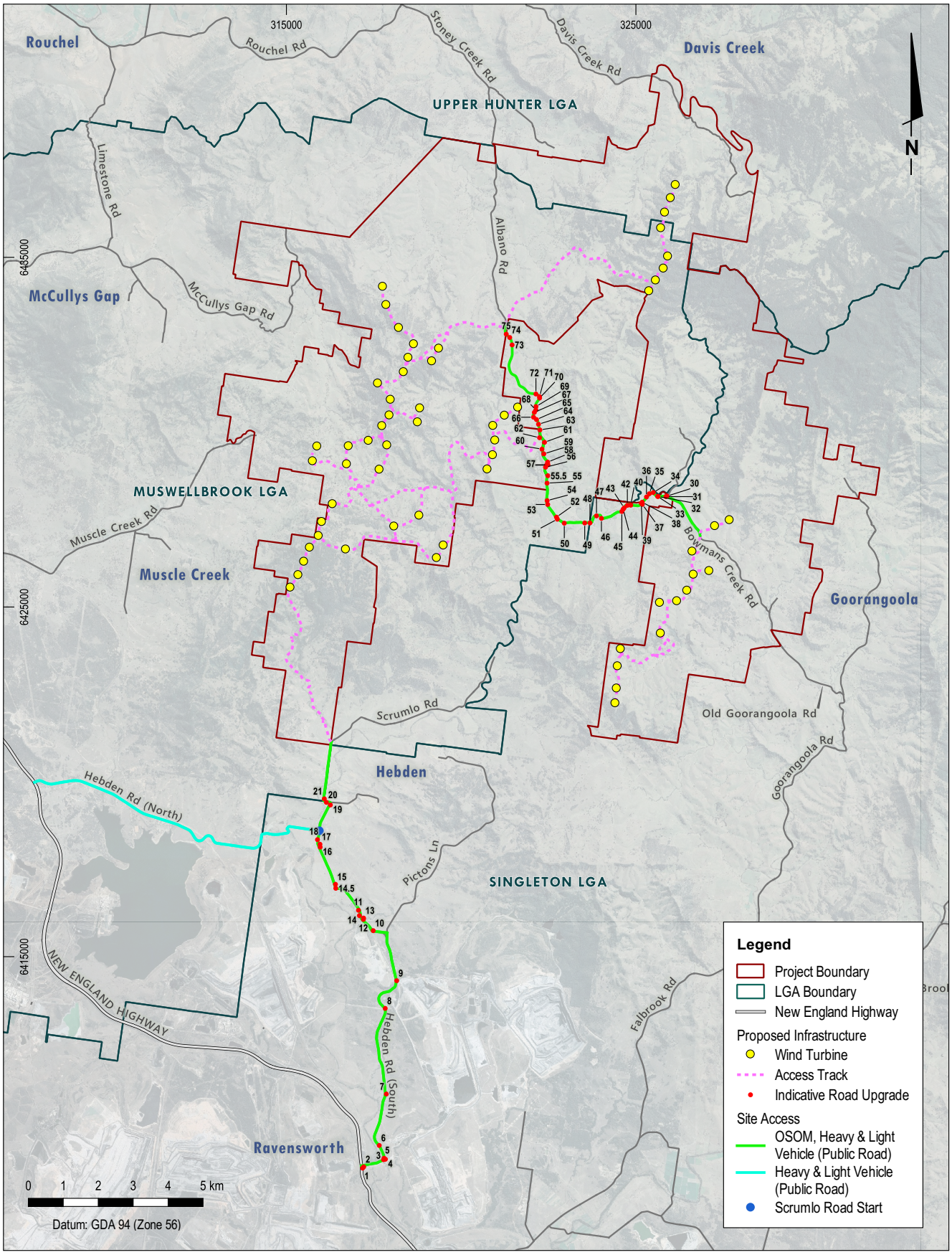
Port of Newcastle to Hebden Road (south)

Minor works are also required on Selwyn Street upon exit from the Port of Newcastle. Access to Pacific Highway and Hunter Expressway will require traffic management measures and likely short-term road closures.

Two alternate paths are identified for movement from Industrial Drive onto the Pacific Highway. Minor works likely to be required to enable cross over of the central median, operating under traffic control. Two alternate paths are identified for movement from John Renshaw Drive onto the Hunter Expressway. Navigating the roundabout interchange under normal road conditions may require modification to verge areas and the over pass safety screens to allow the OSOM vehicle to turn. The alternate path identified involves closure of the westbound carriageway and off-ramp from the Expressway with minor works required to enable cross over on John Renshaw Drive.

The final path will be detailed in the TMP in consultation with relevant regulators.

Source: Aerial ©2019 Google



Bowmans Creek Wind Farm | Fig39_Indicative Road Upgrades Due to the Project | 16.03.2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Indicative Road Upgrades Due to the Project

FIGURE 39

Hebden Road (south) to Pictons Lane

Initial segment of the route near the NEH requires intersection works, bridge capacity assessment and road widening before the transport vehicle travels north on Hebden Road. The potential works on NEH are based on the tail of the OSOM vehicle potentially encroaching into the cutting on the western side of the Highway.

There is anticipated to be road works and vegetation removal / trimming, however this is considered to be minor and will be refined as part of the detailed design for the works.

The box culverts / causeways and bridges along Hebden Road and Scrumlo Road appear adequate with any minor modifications to be addressed at the detailed design of the TMP.

Hebden Road and Scrumlo Road to Site Access locations

Structural bridges / culverts along this route may have structural capacity for the OSOM vehicle and can be addressed as part of the detailed design.

Bowmans Creek Road and Albano Road

The OSOM route on Bowmans Creek Road and Albano Road (Route 3) is generally undulating and consisting of crushed road base surface. The topography of Route 3 in select locations is generally exceeding the maximum 20-25% gradient considered suitable for an OSOM vehicle. Where the gradient is considered to be too high, the road will be modified in consultation with MSC.

Traffic Generation – Construction

The various construction work phases will overlap with each other as indicatively shown in **Section 3.2**. The duration of the Project construction phase is expected to be approximately 18 months. Construction worker parking will be provided on site.

The Project is expected to generate about 141 daily one-way traffic movements during the peak construction period (Months 7 – 8), of which about 47% (or 66) of these trips will be delivery related heavy vehicles. OSOM vehicle movements are scheduled to occur during month 11-16, during which time a peak of 106 to 131 one-way daily vehicle movements will occur. The delivery of WTG is likely to be grouped to minimise the impact on the road network along its journey and occur outside of peak times during periods accepted by TfNSW and the local Council.

Traffic Generation Operations

Routine maintenance will be conducted by up to 15 people working on the Project during operations. The O&M Facility will be based near Hebden Road South (see **Figure 3**). Assuming each person drives themselves to and from the compound, the daily traffic generation during operations will equate to 30 one-way trips per day.

Traffic Generation – Decommissioning

The decommissioning of the Project would result in similar traffic movements when compared to the construction phase, however with a significantly reduced workforce and removal of certain material deliveries (e.g. there will be no need for concrete trucks / pours).

Traffic management controls will need to be considered at the decommissioning stage to mitigate any traffic and transport impacts. This may include the timing of inbound / outbound trips at the Hebden Road intersections with NEH, or preferred routes to local roads via Singleton or Scone for light vehicle access. Decommissioning or refurbishment is not anticipated for approximately 25 years from commencement of operations.

Traffic Distribution

An estimate of Project-related daily traffic movements and the peak distribution for AM and PM conservatively assuming a 12 hour working days, are shown in **Table 24**. It is estimated that in the AM peak, 66 vehicles will enter the site and 20 vehicles will leave the site. In the PM peak, 20 vehicles are estimated to enter the Project Boundary and 66 vehicles leave the site.

The peak number of one-way movements is during month 7-8 (141 one-way movements, or 282 total trips in and out of the Project site).

Table 24
Trip Generation and Distribution AM and PM Peak

Vehicle Type	Daily Two-Way trips	Peak Hour Factor	Peak Hour Total Movements	AM Peak IN / OUT	PM Peak IN / OUT
Light vehicles	150	50%(1)	75	60 / 15	15 / 60
Heavy vehicles	132	8.3%(2)	11	6 / 5	5 / 6
Total	282		86	66 / 20	20 / 66

Traffic Assignment

All vehicles will access the site from NEH via Hebden Road (north) or (south). The workforce from Singleton is assumed to access the site via Hebden Road (south). The workforce from Muswellbrook and Scone is assumed to access the site via Hebden Road (north).

Once light vehicles have entered Hebden Road from NEH, they will access the O&M Facility off Scrumlo Road before dispersing across the site on private tracks.

Intersection Performance

The intersection performance of the NEH and Hebden Road (south) was modelled using SIDRA 8 and assessed using the 'RMS Guide to Traffic Generating Developments' (RMS, 2002). Although the Hebden Road approach was wide enough to provide storage for more than one vehicle, the approaches were modelled conservatively by using a single lane approach.

SIDRA analysis results and movement summaries presented in **Appendix K** indicates the intersection is not detrimentally impacted by the addition of project construction traffic and therefore would not require any upgrades.

Impact to other Intersections

The intersection performance of NEH / Hebden Road (south) intersection is considered to reflect the worst-case impact of the Project. Impacts on the performance of the other nearby intersections is expected to be less based on the lack of other traffic generating land uses nearby and generally low vehicular traffic in the road network.

The highest delay movement of the Hebden Road (south) and the other access at Hebden Road (north) would be the right turn out of the minor side road onto NEH. If delays on this turning movement deteriorates, it is recommended project construction related traffic avoid travelling between the hours of 5 am – 6 am and 4 am – 5pm when traffic peaks on the NEH (in consultation with the relevant regulator).

Local School Bus

Local school buses operate on the northern side of the NEH. The relevant school routes are Singleton Primary & High School Routes 6310 & 6339. These two routes are the same and apply in the AM and PM respectively. They travel from Scrumlo Road to Hebden Road onto the NEH and vice versa. Route 6310 operates at 7:55 am from Scrumlo Road and Route 6339 at 3:42 pm from Singleton once a day. Currently a school bus service also operates along Goorangoola Road to the intersection of Bowmans Creek Road and Old Goorangoola Road. This bus route will not interact with OSOM traffic associated with the Project.

The interaction of heavy vehicle construction traffic and OSOM vehicles will be coordinated with the operator of the relevant bus company for all OSOM routes and managed as part of the TMP (discussed in **Section 7.4.4**). It is anticipated that based on the low frequency of school bus movements (once in the morning and once in the afternoon on each road), the exposure to light vehicle construction traffic will be low and therefore will be a minor conflict.

7.4.4 Mitigation and Management

The following strategies will be undertaken to mitigate Project impacts on the road network.

OSOM Road Restrictions

The Proponent will schedule OSOM vehicular movements to meet the restrictions described in **Section 7.4.2** on the following roads:

- NEH, from Pacific Highway, Hexham to John Renshaw Drive, Tarro; and
- Hunter Expressway, from John Renshaw Drive, Buchanan to Magpie Street, Singleton.

Traffic Management Plan

A TMP will be prepared to address the life of the Project (construction, maintenance, operation and decommissioning) that will include the following:

- Minimise the traffic safety impacts of the development and disruptions to local road users during the construction and decommissioning of the development, including:
    - Temporary traffic controls, including detours and signage;
    - Notifying the local community in advance about development-related traffic impacts;

  - Minimise potential conflict between development-related traffic and:
    - School buses, in consultation with local schools and bus companies;
    - Mining related traffic;
    - Stock movements; and
    - Domestic animals.
  - Implement measures to minimise development-related traffic on the public road network outside of standard construction hours;
  - Ensure development-related traffic does not track dirt onto the public road network;
  - Ensure loaded vehicles entering or leaving the site have their loads covered or contained;
  - Provide sufficient parking on site for all development-related traffic;
  - Respond to any emergency repair requirements or maintenance during construction and/or decommissioning;
  - Contain a traffic management system for managing over-dimensional vehicles; and
  - Consider fatigue management.
- Include a drivers' Code Of Conduct that addresses:
  - Travelling speeds;
  - Procedures to ensure that drivers to and from the development adhere to the designated over dimensional and heavy vehicle routes; and
  - Procedures to ensure that drivers to and from the development implement safe driving practices;
- Finalise the works required from the preliminary swept path analysis;
- Any tree removal required for works relating to road widening will exclude two existing trees on the eastern side of Scrumlo Road on the north of the dog leg corner; and
- Include a detailed program to monitor and report on the effectiveness of these measures and compliance with the specified code of conduct developed for traffic related matters.

The notable conflict points resulting from the swept path analysis will be addressed as part of the TMP in consultation with relevant regulators. Further, the serviceability of all box culverts / causeways and bridges along Hebden Road and Scrumlo Road will be carefully considered in the preparation of the TMP.

As part of the consultation process, TfNSW indicated the need to consider future projects in the region such as M1 to Raymond Terrace and the Hexham Road Straight projects which are proposed in a similar timeframe to the Project. The Proponent will consult with TfNSW and relevant stakeholders in the development of the applicable TMP at the time to reduce impacts from the turbine delivery program should the projects occur in parallel.

Following construction, a dilapidation assessment will be conducted over those parts of the local government road network relied upon, to capture any changes in conditions during OSOM and other heavy vehicle construction traffic movements. Any identified damage related to construction activities will be remedied by the Proponent in consultation with the relevant authority.

Stakeholder Management Plan

A SEP as described in **Section 5.7** will be implemented for the Project including relevant notifications for Project-related traffic movements and interruptions.

A site safety induction process will ensure that all personnel on-site understand the speed limit restrictions on internal access tracks, procedures for radio communications and the imperative to follow site safety signage.

7.5 BIODIVERSITY

7.5.1 Background

A Biodiversity Development Assessment Report (BDAR) was undertaken for the Project by Cumberland Ecology and is presented in **Appendix L**.

Section 7.9 of the BC Act requires all SSD applications for Development Consent to be accompanied by a BDAR.

The native vegetation that occurs across the Disturbance Area and wider Survey Area varies from patches of dry rainforest, open forest and woodland to derived native grassland (native-dominated grassland created from the clearing of forest or woodland). Some areas within the farming properties have been historically subject to pasture improvement, with areas of heavy grazing dominated by exotic pasture species.

The purpose of the BDAR is to document the findings of an assessment undertaken for the Project in accordance with Stage 1 (Biodiversity Assessment) and Stage 2 (Impact Assessment) of the BAM.

A summary of the BDAR is presented below including key impact assessment findings, as well as management measures committed to by the Proponent. As per the requirements of the Biodiversity Assessment Method (BAM), the BDAR defines a "subject land" and "assessment area" in addition to the Disturbance Area and Survey Area. These are defined in detail within the BDAR in **Appendix L**.

7.5.2 Methodology

The following provides a summary for the methodology utilised for the BDAR. Additional detail is provided in **Appendix L**.

Database and Literature Review

A number of databases were utilised to prepare the BDAR, including:

- Environment, Energy and Science (EES) BioNet Atlas (EES, 2020a);
- EES Threatened Biodiversity Data Collection (EES, 2020a);
- EES BioNet Vegetation Classification database (EES, 2020a);
- DAWE Protected Matters Search Tool (DoEE, 2019);
- DAWE Directory of Important Wetlands in Australia (DoEE, 2019); and
- Groundwater Dependent Ecosystems Atlas (BOM, 2020).

The BDAR has given due consideration to the results and spatial data from the following:

- State Vegetation Type Map: Upper Hunter v.1.0. VIS_ID 4894;
- Topographic Map Sheets (Camberwell, Dawsons Hill, Rouchel Brook, Muswellbrook and Aberdeen);
- DPI (Fisheries) Key Fish Habitat maps for MSC, SSC and UHSC;
- DPI (Fisheries) Freshwater threatened species distribution maps;
- 'Guidelines for Development Adjoining Land and Water Managed by DECCW' (OEH, 2010);
- 'Policy and Guidelines for Fish Habitat Conservation and Management' (DPI, 2013);
- 'Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings' (DPI 2003);
- 'Risk Assessment Guidelines for Groundwater Dependent Ecosystems' (DPI, 2012); and
- *State Environmental Planning Policy (Koala Habitat Protection) 2019*.

Field Survey

Vegetation Mapping

Vegetation surveys to refine the Upper Hunter SVTM mapping (VIS_ID 4894) within the Project Boundary were conducted between September 2019 and January 2020 with additional surveys for parts of the transmission line and transport route conducted in March 2020, October 2020 and February 2021.

The vegetation survey area was ground-truthed to examine and verify the mapping of the condition and extent of the different vegetation communities by conducting random meander searches, noting key characteristics of areas in similar broad condition states such as similar tree cover, shrub cover, ground cover, weediness or combinations of these.

Vegetation integrity assessments were undertaken across the survey area in accordance with the BAM during the September 2019 – January 2020, March 2020, October 2020 and February 2021 survey periods. Surveys included establishment of 20 x 50 m plots, with an internal 20 x 20 m floristic plot. Significant data was collected within each of the plots.

Flora

In accordance with Section 6.4.1.13 and 6.4.1.17 of the BAM, desktop assessments and field surveys within the Survey Area included assessments of habitat constraints and microhabitats for predicted species credit flora species to refine a list of candidate species credit species.

Targeted threatened flora surveys were undertaken within the Survey area for candidate species credit species. All surveys were undertaken during the appropriate survey period specified in the Threatened Biodiversity Database Collection (TBDC) for each species and according to relevant survey guidelines. Targeted species included: Bynoe's Wattle, Acacia pendula population in the Hunter catchment, Charmhaven Apple, Trailing Woodruff, Netted Bottle Brush, Cymbidium canaliculatum population in the Hunter Catchment, White-flowered Wax Plant, Pine Donkey Orchid, Slaty Red Gum, Small-flower Grevillea, Large-leafed Monotaxis, Scant Pomaderris, Singleton Mint Bush, Illawarra Greenhood, Scrub Turpentine, Native Guava, Heath Wrinklewort, Austral Toadflax and Rainforest Cassia.

Fauna

As with flora, desktop assessments and field surveys within the survey area included assessments of habitat constraints and microhabitats for predicted species credit fauna species to refine a list of candidate species credit species.

Under Section 6.7.1.15 of the BAM, assessments for wind farms require identification of a candidate list of species that may use the development site as a flyway or migration route in addition to identification of candidate threatened fauna species. Fauna surveys therefore focused on surveys to target fauna known to be most affected by wind farms, via blade-strike impacts (i.e. avifauna and bats).

Targeted threatened fauna surveys were undertaken within the Survey Area for species credit species or breeding habitat for species/ecosystem credit species (hereafter referred to as "dual credit species") that were assessed as candidate species for further assessment. Targeted candidate species included: Gang-gang Cockatoo, Glossy Black-Cockatoo, White-bellied Sea-Eagle, Little Eagle, Square-tailed Kite, Barking Owl Powerful Owl, Masked Owl, Brush-tailed Phascogale, Large-eared Pied Bat and Southern Myotis.

Larger hollows observed during the fauna habitat assessments or incidental observations were further assessed for suitability as harbour for threatened owls (>20 cm) or cockatoos (>15 cm) including the following: Gang-gang cockatoo, Glossy-black cockatoo, Barking Owl, Powerful Owl and Masked Owl.

Raptor nest searches particularly focused on detection of raptor nests for the target species namely: White-bellied Sea Eagle, Little Eagle, Square-tailed Kite and Wedge-tailed Eagle. Although the Wedge-tailed Eagle is not a listed threatened species in NSW, this species was also included in the targeted raptor searches as it is considered a high-risk strike species for wind farm projects. These surveys were conducted as a subset of the fauna habitat assessments.

Any incidental fauna species, particularly avifauna species, that were observed, heard calling, or otherwise detected based on tracks or signs, were recorded and listed in the total species list for the survey area.

Suitably large hollows for threatened owls and cockatoos were examined for indications of nesting material and other indications of hollow usage during targeted surveys conducted in August 2020. Targeted surveys for threatened owls were conducted at two locations where suitably sized hollows were present within or immediately adjacent to the Disturbance Area.

Owl surveys were conducted over four nights and involved a combination of hollow watches at dusk, call playback and spotlighting. Call playback involved playing calls of each of the three targeted species intermittently for five minutes followed by a listening period/spotlighting meanders of 10 minutes. As Powerful Owl is not considered to respond well to call playback, the spotlighting and call playback surveys were supplemented with hollow watches at dusk as well as searches for indications of owl usage such as owl wash and pellets.

Bird surveys conducted during the August 2020 survey period were specifically targeted at detection of Glossy Black-Cockatoo and were supplemented by searches for chewed cones around *Casuarina and Allocasuarina* species.

As wind farms comprise a strike risk to avifauna (listed and non-listed), and bird surveys were conducted across a single spring-summer and a single winter season, local bird watchers were contacted to gain further information on avifauna historically observed within the Survey Area. Some local residents were particularly helpful in this regard. Bird lists provided were compared to data collected during the bird surveys and the combined lists of birds were further analysed for flight height categorisation. Detail on field survey and limitations are described in **Appendix L**.

Bird / Bat Strike Assessment

All avifauna and bat species recorded within the Survey Area (including additional avifauna species as provided by local bird watchers) were classified into various "Flight height" categories based on a combination of field observations and known foraging/flight behaviour. Flight height categories were based on the Rotor Swept Area (RSA) and were classified as Below RSA height (<40 m), At RSA height (40 – 220 m) or Above RSA height (>220 m).

Impacts on Serious and Irreversible Impact Entities

In accordance with Section 10.2 of the BAM, an assessment for one 'Serious and Irreversible Impact' (SAII) entity was conducted for the CEEC – White Box - Yellow Box - Blakely's Red Gum Woodland (Box Gum Woodland CEEC).

BAM-C Assessment

Section 6.4.1.7 of the BAM requires separate habitat suitability assessments to be conducted for each IBRA subregion for linear developments. As the Project comprises a linear development that extends across four IBRA-subregions, a total of four separate "child case" assessments were conducted for each subregion.

7.5.3 Impact Assessment

Landscape Features

No important wetlands listed in the Directory of Important Wetlands in Australia are present in the Disturbance Area, with the closest being the Barrington Tops Swamps located 30 km north-east. The main fauna corridor in occurs in the north-eastern parts of the Survey Area. The vegetation in this corridor lies at the western extent of a band of dense vegetation that extends generally eastwards towards Mount Royal National Park shown on **Figure 41**. On a wider regional level, with the exception to the vegetation corridor in the north-east, the Survey Area has patchy or "stepping-stone" connectivity to the north, west and east due to widespread clearing across large expanses of agricultural lands.

No karsts, caves, crevices, cliffs or areas of geological significance have been identified within the Survey Area. A small cliff in an area known as Yellow Rock (see **Section 2.1**) is not located within the Disturbance Area but is present in the Survey Area in close proximity to a section of proposed underground reticulation.

No areas of outstanding biodiversity value have been mapped within the Survey Area.

Native Vegetation

The native vegetation extent (including DNG) within the Disturbance Area is shown in **Figure** 40 and occupies 330 ha, which represents approximately 61% of the Disturbance Area. **Figure** 41 to **Figure** 44 provide insets (see **Figure 40** for locations) to illustrate additional detail, including: Eastern and northern areas; Western Areas; and transmission line and road widening areas.

The native vegetation extent comprises predominantly remnant vegetation, with some scattered occurrences of planted vegetation within the public road corridor and Crown land. The remaining areas is comprised of exotic/cleared areas, dams and water (Lake Liddell).

Identification of the Plant Community Types (PCTs) occurring within the Disturbance Area and wider Survey Area was guided by the results of the surveys. The data collected during surveys of the Survey Area was analysed in conjunction with a review of the PCTs held within the BioNet Vegetation Classification Database.

The analysis determined that the native vegetation within the Survey Area aligned with 18 PCTs (with PCT 618 occurring in two condition states), as shown in **Table** 25. Discussion on the justification for PCT selection and condition stage is included **Appendix L**. This section also includes a vegetation integrity assessment.

Groundwater Dependant Ecosystems

Five PCTs within the Disturbance Area and Survey Area that could potentially comprise GDEs were identified: PCTs 486, 1541, 1543, 1731 and 1071.

As PCT 1541 and PCT 1543 occur at relatively high elevations on hillslopes, they are unlikely to be able to access deeper groundwater sources and therefore are considered, at most, to be opportunistic GDEs.

As PCT 486 is located along existing creek lines, it is more likely to be dependent on soil moisture and the surface water flows present in the creeks (when flowing). Given that most creeks within the Disturbance Area and survey area comprise ephemeral to intermittent streams, the contribution of groundwater towards the baseflow in creeks is considered to be very low to unlikely. PCT 486 is at most, considered to be an opportunistic GDE.

PCTs 1731 and 1071 are limited to the shores of Lake Liddell and represent degraded regrowth on highly disturbed lands. Given that the occurrence of these PCTs is limited to areas where the known water source comprises a large lake, the occurrences of PCT 1731 and PCT 1071 within the Disturbance Area are not considered to comprise groundwater dependent wetlands.

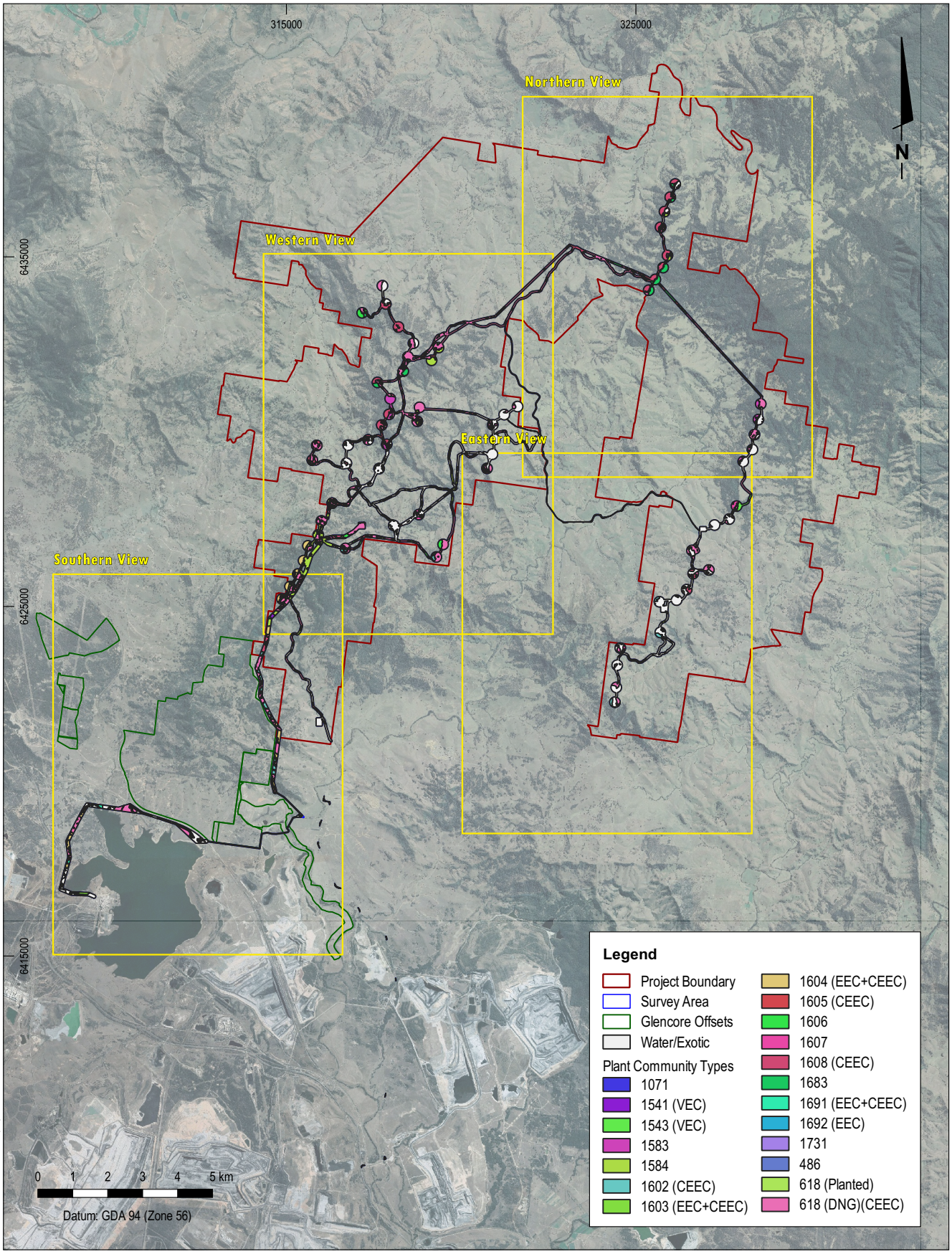
Table 25
Plant Community Types within the Survey Area

PCT	PCT Name	BC Act Status	EPBC Act Status	Survey Area (ha)
486	River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range	-	-	5.2
1541	Whalebone Tree - Red Kamala dry subtropical rainforest of the lower Hunter River	VEC – Lower Hunter Valley Dry Rainforest	-	1.2
1543	Rusty Fig - Native Quince - Native Olive dry rainforest of the Central Hunter Valley	VEC – Lower Hunter Valley Dry Rainforest	-	4.9
1583	Thin-leaved Stringybark - Grey Gum - Broad-leaved Apple shrub - grass tall open forest on ranges of the lower North Coast	-	-	29.8
1584	White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley	-	-	64.4
1683	Silvertop Stringybark - Tussock Grass grassy open forest of the Northern Tablelands escarpment and Barrington Tops	-	-	25.4
1602	Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	-	CEEC - Central Hunter Valley Eucalypt Forest and Woodland	25.3
1604	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	EEC – Central Hunter Grey Box – Ironbark Woodland	CEEC - Central Hunter Valley Eucalypt Forest and Woodland	31.9
1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	-	CEEC - Central Hunter Valley Eucalypt Forest and Woodland	1.4
1606	White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	-	-	16.6
1607	Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	-	-	13.1
1608	Grey Box - Grey Gum - Rough-barked Apple - Blakely's Red Gum grassy open forest of the central Hunter	CEEC – White Box - Yellow Box - Blakely's Red Gum Woodland and Derived Native Grassland (Woodland form)*	CEEC – White Box - Yellow Box - Blakely's Red Gum Woodland and Derived Native Grassland (Woodland form)	107.1

PCT	PCT Name	BC Act Status	EPBC Act Status	Survey Area (ha)
618 (DNG)	White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley (derived native grassland)	CEEC – White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and DNG (DNG only)*	CEEC – White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and DNG (DNG only)	359.9
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	EEC – Central Hunter Grey Box – Ironbark Woodland	CEEC – Central Hunter Valley Eucalypt Forest and Woodland	2.6
1603	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	EEC – Central Hunter Grey Box – Ironbark Woodland	CEEC - Central Hunter Valley Eucalypt Forest and Woodland	2.7
1692	Bull Oak grassy woodland of the central Hunter Valley	EEC – Central Hunter Grey Box – Ironbark Woodland	-	0.2
1731	Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	-	-	1.5
1071	Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	-	-	0.7
618 (Planted)	White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley (Planted form)	-	-	5.0

*"-" Not listed. * EEC in current version of BAM-C*

Source: Plant Community Types courtesy of Cumberland Ecology (2020); Aerial ©2019 Google



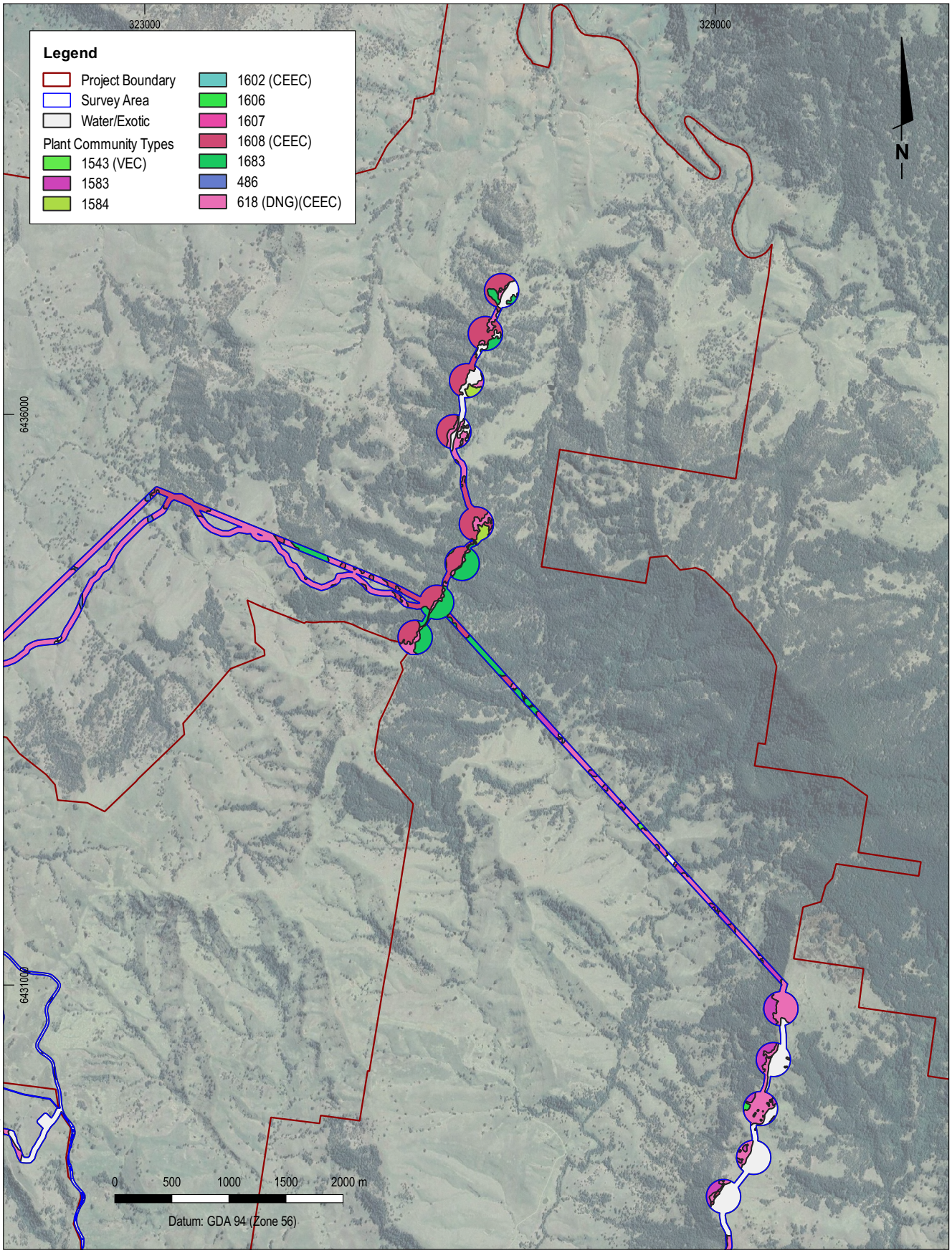
BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Vegetation Communities

FIGURE 40

Source: Plant Community Types courtesy of Cumberland Ecology (2020); Aerial ©2019 Google



Bowmans Creek Wind Farm | | 23.03.2021

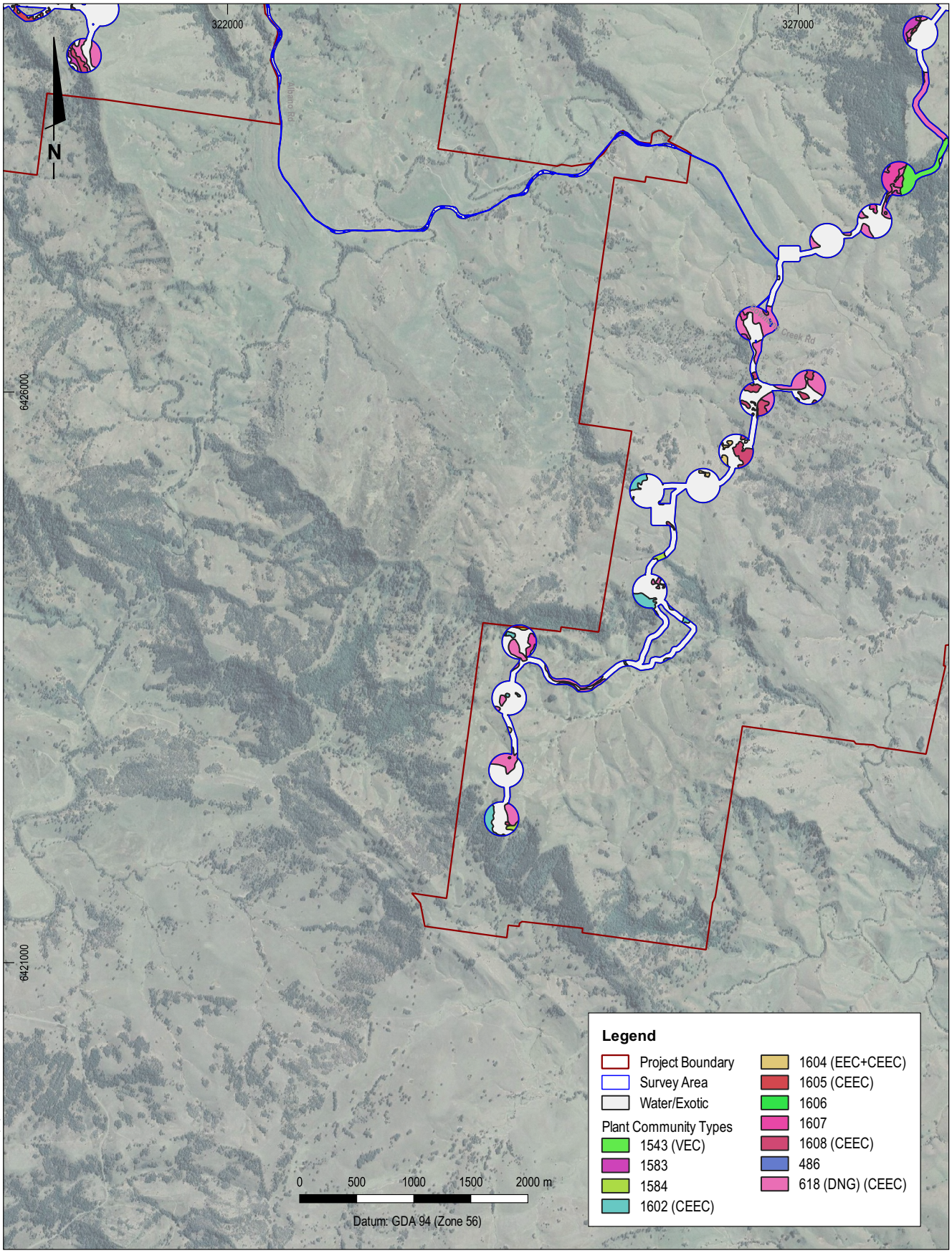
BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Vegetation Communities - Northern

FIGURE 41

Source: Plant Community Types courtesy of Cumberland Ecology (2020); Aerial ©2019 Google



Bowmans Creek Wind Farm | | 23.03.2021

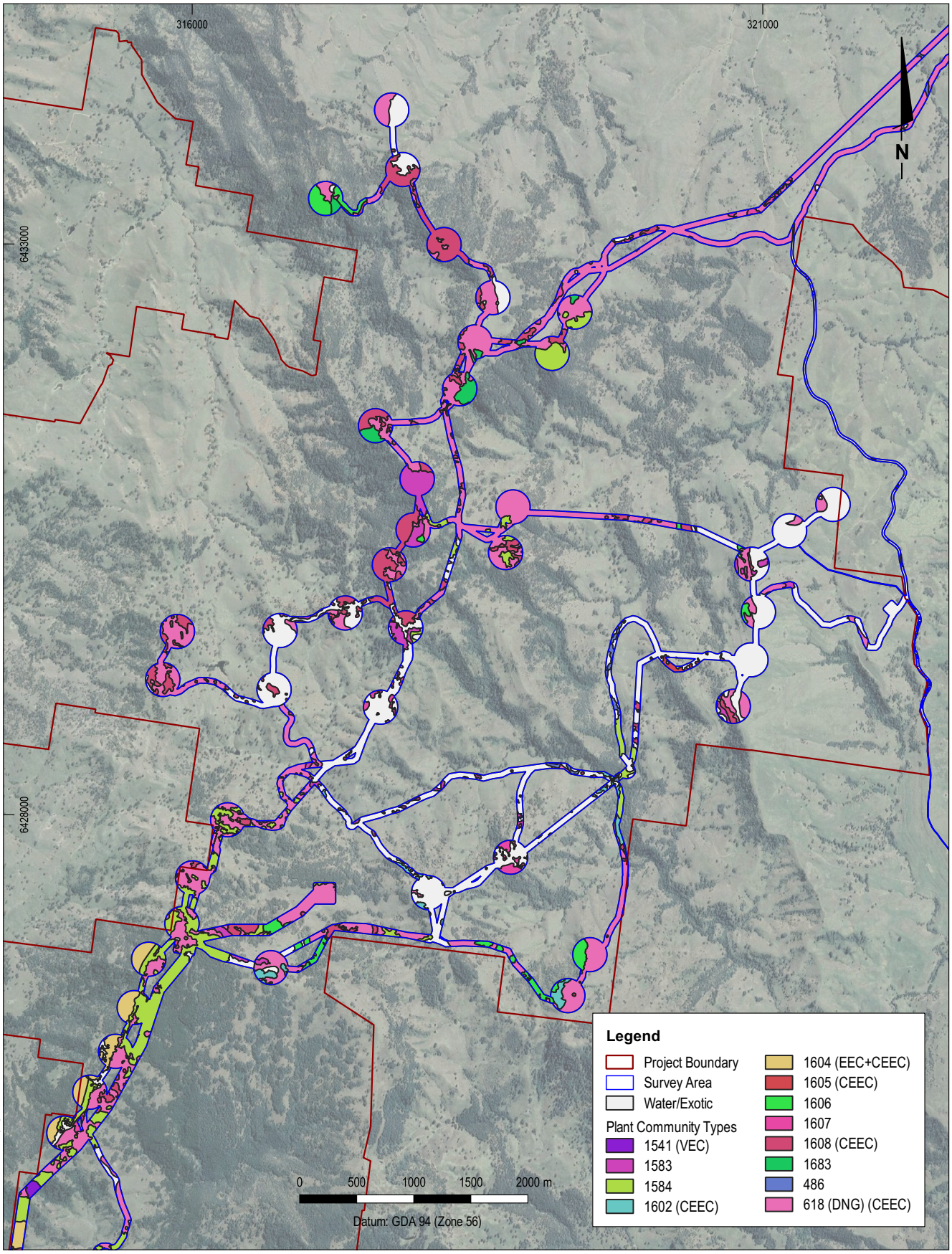
BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Vegetation Communities - Eastern

FIGURE 42

Source: Plant Community Types courtesy of Cumberland Ecology (2020); Aerial ©2019 Google



Bowmans Creek Wind Farm | | 23 03 2021

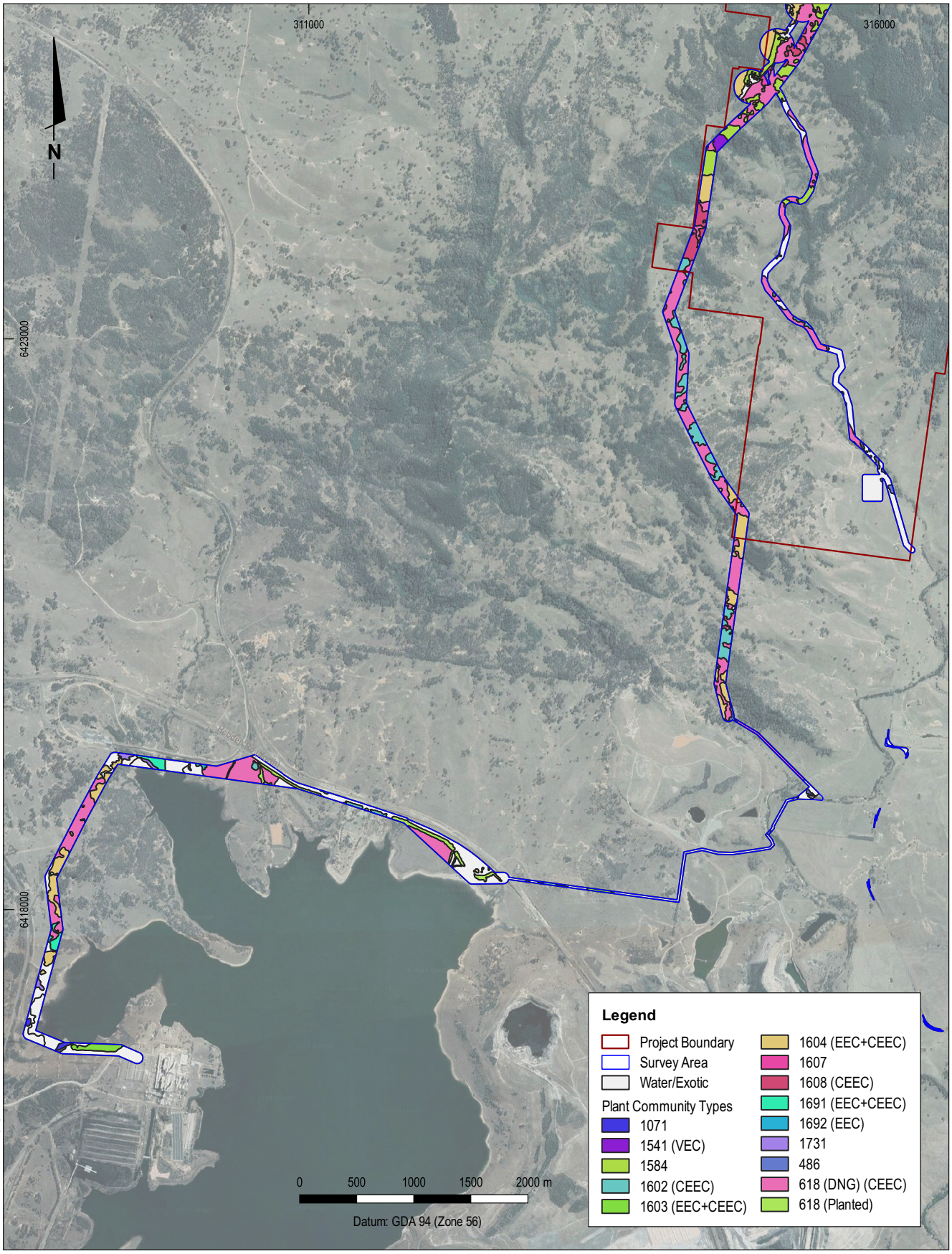
BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Vegetation Communities - Western

FIGURE 43

Source: Plant Community Types courtesy of Cumberland Ecology (2020); Aerial ©2019 Google



BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Vegetation Communities - Southern

FIGURE 44

Threatened Species

Credit Species

The BAM-C generates a list of threatened species requiring assessment utilising a number of variables. The following criteria have been utilised to predict the threatened species requiring further assessment for the Project: IBRA subregions: Hunter, Upper Hunter, Tomalla, Ellerston, Geographic constraints, associated PCTs including: 486, 1541, 1543, 1583, 1584, 1683, 1602, 1604, 1605, 1606, 1607, 1608, 618 (two condition states), 1691, 1603, 1692, 1731, 1071; percent native vegetation cover within the Survey Area for each IBRA subregion, Patch size: >100 ha; and Credit type: Ecosystem and/or species.

Based on the above variables, the BAM Calculator generated a list of 54 ecosystem credit species and 75 species credit species across the four IBRA subregions. These totals include 20 dual credit species which are considered as ecosystem credit species for their foraging habitat and as species credit species for their breeding habitat.

A total of two candidate species credit species were assessed as occurring in the Disturbance Area, including: Large-eared Pied Bat and Brush-tailed Phascogale. The Brush-tailed Phascogale was assumed present based on the presence of suitable habitat. The Large-eared Pied Bat was recorded on ultrasonic bat detectors at two locations. Additionally, the Square-tailed Kite was recorded within the Disturbance Area but has been assessed as an ecosystem credit species for foraging habitat only due to lack of breeding habitat. No candidate threatened flora species were recorded.

In relation to non-candidate species, the following threatened bat species were recorded: Eastern Coastal Freetail-bat, Large Bent-winged Bat, and Yellow-bellied sheath-tailed bat.

The following ecosystem credit species were recorded during the bird surveys: Brown Treecreeper, Dusky Woodswallow, Little Lorikeet, Scarlet Robin, Speckled Warbler and Spotted Harrier. The locations of threatened fauna species are shown in **Figure 45**.

Aquatic Species

The majority of the higher order streams within the Survey Area overlap with areas mapped as Key Fish Habitat for the SSC, MSC and UHSC. As all WTGs are proposed to be built on ridges and hillslopes away from these water sources, any potential impacts on Key Fish Habitat are likely to be limited to construction of access tracks and supporting infrastructure. The Project is considered unlikely to significantly impact upon matters listed under the FM Act and no further assessments are considered warranted.

Prescribed Impacts

Prescribed impacts as identified in Clause 6.1 of the *Biodiversity Conservation Regulation 2017* (additional to the clearing of native vegetation and associated habitat) which are relevant to the Project include:

- Connectivity of different areas of habitat that facilitates movement across a species' range;
- Vehicle strikes,
- WTG strikes;
- Barrier effect; and
- Habitat removal for protected species.

Habitat Connectivity

The fragmented or stepping-stone movement corridors within the Disturbance Area is likely to provide connectivity for ecosystem species, such as the Grey-headed Flying-fox, microchiropteran bats and avifauna.

Habitat connectivity will be reduced by the long-term removal of approximately 133 ha of woody vegetation within vegetation zones 1 – 12 and vegetation zone 14 which form part of fragmented or stepping-stone habitats.

As the Project is linear in nature and involves relatively narrow clearance corridors, it does not result in large consolidated areas of clearing. As much of the disturbance area occurs in cleared grasslands or open woodlands with widespread tree cover, fragmentation in terms of habitat use by fauna is likely to be minimal. The reduction of this area of habitat is not considered to significantly impact the movement of mobile fauna species.

Vehicle Strike

Current vehicular usage across most of the Disturbance Area and Survey Area is limited to occasional usage by landowners for agricultural purposes.

Regular usage for the maintenance of WTGs will increase the number of vehicles that will be accessing the Disturbance Area. However, as the tracks are windy, step and unsealed, vehicle speeds will remain such that fauna vehicle strikes have a low likelihood of occurrence.

WTG Blade Strike / Barotrauma

WTG strike or collision risk is the likelihood of individual species occurring in the proximity of a wind farm colliding with a WTG. Collision risk varies with species, number and behaviour of birds, site specific topography, weather conditions, WTG height/design and WTG layout (Smales, 2006).

In addition to fatalities caused directly by WTG blade strikes, microchiropteran bats are known to be at risk to a condition known as “Barotrauma”. This condition is caused by air pressure changes around WTG blades, which can result in tissue and lung damage (Baerwald et al., 2008). WTG blades create zones of low-pressure as air flows over them and animals entering these low-pressure zones may suffer barotrauma. Microchiropteran bats most at risk from barotrauma comprise relatively high-flying species that prefer to forage above canopy height.

Flight height and strike risk assessments determined that the vast majority of bird and bat species occurring within the Survey Area occur below RSA height or occur in suitably lower abundances such that the strike risk is considered to be negligible.

Threatened and non-threatened bird and bat species recorded within the Survey Area that regularly fly at RSA height and have some strike risk include the Wedge-tailed Eagle, Spotted Harrier, Large Bent-winged Bat and White-striped Freetail Bat.

Although the Wedge-tailed Eagle is not a listed threatened species on mainland Australia, it is recognised as an at-risk raptor species in wind farm developments as it is considered vulnerable to collision with operating WTGs because of their soaring habits while foraging. Similarly, while the White-striped Freetail Bat is not a listed threatened species, it is considered an at risk species for WTG strike/barotrauma due to its regular flights at RSA height.

Birds

A total of 91 bird species were recorded across the Survey Area during surveys. The species of birds recorded largely comprised those commonly found in wooded agricultural landscapes in south-eastern Australia. Data for the past few decades, as provided by local bird watchers, indicated the presence of an additional 42 bird species beyond those recorded during surveys within the Survey Area.

Of the 133 birds in the combined dataset, only two species the Fork-tailed Swift and the Satin Flycatcher are listed migratory species under the EPBC Act. Sightings of the Satin Flycatcher were limited to occasional individuals, mainly in the north-eastern parts of the Survey Area.

A total of 23 birds (~17.5%) were assessed as regularly occurring at RSA height with a further 21 birds (~16%) assessed as occasionally entering the lower extent (~40 - 50 m) of the RSA height. Although the distribution of birds flying at RSA heights varied across the Survey Area, birds were not observed to be flying at RSA heights at one location more than others. This indicates that the risk to birds at RSA height is relatively uniformly distributed over the Survey Area.

A risk assessment, based on the Risk Evaluation Matrix Model which is relied upon to assess environmental risk across a wide range of industry sectors, was used to measure the overall risk of blade strike/collision for the 44 bird species assessed as occurring at RSA height. Although the Disturbance Area lies outside of the mapped important areas for Regent Honeyeater and Swift Parrot and no incidental sightings of these species were recorded during surveys or in data provided by local birdwatchers, due to the Critically Endangered listing for these species under both the BC Act and the EPBC Act, these species were included in the strike risk assessments as a precautionary measure.

Based on the outcome of the Risk Assessment, risk of blade strike/collision for most birds was negligible. None were rated severe or high. Species assessed as a Moderate to Low risk include:

- Wedge-tailed Eagle;
- Spotted Harrier;
- Regent Honeyeater; and
- Swift Parrot.

Collision risk modelling developed for Australian birds by Biosis Research (Biosis Research, 2006; Smales, 2013) indicates that most species are assumed to have an avoidance rate of 98-99% (i.e. 1 in 100 likelihood of collision with WTG rotors). However due to their size and flight behaviour, Wedge-tailed Eagles have a lower avoidance rate at between 90% and 95% (Smales, 2006).

The surveys, combined with discussions with landowners and data provided by local birdwatchers indicate the Project potentially lies within the home range of at least 2 – 4 resident Wedge-tailed Eagles. Based on the common occurrence of this species, regular flight at RSA height and relatively lower avoidance rate, the blade strike/collision risk for this species is considered to be moderate. However, it is noted that studies of Wedge-tailed Eagles have found resident Wedge-tailed Eagles at most wind farms and have even detected successful breeding within 200 m of operating WTGs (BL&A, 2017).

The Spotted Harrier is nomadic with movements linked to the abundance of prey species. It is widespread but generally uncommon. Although the species can occur almost anywhere in mainland Australia, the stronghold of the Spotted Harrier is the arid and semi-arid zones (Australia, 2020). The Spotted Harrier is an ecosystem credit species and is generally not associated with the vegetation communities present within the Survey Area. Although it regularly occurs at RSA height, the strike risk is considered to be low, especially as the main stronghold for this species lies outside the Survey Area.

Although the Survey Area lies outside of Mapped Important Area for the Regent Honeyeater and Swift Parrot, a Risk Assessment was conducted for this species as flocks can potentially converge on flowering coastal woodlands and forests outside of the important areas. Although the likelihood of a strike is Rare, the consequences of loss of even one individual is considered to be High given the Critically Endangered status of this species. However, given the paucity of records in the locality, the risk rating of Low is considered to be highly conservative.

Bats

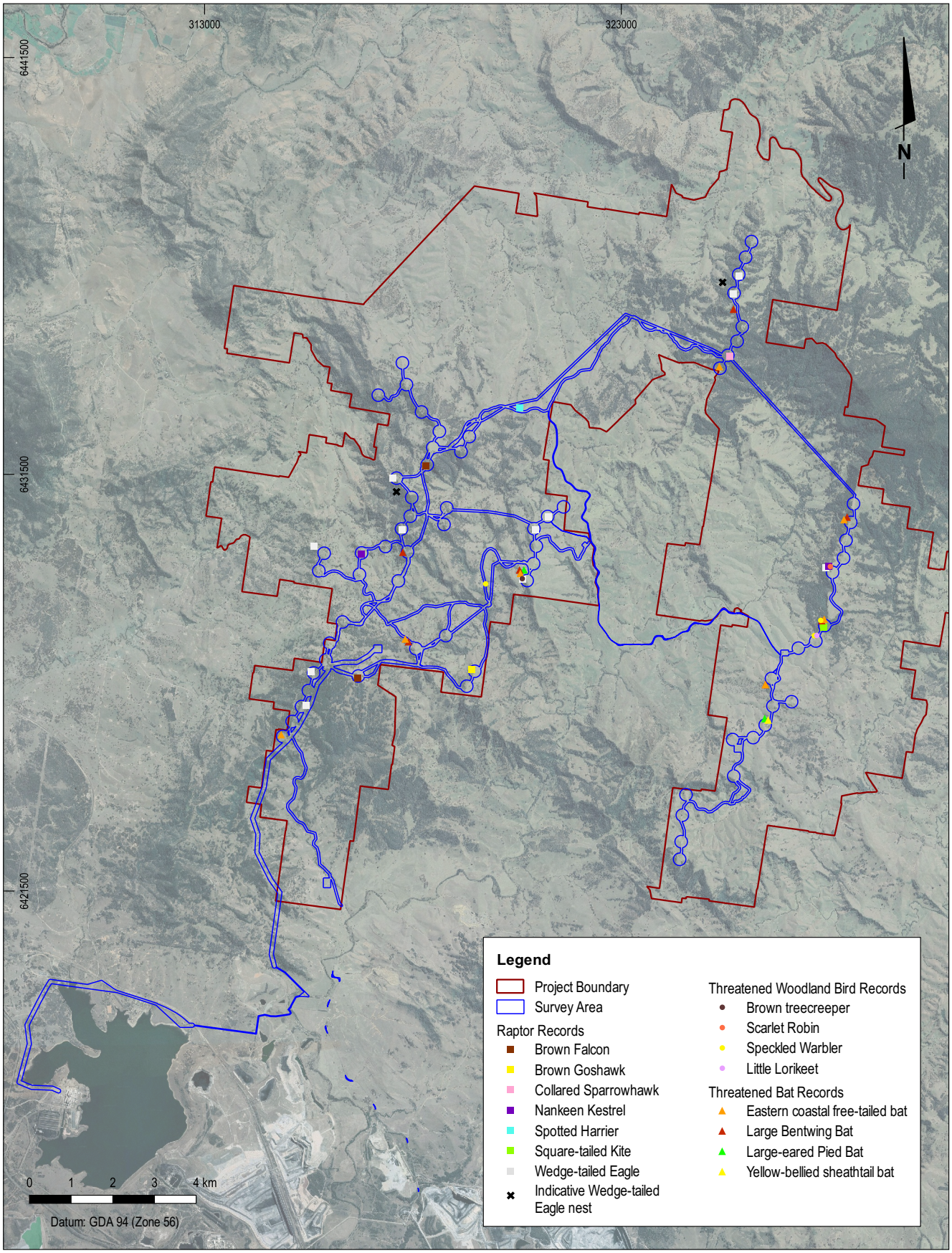
A total of 15 microchiropteran bat species were positively identified across the ultrasonic recordings and harp trapping conducted within the Survey Area. The occurrence of threatened bat species was rare to uncommon and included five species.

The potential for collision for the Large-eared Pied Bat is considered to be unlikely as this species generally flies at heights of about 6 – 10m but the consequence is considered to be moderate for any existing local population given the rarity of the species. The risk rating of Low is highly conservative.

Large Bent-winged Bat migrates annually to maternity caves where females breed and hibernate while males can remain dispersed throughout suitable habitat. Females emerge after breeding period and disperse across landscape. The foraging behaviour in treed areas indicates that the species may be at risk from WTG interactions when dispersing in large numbers from maternity/breeding caves. The closest known maternity caves to the Project include the Willi Willi caves in the Macleay Karst Arc, located approximately 200 km north-east of the Project and the Kanangra-Boyd Karst in the Kanangra-Boyd NP, located approximately 200 km south-south-west of the Project. Although the Large Bent-winged-bat is known to fly at RSA height, due to distance of maternity cave and fragmentation of habitat (i.e. large areas of grassland) in the Survey Area, significant numbers not expected to occur at RSA height within the Survey Area. Accordingly, the collision risk is considered to be Low.

The White-striped Freetail bat the largest and most widely distributed of Australia's free-tail bats and can be found across all of southern Australia. Although the White-striped freetail bat is almost certain to be impacted, the species is widespread and common and the risk consequences to the population are considered to be Low.

Source: Threatened fauna locations courtesy of Cumberland Ecology (2020); Aerial ©2019 Google
Note: Overlapping fauna locations have been moved slightly to ensure visibility



Bowmans Creek Wind Farm | Fig45_Threatened Fauna Species | 11 03 2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Threatened Fauna Species

FIGURE 45

Habitat Removal

The primary habitat feature for protected species that will be removed/impacted comprises hollows within trees. Hollows potentially provide roosting habitat for threatened and non-threatened fauna species such as microbats, parrots, owls and arboreal mammals.

HBTs were recorded across the Survey Area and occur in all vegetation zones / PCTs as well as within isolated scattered trees within grassland areas. In general, the majority of hollows were of small to medium hollow entrance size and are most likely to be utilised by small to medium birds and microchiropteran bats, rather than owls and gliders. The impact of HBT removal is assessed within the BAM-C via the plot data collected for each vegetation zone. This data adds to the value of the habitat to be removed, thereby requiring a greater number of credits to be retired.

Barrier Effect

The long-term risk of barrier effects is largely confined to the sections of WTG clusters. No large flocks utilising habitual flight paths were observed during surveys. The relative paucity of migratory birds indicates that the Survey Area is unlikely to comprise a habitual flight path for migratory bird species. The Survey Area has patchy or "stepping-stone" connectivity to the north, west and east due to widespread clearing across agricultural lands. Connectivity to the south is further reduced by the presence of hostile barriers such as the NEH and multiple open cut mines.

Although parts of the Survey Area in the north-west have connectivity to vegetation that extends into Mount Royal National Park to the east, the vegetation within the Survey Area largely comprises the western-most extent of the connected vegetation and therefore is unlikely to comprise part of a major regional corridor due to extent of cleared lands to the west.

Impacts on Serious and Irreversible Impact Entities

The SAII entity, White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland or Box Gum Woodland TEC will be impacted by the Project. This community is represented by two PCTs - PCT 1608 and PCT 618 (DNG form only).

The location of Box Gum Woodland in relation to the disturbance area is shown in **Figure 41** to **Figure** 44. The extent of clearing is likely to be reduced as the Disturbance Area is refined at the detailed design stages. Nonetheless, as a conservative estimate, approximately 234 ha of Box Gum Woodland, in the form of approximately 39 ha of woodland and 196 ha of DNG, has been assessed as directly impacted in the form of removal as a result of the Project.

A detailed review is presented in **Appendix L**. It concluded that the Project is unlikely to result in a significant and irreversible impact to the TEC.

Avoidance and Disturbance Minimisation

Based on the requirement for WTGs to be placed on the ridge top and the presence of TECs and threatened species across the Survey Area, including on ridgetops, opportunities to avoid all impacts are limited. The linear layout of WTGs along ridgelines, required for the wind farm to function at an economically feasible capacity has limited the extent to which WTGs can be moved to avoid impacts.

A number of amendments have been able to be made to the location of the Project and the components within the disturbance area which have resulted in avoidance or minimisation of impacts on native vegetation and habitat, including:

- Designing location of turbines to maximise avoidance of threatened ecological communities, in particular communities listed under both BC Act and EPBC Act;
- Designing access in consideration of current tracks, roads and creek crossings present within the Survey Area where possible, to avoid additional vegetation clearance for access;
- Placement of WTGs in cleared or treeless areas, wherever possible, to minimise tree clearance and hollow loss;
- For WTGs in woodland areas, situating WTGs in naturally lower density areas or areas where disturbance (e.g. from grazing) has previously taken place, wherever possible;
- Hollow-bearing tree clearance has been avoided, where possible to date and will be further avoided where practical during detailed design and micro-siting;
- Placement of construction compounds, substations and rock crushing facilities outside areas of native vegetation, where possible;
- A commitment to the removal of canopy only and retention of understorey where possible for the installation of the external overhead powerlines;
- Placement of underground reticulation within the access track footprint where possible to allow for temporary rather than permanent disturbance; and
- Where possible, utilisation of existing creek crossings to minimise impacts on hydrological processes.

A discussion on Project changes to reduce environmental impacts is provided in **Section 3.10**.

Habitat connectivity, vehicle strike and WTG strike/barotrauma have been identified as prescribed impacts for the Project. In determining the location and design of the disturbance area, the Project has sought to avoid and minimise these prescribed impacts by:

- Retaining areas of native vegetation, including mature canopy trees where feasible;
- Maximising WTG spacing to allow greater opportunity for birds and bats to pass between WTG and reduce collision risk;
- Maintenance of a buffer between all WTGs and nearby hollow-bearing trees (where practical) to minimise the likelihood of bird and bat strike during operation; and
- Speed limits specified across access tracks to reduce risk of vehicle strike to fauna.

Direct Impact Summary

The primary and direct impact resulting from the Project is the loss of vegetation and associated habitat within the indicative Disturbance Area (shown in **Appendix L**) of up to 515 ha. **Table 26** and **Table 27** identify the indicative impacts to vegetation and threatened species habitat within the Disturbance Area. Impacts to PCT 1-18 (including two condition states for PCT 618) total up to 330 ha.

The distribution of disturbance across the different types of infrastructure is summarised in **Table 28**. This conservative assessment assumes 100% vegetation clearance beneath overhead reticulation and transmission lines of 186 ha (of which 44 ha is exotic vegetation or dams) and up to 50 m disturbance for access tracks across 295 ha (of which 121 ha is exotic or dams). WTG footings of up to 13 ha have been included.

Construction compounds, the O&M Facility, batch plants and substation are conservatively estimated to total 12 ha. External road upgrades of 7 ha have been calculated. Detail on the change in vegetation integrity score for each vegetation zone and management zone is presented in **Appendix L**.

Table 26
Plant Community Type Vegetation Impacts

Vegetation Zone	PCT Name (Listing^)	Indicative Disturbance Area (ha)				
		Total	***Hunter***	***Upper Hunter***	***Tomalla***	***Ellerston***
1	486	4.0	0.1	1.4	1.2	1.3
2	1541 (VEC)	0.8	-	-	-	0.8
3	1543 (VEC)	0.3	-	0.2	0.1	-
4	1583	10.0	-	0.7	9.3	-
5	1584	33.2	-	4.2	10.0	19.0
6	1683	6.2	-	-	6.2	-
7	1602 (CEEC)	12.0	1.5	2.8	1.8	5.9
8	1604 (EEC and CEEC)	11.4	6.2	0.1	-	5.2
9	1605 (CEEC)	1.3	-	-	1.3	-
10	1606	5.9	-	-	5.8	-
11	1607	3.2	-	0.6	1.9	0.7
12	1608 (CEEC)	38.8	-	2.1	25.9	10.8
13	618 (DNG) (CEEC)	195.6	14.1	15.8	111.8	53.9
14	1691 (CEEC and EEC)	1.5	1.5	-	-	-
15	1603 (EEC and CEEC)	1.9	1.9	-	-	-
16	1692 (EEC)	0.1	0.1	-	-	-
17	1731	0.9	0.9	-	-	-
18	1071	0.4	0.4	-	-	-
19	618 (planted)	2.0	2.0	-	-	-
TOTAL*		**329.5**	**28.7**	**27.8**	**175.4**	**97.6**

*^ See Table 25 for relevant legislation. *Minor differences may occur due to rounding.*

Table 27
Threatened Species Impacts

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Area (ha)*				
				Total	***Hunter***	***Upper Hunter***	***Tomalla***	***Ellerston***
Chalinolobus dwyeri	Large Eared Pied Bat	Vulnerable	Vulnerable	2.0	-	0.0	2.0	-
Phascogale tapoatafa	Brush-tailed Phascogale	Vulnerable	-	32.9	10.5	0.9	16.4	5.2

**Minor differences may occur due to rounding.*

Table 28
Disturbance Area by Infrastructure Type

Zone	PCT*	WTG Footing	Access Tracks	Underground reticulation	Overhead reticulation	Batch plant	Sub-station	Construction compound	O&M Facility	Road upgrades	Transmission line	Total
1	486	-	3.5	-	0.3	-	-	-	-	0.1	0.1	4.0
2	1541	-	-	-	-	-	-	-	-	-	0.8	0.8
3	1543	-	-	0.1	0.0	-	-	-	-	-	-	0.1
4	1583	0.4	5.4	0.0	3.8	-	-	-	-	-	0.5	10.0
5	1584	0.7	16.2	0.0	4.2	0.0	0.7	-	-	-	11.4	33.2
6	1683	0.2	2.4	0.0	3.7	-	-	-	-	-	-	6.2
7	1602	0.0	4.5	-	0.4	-	-	-	-	0.1	7.0	12.0
8	1604	0.2	0.5	-	-	-	-	-	-	-	10.7	11.4
9	1605	-	1.2	-	0.1	-	-	-	-			1.3
10	1606	0.0	4.4	-	0.6	-	-	-	-	-	0.9	5.8
11	1607	0.0	1.8	0.0	1.4	-	-	-	-	-	-	3.2
12	1608	1.5	24.2	0.1	8.6	0.1	0.1	-	-	0.1	4.2	38.8
13	618 (DNG)	4.3	109.9	0.4	41.4	0.2	3.7	-	-	0.1	35.6	195.6
14	1691	-	-	-	-	-	-	-	-	-	1.5	1.5
15	1603	-	-	-	-	-	-	-	-	-	1.9	1.9
16	1692	-	-	-	-	-	-	-	-	-	0.1	0.1
17	1731	-	-	-	-	-	-	-	-	-	0.9	0.9
18	1071	-	-	-	-	-	-	-	-	-	0.4	0.4
19	618 (planted)	-	-	-	-	-	-	-	-	-	2.0	2.0
-	Exotic	5.8	119.9	1.5	18.2	1.0	2.1	4.2	0.3	6.5	20.9	180.2
-	Dam/Water	-	0.6	-	0.2	0.0	0.0	0.0	-	-	4.3	5.1
Total		**13**	**295**	**2**	**83**	**1**	**7**	**4**	**0**	**7**	**103**	**515**

** See Table 26 for Listing.* *# In some cases total may not equal the appropriate total number due to rounding.*

Indirect Impacts

As the Disturbance Area occurs within highly modified agricultural lands, essential supplies land and parts of a public road corridor, the indirect impacts of the Project are not considered to be significant. **Appendix L** outlines the indirect impacts to native vegetation and habitat.

7.5.4 Mitigation and Management

With the implementation of the proposed avoidance, management and offsetting measures described below, the Project is considered likely to maintain or improve biodiversity values in the long term and will meet the no net loss standard required under the BAM.

The Proponent has committed to meeting the following range of measures for the Project to mitigate the residual impacts that are unable to be avoided.

Habitat Connectivity

The following mitigation measures are proposed to limit any impacts on habitat connectivity:

- Delineation of clearing limits;
- Pre-clearance survey;
- Staging of clearing; and
- Habitat feature salvage.

Felled logs / other features from cleared areas that are suitable for habitat enhancement may be provided to the landholder for their habitat enhancement works, if requested.

Vehicle Strike

The following mitigation measures are proposed to limit impacts due to vehicle strike:

- Security measures to limit access to the track network to authorised personnel and relevant landowners;
- Installation of appropriate signage notifying vehicles of potential fauna presence;
- Speed limits to restrict the speed of vehicles travelling along the access tracks; and
- Consideration of implementation of measures identified in ongoing research (Australian or international studies) that reduce risks of bird/bat strike at wind farms such as use of "Identi-flight" cameras (or similar) or painting single turbine blades black.

Detailed Design Surveys

During the detailed design stage, additional survey will be undertaken to confirm the presence of any potential threatened flora species so that access track (and other relevant infrastructure components) alignments can be adjusted to minimise any impacts to threatened flora.

Native Vegetation and Habitat

Table 29 provides a summary of mitigation measures for impacts to native vegetation and habitat.

Table 29
Mitigation Measures for Impacts to Native Vegetation and Habitat

Mitigation Measure	Proposed Techniques	Timing	Frequency	Risk and Consequences of Residual Impacts
Further threatened flora searches	Searches conducted in all areas of appropriate habitat in accordance with the NSW Guide to Surveying Threatened Plants (OEH, 2016)	Detailed design phase	At least one survey period for each species. Further surveys as required during refinement of design	Potential loss of local populations of threatened flora species, if present
Weed management	Appropriate weed control activities will be undertaken in accordance with the Hunter Regional Strategic Weed Management Plan 2017 – 2022 (LLS, 2017) (or latest version)	Construction	Prior to construction, following vegetation clearing	Spread of weeds throughout the Survey Area and surrounding land
Delineation of clearing limits	Clearing limits marked on trees fencing or an equivalent boundary marker Disturbance, including stockpiling, restricted to clearing limits	Construction	Once	Unnecessary damage to trees or vegetation to be retained
Pre-clearance survey	Pre-clearance surveys will be conducted in all areas of vegetation that are required to be cleared Pre-clearing surveys will be undertaken within one week of clearing. Habitat features will be marked	Construction	Once	Increased and unnecessary mortality of native fauna
Staging of clearing	Clearing will be conducted in a two-stage process Animals disturbed or dislodged during the clearance but not injured will be assisted to move to adjacent bushland or other specified locations	Construction	Once	Increased and unnecessary mortality of native fauna
Sedimentation control	Construction activities will be undertaken in accordance with "The Blue Book' (Landcom, 2004).	Construction	Throughout construction period	Sedimentation into retained and adjoining vegetation

Project Ecological Offsets

The BAM sets a standard that will result in no net loss of biodiversity values where the impacts on biodiversity values are avoided, minimised and mitigation, and all residual impacts are offset by retirement of the required number of biodiversity credits.

The biodiversity credit requirement for the Project is summarised in **Table 30**. Credit reports outlining the like-for-like credit options are provided in **Appendix L**.

Table 30
Project Ecological Offset Credit Summary

Entity*	Status^	Credits				
		Hunter	Upper Hunter	Tomalla	Ellerston	Total
PCT 486	Not listed	3	37	30	34	104
PCT 1541	VEC – BC Act only	-	-	-	26	26
PCT 1543	VEC – BC Act only	-	4	3	-	7
PCT 1583	Not listed	-	23	295	-	318
PCT 1584	Not listed	-	123	296	563	982
PCT 1683	Not listed	-	-	215	-	215
PCT 1602	CEEC – EPBC Act	48	84	56	179	367
PCT 1604	CEEC – EPBC Act EEC – BC Act	213	4	-	170	387
PCT 1605	CEEC – EPBC Act	-	-	29	-	29
PCT 1606	Not listed	-	1	137	-	138
PCT 1607	Not listed	-	14	47	18	79
PCT 1608	CEEC – EPBC Act CEEC – BC Act (EEC in current version of BAM-C)	-	75	923	385	1383
PCT 618 (DNG)	CEEC – EPBC Act CEEC – BC Act (EEC in current version of BAM-C)	161	150	1058	510	1,879
PCT 1691	CEEC – EPBC Act EEC – BC Act	52	-	-	-	52
PCT 1603	CEEC – EPBC Act EEC – BC Act	62	-	-	-	62
PCT 1692	EEC – BC Act	1	-	-	-	1
PCT 1731	Not listed	10	-	-	-	10

Entity*	Status^	Credits				
		Hunter	Upper Hunter	Tomalla	Ellerston	Total
PCT 1071	Not listed	12	-	-	-	12
PCT 618 (Planted)	Not listed	67	-	-	-	67
Large-eared Pied Bat	V – BC Act and EPBC Act	-	1	101	-	102
Brush-tailed Phascogale	V – BC Act	340	36	615	170	1161
PCT Totals		**629**	**515**	**3,089**	**1,885**	**6,118**
Species Totals		**340**	**37**	**716**	**170**	**1,263**

** See Table 26. CEEC – Critically Endangered Ecological Community, EEC - Endangered Ecological Community, V- Vulnerable.*

Revised Offset Calculations

Revised offset calculations to that presented above, utilising additional survey effort and the final project layout will include requisite credit calculations for any impacted threatened flora species. The calculations will be undertaken in accordance with conditions of development consent in consultation with relevant regulators.

Adaptive Management of Uncertain Impacts

The primary uncertain impact for the Project is the extent of blade strike/barotrauma risk to birds and bats. The adaptive management strategy for this uncertain impact is the preparation of a Bird and Bat Adaptive Management Plan (BBAMP). The Bird and Bat Adaptive Management Plan, as a minimum, will include:

- Ongoing bird and bat monitoring in accordance with the Best Practise Guidelines for implementation of Wind Energy Projects to assess the impact of the project on local and potential migratory bird and bat populations;
- A decision-making framework setting out thresholds and specific actions in relation to impacts to bird/bat populations identified by the monitoring surveys;
- Identification of mitigation measures and implementation timeframes, such as switching off/slowing down of specific turbines at specific timeframes or use of deterrents to reduce potential mortalities if identified during monitoring surveys; and
- Consideration of implementation of measures identified in ongoing research (Australian or international studies) that reduce risks of bird/bat strike at wind farms such as use of "Identi-flight" cameras or painting single turbine blades black.

Management Plan

A Biodiversity Management Plan and BBAMP will be prepared.

7.6 ABORIGINAL CULTURAL HERITAGE

7.6.1 Background

An Aboriginal and Cultural Heritage Assessment Report (ACHAR) was undertaken for the Project by Ozark Environment and Heritage Management Pty Ltd (Ozark) and is presented in **Appendix M**.

The purpose of the ACHAR was to identify and assess Aboriginal Cultural Heritage constraints and/or impacts relevant to the Project.

A summary of the ACHAR is presented below including key impact assessment findings, as well as management measures to minimise impacts as committed to by the Proponent.

Aboriginal Heritage Background

The Survey Boundary is located in the border country of the Wonnarua, Geawegal and Kamilaroi tribal areas of the upper Hunter River valley.

A regional archaeological context that focuses on work in similar landforms to the Project Boundary is provided in **Appendix M**. Those archaeological sites investigated revealed relatively sparse artefact concentrations in shallow and disturbed contexts. Given the nature and extent of the archaeological sites identified, there was little additional knowledge which could be added to the archaeological record from any further investigation of this material. There is little probability for the presence of undisturbed and deeply stratified archaeological sites.

7.6.2 Methodology

Relevant Guidelines

The ACHAR followed the 'Code of Practice for the Investigation of Aboriginal Objects in NSW' (DECCW, 2010) (Code of Practice) to meet the following objectives:

- Undertake background research on the Project Boundary to formulate a predicative model for site location within the Survey Boundary;
- Identify and record objects or sites of Aboriginal heritage significance within the Survey Boundary, as well as any landforms likely to contain further archaeological deposits; and
- Assess the likely impacts of the Project to Aboriginal cultural heritage and provide management and mitigation recommendations.

Appendix M tabulates the compliance of the ACHAR with the requirements established by the Code of Practice.

Field assessment and reporting followed the 'Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW' (OEH, 2011). A summary of consultation undertaken in accordance with the Consultation Guidelines with the RAPs is presented in **Section 5.6** and a detailed log in **Appendix M**.

Survey Units

For the purposes of the ACHAR, the Survey Boundary has been described as two distinct units: the hill and valley landforms in the north (Survey Unit 1) and the lowland landforms in the south (Survey Unit 2). Survey Units 1 and 2 are shown in **Appendix M**. **Plate 5** and **Plate 6** (sourced from **Appendix M**) provide indicative scenes from Survey Unit 1 and Survey Unit 2, respectively.

Survey Unit 1 is characterised by broadly benched spurs with moderate to steep slope forms off the crests/ridgelines. The slopes and creeks are largely bedrock controlled except for areas adjacent to the larger drainage lines such as Bowmans Creek that have some alluvial development. This topography has been largely cleared of trees in the past and has been used for long-term, low density grazing.

Survey Unit 2 contains the low undulating hills typical of the Hunter Valley floor, which are divided by drainage lines that once flowed into Bayswater Creek (now Lake Liddell) to the south. The lowlands have historically been used for grazing, with extensive grasslands the result of past clearance.

Modelling

The Aboriginal Site Decision Support Tool has been developed to support the assessment of Aboriginal site issues in NSW at the landscape-scale. Artefact site probability, scarred tree site probability and accumulated impacts have each been modelled using this tool. The modelled outcomes are summarised below:

- The majority of the Survey Boundary is in landforms with a low to moderate probability of recording artefact sites. Only the very southern portions of the Survey Boundary have a higher probability of recording this site type;
- The majority of the Survey Boundary is in landforms with a low to moderate probability of recording modified tree sites. The southern portions of the Survey Boundary have a slightly raised probability of recording this site type; and
- The majority of the Survey Boundary is in landforms with a low accumulated impact which raises the possibility of recording sites in these landforms.

AHIMS Search

A search of the AHIMS database returned 154 records of Aboriginal heritage sites within the designated search areas within 24 km^2 of the Survey Boundary. A review of the relevant AHIMS sites, shows that stone artefact sites (isolated finds, artefact scatters) are by far the most commonly-recorded local site types, together representing 148 (96%) of the 154 sites returned in the AHIMS database search area.

Recorded Sites

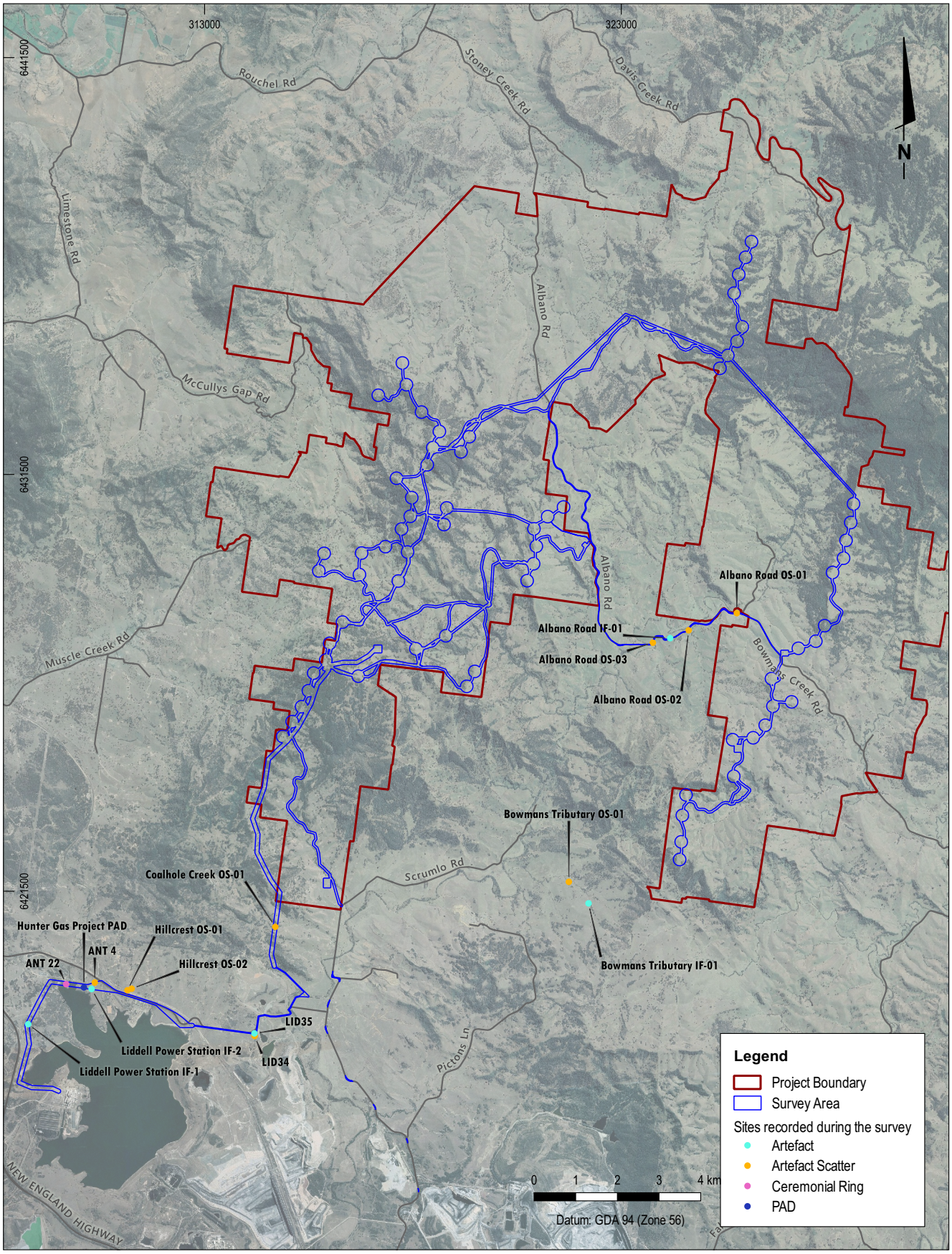
Figure 46 and **Table 31** show and describe the three previously recorded within the Survey Boundary on AHIMS. All AHIMS sites are located within the proposed Transmission Line Survey Area where the Transmission Line corridor passes to the north of Lake Liddell. The three sites consist of a PAD, artefact scatter and ceremonial ring.

An additional 13 sites were identified during the field survey as listed in **Table 31,** however only six of these sites are within the Survey Boundary.

Plate 5
Landscape around WTG 49 in the west of the Survey Boundary

Plate 6
View of the route of the Transmission Line on the Valley Floor

Source: Aerial ©2019 Google



Bowmans Creek Wind Farm | Fig46_Aboriginal Cultural Heritage | 15.03.2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Aboriginal Cultural Heritage

FIGURE 46

Table 31
Aboriginal Artefact Sites

Site Name	AHIMS ID	Features	Survey Unit	Landform
AHIMS Sites				
ANT 4	37-2-2021	Artefact scatter: 20 artefacts	2	Drainage line
Hunter Gas Project PAD	37-2-2029	PAD	2	Lower slope near Lake Liddell
ANT 22	37-2-2072	Ceremonial ring	2	Crest of promontory near Lake Liddell
Field Survey Identified Sites				
LID34	37-3-1592	Artefact scatter: five artefacts	2	Undulating plain
LID35	37-3-1593	Isolated artefact	2	Undulating plain
Coalhole Creek OS-01	37-3-1594	Artefact scatter: 34 artefacts	2	Creek valley
Bowmans Tributary OS-01	37-3-1595	Artefact scatter: 21 artefacts. PAD present at site	2	Creek valley
Bowmans Tributary IF-01	37-3-1596	Isolated artefact	2	Creek valley
Hillcrest OS-01	37-2-6043	Artefact scatter: six artefacts	2	Undulating plain
Hillcrest OS-02	37-2-6044	Artefact scatter: two artefacts	2	Undulating plain
Albano Road OS-01	37-3-1587	Artefact scatter: three artefacts	2	Broad valley
Albano Road OS-02	37-3-1588	Artefact scatter: 13 artefacts. PAD present at site. The PAD designation is based on the landform type but was not closely inspected as access was not possible	2	Broad valley
Albano Road OS-03	37-3-1589	Artefact scatter: Three artefacts. PAD present at site. The PAD designation is based on the landform type but was not closely inspected as access was not possible	2	Broad valley
Albano Road IF-01	37-3-1590	Isolated artefact	2	Broad valley
Liddell Power Station-IF1	37-2-6263	Isolated artefact	2	Undulating plain
Liddell Power Station-IF2	TBC	Isolated artefact	2	Undulating plain

7.6.3 Impact Assessment

Landscape Context

Topography

Due to the steepness of the terrain, the topography of the Survey Boundary is unlikely to have been a favoured area for Aboriginal occupation for extended periods of time and is more likely to have been utilised as a vantage point or access route. Areas facing west would have been unfavourable occupation areas due to the winds.

Geology and Soils

The underlying geology of the Survey Boundary has limited resources in terms of stone for stone tool production. Erosion across the landforms of Survey Unit 1 will likely have led to the displacement of any Aboriginal stone artefacts by moving them downslope. In those areas of Survey Unit 2 in an aggrading environment, the movement of soil may have led to objects or features being covered by accumulated sediment.

Waterways

The Survey Boundary is well-watered generally allowing traditional Aboriginal occupation over most portions of the Survey Boundary. However, the Survey Boundary lacks larger order waterways, such as the Hunter River, where aquatic and terrestrial resources would have been more abundant than that able to be afforded by systems such as Bowmans Creek. The conclusion is that the hydrology of the Survey Boundary probably only supported short-term or sporadic visits into the area and that the large base camps would have been associated with higher order waterways to the south of the Survey Boundary.

Vegetation

The distribution of vegetation and water resources within the local landscape are important factors influencing patterns of Aboriginal land use and occupation. Additionally, the effectiveness of the archaeological survey is directly impacted by visibility conditions, of which vegetative cover is an important feature. Due to extensive clearance, the Survey Boundary now consists of a dense grass cover with limited tree and shrub vegetation. The native vegetation mainly consists of regrowth from earlier clearance for grazing land. This grazing process has also resulted in a substantive change in the form of grass cover, with grazing stock preferring the introduced grasses over native grasses.

Modelling

Based on knowledge of the environmental contexts of the Survey Boundary and a desktop review of the known local and regional archaeological record, the following predictions are made concerning the probability of those site types being recorded within the Survey Boundary:

- As isolated finds can occur anywhere, particularly within disturbed contexts, it is predicted that this site type could be recorded within the Survey Boundary;
- Large, complex, stone artefact distribution sites are predicted to be absent from the Survey Boundary;

- The ridgelines where most of the Project will take place, are mostly cleared of vegetation, therefore scarred tree sites are not predicted likely to occur. It is also noted that this site type is very rare at a regional level due to historical tree clearance;
- Quarry sites and stone procurement sites could be recorded within the Survey Boundary if suitable rock outcroppings are available;
- Given the low prospect of suitable rock exposures being present, grinding groove sites are unlikely to be present. In addition, the Survey Boundary does not contain extensive lengths of waterways where such sites are more likely to be located;
- While a rock shelter has been previously recorded 2.6 km to the west of the Survey Boundary, rock shelters are not likely to be common based on examination of available aerial photography. However, as the Survey Boundary contains ridges and the immediately adjacent upper slopes, rock shelters may be present;
- Given the topography, nature of the soils and geology, burials are not predicted to be present in the Survey Boundary; and
- Bora/ceremonial sites does not necessarily follow landform predictability and are more likely to be identified by local Aboriginal people, rather than through archaeological evidence. These sites are generally identified through consultation with the RAPs. It is noted that there is a "ceremonial ring" located close to the Survey Boundary to the north of Lake Liddell (see further discussion under Cultural Values and in **Table 33**).

Site Significance

Cultural, scientific, aesthetic and historical significance are identified as baseline elements of significance assessment, and it is through the combination of these elements that the overall cultural heritage values of a site, place or area are resolved.

Table 32 presents a summary of the significance assessment of Aboriginal cultural heritage sites recorded during the ACHAR (excludes AHIMS sites).

Table 32
Aboriginal Cultural Heritage Significance Assessment

Site Name	AHIMS ID	Social or Cultural Value	Scientific Value	Aesthetic Value	Historic Value
LID34	37-3-1592	High	Low	Low	None
LID35	37-3-1593	High	Low	Low	None
Coalhole Creek OS-01	37-3-1594	High	Low	Low	None
Bowmans Tributary OS-01	37-3-1595	High	Low-Moderate	Low	None
Bowmans Tributary IF-01	37-3-1596	High	Low	Low	None
Hillcrest OS-01	37-2-6043	High	Low	Low	None
Hillcrest OS-02	37-2-6044	High	Low	Low	None
Albano Road OS-01	37-3-1587	High	Low	Low	None

Site Name	AHIMS ID	Social or Cultural Value	Scientific Value	Aesthetic Value	Historic Value
Albano Road OS-02	37-3-1588	High	Low-Moderate	Low	None
Albano Road OS-03	37-3-1589	High	Low-Moderate	Low	None
Albano Road IF-01	37-3-1590	High	Low	Low	None
Liddell Power Station-IF1	37-2-6263	High	Low	Low	None
Liddell Power Station-IF2	TBC	High	Low	Low	None

Impact Summary

The following management options are general principles, in terms of best practice and desired outcomes, rather than mitigation measures against individual site disturbance:

- Avoid impact by altering the Project to avoid impact to a recorded Aboriginal site. This is a distinct possibility with the Project as sites recorded in the Transmission Line corridor and some access tracks may be able to be avoided by small Project design changes. If this can be done, then a suitable curtilage around the site will be provided to ensure its protection both during the short-term construction phase and in the long-term use of the area; or
- If impact is unavoidable then approval to disturb sites under the authority of an ACHMP will be required as described in **Section 7.6.4**.

Potential Project impacts are described in terms of Project components as follows:

- Transmission Line – as the final Transmission Line design plans are not known, it will be assumed here that all sites within that portion of the Survey Boundary will be impacted. However, some sites will be avoided; and
- Transport Route – two sites were recorded within or partially within the Survey Boundary along Albano Road and they have potential to be impacted by that involve widening the existing road. As these works involve modification to an existing road, there is little room for avoidance, and it is assumed all will be impacted by the Project.

Cultural Values

No specific cultural values pertaining to the Survey Boundary were received during the fieldwork. The general feeling was that the steep sided hills of Survey Unit 1 would not have attracted occupation in the past. As no sites were recorded in these landforms, there were no management recommendations discussed in the field. In Survey Area 2, the recorded sites were held to be significant by the RAPs and there was a unanimous desire to see the sites conserved and protected.

None of the RAPs involved in the field assessment of the Survey Boundary knew of the existence of the previously recorded site 37-2-2072 (ceremonial ring) or any cultural associations with it.

Summary

There were 16 sites considered in the ACHAR, however only nine sites (six newly recorded and three previously recorded) are located within the Survey Boundary. As shown on **Figure 47** for the 16 sites:

- Eight sites will be avoided by the Project (including ANT 22);
- Eight sites have potential to be impacted by the Project, however:
    - Six individual sites have potential to be avoided during the Transmission Line design;
    - Two sites have a low probability for avoidance along Albano Road.

7.6.4 Mitigation and Management

An Aboriginal and Cultural Heritage and Management Plan (ACHMP) will be prepared for the Project in accordance with conditions of consent. The ACHMP will quantify the exact sites to be impacted, the methods by which they will be managed and the fate of any artefacts that are recovered prior to the works. The ACHMP will also provide a protocol for unanticipated finds and the discovery of human skeletal material. The ACHMP will include the mitigation measures below and be prepared in consultation with the RAPs and relevant regulators.

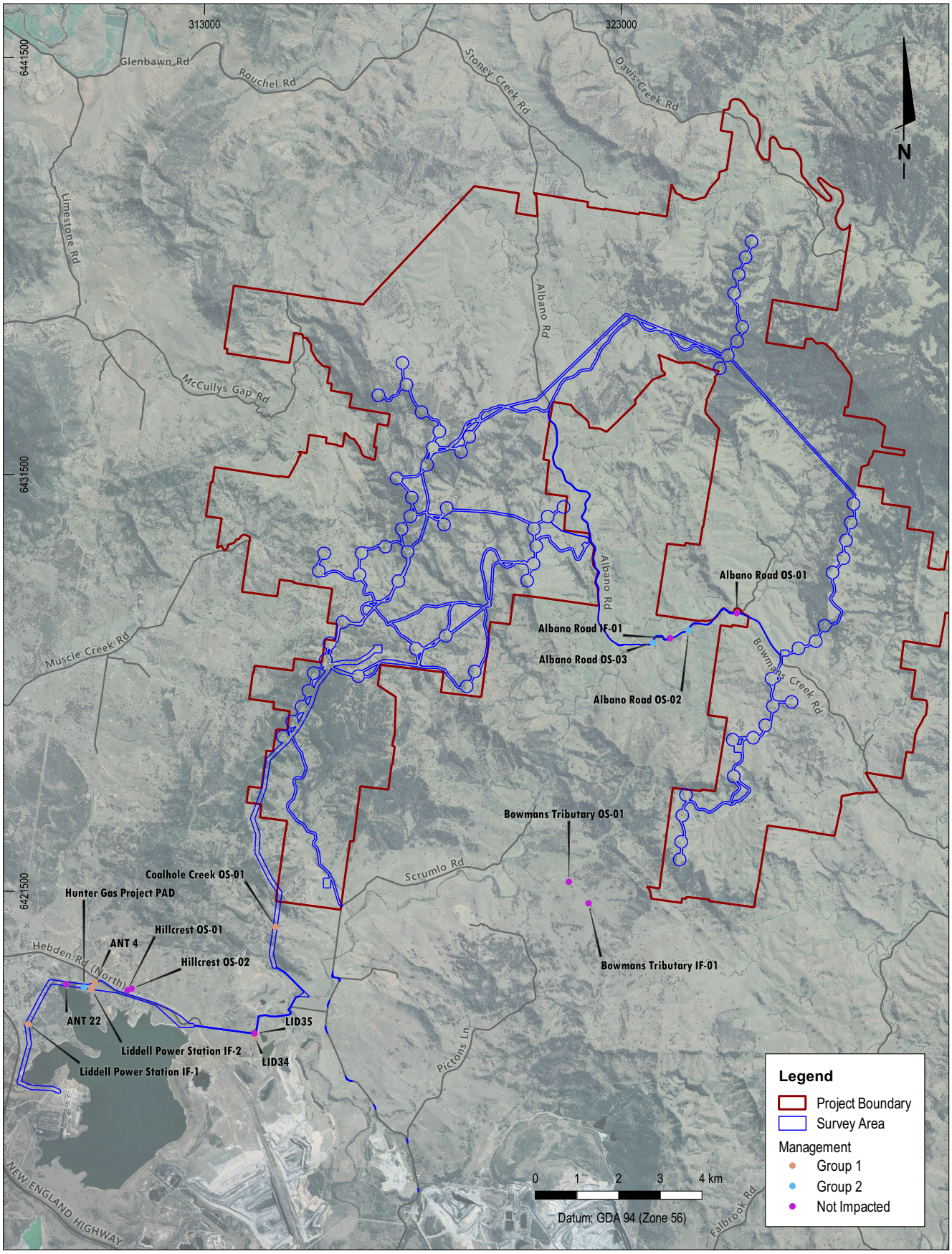
In accordance with Section 89A of the NPW Act, any newly-recorded Aboriginal sites will be registered with AHIMS.

Avoidance and Management

As part of the Project detailed design phase there may be some flexibility to avoid impact to certain Aboriginal sites, particularly with regards to the design of the Transmission Line.

Table 33 contains recommendations for the sites including for either: if the site can be avoided during detailed design, or if the site is to be impacted. Site management is also shown on **Figure** 47. It will be possible to position poles so that sites are spanned and not impacted, and access tracks can be designed so that they avoid sites. As such, it is expected that less than eight sites will be impacted as design plans are finalised to avoid sites. The two management measures detailed in **Appendix M** are summarised below and will be undertaken as described in the ACHMP.

Source: Aerial ©2019 Google



Bowmans Creek Wind Farm | Fig47_Aboriginal Cultural Heritage Management | 15.03.2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Aboriginal Cultural Heritage Management

FIGURE 47

Table 33
Aboriginal Cultural Heritage Site Impact and Management Summary

AHIMS ID	Site Name	Description	Management Protocol	Potential for Avoidance	Management
SITES OUTSIDE OF THE SURVEY BOUNDARY					
37-2-6043	Hillcrest OS-01	Artefact scatter: six artefacts	• Outside of the Survey Boundary and will not be impacted. Therefore, management not required	N/A	Will not be impacted
37-2-6044	Hillcrest OS-02	Artefact scatter: two artefacts	• Outside of the Survey Boundary and will not be impacted. Therefore, management not required	N/A	Will not be impacted
37-3-1593	LID35	Isolated artefact	• Outside of the Survey Boundary. Will not be impacted • Temporarily fence site with high visibility fencing for the duration of works in the area	N/A	Will not be impacted due to management protocol
37-3-1587	Albano Road OS-01	Artefact scatter: three artefacts	• Outside of the Survey Boundary. Will not be impacted • Temporarily fence site with high visibility fencing for the duration of works in the area	N/A	Will not be impacted due to management protocol
37-3-1590	Albano Road IF-01	Isolated artefact	• Outside of the Survey Boundary. Will not be impacted • Temporarily fence site with high visibility fencing for the duration of works in the area	N/A	Will not be impacted due to management protocol
37-3-1595	Bowmans Tributary OS-01	Artefact scatter: 21 artefacts. PAD present at site	• Outside of the Survey Boundary and will not be impacted. Therefore, management not required	N/A	Will not be impacted
37-3-1596	Bowmans Tributary IF-01	Isolated artefact	• Outside of the Survey Boundary and will not be impacted. Therefore, management not required	N/A	Will not be impacted

AHIMS ID	Site Name	Description	Management Protocol	Potential for Avoidance	Management
TRANSMISSION LINE					
37-2-2072	ANT 22	Ceremonial ring	• Direct impacts include the installation of electricity poles and access tracks within 50 m of the site, and these will be avoided • It is acceptable for the electricity wires to be overhead within this 50 m buffer • Any felling of trees that are necessary within this buffer will be hand cleared and machinery will not enter the 50 m exclusion zone (i.e. any timber will have to be left where it falls, or, preferably, manually dragged out of the buffer area).	• Within the Survey Boundary but with a high chance for avoidance if spanned by the Transmission Line • If there are no direct impacts within the 50 m buffer the potential intangible and tangible values of this site will be conserved	Will not be impacted due to management protocol
37-3-1592	LID34	Artefact scatter: five artefacts	• Temporarily fence site with high visibility fencing for the duration of works in the area	• Within the Survey Boundary but with a high chance for avoidance if spanned by the Transmission Line	Group 1
37-3-1594	Coalhole Creek OS-01	Artefact scatter: 34 artefacts	• Temporarily fence site with high visibility fencing for the duration of works in the area	• Within the Survey Boundary but with a high chance for avoidance if spanned by the Transmission Line	Group 1

AHIMS ID	Site Name	Description	Management Protocol	Potential for Avoidance	Management
37-2-2021	ANT 4	Artefact scatter: 20 artefacts	• Temporarily fence site with high visibility fencing for the duration of works in the area	• Partially within the Survey Boundary but with a high chance for avoidance if spanned by the Transmission Line	Group 1
37-2-2029	Hunter Gas Project PAD	PAD	• Works within the PAD extent should be avoided • Temporarily fence the PAD extent with high visibility fencing for the duration of works in the area • If works are required within the PAD, limited test excavation will be required prior to the works commencing to determine the nature of the PAD	• Within the Survey Boundary but with a high chance for avoidance if spanned by the Transmission Line	Group 2
37-2-6263	Liddell Power Station-IF1	Isolated find	• Temporarily fence site with high visibility fencing for the duration of works in the area	• Within the Survey Boundary but with a high chance for avoidance if spanned by the Transmission Line	Group 1
TBC	Liddell Power Station-IF2	Isolated find	• Temporarily fence site with high visibility fencing for the duration of works in the area	• Within the Survey Boundary but with a high chance for avoidance if spanned by the Transmission Line	Group 1
TRANSPORT ROUTE					
37-3-1588	Albano Road OS-02	Artefact scatter: 13 artefacts	• Those portions of the site outside of the Survey Boundary will not be harmed by the Project and	• Low probability for avoidance	Group 2

AHIMS ID	Site Name	Description	Management Protocol	Potential for Avoidance	Management
			will be conserved in the landscape • Temporary fence site with high visibility fencing for the duration of works in the area • If this site is harmed by the Project, the site will be first salvaged by a collection of all surface artefacts (Group 1 management) • As the site has an associated PAD, areas of the PAD within the Survey Boundary will be investigated by limited archaeological excavation (Group 2 management)		
37-3-1589	Albano Road OS-03	Artefact scatter: three artefacts	• Those portions of the site outside of the Survey Boundary will not be harmed by the Project and will be conserved in the landscape • Temporary fence site with high visibility fencing for the duration of works in the area • If this site is harmed by the Project, the site will be first salvaged by a collection of all surface artefacts (Group 1 management) • As the site has an associated PAD, areas of the PAD within the Survey Boundary will be investigated by limited archaeological excavation (Group 2 management)	• Low probability for avoidance	Group 2

Group 1: Archaeological Salvage and surface Artefact Collection

For the sites recommended for Salvage and surface Artefact Collection in **Table 33**:

- All visible artefacts at a site will be flagged in the field;
- The site will be photographed after flagging and before recording;
- All artefacts will have artefact information entered directly into a GPS unit;
- A selection of indicative and / or unusual artefacts from each site will be photographed;
- If required, a sketch plan of the site will be completed indicating zones for the surface collection of artefacts;
- Once all recording is complete, the artefacts will be collected according to site zones with artefacts from each zone being kept separate; and
- The recording of the artefacts recovered will largely be completed in the field and this data would be incorporated into a report.

Analysis will attempt to answer the research aim which is to record a statistically valid artefact assemblage from across the Survey Boundary in order to better understand inter-site variations.

Group 2: Archaeological salvage: limited manual excavation

For the sites recommended for subsurface excavation in **Table 33**, the surface collection of artefacts will occur first. Manual excavation at the sites will then take place. The maximum area of excavation will be determined by the results of the excavations but a minimum of 2 m^2 at each site will be required in order to confirm the nature of the subsurface deposits.

The manual excavation at these locations will generally follow the framework in **Appendix M** as described in the ACHMP.

Human Remains

If the collection team encounter a human burial, all work will cease in the area and advice from the NSW Police sought. If the remains are determined to be Aboriginal, BCD and the RAPs will be contacted.

Additional Fieldwork

Following completion of the field assessments, a 3.7 km section of Albano Road in the north was added to the Survey Boundary. This portion of Albano Road was driven during the field assessment but no pedestrian survey was undertaken. Based on an examination of the undulating landforms present, most of this portion is considered to have low archaeological potential. However, this portion includes a crossing of Fish Hole Creek and there are spurs adjacent to the creek which are landforms considered to have increased archaeological potential. As such, prior to construction works commencing, the Disturbance Area within 200 m of Fish Hole Creek will require assessment.

7.7 HISTORIC HERITAGE

An Historic Heritage Impact Assessment (HIA) was undertaken for the Project by Ozark Pty Ltd and is presented in **Appendix N**.

The HIA applied the Heritage Council's 'Historical Archaeology Code of Practice' (Heritage Council, 2006) in the completion of a historical heritage assessment, including field investigations, to meet the following objectives:

- To identify whether historical heritage items or areas are, or are likely to be, present within the Project Boundary;
- To assess the significance of any recorded historical heritage items or areas;
- To determine whether the Project is likely to cause harm to recorded historical heritage items or areas; and
- Provide management recommendations and options for mitigating impacts.

A summary of the HIA is presented below including key impact assessment findings, as well as management measures committed to by the Proponent.

7.7.1 Background

Literature Review

Colonial settlement in the Hunter Valley has been well researched and documented. The initial phase of colonial exploration of the Hunter Region was initiated by Surveyor General John Oxley when he instructed the surveyor Henry Dangar and botanist Alan Cunningham in 1823 to explore the region. Dangar's survey eventually extended to the Upper Hunter Valley. He named Fal and Foy Brooks in July 1824, and his 'discoveries' included detecting the confluence of the Goulburn and Hunter Rivers in October that year. Foy Brook is better known today as Bowmans Creek.

By 1825 the Hunter River's upper reaches were occupied with large pastoral estates. Chief Constable John Howe first discovered Muscle Brook in 1819. It was named due to the large number of mussel shells that were found on the banks of the local creek.

Colonial settlement in the Hunter Valley began with blocks being distributed in 1822 and settlers looking to establish farms began to flock to the area. Villages and townships were established as more colonists moved to the Upper Hunter Valley, including the villages of Muswellbrook and Scone in the 1830s. The Muswellbrook region provided rich, fertile soils and this, coupled with easy access to watercourses and the relative ease of transport to Newcastle and Sydney, led to Muswellbrook being established as a farming centre.

Wool production, dairying and wheat growing were the main industries in the Hunter Valley from an early date and by the 1840s, agriculture was a major land use in the Upper Hunter Valley, with crops mostly yielding wheat. Wheat production declined due to issues with disease in the late nineteenth century and Lucerne, which was a more robust crop, took over.

A move towards dairying in the Muswellbrook region was intensified with the growth of urban markets such as Newcastle and Sydney and the development of technological innovations such as the cream separator and refrigeration which opened international markets for meat and dairy products. The number of dairy farms in the Upper Hunter Valley has declined since the 1950s.

Coal mining was not prevalent in the Muswellbrook Shire until the late 1800s. As the demand for coal increased, the development of transportation between Muswellbrook and the main cities became vital and this was accomplished by the construction of the Main Northern Railway Line that connected Singleton to Muswellbrook in 1869.

As coal mining started to emerge in the Upper Hunter Valley in the 1900s, both dairying and horticulture started declining. Muswellbrook is now more associated with coal mining and the electrical generation industry rather than being a significant agricultural supply centre as it was in the past. Within the Project Boundary, beef cattle raising has become the major industry following the decline of the dairy industry.

Relevant Legislation

Cultural heritage is managed by several state and national Acts. Baseline principles for the conservation of heritage places and relics can be found in the 'Burra Charter' (Burra Charter 2013). The Burra Charter recognises four categories of heritage value: historic, aesthetic, scientific, and social significance.

There are no Commonwealth or National heritage listed places within the Survey Boundary, and as such, the heritage provisions of the EPBC Act and other Commonwealth Acts do not apply.

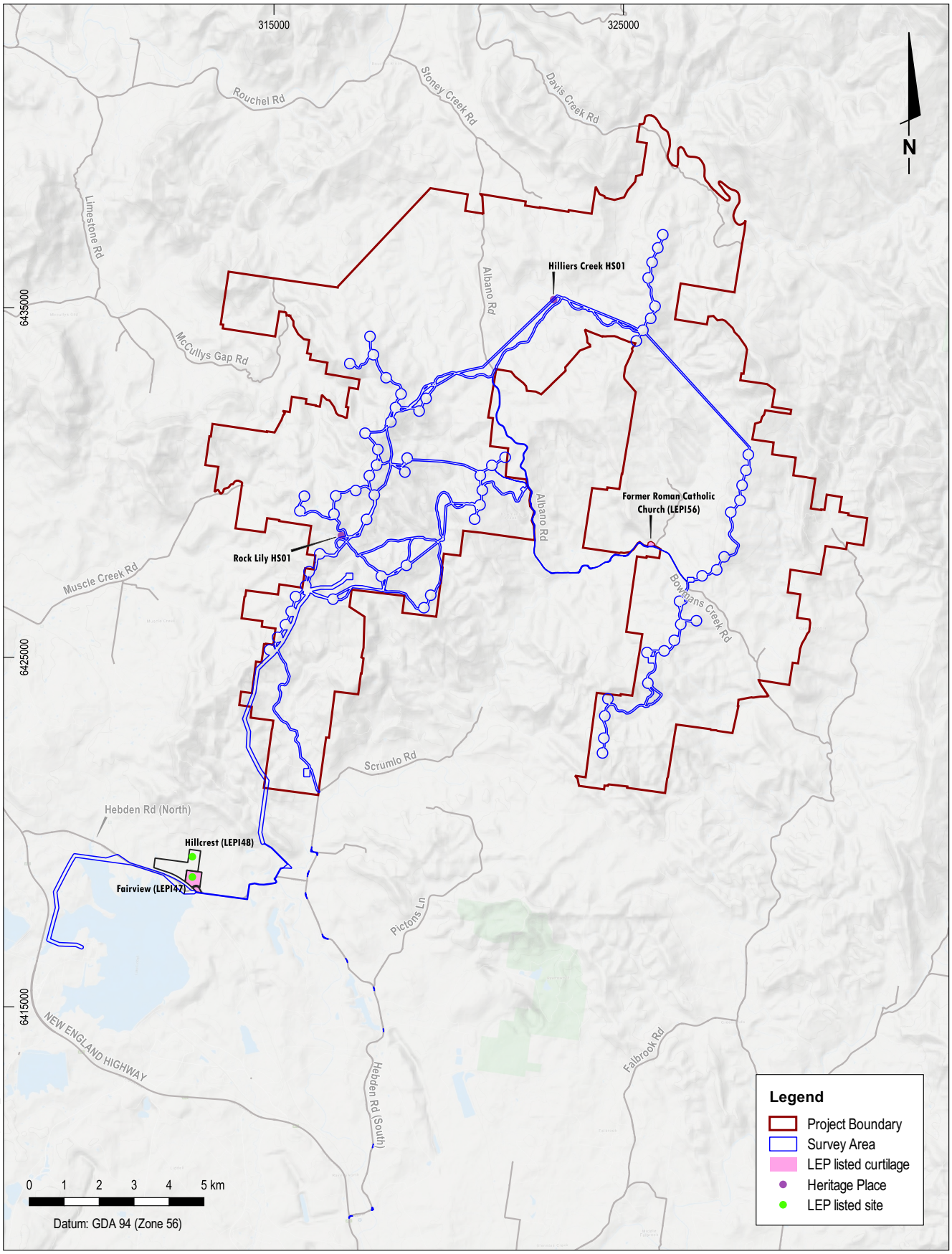
There are no State Heritage Register listed items within, or near to, the Survey Boundary (see **Table 34**).

Automatic protection is afforded under Section 4(1) of the Heritage Act to "relics", defined as "*any deposit or material evidence relating to the settlement of the area that comprised NSW, not being Aboriginal settlement, and which holds state or local significance*". Relics are protected according to their heritage significance assessment rather than purely on their age.

The Survey Boundary is within areas governed by the MSC, SSC and UHSC LEPs. The LEPs include a schedule of heritage conservation areas and items that require either development consent or exemptions for projects that may impact on conservation outcomes.

As shown on **Figure 48**, there are three items listed within a LEP proximate to the Project. Item I47 and I48 ('Fairview' and 'Hillcrest' homesteads) listed in the Muswellbrook LEP are outside the Survey Boundary. Item I156 ('Former Roman Catholic Church') listed in the Singleton LEP is also outside the Survey Boundary.

Source: Terrain ©2019 Google



Bowmans Creek Wind Farm | Fig48_Historic Heritage | 11 03 2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Historic Heritage

FIGURE 48

Table 34
Historic Heritage Desktop Database Search Results

Database	Type of Search	Comment
National and Commonwealth Heritage Listings	NSW	No places listed on either the National or Commonwealth heritage lists are located within the Survey Boundary
State Heritage Register (SHR)	SSC, MSC and UHSC	No items on the SHR are located within or near the Survey Boundary There are no SHR items within 5 km of the Survey Boundary There are 18 places registered on the SHR within 25 km of the Project Boundary
Section 170 Register	SSC, MSC and UHSC	No items on the Section 170 Register are located within or near the Survey Boundary
Local Environmental Plan (LEP)	Singleton, Muswellbrook and Upper Hunter LEPs	The curtilage for the following LEP listed item are located outside the Survey Boundary: • Muswellbrook LEP. I47: 'Fairview' (homestead) • Muswellbrook LEP. I48: 'Hillcrest' (homestead) • Singleton LEP. I156: 'Former Roman Catholic Church'

Fairview – MSC LEP I47

"Fairview" has exterior weatherboard walls and a galvanised iron roof. On the interior there is evidence of pressed metal ceilings. It is associated with a timber slab and galvanised iron outbuilding.

"Fairview" has local historic significance for its association with later 19th century land subdivision in the Lake Liddell area. It is one of the few remaining groupings of its age and type in that area. It has local scientific significance for its potential to reveal information which could contribute to an understanding of the economic means and lifestyle of the earliest tanners in this area. The place was not inspected as part of the current survey.

Hillcrest – MSC LEP I48

'Hillcrest' has exterior weatherboard walls and a galvanised iron roof. It is associated with a galvanised iron outbuilding. Like 'Fairview', 'Hillcrest' has local historic significance for its association with later 19th century and early 20th century land subdivision in the Lake Liddell area. Its greatest significance must be its aesthetic significance which derives from its being a rare regional example of Federation Bungalow executed in timber. It has local scientific significance for its potential to reveal information which could contribute to an understanding of the economic means and lifestyles of the earliest farmers of the land in this area. The place was not inspected as part of the current survey.

Former Catholic Church – SSC LEP I56

Mr William Schmierer with the assistance of friends and family erected the Catholic Church at Bowmans Creek in 1902. The church and site have strong historical association with the early settlers of the area and in particular the five generations of the Ball family, who provided the land, worshipped at and largely maintained the church and land for 118 years. The place was inspected as part of the current survey from the road corridor.

7.7.2 Methodology

Survey

The HIA took place at the same time as the ACHAR as described in **Section 7.6**. The survey was completed by over 10 days within the Survey Area from 25–29 November 2019, 23–27 March 2020 and February 2021. Fieldwork Session 1 consisted of two teams of two OzArk archaeologists in each team. Fieldwork Session 2 consisted of one team of two OzArk archaeologists. Fieldwork Session 3 and 4 consisted of one Ozark archaeologist.

Standard archaeological field survey and recording methods were employed in the HIA (Burke & Smith 2004). The Survey Boundary was divided into two survey units: Survey Unit 1 and Survey Unit 2 as discussed in **Section 7.6.2**.

Assessment

The HIA evaluated the heritage significance of the historic heritage sites identified within the study area in accordance with the NSW Heritage Office's publication 'Assessing Heritage Significance' (Heritage Office, 2001). A historic heritage site must satisfy at a minimum, one of the criteria as specified in the publication to be assessed as having heritage significance.

7.7.3 Impact Assessment

Historic Heritage Places

Although not listed on a LEP, two historic heritage places were recorded during the survey. These are shown on **Figure 48** and included:

- Rock Lily Gully (HS01) – family burial plot; and
- Hilliers Creek (HS01) – farm house ruin.

Table 35 indicates whether each would be impacted by the Project and any relevant comments. Additional detail on each is provided in **Appendix N**.

The two items recorded during the survey are assessed below against the criteria establish by the NSW Heritage Council. Further detail is provided in **Appendix N**.

Both Rock Lily Gully-HS01 and Hilliers Creek (HS01) were assessed against the assessment criteria and does not satisfy any criterion. A review of each against the NSW Heritage Office guidelines and the Burra Charter confirmed neither displays significance heritage values.

However, it should be noted that while neither item satisfies the criteria for local or state heritage significance, it does not mean that the items are without any historic significance. Rock Lily Gully-HS01, for example, will be obviously significant to the current owners of the property in which the graves are located as the same family continues to own the property.

The graves would also be of interest to the general public as they 'speak' of the establishment of farming in the district.

Hilliers Creek-HS01 is representative example of the small rural dwellings that would have been common in the district but are becoming rarer due to natural deterioration. Places such as Hilliers Creek-HS01 would be evocative to the general public as they illustrate a past way of life in rural Australia that no longer exists.

Although neither place would satisfy the criteria to be considered to have local heritage values, the loss of either item would be regretful, and as such both items will be retained in the landscape.

Ozark assessed that there are no areas within the Survey Boundary that are likely to contain significant archaeological deposits of conservation value.

Table 35
Recorded Historic Heritage Items and Project Impacts

Site Name	Type	Impact	Comment
Rock Lily Gully (HS01)	Family burial plot	No	The site is located outside of proposed impacts and will be avoided. Recommendations will be made to avoid inadvertent damage to the site during construction of the Project
Hilliers Creek (HS01)	Farm house ruin	No	The site is within the Survey Boundary and has a potential to be impacted. The site will be avoided by ensuring that it is spanned by the electricity line and that access tracks are kept away from the hut.

LEP Listed Items

There are three places listed on an LEP that are in close proximity but outside the Survey Boundary.

The heritage curtilage of the 'Former Roman Catholic Church' is located immediately outside the Survey Boundary and therefore will not be impacted. As there will be impacts immediately outside the curtilage of the 'Former Roman Catholic Church', a Statement of Heritage Impact (SOHI) is presented in **Appendix N** to assess the degree of impact to the item's identified heritage values.

The heritage curtilage of both 'Fairview' and 'Hillcrest' is located 80 m from the Survey Boundary and therefore will not be impacted. Additionally, the closest impacts to the homesteads associated within these listings are over 360 m from 'Fairview' homestead and 775 m from 'Hillcrest' homestead. As there will not be impacts within or close to the heritage curtilage of these LEP listed items, a SOHI is not required.

Cultural Landscape

The Project is occurring within a cultural landscape typified by small rural holdings containing a variety of structures such as homesteads that exemplify a long history of settlement over the past 150 years.

While the Project will, in places, have a visual impact that could disrupt the rural nature of the landscape, this impact will not adversely impact the fundamental values of the cultural landscape that will remain physically intact. The cultural landscape values identified in the vicinity of the Project are representative of rural landscapes across large areas of NSW and do not contain any rare or unique features worthy of special conservation efforts.

7.7.4 Mitigation and Management

Historic Heritage Places

Management of heritage items is primarily determined based on their assessed significance as well as the likely impacts of the proposed development. In terms of best practice and desired outcomes, avoiding impact to any historical item is a preferred outcome, however, where a historical site has been assessed as having no heritage value, impacts to these items does not require any legislated mitigation.

Rock Lily Gully (HS01)

HS01 is outside the Survey Boundary. However, as there is still the potential for impacts from the construction of access tracks in proximity to it the following will be undertaken:

- In consultation with the landowner, management measures to be implemented could include, but not be limited to, restoring the fence surrounding the graves and/or plantings to shield the graves from the nearby proposed access tracks; and
- The grave site will be fenced with a high visibility barrier during construction of the Project to avoid inadvertent impacts.

Hilliers Creek (HC01)

As the site is within the Survey Boundary it has a potential to be impacted. Although the site does not have local or state heritage values, it is, nonetheless, highly desirable for the place to remain within the landscape. The following will be undertaken:

- The site location will be considered when the design of the overhead electricity reticulation is finalised to ensure that the place is avoided by not constructing an electricity pole within 20 m of the place; and
- Access tracks for the construction of the overhead electricity reticulation line will not be within 10 m of the place.

LEP Listed Items

Former Roman Catholic Church

Consistent with the SOHI, and as there is no proposed work within the defined heritage curtilage of the "Former Roman Catholic Church" (Lot 1 DP1167323), there are no management recommendations beyond ensuring that there are no impacts within the lot containing this item (including vehicle movement and the storage of materials).

Hillcrest and Fairview

As there is no proposed work within the defined heritage curtilage of these items, there are no management recommendations.

Cultural Landscape

In terms of the cultural landscape surrounding the Survey Boundary, particularly along Albano (Bowmans Creek) Road, some members of the local community feel that the Project will diminish the rural "feel" of the area by introducing an "industrial" element into the landscape.

In order to provide an avenue for the local community to nominate places and landscapes that they feel are important, following detailed design, the Proponent will commission a community-based heritage study that will document and archivally record any items held to be significant by the local community.

This may be of value at the demolition of the Project when rehabilitating the site and reinstating any curtilage.

7.8 ECONOMICS

7.8.1 Background

An Economic Impact Assessment (EIA) was undertaken for the Project by Gillespie Economics and is presented in **Appendix O**. The purpose of the EIA was to assess the economic impacts and benefits of the Project for the region and NSW.

A summary of the EIA is presented below, including key impact assessment findings and management and mitigation commitments made by the Proponent.

7.8.2 Methodology

The EIA was undertaken in accordance with the SEARs and included assessment of the regional economic impacts of the Project using the Input-Output (IO) analysis method.

The IO analysis is a two-step assessment method that involves:

- Construction of an appropriate IO table (regional transaction table) that can be used to identify the economic structure of the region and multipliers for each existing sector of the economy; and
- Identification of the impact or stimulus of the Project (economic activity from construction and operation of the Project and economic contraction of current land use) in a form that is compatible with the IO equations so that the IO multipliers and flow-on effects for the impacts or stimulus of the Project can then be estimated.

IO analysis identifies the economic activity of a Project on the regional economy (i.e. the MSC, SSC and UHSC) in terms of four main indicators:

- Gross regional output – the gross value of business turnover;
- Value-added – the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output. These costs exclude income costs;
- Income – the wages paid to employees including imputed wages for self-employed and business owners; and
- Employment – number of people employed (including self-employed, full-time and part-time).

7.8.3 Impact Assessment

The EIA found that the Project will provide economic activity to the NSW and regional economies during both the construction and operations phase.

Construction

The IO analysis identified that the peak construction year of the Project (Year 1) is estimated to make up to the following total contribution to the regional economy:

- $114 M in annual direct and indirect output;
- $48 M in annual direct and indirect value-added;
- $17 M in annual direct and indirect household income; and
- 209 direct and indirect jobs.

The peak construction year of the Project (Year 1) is estimated to make up to the following total contribution to the NSW economy:

- $218 M in annual direct and indirect output;
- $99 M in annual direct and indirect value added;
- $58 M in annual direct and indirect household income; and
- 494 direct and indirect jobs.

Operations

The Project is estimated to make the following total annual contribution to the regional economy for up to 25 years:

- $65 M in annual direct and indirect regional output or business turnover;
- $53 M in annual direct and indirect regional value-added;
- $2 M in annual direct and indirect household income; and
- 30 direct and indirect jobs.

The Project is estimated to make the following annual contribution to the NSW economy for up to 25 years:

- $74 M in annual direct and indirect regional output or business turnover;
- $57 M in annual direct and indirect regional value-added;
- $6 M in annual direct and indirect household income; and
- 58 direct and indirect jobs.

While there will be impacts to agricultural activity over the life of the Project as described in **Section 7.16.2**, this was estimated to be less than 0.01% of the total agricultural activity in the region. This economic impact will not impact the capability of the land in perpetuity. If the Project does ever become redundant, the land could be returned to its former rate of agricultural productivity.

The impacts to foregone agricultural productivity will be borne by the Associated landholders, for which they will be compensated. The regional economic activity impacts of foregone agricultural activity are far less than those of the construction and operation of the Project.

7.8.4 Mitigation and Management

The Proponent will work in partnership with the relevant Councils in the region (i.e. SSC, MSC and UHSC) and the local community so that, as far as possible, the benefits of the projected economic growth in the region as a consequence of the Project are maximised and the impacts minimised.

The range of general economic impact mitigation and management measures proposed include:

- Employment of regional residents where practicable (i.e. where they are motivated to work, have the required skills and experience and are able to adhere to occupational health and safety policies, construction and operations protocols and demonstrate a cultural fit with the relevant organisations);
- Participating, as appropriate, in business group meetings, events or programs in the regional community;
- Purchase local non-labour inputs to production, preferentially where local producers can be cost and quality competitive, to support local industries;
- Design the Project infrastructure so that the continued agricultural productivity of the Associated landholdings is maintained to the maximum extent practicable; and
- The establishment of a Neighbour Benefit Program to share the benefits of the Project as described in **Section 2.4**; and
- Enter into a VPA with the three relevant LGAs for the provision of social infrastructure, commensurable with the Project's impacts (refer to **Section 3.1.1**).

7.9 TELECOMMUNICATIONS

7.9.1 Background

A Radiocommunications Services Impact Assessment (RIA) was undertaken for the Project by Lawrence Derrick and Associates and is presented in **Appendix P**.

The purpose of the RIA was to identify and assess potential impacts to radiocommunication and associated services relevant to the Project in accordance with the SEARs, and relevant NSW legislation and guidelines. It assessed impacts to radio communications link and sites within 50 km (RIA Study Area).

A summary of the RIA is presented below including key impact assessment findings, as well as management measures committed to by the Proponent.

7.9.2 Methodology

All licensed radio facilities were identified from the ACMA's RRL database. Radio links were identified in two classes – above 1,000 MHz in operating frequency (microwave) and below 1,000 MHz (VHF/UHF). A search of the ACMA database to a 100 km radius did not determine any additional licensed links.

All microwave links paths were checked for Fresnel zone clearance to the tip of the WTG blades. For VHF/ UHF links, a criteria of 0.6 X 1st Fresnel zone clearance was used, as the most often used clearance required for radio link path design for static obstacles (e.g. ground, trees, buildings, etc). **Figure 49** shows known links in the vicinity of the Project.

7.9.3 Impact Assessment

Link Clearances to WTG Blade Tips

The only link potentially impacted by the Project is the 400 MHz NSW Rural Fire Service link which intersects with the swept path of the proposed location of Turbine T70. In order to avoid impacts to this link a clearance distance of 160 m either side of the ray line will be required to be maintained as calculated in Attachment 6 of **Appendix P**. Any micro-siting of other close turbines for example T69 will need to maintain the specified clearance of 160 m.

Alternatively, if topographic or geological conditions do not allow for sufficient clearance to be achieved the link could be rerouted via the installation of a repeater station to avoid the swept path of the proposed turbines.

During detailed design, consultation will be undertaken with the owner of the link to discuss possible mitigation options. No other links from other sites in the area were identified as crossing the Project Boundary.

FM Radio Broadcasting Sites

Six FM broadcast transmitter sites were identified in the Study Area: Bulga Mine, Liddell Mine, Ravensworth Mine, Glendell Mine, Aberdeen (103.3, 104.9 and 105.7), and Muswellbrook (98.1). All are sufficiently distant such that the Project will not have impact on the coverage of these stations. The four mine site stations are low power and only provide coverage to the mine site areas individually.

The impact of the WTG on residents living near the WTG is unlikely as FM signals have been shown to be somewhat immune to WTG impacts on reception.

TV Broadcasting Sites

Two Broadcasting sites were identified. The station at “Rossgole” (ACMA ID 151218) is a commercial TV relay station to the Upper Hunter TV station only. No impact is predicted.

The Upper Hunter medium-power station (ACMA ID 6361) is located approximately 27 km from the nearest WTG. This is too far to impact on general coverage, however in some locations close to the wind farm it is used by residents for TV reception.

An investigation was conducted in relation to the possible main TV transmitting sites for coverage of the residents in the area surrounding the Project Boundary. The ‘My Switch’ (ACMA, 2020) prediction online tool was used to predict coverage areas and to identify the transmitting stations available. **Table 36** lists the TV stations predicted and current quality of reception.

The observation from the prediction maps online is that terrestrial TV reception is available at the elevated sites with a clear outlook to one of the two stations available (Newcastle and Upper Hunter). In the valleys or where terrain blockage toward the stations exists, no reception is possible.

Table 36
Existing TV Stations and Quality of Reception

Town	TV Station(s)	Quality of Reception
Bowmans Creek	Newcastle	Patchy
Hebden	Newcastle/ Upper Hunter	Patchy
Muscle Creek	Upper Hunter	Good
McCullys Gap	No Cover	No Cover
Goorangoola	No Cover/Upper Hunter	Patchy
Rouchel Brook	No Cover	No Cover

Aviation

Three aeronautical sites were identified with a potential to be impacted by the Project, including: Scone Airport (ACMA ID: 1013103), SES Singleton (ACMA ID: 6232) and Army Singleton (ACMA ID: 6285) (see **Figure 49**).

No interference to this ground air directional communications system is expected due to the significant separation distances (Scone Airport 30 km, SES Singleton 27 km and Army Singleton 28 km). No Radar licences were found in the RIS Study Area. Additional aviation aspects (including radar) at distances beyond the RIA Study Area are discussed at **Section 7.3.3**.

Cellular, Private, Business and Government Mobile

The main telecommunications mobile base station infrastructure are distributed through the RIA Study Area. They include Telstra and Optus Cellular towers, RFS Paging Service, NBN, Australian rail track sites and Liddell Coal's two way network(as shown on **Figure 49**).

Considering the separation between these sites and the nearest WTG, all are sufficiently distant to have no impact on the coverage of these services.

NBN Services

Four NBN sites were identified at Parkville, Muswellbrook, Scone and Roughit. These NBN Sites have microwave Point to Multipoint Systems operating to connect residents in the surrounding area to the broadband network via these microwave systems. The ACMA database does not identify the customer ends of these links so the line of site from these base stations to customers dwellings and cannot be checked for WTG clearance.

As the base stations are a substantial distance to the closest WTG (at least 15 km) there is low risk of interference to customer links.

Other Systems

Licensed, prediction GPS systems were not identified in the RIA Study Area.

Bureau of Meteorology weather radar sites were not identified within the RIS Study Area. A number of registrations on 151.5 MHz for Weather Balloon signal receiving were identified, however are not likely to be impacted by the WTGs.

7.9.4 Mitigation and Management

The following mitigation and management measures will be implemented by the Proponent.

TV Broadcasting Sites

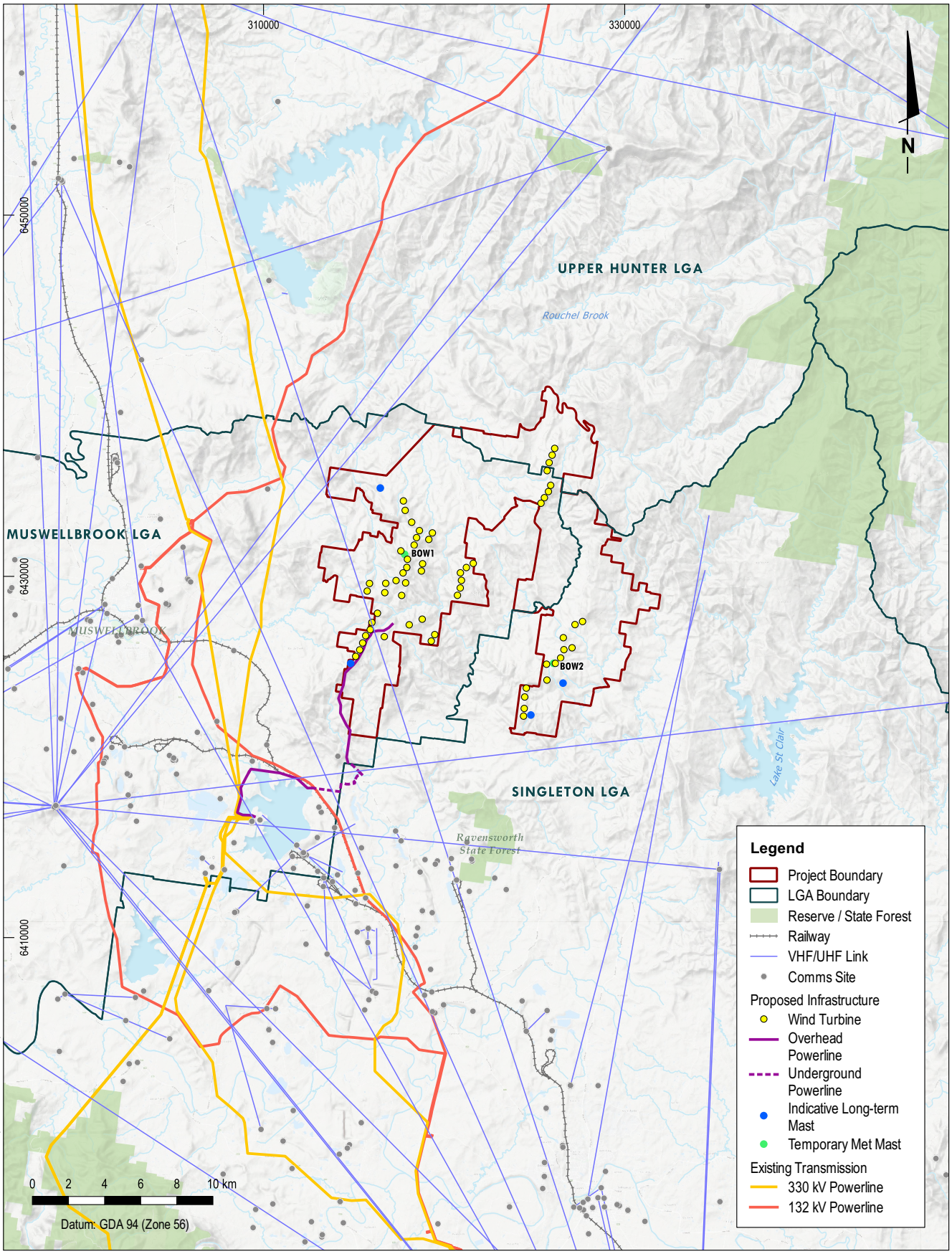
A pre-construction TV survey will be undertaken at a sample of dwellings out to 5 km from the closest WTG (see **Appendix P**) to establish a benchmark of TV reception. This will provide TV reception data to compare with any potential interference during operations.

In the unlikely event that TV reception of the two main stations is impacted by WTGs located in the direction of the main TV stations (confirmed through the benchmarking above), the Viewer Access Satellite Television (VAST) service will be offered by the Proponent to any affected residence.

Detailed Design

During Project detailed design consideration will be given to micro-siting T70 and T69 to achieve the required clearance zone for the impacted link. If this cannot be achieved, consultation with RFS will occur to relocate its 400 MHz communications equipment. If this cannot be resolved to RFS's satisfaction, T70 will either not be constructed or the link may be rerouted via the installation of a repeater station. T69 may also be relocated in consideration of this constraint during micro-siting (by around 160 m).

Should this be required, additional due diligence inspections will be conducted as part of the 'Land Disturbance Procedure' to ensure unacceptable impacts to archaeology and ecology do not occur. Findings will be included in the relevant management plans as described in **Section 7.5.4** and **Section 7.6.4.**



BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Telecommunications

FIGURE 49

7.10 BUSHFIRE

7.10.1 Background

An assessment of bushfire risk was conducted with regard to the principles of PBP. The principles of PBP apply to the Project because it is located on mapped bushfire prone land. The provisions of the RF Act that are relevant to the Project are discussed in **Section 4.4.9**.

The purpose of the assessment was to identify the risk to assets located within and immediately surrounding the Project Boundary. The risk assessment is not limited to the unlikely event of a fire being caused by the Project, and it also addresses risks associated with fires triggered by natural causes or third parties.

PBP states that wind farms require "special consideration and should be provided with adequate clearances to combustible vegetation as well as firefighting access and water". The design of the Project has incorporated adequate setbacks from vegetation and access tracks that can be used for firefighting purposes.

7.10.2 Methodology

The risk assessment process consisted of the following steps:

- Identify the assets located within and immediately surrounding the Project Boundary;
- Identify the relevant bushfire risk factors such as fire history, slope and fuel loads;
- Identify the Project hazards that may result in the ignition or spread of fires;
- Assess the risks to assets based on likelihood and consequence of impacts; and
- Recommend treatments to mitigate bushfire risk.

7.10.3 Impact Assessment

Assets

BFRMPs generally prescribe four categories of assets:

- Human settlement (including residential areas, schools, hospitals, nursing homes etc);
- Economic (including agricultural, commercial, industrial and mining infrastructure, as well as drinking water catchments and tourist/recreational facilities);
- Environmental (including threatened species, populations and ecological communities); and
- Cultural (including Aboriginal items, heritage sites and other cultural assets).

The Singleton, Muswellbrook and Liverpool Range BFRMPs include registers of assets located within their subject areas. **Table 37** lists the assets identified by the relevant BFRMPs that are located within or near the Project Boundary.

In addition to the assets identified by BFRMPs, other assets located within the Project Boundary are listed in **Table 38**. It also describes which section of this EIS each is identified in.

Table 37
Bushfire Risk Management Plans Listed Assets

BFRMP	Asset ID	Description
Muswellbrook	54	Rural properties on Albano Road and Bowmans Creek Road
	16*	Liddell Coal Mine
	39*	Tree-line properties at McCullys Gap
	56*	Rural properties at Hebden
Singleton	89*	Rural properties at Goorangoola

** Located outside but near the Project Boundary*

Table 38
Other Assets Located with Project Boundary

Category	Assets	Section
Human settlement	Private dwellings on rural residential properties	**2.4**
Economic	Infrastructure associated with the Project (including WTG generators, substations, powerlines, ancillary buildings etc.), private farm infrastructure, public utilities	**3**
Environmental	Areas of native woodland (including listed ecological communities)	**7.5.3**
Cultural	Items of historic interest (but not listed as having heritage significance)	**7.7.3**

Bushfire Risk Factors

The bushfire season in the Upper Hunter Valley generally persists from October to March. Prevailing weather conditions during the bushfire season include north-westerly to westerly winds, high day time temperatures and low relative humidity (Singleton BFMC, 2011).

The major summer rainfall generally occurs from December to February (BOM, Site 061374). Longer bushfire seasons can occur when summer rainfall is lower than normal. In such cases the bushfire season can extend through summer to early autumn.

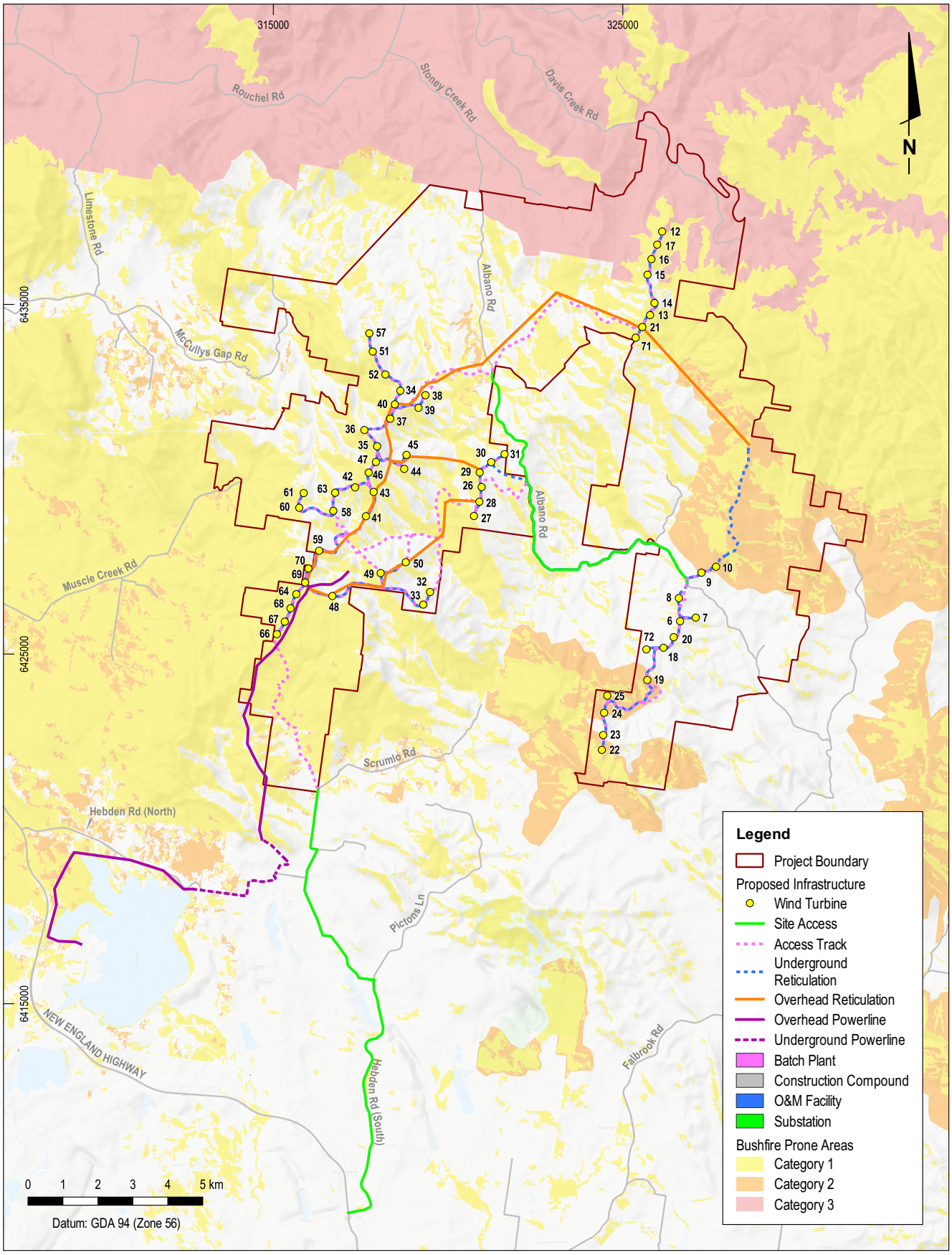
The main sources of ignition include lightning storms, electrical powerlines, escapes from legal burning, illegal burning activities and arson (Muswellbrook BFMC, 2011).

The risk of fires spreading is affected by topography. Fires increase in speed when burning uphill and decrease in speed when burning downhill. PBP recommends that development on wooded slopes steeper than 18° should be avoided if possible (NSW RFS, 2019a). The topography within the Project Boundary is characterised by a series of ridges running north-south with moderate to steep slopes (between 1-3 %).

The risk of fires is influenced by the available fuel load (i.e. vegetation). Areas of dense vegetation are present along the ridgelines and upper slopes (see **Section 7.5**). However, the majority of the land within the Project Boundary is previously cleared agricultural land (see **Section 2.3**).

Figure 50 indicatively shows the mapped bushfire prone land within the Project Boundary.

Source: Terrain ©2019 Google



Bowmans Creek Wind Farm_I_Fig50_Mapped Bushfire Prone Land_I_11.03.2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Mapped Bushfire Prone Land

FIGURE 50

Bushfire prone land is categorised into three categories according to level of risk, namely:

- Vegetation Category 1 represents the highest bushfire risk and includes forests, woodlands, heaths and timber plantations;
- Vegetation Category 2 represents the lowest risk and includes rainforests, remnant vegetation and land that is actively managed; and
- Vegetation Category 3 was the most recently introduced category and falls between categories 1 and 2. Vegetation Category 3 includes grasslands and shrublands.

The most prevalent vegetation category within the Project Boundary is Vegetation Category 1. However, there is also a substantial proportion of the site that is not mapped as bushfire prone. Some areas of Vegetation Category 2 are in the eastern and south-eastern extents of the Project Boundary. An area of Vegetation Category 3 is in the northern portion of the Project Boundary.

Bushfire Hazards

The following aspects of wind farm developments have the potential to be bushfire hazards:

- Use and storage of ignition sources (e.g. flammable materials) during the construction, operational and decommissioning phases;
- Ignition events resulting from operation of WTG generators and electricity transmission infrastructure; and
- Changes to site accessibility for emergency services (including firefighting aircraft).

The NSW RFS (2019b) defines hazardous materials as:

> *"anything that, when produced, stored, moved, used or otherwise dealt with without adequate safeguards to prevent it from escaping, may cause injury or death or damage to property".*

Some of the fuels and lubricants required during the construction and operation of the Project will fall within this definition of hazardous materials (see **Section 7.20**). The risk of ignition will be minimised by implementing correct storage and handling procedures.

The proposed WTG and electricity infrastructure (i.e. substations, transmission lines, etc) have the potential to initiate or exacerbate the spread of fires. For WTGs, the risk of fire may arise due to malfunctioning bearings, inadequate crankcase lubrication, electrical reticulation facilities, electrical shorting or arcing occurring in transmission and cable damage during rotation. With the standard mitigating measures to be installed at the Project (**Section 8**), the risk of WTG ignition is also considered to be low.

Lightning conductors are installed in WTGs to ground lightning strikes in order to minimise the risk of damage to the WTG and risk of ignition of a fire. Experience at the Crookwell Wind Farm indicates that lightning conductors are effective for this purpose. At Crookwell, a lightning strike to one of the WTGs resulted in damage to the blade but did not result in a fire.

There is the risk that overhead powerlines may ignite fires, particularly where the cables come into contact with vegetation. The powerlines for the Project have been designed to avoid treed vegetation, wherever practicable. Vegetation near powerlines that cannot be avoided will be managed in accordance with the PBP.

Operation of the substations will involve use of transformer oil for cooling and insulation purposes. Transformer oil is a hazardous substance and requires appropriate management. The substation facilities will be bunded to contain the oil in the event of a major leak or fire. Bunded areas will be regularly inspected and maintained (including removal of accumulated rainwater) to ensure that oil leaks do not present a fire hazard. Transformer oil will be replaced by qualified staff at regular intervals to minimise the potential for fire caused by contaminated oil. Waste oil will be removed from site and disposed of appropriately.

Bushfires are more likely to occur within the Project Boundary due to causes unrelated to the Project. The Project will involve the removal of approximately 515 ha of vegetation, thereby reducing the fuel load within the Project Boundary. Therefore, the Project will have a positive effect on the containment of fires.

Firefighting operations (if required) will be undertaken by the NSW Fire Brigade, with support from the RFS. The Project will involve the construction or upgrade of access tracks within the Project Boundary. The improved vehicular access will aid ground-based firefighting operations. The interaction of the Project with aerial firefighting activities is addressed in **Section 7.3**.

Risk Assessment

BFRMPs provide likelihood, consequence and risk ratings for the assets identified by local BFMCs. **Table 39** outlines the likelihood, consequence and risk ratings for the assets listed in **Table 37**.

For the assets that are not listed in a BFRMP, a risk assessment was undertaken using the likelihood, consequence and risk rating criteria prescribed by 'Bush Fire Risk Management Planning Guidelines for Bush Fire Management Committees' (RFS, 2008). Of the assets listed in **Table 38**, the level of risk will be similar for assets in the human settlement, commercial and cultural categories. The risk to human life is closely related to the risk to human settlements. Accordingly, the risk to people and private property will be assessed collectively. The risks to Project infrastructure and environmental assets will be considered separately, as the likelihood and consequence of impacts will differ for these assets.

Table 39
Risk Assessment for Assets Identified in Bushfire RMPs

BFRMP	Asset ID	Description	Likelihood	Consequence	Risk
Muswellbrook	54	Rural properties on Albano Road and Bowmans Creek Road	Likely	Minor	Medium
	16*	Liddell Coal Mine	Likely	Major	Very High
	39*	Tree-line properties at McCullys Gap	Likely	Moderate	High
	56*	Rural properties at Hebden	Likely	Minor	Medium
Singleton	89*	Rural properties at Goorangoola	Likely	Minor	Medium

** Located in close proximity (<5 km) of Project Boundary*

Likelihood

RFS (2008) recommends criteria for rating the likelihood of bushfire impacts (see **Table 40**).

There have been few instances of fires being ignited by wind farm infrastructure. However, there remains the possibility of fires ignited by other causes. The Singleton BFMC area experiences an average of 203 bushfires per year, of which approximately 30 are major fires (Singleton BFMC, 2011). The Muswellbrook and Liverpool Range areas experience fewer major fires. The likelihood of fires within the Project Boundary will be lower than other parts of the region due to the absence of main transport corridors (e.g. NEH, railway lines) and industrial sites. As such, fires due to natural causes may occur infrequently within the Project Boundary.

If a fire occurs, it is likely to spread to areas of woodland vegetation (i.e. environmental assets). The likelihood of impacts to environmental assets is deemed to be 'Likely'.

With regard to people and private property, the dwellings within the Project Boundary are generally not located within areas of dense vegetation or on steep slopes (between 1-3 %). For these reasons, it is not expected that the Project will exacerbate fires spreading to these assets. As such, the likelihood of impacts to people and property being exacerbated by the Project is deemed to be 'Unlikely'.

The proposed WTGs are generally sited on ridgelines and hillslopes. Given that fire burns more quickly upslope, externally ignited fires are more likely to spread to Project infrastructure than to private infrastructure. The likelihood of impacts to Project infrastructure is deemed to be 'Likely'.

Table 40
Likelihood Rating Criteria

Frequency	Fires are expected to spread and reach	Fires are not expected to spread and reach assets
Fires occur frequently	Almost Certain	Possible
Fires occur infrequent	Likely	Unlikely

Consequence

The consequence rating criteria recommended by NSW RFS (2008) are presented in **Table 41**.

If a bushfire occurs within the Project Boundary, it is expected that significant injury or property damage can be prevented. This is due to the reduced fuel loads around dwellings, their location downslope of the proposed WTGs and the good accessibility for emergency services. Notwithstanding, the potential for evacuation and property damage cannot be discounted. Accordingly, the consequence of impacts to people and property is deemed to be "Moderate".

If a fire is ignited, it is likely that there will be a loss of woodland vegetation, including listed communities. Areas affected by bushfire are expected to regenerate naturally. Although there may be a loss of habitat for threatened species, there is ample habitat for these species in the local area. Given that the potential impacts to environmental assets are unlikely to result in local extinction of a threatened species or require remediation, the consequence of impacts is deemed to be "Moderate".

Although fire is more likely to spread to Project infrastructure than private assets, WTGs and substations will be primarily constructed from non-flammable materials. These structures will also be located within concrete hardstands. For these reasons, significant damage to Project infrastructure is not expected to occur. The consequence of impacts to Project Infrastructure is considered to be "Moderate".

Table 41
Consequence Rating Criteria

Rating	Description
Minor	• No fatalities • Some minor injuries with first aid treatment possibly required • No persons are displaced • Little or no personal support (physical, mental, emotional) required • Inconsequential or no damage to an asset • Little or no disruption to community • Little or no financial loss
Moderate	• Medical treatment required but no fatalities • Localised displacement of persons who return within 24 hours • Personal support satisfied through local arrangements • Localised damage to assets that is rectified by routine arrangements • Community functioning as normal with some inconvenience • Local economy impacted with additional financial support required to recover • Small impact on environment / cultural asset with no long term effects
Major	• Possible fatalities • Extensive injuries, significant hospitalisation • Large number of persons displaced (more than 24 hours duration) • Significant resources required for personal support • Significant damage to assets that requires external resources • Community only partially functioning, some services unavailable • Local or regional economy impacted for a significant period of time with significant financial assistance required • Significant damage to the environment/cultural asset which requires major rehabilitation or recovery works • Local extinction of native species
Catastrophic	• Significant fatalities • Large number of severe injuries • Extended and large number requiring hospitalisation • General and widespread displacement of persons of extended duration • Extensive resources required for personal support • Extensive damage to assets • Community unable to function without significant support • Regional or state economy impacted for an extended period of time and financial assistance required • Permanent damage to the environment • Extinction of a native species in nature

Risk

The risk matrix recommended by NSW RFS (2008) was used to determine risk ratings based on the aforementioned likelihood and consequence ratings (see **Table 42**). The ratings represent the risk posed by any fire (regardless of cause) to assets within and immediately surrounding the Project Boundary. Given that there are few instances of fires being ignited by wind farm infrastructure, the residual risks are predominantly attributed to other causes.

The risk to people and private property is "Low" based on a likelihood rating of "Unlikely" and consequence rating of "Moderate".

The risk to environmental assets is "High" based on a likelihood rating of "Likely" and consequence rating of "Moderate".

The risk to Project infrastructure is "High" based on a likelihood rating of "Likely" and consequence rating of "Moderate". Risks to Project infrastructure will be borne by the Proponent.

Table 42
Risk Matrix

Likelihood	Consequence			
	Minor	Moderate	Major	Catastrophic
Almost Certain	High	Very High	Extreme	Extreme
Likely	Medium	High	Very High	Extreme
Possible	Low	Medium	High	Very High
Unlikely	Low	Low	Medium	High

7.10.4 Mitigation and Management

Preventative Measures

Controls will be implemented to minimise the risk of fires being ignited due to Project activities:

- Appropriate storage and handling of hazardous materials in accordance with the relevant Australian Standards;
- Bunding around areas where spills of hazardous materials may occur;
- Routine replacement and disposal of transformer oil;
- Modifying activities to suit the risk level determined by the RFS (e.g. avoiding ignition generating activities during total fire bans or notification if such activities are not avoidable);
- Management of vegetation growth near powerlines;
- Ensuring that the site is equipped with first response firefighting equipment;
- Regular training of relevant construction and operational personnel in first response firefighting and evacuation procedures;
- Regular consultations with the local Bush Fire Brigade and provision of access to the facilities for advice and familiarisation purposes; and
- Security fencing to prevent unauthorised access to areas containing electrical infrastructure and hazardous materials.

In accordance with PBP, the Proponent will develop a Bushfire Management Plan in consultation with the relevant emergency services and regulatory authorities. This Plan will include measures to minimise the risk of ignition, as well as contingency plans for fires that occur within the Project Boundary (regardless of whether it is caused by the Project).

Planning for Bush Fire Protection

PBP recommends key BPMs for proposed developments on bushfire prone land. **Table 43** lists the relevant BPMs and explains how these will be implemented for the Project.

The assets listed in BFRMPs (see **Table 37**) are owned by third parties. Measures to protect those assets and other privately owned property with the Project Boundary are the responsibility of the asset owner. The agricultural land within the Project Boundary will generally continue to be grazed to assist in managing bushfire fuel loads. Grazing activities are also managed by third parties.

Table 43
Compliance with Recommended Bushfire Protection Measures

Bushfire Protection Measure	Commitments
The provision of clear separation of buildings and bush fire hazards in the form of fuel reduced APZ	An APZ is a buffer zone with reduced fuel load. PBP recommends a minimum APZ of 10 m around wind farm infrastructure. APZs will be established and maintained around WTG sites and substation compounds in accordance with PBP
Construction standards and design	All Project infrastructure will be constructed in accordance with Australian Standards (where applicable)
Appropriate access standards for residents, fire fighters, emergency service workers and those involved in evacuation	Access tracks will be designed as described in **Section 3** and regularly maintained to ensure good trafficability. The access tracks will be suitable for use by local bush fire firefighting tankers New and upgraded access tracks will improve the efficiency of evacuation efforts (if required)
Adequate water supply and pressure	Water tanks will be utilised as described in **Section 3.** Emergency services will be given access to these water supplies if required for firefighting purposes
Emergency management arrangements for fire protection and/or evacuation	Develop emergency protocols for its personnel Information will be provided to emergency authorities (Fire Brigade, RFS, etc.) to assist in emergency management planning
Suitable landscaping, to limit fire spreading to a building	WTGs and substations will be constructed within non-flammable hardstand areas

7.11 BLADE THROW

7.11.1 Background

Blade throw refers to a potential incident where a WTG blade becomes detached and is projected into the surrounding environment. Such incidents are very rare but may occur where blades are damaged by lightning strikes, storms and material fatigue. The proposed WTGs are equipped with safety mechanisms including lightning conductors and automated monitoring systems. The latter is used to detect declines in structural integrity at an early stage.

Ice may accumulate on the WTG blades during cold temperatures. Ice throw refers to a potential incident where accumulated ice is projected into the surrounding environment.

The risk of blade and ice throw is largely influenced by the speed at which the blades are turning. The proposed WTGs will be equipped with automatic braking systems to maintain the rotors at a safe speed.

7.11.2 Impact Assessment

The region around each WTG that is susceptible to blade throw risk can be determined using the principles of projectile motion. The theoretical maximum trajectory would occur when the rotor is turning at its maximum operating speed and the blade is launched at an angle of 45° above the horizontal.

At speeds above 25 m/s a WTG will shut off via blade feathering and stop the blade from spinning. Brakes are applied once the WTG blade is stopped.

The proposed WTGs will have an indicative hub height between 140 m to 150 m, which represents the height from which a blade could be thrown. Based on these parameters, the maximum distance that a blade may be projected is approximately 95 m. This theoretical maximum does not account for wind resistance, which will reduce how far the projectile can travel. Given that the blades are indicatively 80 m long, the region within 175 m of each WTG has the potential to be struck.

Ice throw may occur when the ambient temperature is less than freezing point. Sub-zero temperatures are not common in the Hunter Region but can occasionally occur during the winter months. Ice throw presents less of a risk than blade throw because the accumulated ice reduces the efficiency of the blade, thus reducing its rotational speed. Empirical evidence from other wind farms indicates that ice fragments have been found between 15 to 100 m from WTGs and vary in mass from 0.1 to 1 kg (EDP Renewables, 2005).

There are no private non-Associated dwellings located within 175 m of a WTG location. The closest private residence to a WTG is Receiver P22-1, which is approximately 1,381 m from WTG 23. As a result, there is no risk of damage to property due to blade throw.

Most WTGs are located in elevated areas, which will generally not be accessed by persons other than operational personnel and some host landholders. All WTGs will be located on private property and at least 400 m from public roads. As a result, blade throw presents no risk to members of the general public.

7.11.3 Mitigation and Management

The risk of blade throw is most effectively managed by reducing the likelihood of a component failure. This will be achieved through the following:

- International safety and structural integrity standards that govern the manufacture of WTG components;
- Ongoing monitoring of structural integrity, through both automated systems and manual inspections;
- Routine maintenance of WTG components;
- Immediate replacement or repair of components that exhibit signs of damage or excessive wear; and
- Operational controls that enable the rotors to be slowed down (or fully stopped) during extreme wind conditions.

Notwithstanding the aforementioned controls, the risk of blade or ice throw within 175 m of the proposed WTGs cannot be completely eliminated. The residual risk will be managed through administrative controls, such as avoiding activities in close proximity to WTGs during certain meteorological conditions. These administrative controls will be developed in consultation with host landowners.

7.12 PROPERTY VALUE

A review of potential impacts to property values for the Project was undertaken by Gillespie Economics and is included in **Appendix O**.

The economic value of private land is determined by the interaction of demand and supply in the market, with the market price for land reflecting the willingness to pay of a potential purchaser. Willingness to pay reflects the discounted future potential returns from the land (whether from agriculture, rural residential uses, mining and extractive industries, recreation uses and potential (real or otherwise) to convert to higher value uses e.g. rural residential, urban, industrial or commercial uses. These potential future returns reflect the structural, access and environmental attributes of the land.

Preston Rowe Patterson (2009) in a study of the impact of wind farms on property values found that properties in rural/agricultural areas appeared to be the least affected by wind farm development, with no reductions found near any of the eight wind farms investigated. The only properties where a possible effect was observed were lifestyle properties in Victoria within 500 m of a wind farm. For the Project, there are not any non-Associated dwellings within 500 m of a turbine.

A literature review by Urbis (2016) of Australian and international studies found that the majority of published reports conclude that there is no impact or a limited defined impact of wind farms on property values. Those studies which identified a negative impact are based in the northern hemisphere and are associated with countries with higher population densities and a greater number of traditional residential and lifestyle properties affected by wind farms. This is generally contrary to the Australian experience, with most wind farms being located in low population density environments that derive the majority of their value from productive farming purposes (Urbis, 2016).

Urbis (2016) undertook an assessment of the impact of wind farms on surrounding land values in NSW and Victoria for the Office of Environment and Heritage (OEH). It found that there is insufficient sales date to provide a definitive answer utilising statistically robust quantitative analysis techniques.

However, from its case study assessments it did not identify any conclusive trends that would indicate that wind farms have negative impacts on property values. Its property resale analysis indicated that all of the properties examined demonstrated capital growth that aligned with the broader property market at the time. Consequently, Urbis (2016, p. 21) concluded:

> *"In our professional opinion, appropriately located wind farms within rural areas, removed from higher density residential areas, are unlikely to have a measurable negative impact on surrounding land values."*

7.13 GREENHOUSE AND LIFE CYCLE

7.13.1 Background

Global GHG emissions are generally recognised as a major contributor to climate change. CSIRO (2011) explains that:

> *"Greenhouse gas emissions from human activities are more than 90 per cent likely to have caused most of the global warming since the mid-20th century".*

The International Energy Agency (IEA) collates data on global and national energy generation and GHG emissions. In 2018, Australia generated approximately 383 Mt of CO_2-e from all sources combined. Australia's total annual emissions have remained relatively constant since 2009, ranging from 367 to 391 Mt CO_2-e per annum. Prior to 2009, total emissions consistently increased from year to year.

Australia's emissions per capita have decreased consistently since 2007. However, Australia's emissions per capita (15.6 t CO_2-e) remain more than three times the global average of 4.4 t CO_2-e (IEA, 2020).

Generation of electricity and heat was the largest source of emissions, accounting for almost half (186 Mt CO_2-e) of total emissions in 2018 (IEA, 2020). Reduction of GHG emissions from the electricity sector is therefore a critical step in the reduction of Australia's total emissions. Renewable energy developments (including wind farms) can facilitate a reduction in emissions from the electricity sector by reducing reliance on fossil fuels for energy.

7.13.2 Impact Assessment

WTGs once commissioned can generate electricity without producing any GHG emissions. The electricity generated by the Project will displace electricity produced using fossil fuel sources (such as coal and gas), thereby reducing GHG emissions from the stationary electricity sector. Therefore, the Project will have a positive impact on GHG emissions during its operational phase.

GHG emissions will be generated in the course of manufacturing, transporting and constructing the proposed WTGs. The GHG emissions cost of a WTG is largely represented by the energy required to produce its materials (embodied energy).

The net impact of a WTG is determined by comparing the energy it generates (when operational) to the embodied energy of its components. Smil (2016) states that *"a well-sited and well-built WTG will generate as much energy as it embodies in less than a year".*

Energy Expenditure

Construction of the footing and hardstand for each WTG will require approximately 600 m^3 of concrete. Based on a typical density of 2,400 kg/m^3, each WTG site will require approximately 1,440 t of concrete. CSIRO (2000) estimated that the embodied energy of concrete is in the order of 2 GJ/t. Therefore, approximately 2,880 GJ of energy is required for the production of the concrete used to construct each WTG site.

Steel is used for the production of the hub, nacelle and tower components of a WTG (design discussed in **Section 3.3**). For a typical 5.6 MW WTG, these components have a combined mass of 667 t. In addition, approximately 60 t of steel rebars will be used in the reinforced concrete footing. CSIRO (2012) estimates the embodied energy of steel at 20 MJ/kg (or 20GJ/t). Therefore, the steel used in the construction of a WTG will require approximately 14,540 GJ of energy to produce it. The embodied energy of each component is shown in **Table 44**.

The blades of a WTG are constructed from a composite material. The three blades in a 5.6 MW WTG have a combined mass of approximately 65 t. The embodied energy of a fibre-reinforced composite is typically around 170 GJ/t (Smil, 2016). Therefore, production of the composite material used for WTG blades will involve 10,050 GJ of energy.

The total energy required to produce the raw materials is estimated at 28,470 GJ. Energy will also be expended during the fabrication, transportation and installation of the WTG components. However, the energy associated with these processes is expected to be less than the embodied energy of the component materials. The total energy expenditure required to construct a WTG has been conservatively estimated by doubling the embodied energy of its components, which results in a value of approximately 57,000 GJ per WTG.

The total embodied energy in a typical 5.6 MW WTG (including its foundation) is shown in **Table 44**.

Table 44
Embodied Energy of Main Wind Turbine Generator Components

Component	Material	Quantity (t)	Embodied Energy of Material (GJ/t)	Embodied Energy of Component (GJ)
Hub	Steel	60	20	1,200
Nacelle	Steel	65	20	1,300
Tower	Steel	542	20	10,840
Blades x 3	Composite	65	170	11,050
Concrete footing	Concrete	1,440	2	2,880
Steel reinforcement bars	Steel	60	20	1,200
Total (per WTG)				**28,470**

Energy Production

At maximum output, a 5.6 MW WTG will generate approximately 49 GWh of electrical energy per year, which is equivalent to 176,600 GJ/year. The maximum annual energy output of a 5.6 MW WTG is greater than the energy required for its construction.

The intermittent nature of wind is often quoted as a limitation of wind energy developments. The total energy output of a wind turbine therefore depends on the quality of the resource (wind) at a particular site. When factoring in the actual generation compared to the theoretical maximum (known as the "capacity factor") a wind turbine will still produce significantly more energy than it consumes when selected appropriately.

Data from the Clean Energy Council (2020) indicates that in 2019, Australia had 6,279 MW of installed wind farm capacity and generated 19,487 GWh of electricity through wind energy. This equates to an average capacity factor of 35.4% across Australia. Using this capacity factor, a 5.6 MW turbine would generate 62,563 GJ (or 17.3 GWh) of energy in a single year. The energy output in the first year is greater than the energy required to construct the turbine.

The proposed WTGs will offset their energy expenditure in less than one year, assuming an average capacity factor for Australian wind farms. This is consistent with Smil's (2016) conclusion that a well-designed WTG will generate more energy than it embodies in less than a year. The proposed WTGs will have an operational life of approximately 25 years. As such, the energy produced by a WTG over its lifespan will substantially outweigh the energy required for its construction.

Greenhouse Gas Savings

Given that the proposed WTGs will offset their construction energy expenditure in less than one year, the Project will generate zero-emissions energy for most of its duration. The energy generated by the Project will displace energy generated from non-renewable sources, thereby reducing state and national GHG emissions.

The Project has an indicative nameplate capacity of 336 MW (60 x 5.6 MW). The energy and GHG emissions savings facilitated by the Project are estimated in **Table 45**. For this analysis, it has been assumed that the Project will offset the emissions generated by the existing make up of generation supply on the NEM is generated from combustion of coal. The 'National Greenhouse Accounts Factors' (DISER, 2020) prescribes an emissions factor of 790 kg CO_2-e/MWh for electricity generated on the NEM. That is, each MWh electricity generated by the Project will displace 790 kg of carbon dioxide equivalent.

The Project is estimated to result in annual greenhouse gas savings of 813,700 tonnes of carbon dioxide equivalent (from 1,030 gigawatt hours of generated electricity) (CER, 2020a). Assuming an average wind farm capacity factor, the Project has the potential to provide sufficient renewable energy to support the annual electricity needs of approximately 145,000 households.

The GHG emissions associated with supplying electricity to this number of households will be foregone as a result of the Project.

Table 45
Greenhouse Gas Emissions Displaced by the Project

Scenario	Energy Generated	Annual GHG emissions Savings (t CO2-e)
	GWh	
Nameplate rating	2,943	2,453,440
Average capacity factor for Australian wind farms*	1,030	813,700

** Based on actual energy generation from Australian wind farms in 2019 (Clean Energy Council, 2020)*

7.13.3 Management and Mitigation Measures

Although the Project will result in a net reduction in national GHG emissions, appropriate measures will be implemented during the construction phase to reduce emissions, such as:

- Selection of fuel and energy efficient equipment and vehicles;
- Routine maintenance of equipment and vehicle to optimise efficiency; and
- Sourcing equipment and materials from local suppliers (where practicable) to reduce delivery distances.

7.14 AIR QUALITY

7.14.1 Background

A review was undertaken to assess potential air quality impacts and determine appropriate management and mitigation controls that would be required during the construction and operation of the Project. GHG emissions are addressed in **Section 7.13**.

7.14.2 Impact Assessment

Project Construction

Air quality impacts during Project construction may include due to:

- Excavation works for the construction of Project infrastructure and access tracks;
- Handling and stockpiling of topsoil, subsoil and vegetation material;
- Blasting activities during construction (if required);
- Crushing and screening activities;
- Operation of concrete batching plants;
- Transport of Project infrastructure components to site; and
- Use of Project construction equipment.

Project Operations

Air quality impacts during Project operations will occur as a result of:

- Emissions from exposed surfaces;
- Use of Project operational equipment; and
- Maintenance works on Project infrastructure, including access tracks, hardstands and laydown areas.

7.14.3 Mitigation and Management

Mitigation and management measures that will be implemented to minimise air quality impacts from the Project will be described in the CEMP and OEMP.

A summary of key control measures to minimise air quality emissions during the construction and operation of the Project are outlined below.

Construction

Measures to be implemented to reduce visible dust emissions during Project construction will include:

- Minimising the total surface area that is exposed within the Disturbance Area at any one time;
- Completing progressive reshaping and rehabilitation works;
- Minimising dust emissions from exposed areas by application of water and/or dust suppressants;
- Appropriately locating, shaping and seeding longer term topsoil stockpiles to minimise dust erosion from exposed surfaces;
- Minimising the use of construction equipment outside of areas required to be disturbed for Project infrastructure;
- Implementing speed restrictions for equipment operating on unsealed access tracks and disturbed areas;
- Limiting construction activities during unfavourable weather conditions;
- Blasting activities to be undertaken in accordance with the ANZEC Guidelines; and
- Regular inspections of construction activities to ensure appropriate air quality controls are being implemented to minimise dust emissions.

Operations

Measures to be implemented to reduce visible dust emissions during Project operations may include:

- Minimising dust emissions from exposed areas by application of water and/or dust suppressants;
- Implementing speed reductions for equipment operating on unsealed access tracks or hardstand areas;
- Limiting maintenance activities during unfavourable weather conditions; and
- Regular inspections to ensure appropriate air quality controls are being implemented during Project maintenance activities.

7.15 WATER RESOURCES

7.15.1 Background

Streams and Catchments

The Project is located within the Hunter-Central Rivers Catchment Management Authority (HCRCMA) region. The HCRCMA region encompasses an area of approximately 37,000 km^2 and extends from Taree in the north, Gosford in the south to Merriwa in the west.

The Project is located within the Hunter River catchment, specifically within the sub-catchments that drain to Bowmans Creek, Sandy Creek and Muscle Creek. The Hunter River is the major watercourse in the Hunter Region. Flows in the Upper Hunter are regulated by Glenbawn Dam and Lake St Clair (also known as "Glennies Creek Dam"). Three major water storages are located within 10 km of the Project: Glenbawn Dam, Lake Liddell and Lake St Clair.

Water resources within and surrounding the Project Boundary are shown on **Figure 51**. The majority of the Project Boundary is located within the catchment of Bowmans Creek which is a sixth order stream that exhibits near perennial flow in its higher order reaches (downstream of the Project). The headwaters of Bowmans Creek are located in the Mt Royal Range and the upper catchment is deeply incised in steep bedrock terrain. The lower reaches meander through a broad alluvial floodplain and terrace sequence that is up to 1 km wide. Bowmans Creek has its confluence with the Hunter River to the south of the Project. The named tributaries of Bowmans Creek located within the Project Boundary include Cedar Creek, Fish Hole Creek, Lincolns Creek and Alexander Creek. Coalhole Creek is a tributary of Bowmans Creek located south of the Project Boundary and near the proposed transmission line.

Bowmans Creek provides intermittent water supplies for agricultural land uses. Downstream of the Project, it meanders through and near multiple coal mines as shown on **Figure 51**. Although these mines intercept runoff from the Bowmans Creek catchment, they do not extract water directly from the stream. Due to its intermittent flow regime and the disturbed nature of its catchment, Bowmans Creek does not have significant aquatic habitat value. For these reasons, the primary management objective for Bowmans Creek is to maintain suitable water quality for agricultural use.

The northern portion of the Project Boundary is located within the catchment of Sandy Creek. Sandy Creek is an ephemeral stream (i.e. it flows only following heavy rainfall). The main channel meanders in a generally east-west orientation and has its confluence with the Hunter River near Muswellbrook. The named tributaries of Sandy Creek within the Project Boundary include Limestone Creek, Hilliers Creek and Gins Creek.

A small area within the western portion of the Project Boundary is located within the catchment of Muscle Creek. This is an ephemeral stream that meanders in a generally east-west orientation and meets the Hunter River at Muswellbrook. Only the uppermost reaches of Muscle Creek and its tributary Middle Creek are located within the Project Boundary.

There are no significant wetlands located in the vicinity of the Project Boundary. The absence of GDEs is described in **Section 7.5.3**.

The Project is located outside of the Coastal Zone, as defined under the *Coastal Management Act 2016* (CM Act) and *State Environmental Planning Policy (Coastal Management) 2018*. Accordingly, the provisions of the CM Act do not apply to the Project. Similarly, the Project is not affected by coastal processes, such as sea level rise associated with climate change.

Aquifers

The stratigraphic sequence consists of Permian bedrock strata overlain by alluvial sediments of Quaternary origin. There are three groundwater bearing units surrounding the Project including:

- Unconsolidated alluvial sediments;
- Regolith (weathered bedrock); and
- Fractured rocks within the Permian sequence.

Alluvial sediments are present along the main channel of Bowmans Creek downstream of the Project (BAP, 2014). The regional water table is located within the Permian aquifer. This aquifer typically produces low groundwater yields, although higher yields may occur at highly fractured fault systems (DPI, 2016). The regolith may exhibit higher conductivity than the underlying bedrock due to the effects of weathering.

Jolly Springs is a naturally occurring groundwater spring located near the eastern extent of the Project Boundary, as shown on **Figure 51**. The springs discharge into the catchment of Goorangoola Creek.

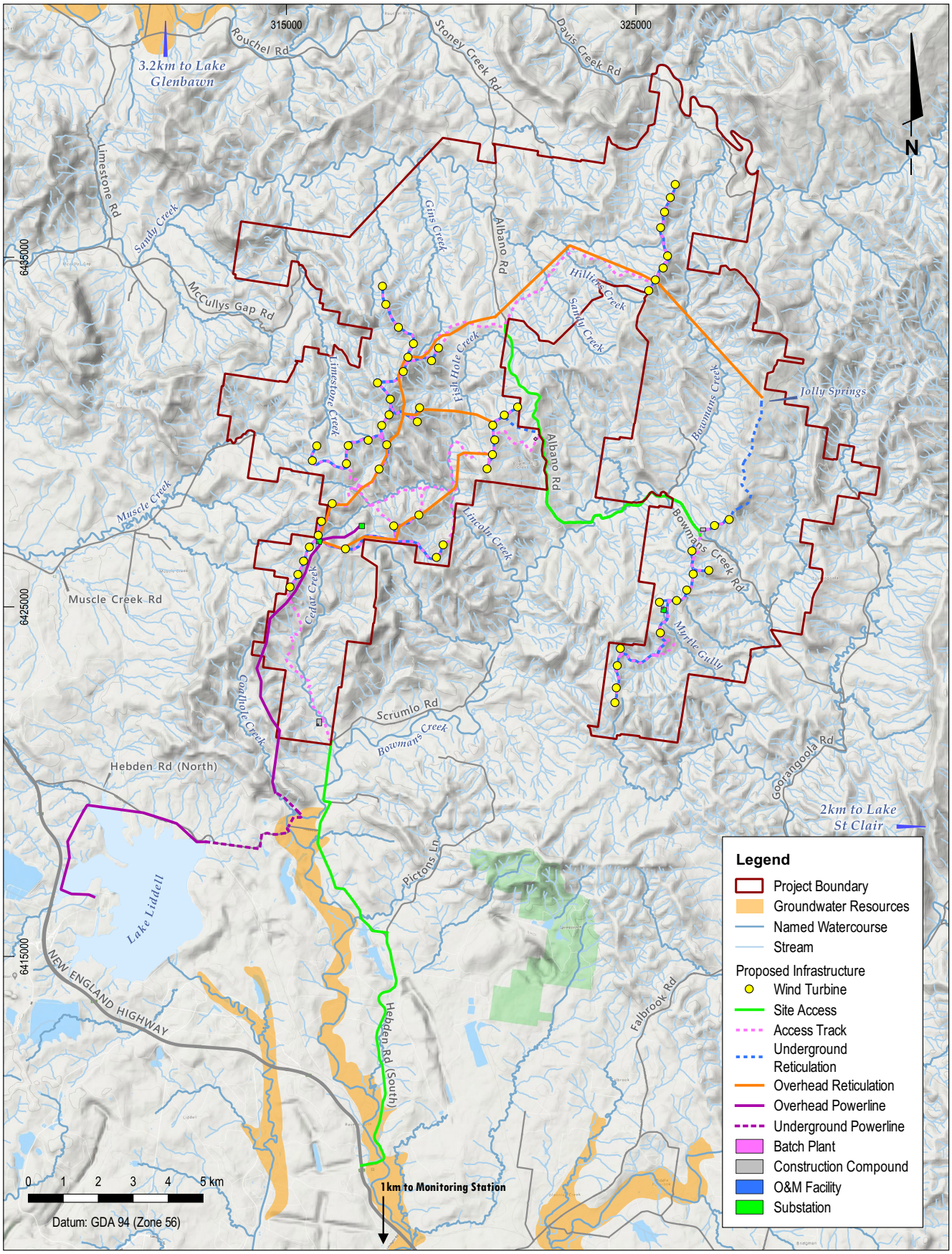
Regional Water Supply Scheme

The 'Greater Hunter Regional Water Strategy' (DoI, 2018) considered measures to manage the drought risks to the primary industries of the Upper Hunter. The Strategy recognised that the Upper Hunter has significant water storage capacity but less rainfall yield than the Lower Hunter. Accordingly, connections to other water distribution systems are necessary to improve the water security of the Upper Hunter. The Strategy recommended investigation of the following options:

- Two-way connection between Lostock Dam and Glennies Creek Dam;
- Potable pipeline from the Hunter Water network to Singleton;
- Large scale water reuse scheme; and
- Continued operation of the Barnard Scheme after closure of the Liddell Power Station.

Lostock Dam, Glennies Creek Dam and the Hunter Water network are located south-east of the Project. The Barnard Scheme is a pipeline system that facilitates the transfer of water between the Barnard River (in the Manning Valley) and the Hunter River. All infrastructure components of the Barnard Scheme are located north of the Project. As such, the Project will not affect the ability to implement the options identified by the Greater Hunter Regional Water Strategy.

Source: Water features courtesy of the Spatial Collaboration Portal (accessed June 2020); Terrain ©2019 Google



Bowmans Creek Wind Farm | Fig51_Water Resources | 12 03 2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Water Resources

FIGURE 51

7.15.2 Impact Assessment

Water Balance

Construction

During the construction phase, water is required for activities including concrete batching, dust suppression and road construction. Water for construction activities will be obtained from external sources and transported to the site using water tankers (or utilised from Associated landholders farm dams under the controls as described in **Section 4.4.7**).

The estimated water balance for the construction phase is outlined in **Table 46**. Given that water will only be sourced as needed to meet actual demand, there will be no water surplus or deficit. The total water demand for the construction phase is estimated at 95 ML. This quantity is equivalent to the average annual consumption for 489 households, based on the average NSW household consumption of 194 kL/year (ABS, 2019). Therefore, the Project will not have a significant impact on the local water supply.

Table 46
Construction Phase Indicative Water Balance

Component	Volume (ML)
Inputs	
External water supplies	95*
Outputs	
Concrete batching	6
Dust suppression and road construction	89

** Will be adjusted to match actual demand.*

Operations

The operational phase of the Project will only require a small volume of water (approximately 1 ML/year). Water for ongoing operational activities will be supplied by tanks at the O&M Facility. The Proponent does not own the land within the Project Boundary and as such, is not entitled to any harvestable rights. However, there are farm dams located within the Project Boundary that may be consistent with the relevant harvestable rights order. The Proponent will enter into agreements with these landowners if it is necessary to use water captured in these farm dams.

Stream Channels

Streams within the Project Boundary were defined using the hydroline spatial data published by the NSW Department of Finance, Services and Innovation (2017). Stream orders were determined using the Strahler stream classification system. Most of the streams present within the Project Boundary are minor drainage lines (1st or 2nd order streams). The infrastructure associated with the Project has been designed to minimise impacts to streams. As shown in **Section 3.10**, the proposed WTGs have been carefully sited to avoid stream channels.

Due to their linear nature, stream channels cannot be completely avoided by the proposed access tracks and underground cables. **Table 47** indicatively lists the streams and gullies that may be intersected by the proposed linear infrastructure.

The transmission line is comprised of both overland powerlines and underground cables. The overhead sections of the transmission line will be designed to span across significant stream channels and therefore will not affect stream flows. The underground portion of the transmission line may intercept the main channels of Bowmans Creek and Coalhole Creek as well as unnamed tributaries of Coalhole Creek (see **Figure 51**). The underground transmission cable will be underbored beneath the main channels of Bowmans Creek and Coalhole Creek. The underground cable will also pass beneath the ephemeral tributaries of Coalhole Creek, except these crossings will be via trenching.

Table 47
Indicative Stream Channel and Gully Crossings

Stream	Intersected By
Unnamed tributaries of Limestone Creek	Access track and underground cables
Fish Hole Creek and its unnamed tributaries	Access track and underground cables
Sandy Creek and its unnamed tributaries	Access track
Unnamed tributary of Gins Creek	Access track
Hilliers Creek and an unnamed tributary	Access track
Lincolns Creek and its unnamed tributaries	Access tracks and underground cables
Rock Lilly Gully (tributary of Lincolns Creek)	Access track
Cedar Creek and its unnamed tributaries	Access track
Bowmans Creek and its unnamed tributaries	Access track and underground cables (including underground section of the transmission line)
Myrtle Gully and its unnamed tributaries	Access track and underground cables
Unnamed tributary of Cross Creek	Access track
Coalhole Creek and its unnamed tributaries	Underground section of the transmission line

Hydrology

Most of the streams listed in **Table 47** are tributaries of Bowmans Creek. WaterNSW operates a monitoring station on Bowmans Creek (Station 210130) downstream of the Project. This station has measured water level and flow volume since 1993. At this location, Bowmans Creek has a median flow of approximately 1.0 ML/day and a mean flow of approximately 43.2 ML/day.

This indicates that Bowmans Creek experiences nil to low flows for most of the time, with substantial flows occurring only after heavy rainfall. Station 210130 is located approximately 15 km downstream of the Project (as shown on **Figure 51**). As a result, the streams within the Project Boundary will exhibit much lower flow volumes than those measured at Station 210310.

Some linear infrastructure will cross Sandy Creek and its tributaries, Limestone Creek and Gins Creek. There is no monitoring data available for Sandy Creek. Given that it has a smaller catchment than Bowmans Creek, Sandy Creek is also expected to exhibit intermittent flows.

Creek crossings for access tracks will involve the construction of culverts and/or small bridges spanning the creek bed.

Underground cables (including a section of the transmission line) will pass beneath streams via underboring or trenching. Underbore crossings avoid the need for disturbance of stream beds or banks, whereas trench crossings will involve temporary disturbance during construction. Trenches will be backfilled and rehabilitated as soon as practical following cable installation. Given that linear infrastructure will either pass above or beneath the stream bed, there will be no impacts on flow volumes. Similarly, fish passages are not required for the proposed creek crossings because these will not impede stream flow.

Water Quality

WaterNSW's monitoring station on Bowmans Creek has measured electrical conductivity (EC) since 1993. The EC of Bowmans Creek is generally less than 2,000 µS/cm, with a median value of approximately 1,170 µS/cm. The 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality' (ANZECC, 2000 recommends an EC range of 950 - 1,900 µS/cm for "moderately sensitive crops". This indicates that the existing EC of Bowmans Creek is generally suitable for irrigation, with the exception of salinity sensitive crops. The dominant agricultural land use within the Project Boundary is livestock grazing, which is generally less sensitive to water quality than cropping. Therefore, the existing EC of Bowmans Creek is suitable for most agricultural activities.

The Project will not involve any controlled discharges to the surrounding watercourses. All wastewater will be removed from the site as described in **Section 7.17**.

Construction of the creek crossings listed in **Table 47** will involve disturbance and earthworks in and adjacent to these stream beds. In the absence of controls, these works would have the potential to impact upon water quality through the following mechanisms:

- Erosion of soil from exposed areas; and
- Spills of hazardous substances.

Hazardous substances will be stored within bunded areas to prevent spills from escaping into the surrounding environment. In particular, bunding will be established around substations and concrete batching plants. These areas will also be equipped with spill containment kits.

The Project includes overhead powerlines that pass over streams in addition to the indicative creek crossings listed in **Table 47**. Overhead powerlines can be designed such that the poles avoid the stream beds. The proposed powerlines will not result in any impacts to water quality.

By implementing appropriate spill and sediment controls, the impacts of the Project on the water quality of Bowmans Creek will be negligible. The water quality in Bowmans Creek will continue to be suitable for agriculture.

Flooding

The Project is located in the upper catchments of Bowmans Creek, Sandy Creek and Muscle Creek. As such, these streams have a relatively small catchment and only flow after significant rainfall (i.e. they are ephemeral).

Figure 51 shows that alluvial sediments occur along Bowmans Creek downstream of the Project, but not within the Project Boundary. The absence of alluvium suggests that the streams within the Project Boundary do not regularly break their banks. The proposed creek crossings will be designed at grade so that they do not result in the detention of floodwaters.

Groundwater

Given that there will be no extraction of groundwater for site water use, the Project will not result in any drawdown of the water table. Excavation will be required for the construction of infrastructure foundations and underground cables. Such excavations will be relatively shallow and are not expected to intersect the water table. Similarly, the Project will not disturb any alluvial sediments given that there is no alluvium within the Project Boundary (see **Figure 51**).

The yield of Jolly Springs may be affected if either of the following occurred:

- Depressurisation of the groundwater system; and
- Fracturing of the underlying bedrock.

The Project is not expected to result in either of these impacts. The Project does not involve any activities that would result in depressurisation of the regional aquifer. Blasting has the potential to fracture bedrock in the area surrounding the blast. However, the nearest WTG (T10) is located over 3.5 km from Jolly Springs. At this distance, the vibration levels generated by blasting are unlikely to result in fracturing.

The NSW Aquifer Interference Policy (AIP) is not applicable to the Project because it does not involve any taking of groundwater.

7.15.3 Mitigation and Management

The potential impacts of the Project on water resources have been substantially mitigated through design constraints. The locations of the proposed WTGs have avoided watercourses. The alignments of the proposed linear infrastructure have also minimised intersections of streams, wherever practicable.

The following erosion and sediment controls will be implemented:

- Drains or bunds to divert clean runoff away from exposed areas;
- Sediment dams or traps to capture runoff from exposed areas;
- Silt fences, sandbags or other filters to be installed where appropriate;
- Re-vegetation or sealing of exposed areas as soon as practicable; and
- Avoidance of earthworks in streams (e.g. trenching) during rainfall events.

Where required, erosion and sediment controls will be retained for the operational phase. For example, drains or bunds that divert drainage away from exposed areas will also serve to divert water away from the constructed hardstands.

Potential areas of flooding will be considered during detailed design.

The construction of creek crossings for cables and access tracks will be "controlled activities" (as defined under Section 91 of the WM Act). These works will be undertaken in accordance with the 'Guidelines for Controlled Activities on Waterfront Land' (DoI, 2018).

In the absence of take from or discharges to the surrounding watercourses and water storages, no water monitoring is necessary for the Project.

The Project will not involve any taking of water via dams or bores which require a new WAL. The responsibility for obtaining the necessary WALs for water carted to the Project during construction will rest with the contractor that supplies the water (as explained in **Section 4.4.7**).

The above management measures will be documented in the CEMP and OEMP.

7.16 SOILS AND AGRICULTURE

7.16.1 Background

This section discusses the mapped land capability classification of the land within the Project Boundary and its suitability for agriculture according to 'The Land and Soil Capability Assessment Scheme Second Approximation' (OEH,2012). It also outlines the rehabilitation objectives for the land to be disturbed by the Project.

The Project is located within the NSW North Coast Bioregion, a short distance north of its interface with the Sydney Basin Bioregion. The geology in this bioregion is characterised by Permian and Devonian bedrocks associated with the New England Fold Belt. Faulting has resulted in small granite and granodiorite intrusions of the sedimentary rocks (NPWS, 2003). The Project Boundary straddles the Hunter, Upper Hunter, Tomalla and Ellerston sub-regions.

7.16.2 Impact Assessment

Soils

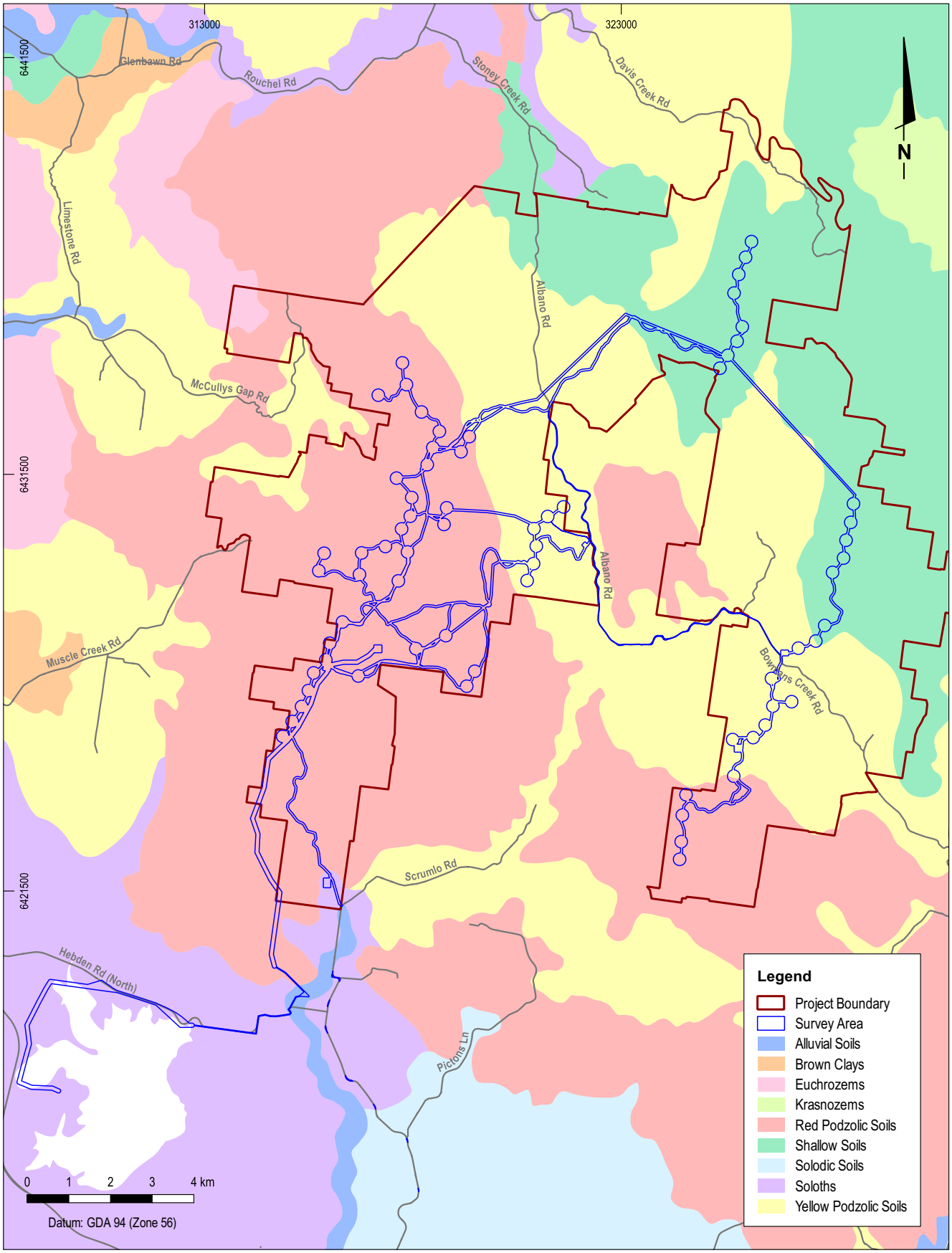
The soil landscapes within the Project Boundary were identified using the 'Soil Landscapes of the Singleton 1:250,000 sheet' (Kovac and Lawrie, 1991). The soil units present within the Project Boundary are shown in **Figure 52**. The Survey Area consists predominantly of red podzolic soils, with smaller areas of yellow podzolic soils and shallow soils.

Red and yellow podzolic soils belong to the soil order known as Chromosols. This order is characterised by strong textural contrast between the A and B horizons. The upper part of the B horizon is generally not sodic and not strongly acidic. Chromosols (particularly red chromosols) are the most widely used soils for agriculture (Isbell, 1996). Chromosols can be susceptible to erosion if the soil is tilled or where there is little ground cover (DLWC, n.d.).

DPIE (2019a) has prepared maps showing the occurrence of acid sulphate soils in NSW. There are no acid sulphate soils present within the Project Boundary.

Soil disturbance will occur during the construction phase and will be limited to within the Survey Area. Excavated soil will be reused on-site, such as constructing bunds to divert water around disturbed areas. Due to the dispersibility of Chromosols, suitable erosion and sediment controls will be implemented to minimise soil loss (as discussed in **Section 7.15.3**).

Source: Kovac, M and Lawrie, JW 1991, Soil Landscapes of Singleton 1:250,000 Sheet



Bowmans Creek Wind Farm | Fig52_Soil Landscapes | 11 03 2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Soil Landscapes

FIGURE 52

Land Capability

The land capability classifications for the land within the Project Boundary were determined using the soil and land capability mapping prepared by DPIE (2019b). Land capability classification is based on multiple soil characteristics including erodibility, structural decline, acidity, salinity, waterlogging, rockiness and mass movement hazard. The land capability class is determined by the most limiting factor (OEH, 2012). As shown in **Figure 53**, the Project Boundary primarily encompasses land that conforms to land capability classes 5 and 7. Topography is a limiting factor for the land within the Project Boundary as steep gradients contribute to increased erosion hazard.

Class 5 land is generally used for grazing. This class of land is often characterised by steep gradients and/or highly erodible soils (OEH, 2012). Given that severe erosion may occur when the soil is exposed, Class 5 land is not suitable for regular cultivation.

Class 7 land is not suitable for agriculture due to steep gradients, rockiness or highly erodible soils (OEH, 2012). Use of Class 7 land for cropping or grazing would result in severe land degradation. It is acknowledged that within the large-scale mapping shown in OEH (2012), some areas are currently utilised for grazing activities. Class 3 land is capable of sustaining cultivation but requires land management practices to control erosion and soil degradation (OEH, 2012).

Agriculture

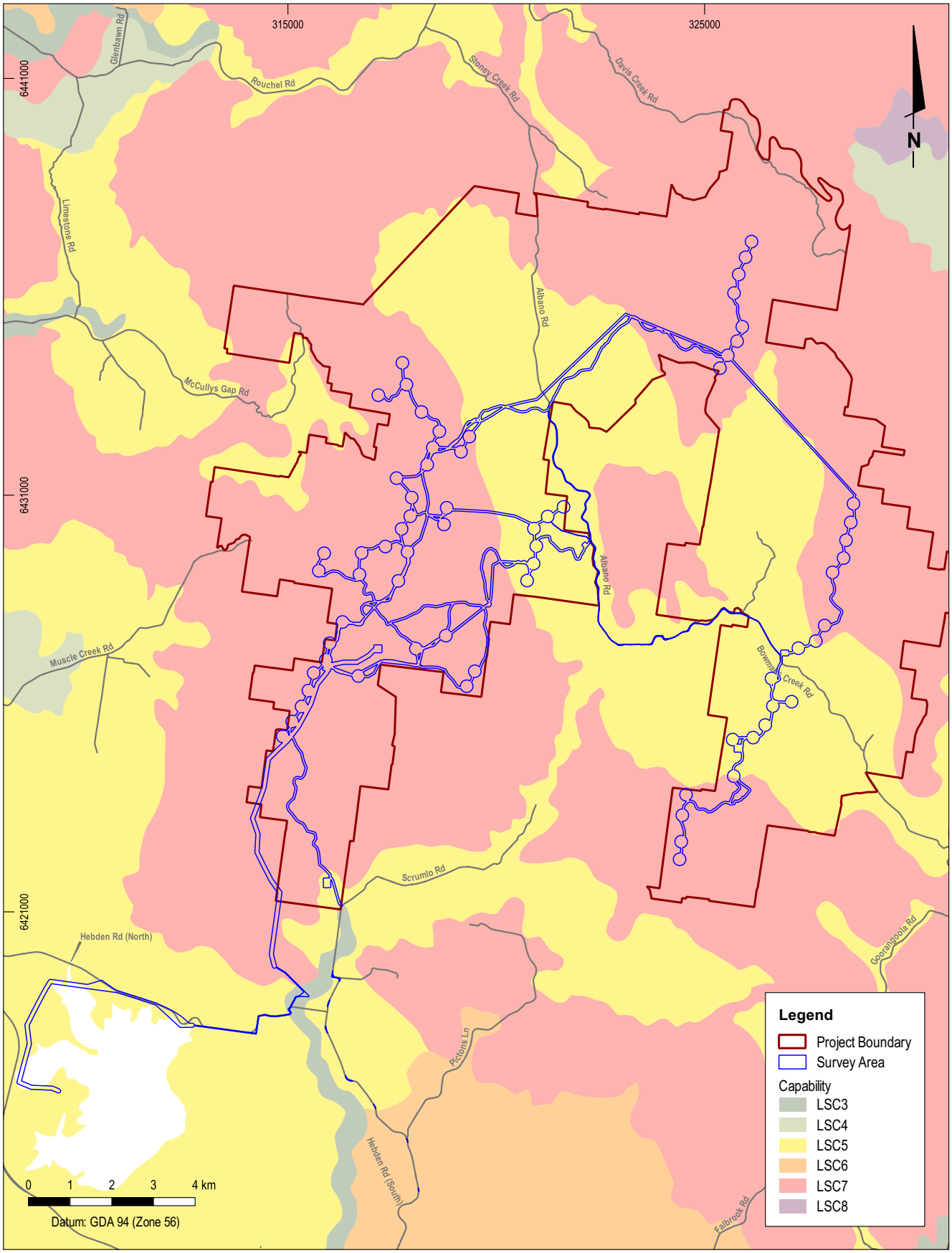
The suitability of the land for intensive agriculture is constrained by the steep gradients present within the Project Boundary. The current land use of low intensity cattle grazing is consistent with the land capability classification of the site.

The Project will disturb approximately 157 ha of Class 5 land within the Disturbance Area. In addition, a negligible area (< 2 ha) of Class 3 land may be impacted to widen an existing public road to enable site access. This land will be temporarily unavailable for agricultural activities. Construction compounds and laydown areas will be rehabilitated following the construction phase and will therefore only be unavailable for agricultural purposes during this phase. The land dedicated to operational infrastructure will be unavailable for the duration of the Project. Due to the mobile nature of cattle and the surrounding Class 4 land that will be unaffected, the existing grazing activities will be able to continue.

The Project may disturb approximately 345 ha of Class 7 land. This does not generally represent a significant impact to agricultural activities as Class 7 land is generally not suitable for agriculture according to OEH, (2012). It is acknowledged that within this large-scale mapping, some areas are currently utilised for grazing activities.

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP) includes mapping of Strategic Agricultural Land (SAL) in NSW. Whilst the Mining SEPP does not apply to the Project, the SAL map was consulted to identify if there is any high value agricultural land within the Project Boundary. There is no Critical Industry Clusters (CIC) located within the Project Boundary as shown on **Figure 54**. A 900 m section of the underground portion of the transmission line is within land mapped as SAL.

Source: Land and Soil Capability Mapping for NSW (Data NSW)



Bowmans Creek Wind Farm | Fig53_Land Capability | 12.03.2021

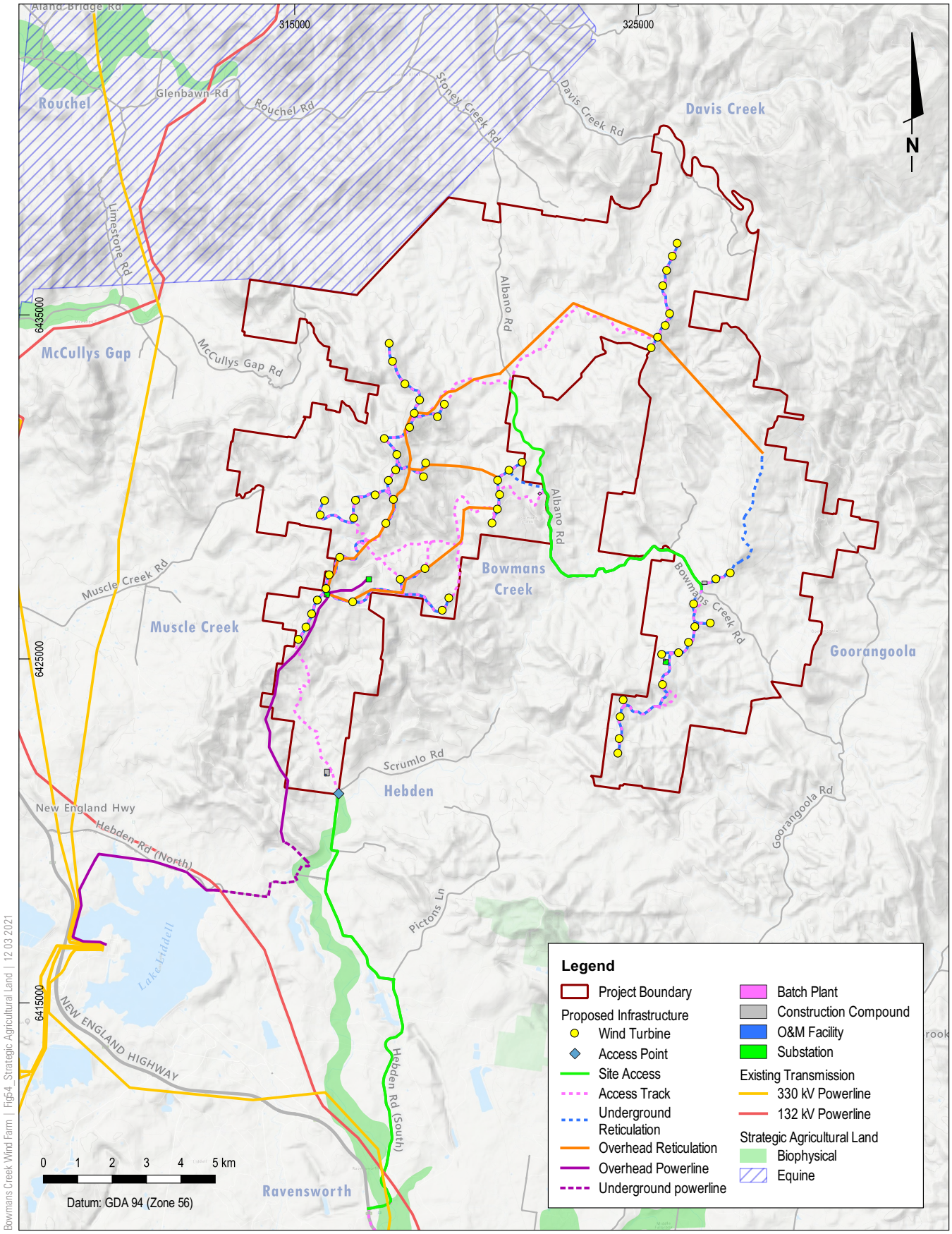
BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Land Capability

FIGURE 53

Source: Terrain ©2019 Google



Bowmans Creek Wind Farm | Fig54_Strategic Agricultural Land | 12.03.2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Strategic Agricultural Land

FIGURE 54

As explained in **Section 4.4.7**, the Project will not extract any water from streams or groundwater aquifers. Therefore, the Project will not affect the availability of water for agricultural purposes.

The Project, like other wind farm developments, is generally compatible with agricultural land uses because the infrastructure occupies a minor percentage of the site. Agricultural activities will continue to be undertaken on the land surrounding the Project infrastructure. In addition, WTGs are generally located in elevated areas (such as ridgelines) which are less suitable for agriculture.

Livestock Stress and Wind Farms

Stress is a term used to describe a wide variety of adverse external influences on an animal. Some researchers consider stress to be the internal manifestation of the external influence, or "stressor." There is no general agreement as to what constitutes a stress on an animal or how stress should be defined. Stress in livestock can lead to increased susceptibility to disease and that the increased susceptibility is partially due to alterations in immune function. A general response of the body to stress is the release of adrenocorticotropic hormone (ACTH) from the anterior pituitary gland, which stimulates the adrenal cortex to increase the synthesis and secretion of cortisol (Roth, 1985).

No published papers were available at the time of writing this EIS which demonstrated that wind farms have any impact on the stress of livestock raised in the vicinity of wind farms.

Further, the 'Wind Farm Guide for Host Landholders' (GHD for NSW Farmers Association, 2012) states "*Host landholders generally find that once a wind farm is operational livestock quickly become accustomed to the moving turbines and are happy to graze in their vicinity and seek shelter in the shadows.*" CSIRO (2012) further states that "Grazing livestock appear unaffected by wind turbines".

Biosecurity

Controls will be implemented to reduce the risk of biosecurity impacts, as defined under Section 13 of the Biosecurity Act. Weeds and feral animals may be extant at the site, irrespective of whether the Project is undertaken. Nevertheless, the Project will mitigate the risk of exacerbating any existing issues or introducing new risks through weed and feral animal controls.

Table 48 identifies potential activities that may cause "biosecurity impacts" and the indicative controls that will be implemented to minimise the risk. These will be implemented in consultation with the landholder and relevant regulators (where regulatory approval is required).

Table 48
Biosecurity Risks

Impact	Hazard	Controls	Residual Risk
Introduction of noxious weeds	Plant matter being carried onto site by vehicles and machinery	• Construction equipment will be cleaned prior to entering the site • Appropriate construction site hygiene measures will be implemented to prevent entry of new weeds to the area such as the use of wash bays	Low
Introduction of feral animals	None	• In consultation with the landholder	Not Applicable
Spread of noxious weeds	Extant weeds being advertently moved around the site	• Initial weed management will focus on targeting species listed under Appendices 1 and 2 of the Hunter Regional Strategic Weed Management Plan (LLS, 2018) • Weeds are segregated from other plant matter to avoid reuse for rehabilitation purposes • Follow-up monitoring and maintenance undertaken in areas that have received past primary weeding treatments in the following months, to contain any re-emergence of weed species • Minimisation of weed species that cannot be effectively controlled on the site, such as exotic grasses, will be prevented from further spread through construction and operational phase site hygiene procedures	Low
Risks to public safety posed by feral animals	Feral animals may be extant at the site	• The Project will not introduce any feral animals • Participate in any local feral animal control programs	Low

7.16.3 Mitigation and Management

Agriculture

The proposed infrastructure will occupy a small proportion of the area within the Project Boundary. Land that is not required for operational infrastructure can continue to be used for agricultural purposes. Impacts on surrounding agricultural activities will be minimised through the following measures:

- Water will be sourced from host farm dams (as per **Section 4.4.7**) or off-site to avoid impacts on landowners' supplies;
- Fencing will be erected to exclude livestock from operational areas;
- Weed and feral animal controls undertaken in consultation with landowners; and
- Rehabilitation of disturbed areas will occur as soon as practicable.

Soils

To achieve these objectives the following management measures will be undertaken:

- A soil survey of the final disturbance area will be undertaken prior to construction. The objectives of the soil survey include:
    - Identifying steep gradients;
    - Identifying any erodible soils present;
    - Establish baseline conditions for future rehabilitation;
    - Defining topsoil and other soil resources for future use in rehabilitation; and
    - Excavated soil will be reused as soon as practicable. If soils cannot be reused in a timely manner, it will be stockpiled and temporarily rehabilitated and / or disposed of in consultation with the landholder (except as stipulated in **Section 7.5.4**).
- A 'Land Disturbance Procedure' will be employed prior to disturbance as described in **Section 7.25**;
- Erosion and sediment controls (as discussed in **Section 7.15.3**);
- Monitoring of excavated material volumes; and
- Progressive rehabilitation of disturbed areas.

Rehabilitation

Disturbed areas that are not required for ongoing operations will be progressively rehabilitated during and after construction works. The land occupied by operational infrastructure will be rehabilitated following the decommissioning phase.

Generally, the objective of rehabilitation is to restore the land to its condition prior to commencement of the Project. Class 3 and 5 land that is disturbed by the Project will be generally reinstated as agricultural grassland (unless the infrastructure on the land is retained for the landholder's use). This enables the land to be continued to be used for grazing, which is the most suitable agricultural activity for those land capability classes.

The majority of the land to be disturbed by the Project is Class 7 land. The rehabilitation objective for Class 7 land is to reinstate the vegetation communities that were present prior to disturbance.

The operator's duty to rehabilitate the land is included as a condition of lease agreements with Associated landowners. The operator and landowner may agree to rehabilitation objectives other than those described above.

The rehabilitation process generally consists of the following actions:

- Excavated areas are backfilled using clean fill and compacted;
- Placement of topsoil (thickness relative to land capability class and pre-construction conditions);
- Grading of previously compacted areas to blend into the surrounding contours;
- Seeding of rehabilitation areas with pasture species or native vegetation, depending on the rehabilitation objective; and
- Implementation of erosion controls to minimise soil loss.

A regular rehabilitation monitoring program will be undertaken (at least until 2 years following decommissioning of infrastructure). The purpose of monitoring is to assess the effectiveness of the rehabilitation undertaken and to implement maintenance or remediation measures (if required) to achieve the rehabilitation objectives.

Measures to facilitate successful rehabilitation may include:

- Works to improve drainage and/or minimise erosion;
- Watering of new planted vegetation during dry conditions;
- Aeration or fertilisation of topsoil to enhance vegetation growth; and
- Fencing to exclude livestock or feral animals from disturbed and rehabilitated areas until vegetation is established.

The above management measures will be documents in the CEMP and OEMP.

7.17 WASTE

7.17.1 Background

Waste associated with the Project will predominantly be generated during the construction and decommissioning phases. Quantities of waste generated during the operational phase will be minimal.

Clause 49 under Schedule 1 of the POEO Act lists six classifications of waste:

- General solid waste (non-putrescible);
- General solid waste (putrescible);
- Hazardous waste;
- Liquid waste;
- Restricted solid waste; and
- Special waste.

This assessment identifies the types of waste that may be generated by the Project and classifies these waste types in accordance with the POEO Act. A review was undertaken in relation to waste in accordance with SEPP 33 (described in **Section 4.3.3**).

7.17.2 Impact Assessment

Table 49 lists types and indicative quantities of waste that may be generated by the Project and describes how these waste streams will be stored, reused, recycled and / or disposed of.

As shown in **Table 49**, most of the waste associated with the Project will be classified as general solid waste (non-putrescible). With the exception of some metal and plastic items, most general solid waste (non-putrescible) is capable of being reused or recycled. For example, excavated soil and rock will be reused as road base for proposed access tracks.

Waste products that are not reusable will include food scraps, sewage, weedy plant matter and some chemical storage containers. Waste products that must be disposed will be removed from site by waste contractors and maintenance personnel. That is, the Project is not expected to rely on the municipal waste collection service. The Project is not expected to generate dangerous sharps or toxic waste.

Table 49
Waste Streams and Management Strategies

Waste Type	Generating Processes	POEO Act Classification	Indicative Quantities	Management Strategy
Paper, plastics, packaging, cartridges	General office activities	General Solid (non-putrescible)	500 kg per year	Recyclable and non-recyclable waste will be segregated. Mixed recycling bins will be provided.
Food	General office activities	General Solid (putrescible)	Negligible compared to other waste streams	Food waste will be segregated from recyclable waste. Food waste will be disposed of at a licensed facility.
Timber pallets, plastic, steel strapping, cardboard	General construction activities	General Solid (non-putrescible)	12 t (total for construction period)	Recyclable and non-recyclable waste will be segregated. Recycling bins will be provided at designated laydown areas.
Excavated material (spoil)	Construction earthworks	General Solid (non-putrescible)	N/A (all material expected to be reused)	Material will be stockpiled and reused on site (e.g. as fill material or road base). Excess material be placed at suitable locations (under agreement with land owners), topsoiled and rehabilitated.
Cleared vegetation	Vegetation clearing	General Solid (non-putrescible)	N/A (all material expected to be reused)	Weeds will be segregated, sprayed and bagged to avoid proliferation. Non-weedy vegetation will be mulched and reused for rehabilitation. Excess material (if any) will be removed from the site and disposed of appropriately.
Formwork,	Construction	General Solid	200 t (total for	This waste will be

Waste Type	Generating Processes	POEO Act Classification	Indicative Quantities	Management Strategy
reinforcing steel, PVC conduits, cables	activities	(non-putrescible)	construction period)	segregated from other waste streams using designated bins. These materials will be removed by a licensed waste contractor.
Cable reels	Construction activities	General Solid (non-putrescible)	N/A (returned to the manufacturer)	Cable reels will be returned to the manufacturer. Reels will be stored in laydown areas until removal from site
Concrete laden water	Concreting and washout of concrete trucks	Liquid waste	N/A (water and sludge will be reused)	Concrete laden water will be contained in wash bays and allowed to evaporate. Wash bays will be established near each WTG site. The residual concrete sludge will be reused for road base (if practicable). Excess sludge will be disposed of at a licensed facility.
Sewage	Toilets and offices	Liquid waste	360 kL per year	Sewage will be collected and stored in specific tanks. Stored effluent will be collected and removed by a licensed waste contractor or irrigated to a defined area in accordance with an EPL.
Empty drums and storage containers	Storage and transportation of chemicals	Varies depending on chemical	300 drums (total for construction period)	When in use, storage containers are stored in appropriately bunded hardstand areas. Used containers will be collected and disposed of by a licensed waste contractor.

Waste Type	Generating Processes	POEO Act Classification	Indicative Quantities	Management Strategy
WTG blades	Replacement or decommissioning	General Solid (non-putrescible)	3,900 t of composite materials every 25 years	WTG blades are a mix of resin and fiberglass. Consistent with current Industry practice, blades will be disposed of by being cut to a size to facilitate handling and transportation and disposed of to landfill (in consultation with Council). Alternate disposal methods for re-using or recycling WTG blades are not yet available in Australia, however reasonable and feasible best practice disposal will be based on available technology and regulatory Guidelines at the time.
WTG towers and nacelles	Replacement or decommissioning	General Solid (non-putrescible)	36,420 t of steel every 25 years	Metal structures will be disassembled and sold as components or scrap metal. Metal that is unable to be reused will be removed and disposed of by a licensed waste contractor.
Transmission and Reticulation Line Poles	Decommissioning	General Solid (non-putrescible)	Approximately 235 t of steel.	Metal structures will be disassembled and sold as components or scrap metal. Metal that is unable to be reused will be removed and disposed of by a licensed waste contractor.

7.17.3 Mitigation and Management

As demonstrated in **Table 49**, the principles of "reduce, reuse, recycle" will be applied wherever practicable to minimise waste generation. Waste management principles fall into the following hierarchy:

- Strategies that prevent products from becoming waste are most preferable;
- Strategies that find a use for waste are the next preference; and
- Strategies for disposal of waste should only be implemented if the other options are not practicable.

The Proponent will prepare a Waste Management Plan as a component of the CEMP. The Waste Management Plan will outline strategies to reuse, recycle and dispose of waste in **Table 49** and will also refine EIS indicative waste quantity values for each waste stream.

7.18 ELECTRIC AND MAGNETIC FIELDS

7.18.1 Background

Introduction

Electric and Magnetic Fields (EMFs) are produced by a wide range of natural and artificial sources. The Earth's magnetic field generates EMFs through atmospheric processes such as ionospheric currents, thunderstorms and lightning.

All human activities involving electricity are sources of EMFs. In Australia, electricity is generated, transmitted and distributed at the frequency of 50 Hz. As a result, Extremely Low Frequency (ELF) EMFs exist near powerlines and electrical cables. ELF refers to frequencies in the range of 0-100 Hz (ARPANSA, n.d.).

ELF EMFs are also produced by common electrical appliances (e.g. electric blankets, televisions, hair-dryers, computers, etc.). Due to the widespread use of electricity, people are exposed to ELF EMFs in the home, environment and workplace. Residential exposure to ELF EMFs depends on many factors, including the distance from local powerlines, the number and type of electrical appliances used in the home, and the configuration and position of household electrical wiring.

EMFs consist of electric and magnetic component fields. The electric field is produced by the voltage whereas the magnetic field is produced by the current. Electric field strength is generally measured in kilovolts per metre (kV/m). Magnetic flux density is usually measured in either microTeslas (μT) or in milliGauss (mG).

In the context of wind farms, EMFs can be produced by electricity infrastructure such as transmission lines, substations and electrical components within the WTG generators. The strength of EMFs reduce with distance from the operating electrical source. Electric field strength can also be reduced through shielding.

Relevant Standards

The 'ICNIRP Guidelines for Limiting Exposure to Time-varying Electric and Magnetic Fields (1 Hz to 100 kHz)' (ICNIRP Guidelines) represents international best practice in relation to managing exposure to ELF EMFs. The ICNIRP Guidelines recognise that stimulation of nervous system tissue may result in disturbance (explained in **Section 7.19**) and recommends exposure limits to

prevent such impacts.

The tissues of the brain and retina are most sensitive to EMFs in the frequency range of 10 to 25 Hz. To avoid disturbance impacts, internal electric fields (i.e. in the tissue) resulting from exposure to EMF should be limited to 0.01 V/m in this frequency range. ICNIRP recommends the following thresholds for external EMFs in the 25 to 50 Hz frequency range:

- Electric field strength of 5 kV/m; and
- Magnetic flux density of 200 µT (or 2,000 mG).

These are the relevant thresholds as alternating current is produced at 50 Hz in Australia. It should be noted that these are long-term exposure limits for the general public. Higher thresholds exist for occupational exposure, as exposure to higher levels is generally not for extended periods.

The National Health and Medical Research Council (NHMRC) previously published the 'Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields' (1989) as part of its Radiation Health Series. NHMRC has since handed over responsibility for review of the Radiation Health Series to the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). The Radiation Health Committee within ARPANSA decided to withdraw NHMRC's interim guideline and endorsed ICNIRP's guideline in its place.

7.18.2 Impact Assessment

EMFs will only be generated during the operational phase of the Project (i.e. after the proposed infrastructure has been commissioned). As such, no assessment is required for the construction and decommissioning phases of the Project.

Powerlines and Cables

The proposed electricity reticulation (i.e. underground cables and overhead powerlines) will transmit electricity from WTGs to substations at the nominal voltage of 33 kV. At the collection substations, the voltage will be stepped up to the transmission voltage (up to 330 kV). Electricity generated by the Project will be transmitted to a new TransGrid connection switchyard at a voltage up to 330 kV. The conceptual transmission and reticulation lines are shown on **Figure 3**.

The strength of the EMFs emitted from an electrical cable is dependent on a range of factors including current, relative phasing of circuits and spacing of conductors. The strength of magnetic and electric fields can also change along a transmission line if there is an unbalanced energy load within the line or sagging due to excessive heat. These effects could result in elevated field strengths directly underneath the transmission line. Powerlines are constructed within dedicated easements so that no other land users are located directly beneath the conductors.

Table 50 shows maximum field strengths for transmission and reticulation lines (National Grid, 2020a).

The maximum values are measured directly beneath the conductors. Field strengths decrease sharply with horizontal distance from the powerline. Sensitive receivers (non-Associated) are located more than 1 km from the proposed powerlines and as such, will experience substantially weaker EMFs than the values in **Table 50**.

The Lake Liddell Recreational Area is located near the proposed transmission line and is on the southern side of Hebden Road. This recreational area includes camping grounds, picnic areas, function rooms, a go-kart track and other outdoor activities. The nearest facilities at the Lake Liddell Recreational Area are approximately 30 m from the proposed transmission line.

The maximum EMFs produced by 33 kV powerlines (as indicated in **Table 50**) are within the limits recommended by the ICNIRP Guidelines. The 132 kV or 330 kV transmission line proposed for the Project will generate similar fields to the 275 kV or 400 kV lines measured by National Grid (2020a). As shown in **Table 50**, the maximum magnetic flux density is less than the 200 µT limit recommended by the ICNIRP Guidelines.

The maximum electric field directly beneath the transmission line (11 kV/m) would exceed the recommended 5 kV/m threshold. However, at a horizontal distance of 25 m, the electric field strength decreases to one tenth of the value directly beneath the conductors (National Grid, 2020a) and would be within the recommended threshold. Given that all non-associated receivers and the Lake Liddell Recreational Area are located more than 25 m from the proposed transmission line, the electric fields experienced at sensitive locations will be less than the 5 kV/m threshold.

ARPANSA (n.d.) provides the following typical magnetic field values near overhead powerlines:

- Directly beneath a distribution line – 2 to 30 mG;
- 10 m from a distribution line – 0.5 to 10 mG;
- Directly beneath a high voltage transmission line – 10 to 200 mG; and
- At the edge of a high voltage transmission line easement – 2 to 50 mG.

These typical values are less than the ICNIRP threshold of 2000 mG (equivalent to 200 µT). Therefore, the data provided by ARPANSA (2021) also supports the conclusion that magnetic field generated by overline powerlines will be less than the recommended threshold.

Underground cables do not generate any electrical fields outside of the metal sheath in which they are installed (National Grid, 2020b). The metal sheathing does not have any effect on magnetic fields. AECOM (2019) assessed the magnetic fields produced by a 330 kV transmission cable placed in a single flat circuit arrangement and at 900 mm depth of cover. The time-weighted average magnetic field strength for such a cable was determined to be 221 mG, which is within the ICNIRP threshold of 2,000 mG. The transmission cable for the Project will be comparable to the 330 kV cable assessed by AECOM (2019). Therefore, the underground sections of the proposed transmission line will not generate magnetic fields above the recommended threshold.

Based on the available empirical evidence, EMFs generated by the proposed powerlines and cables are not expected to result in any health or amenity impacts.

Table 50
Maximum Electrical and Magnetic Field Strengths Beneath Powerlines

Voltage	Maximum electrical field under powerline (kV/m)	Maximum magnetic flux density under powerline (µT)
33 kV	0.7	7
275 kV or 400 kV	11	100

Substations

Electrical substations are a source of electric fields, although the field strength at the boundary of the substation is usually very weak due to effective shielding. Safigianni and Tsompanidou (2009) measured EMFs at a 150 kV substation and recorded a maximum electric field of 4.3 kV/m. This value was measured near the transformer and as such, is expected to be higher than typical levels outside the substation. Notwithstanding, the maximum electric field measured at this substation is below the 5 kV/m limit recommended by the ICNIRP Guidelines.

The strengths of magnetic fields at substations is highly variable based on location. Safigianni and Tsompanidou (2009) found that high magnetic flux densities occur near capacitors. However, the maximum magnetic flux in the wider substation area was approximately 66 µT. Values were even lower in the control room and publicly accessible areas around the substation. Habiballah et al (2003) measured magnetic flux densities at a 230 kV substation and recorded values of up to 35 µT. These measured values are below the 200 µT limit recommended by the ICNIRP Guidelines.

Two substations are proposed for the Project, as described in **Section 3.4.2**. The proposed substations are located a minimum of 2,248 m from private non-Associated dwellings (as shown in **Figure 6**). The EMFs generated by the two substations are not expected to result in any health or amenity impacts to either associated or non-Associated near neighbours.

WTGs

The electrical equipment within a WTG will generate EMFs whilst the WTG is operational. Most electrical equipment is housed within the nacelle (which is approximately 140 m – 150 m above ground) or a small housing unit at the base of the tower. All electrical equipment is enclosed within the WTGs steel exterior. The strengths of these EMFs in the surrounding areas are reduced by the shielding effects of the steel casing and the significant height of some electrical components.

The proposed WTG locations are illustrated in **Figure 3**.

Israel et al (2011) measured magnetic flux densities at a wind farm facility that utilised 3 MW WTG generators. The measured levels ranged from 0.133 to 0.225 mG at 3 m from the base of the tower. These measured values are several orders of magnitude lower than the 2,000 mG (200 µT) limit recommended by the ICNIRP Guidelines. The Project may utilise WTGs with a higher generating capacity (up to 5.6 MW) and as a result, may generate stronger EMFs than the facility studied by Israel et al (2011). However, the larger WTG will not increase EMF strength by orders of magnitude. Therefore, EMFs from the Project WTGs will not impact upon human health.

7.18.3 Mitigation and Management

The risk of exposure to EMFs has been minimised through careful siting of infrastructure and the implementation of best practice design standards for electrical equipment. The following mitigation measures will be adopted for the Project:

- The creation of powerline easements;
- Reticulation (underground cables and overhead powerlines) have been orientated to maximise setback distances to private dwellings;
- Burying underground transmission lines at sufficient depth where feasible to shield electrical fields;

- Placing underground cables together so that the magnetic fields caused by the current in each cable cancel each other out due to the alternating current in each cable being out of phase;
- Creating appropriate exclusion zones, by way of signage and where necessary security fencing, around emitting structures (e.g. collector and switching substations); and
- Ensuring anyone needing to go in close proximity to emitting structures are accompanied by a suitably trained and qualified staff member.

7.19 HEALTH

7.19.1 Relevant Studies

NHMRC is an independent statutory body established by the Commonwealth Government. The purpose of the NHMRC is to issue guidelines and advise the community on health matters. NHMRC (2015) conducted a review of published health studies to determine if there is any evidence of health risks associated with wind farms. At the time of that review, there were 13 studies (including one Australian study) that specifically considered the possible health effects of wind farm emissions (termed "direct evidence"). Due to the small body of direct evidence, NHMRC also considered studies relating to other activities that generate the same types of emissions as wind farms (termed "parallel evidence").

NHMRC (2015) considered three types of emissions that are associated with wind farms: noise, shadow flicker and EMFs. NHMRC (2015) concluded that *"there is currently no consistent evidence that wind farms cause adverse health effects in humans"*. This conclusion was endorsed by the IPCN in its determination of Modification 6 to the White Rock Wind Farm (IPCN, 2019).

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) develops guidelines to protect people and the environment from the effects of non-ionising radiation, which includes EMFs. ICNIRP has published specific guidelines for different frequency ranges. The relevant guideline for EMFs associated with electricity is the 'ICNIRP Guidelines for Limiting Exposure to Time-varying Electric and Magnetic Fields (1 Hz to 100 kHz)' (ICNIRP, 2010). This guideline recommends limits to prevent disturbance caused by stimulation of nervous system. However, ICNIRP (2010) found no conclusive evidence that exposure to EMFs is related to any health conditions.

7.19.2 Noise

In relation to noise, NHMRC (2015) found the direct evidence to be of limited value because none of these studies measured noise levels at private dwellings. As a result, NHMRC relied predominantly on parallel evidence to quantitatively evaluate possible health risks associated with noise. NHMRC (2015) explained that:

> *"There is no evidence to suggest that the health effects from wind farm noise would differ from health effects of other noise sources at similar levels. Based on the studies referred to above, wind farms would be unlikely to cause health effects at distances of more than 500 m, where noise levels are generally less than 45 dBA. At this distance, effects on sleep are likely to be modest at the population level. At distances of more than 1,500 m from wind farms, where the wind farm noise level may be in the order of 30–35 dBA, sleep disturbance is unlikely".*

There was no direct evidence that considered the possible effects of low frequency noise (infrasound) generated by wind farms. However, NHMRC (2015) noted that infrasound levels measured in the vicinity of wind farms were below the levels that are typically found in households.

Due to the limitations of the available direct evidence, NHMRC highlighted the need for further research into the health effects of wind farms, particularly at distances of less than 1,500 m. Notwithstanding, NHMRC concluded that "*there are unlikely to be any significant effects on physical or mental health at distances greater than 1,500 m from wind farms*".

As described in **Section 7.2**, the noise model has predicted that noise levels at sensitive receivers will be less than 35 dBA (inclusive of mitigation for P22-1). The setback distances and predicted noise levels for the Project are consistent with the values identified by NHMRC (2015) as being unlikely to cause health effects.

7.19.3 Shadow Flicker

Shadow flicker refers to the light flickering effect caused by the moving shadows cast by a rotating turbine. Flicker vertigo and photosensitive epilepsy have been raised as health concerns in relation to shadow flicker.

Flicker Vertigo

Flicker vertigo is an imbalance in brain cell activity caused by exposure to low frequency flickering or flashing of light seen through a rotating propeller (Rash, 2004). Amenity effects of flicker vertigo can include nausea, dizziness, headache, panic, confusion and (in rare cases) loss of consciousness.

Flicker vertigo is usually associated with flicker frequencies in the range of approximately 4 Hz (cycles per second) and 20 Hz (NASA, 2001; Rash, 2004).

As explained in **Section 7.21** the proposed turbines are expected to generate flicker frequencies of up to 1 Hz. The potential shadow flicker associated with the Project will be outside the frequency range known to trigger flicker vertigo.

Photosensitive Epilepsy

No studies specifically consider shadow flicker from wind farms and any possible relationship with photosensitive epilepsy (NHMRC, 2015). Instead, NHMRC relied on information regarding the effects of flashing lights on people with photosensitive epilepsy (a rare form of epilepsy). Based on this parallel evidence, NHMRC (2015) concluded:

> *"The risk of shadow flicker from wind farms causing an epileptic seizure is estimated to be less than 1 in 10 million in the general population and 17 in 1 million among people at risk of photosensitive epilepsy".*

The incidence rate of 17 in 1 million (among the photosensitive population) relates to flicker frequencies of less than 3 Hz (Harding et al, 2008). In the case of three-bladed turbines, a frequency of 3 Hz corresponds to a rotational speed of 60 rpm. As explained in **Section 7.21**, the flicker frequency generated by the proposed turbines will be a maximum of 1 Hz. Therefore, the Project is not expected to result in significant risk of epileptic seizures.

In addition, shadow flicker is generally limited to the area within 1.4 km of a WTG (NHMRC, 2015). All of the proposed WTGs are located more than 1.4 km from the nearest non-Associated private dwellings (excluding P22-1 which is assessed at **Section 7.2**). The exposure of private receivers to shadow flicker is quantified in **Section 7.21**.

7.19.4 EMFs

ICNIRP (2010) considered whether exposure to low frequency EMFs is linked to a range of health and behavioural conditions. ICNIRP found no conclusive evidence of any link between EMFs and depressive symptoms, neuroendocrine system function, neurodegenerative disorders (e.g. Alzheimer's disease), cardiovascular diseases and cancers.

The only effect of exposure to EMFs that is well established by evidence is "*stimulation of central and peripheral nervous tissues and the induction in the retina of phosphenes, a perception of faint flickering light in the periphery of the visual field"* (ICNIRP, 2010). Accordingly, ICNIRP has recommended exposure limits to manage transient effects on the brain and retina. However, ICNIRP notes that these effects are not adverse health impacts, and that limits are merely for reducing disturbance.

The EMFs that may be produced by the Project are discussed in **Section 7.18**. These EMF levels are less than the thresholds recommended by ICNIRP.

NHMRC (2015) also acknowledges that EMFs can induce electric currents in human tissue. However, there is no consistent evidence that this effect is causally linked to health risks. NHMRC noted that EMF levels near wind farms is less than the average level measured inside and outside suburban homes.

7.20 HAZARDOUS MATERIALS

Detonators and explosives may be required during construction for blasting of bedrock. These will be transported to the site as required, rather than stored in bulk.

In addition to the hazardous materials listed in **Table 51**, the Project may be equipped with small quantities of paints, cleaning agents, degreasers, motor fluids, etc. The quantities will be less than the relevant screening thresholds.

No assessment is required as the Project does not seek approval for battery storage.

In light of the maximum quantities of hazardous materials to be stored on site as described in **Table** 51, the Project is not classified as a "potentially hazardous industry".

Table 51
Hazardous Materials and Risk Screening

Hazardous Material	Purpose	Dangerous Goods Class	Packaging Group	Storage Threshold	Threshold Exceedance
CONSTRUCTION					
Detonators	Blasting of bedrock for WTG foundations	1.1	N/A	250 kg	No
Explosives	Blasting of bedrock for WTG foundations	1.1	N/A		No

Hazardous Material	Purpose	Dangerous Goods Class	Packaging Group	Storage Threshold	Threshold Exceedance
Welding gases (compressed argon, helium, carbon dioxide etc.)	Welding	2.2	N/A	N/A	N/A
Diesel	Construction equipment and vehicles	3	III	10,000 t	No
Gasoline or Petrol	Construction equipment and vehicles	3	II		No
OPERATIONS					
Gear oils (e.g. polyalphaolefin)	Lubricant in WTGs	3	III	10,000 t	No
Transformer oils (e.g. mineral oil)	Coolant for transformers	3	III		No

7.21 SHADOW FLICKER

7.21.1 Background

A shadow flicker assessment has been undertaken by Epuron generally in accordance with the Visual Bulletin. The assessment is presented below including key impact assessment findings, as well as management measures to minimise impacts as committed to by the Proponent.

Cause of Shadow Flicker

Due to their height, wind turbines can cast shadows on the areas around them. Coupled with this, the moving blades create moving shadows. Viewed from a stationary position, when the turbine is between the viewer and the sun, the moving shadows appear as a flicker giving rise to the phenomenon of "shadow flicker". This is similar to the strobe effect often experienced when driving through scattered trees on a rural highway.

For a particular location, shadow flicker will only occur during periods when the sun's rays pass directly through the swept area of the turbine blades to the viewpoint. The extent of the shadow flicker is dependent on the time of day, geographical location, meteorological conditions of the site and local vegetation.

There are a number of factors influencing the effect and duration of shadow flicker including:

- Position of the sun in relation to the turbine;
- Time of year (season) and time of day;
- Turbine height and rotor diameter;
- Viewer's distance from turbine;
- Topography of the area;

- Vegetation cover;
- Weather patterns, number of cloudy days per year; and
- Airborne particles and haze.

The Visual Bulletin states that the Proponent should minimise shadow flicker to not more than 30 hours per year and utilise available mitigation options to minimise shadow flicker at dwellings.

The 'National Wind Farm Development Guidelines' (EPHC, 2010) (Draft National Guidelines' suggest a distance equivalent to 265 maximum blade chords as an appropriate limit, which corresponds to approximately 1,000 m to 1,600 m for modern wind turbines (which typically have maximum blade chord lengths of 4 m to 6 m). The Proponent has conservatively assessed the potential for Shadow Flicker impacts to a distance of 2 km from the proposed turbine locations.

Amenity

As explained in **Section 7.19.3**, shadow flicker caused by the Project is not expected to pose a significant risk to human health. Shadow flicker is considered an amenity issue rather than a health risk given that it only occurs during daytime and therefore does not generally interrupt sleep patterns.

7.21.2 Methodology

Modelling

A detailed analysis of the potential for shadow flicker and blade glint to affect dwellings has been conducted. Modelling of the shadow flicker was conducted using specialist industry software Windpro, assessing the largest turbine (maximum tip height of 220 m) proposed for the Project to represent the worst-case impact scenario. The maximum number of annual hours at each of the nearby non-Associated dwellings where shadow flicker may be experienced was calculated using this model.

The number of annual hours of shadow flicker at a given location can be calculated using simple geometrical models incorporating data such as the sun path, the topographic variation and wind turbine details such as rotor diameter and hub height. In such models, the wind turbine rotor is modelled as a disc and assumed to be in the worst-case (i.e. perpendicular) to sun-turbine vector. Furthermore, the sun is assumed to be a point light source.

The methodology used for Shadow Flicker Assessment is as follows:

- Determine the extent of shadows from turbines, based on a distance of 265 m x maximum blade chord of 5 m (1,325 m). Extend the assessment distance to 2 km;
- Identify all existing or approved dwellings within the potential extent of shadows from proposed turbine positions; and
- Select a receptor height of 2 m above ground level at dwelling locations.

Shadow flicker calculated in this manner overestimates the number of annual hours of shadow flicker experienced at a specified location due to several reasons (EPHC, 2010), including:

- The occurrence of cloud cover has the potential to significantly reduce the number of hours of shadow flicker;

- The probability of wind turbines consistently yawing to the "worst-case" scenario where the wind turbine is facing into or away from the sun - wind turbine vector is less than 1 (i.e. less than 100% of the time);
- The modelling of the wind turbine blades as discs to determine shadow path overestimates the shadow flicker effect;
- The blades are of non-uniform width with the thickest viewable blade width (maximum chord) occurring closer to the hub and the thinnest being located at the tip of the blade;
- Modelling the sun as a point light source rather than a disc has an effect similar to that of point 3 above;
- The presence of vegetation shields incidences of shadow flicker; and
- Periods where the wind turbine is not in operation due to low winds, high winds or operational and maintenance reasons.

Therefore, the modelling conducted here represents a very conservative scenario and overestimates the actual annual hours of shadow flicker experienced at a location.

7.21.3 Impact Assessment

The modelling has calculated the maximum number of annual hours at each dwelling within 2 km of the proposed wind turbines. In accordance with the Visual Assessment Bulletin, shadow flicker at Non-Associated dwellings should not exceed 30 hours per year. The results of the modelling are presented in **Table 52**.

The second column of **Table 52** represents the theoretical maximum hours of shadow flicker in one year. This approach is based upon the assumption that the wind turbine is yawed to the worst-case position of facing into or away from the sun.

The results show that there are no non-Associated dwellings within 2 km that would experience 30 hours or more of shadow flicker per year.

Figure 55 conceptually illustrates the predicted shadow flicker levels within 2 km of the proposed wind turbines. Given the results of the shadow flicker assessment, the Project will meet the performance objectives for shadow flicker as set out in the Visual Assessment Bulletin.

Table 52
Shadow Flicker Assessment Results

Residence ID	Theoretical maximum shadow flicker (hrs/yr)
G15-1	15:18
P22-1	18:03
P22-3	12:15
S17-2	14:59

7.21.4 Mitigation Measures

The following mitigation measures will be adopted for the Project:

- If shadow flicker is found to be a nuisance at a particular non-Associated residence:
  - At a known location, a physical screen will be placed between the location and the wind turbines. Additional trees or other vegetation will also be used to accomplish this;
  - Conditions could be pre-programmed into the control system so that individual wind turbines automatically shut down whenever these conditions are present; and/or
- Shadow flicker effects on motorists would be monitored following commissioning and any remedial measures to address concerns would be developed in consultation with the TfNSW and DPIE.

7.22 DECOMMISSIONING

The general decommissioning process is described in **Section 3.8**. The dismantling of infrastructure will involve the following activities:

- Delivery of construction equipment (including cranes) to site;
- Use of construction equipment;
- Transport of materials (including WTG parts) on the public road network; and
- Disposal of waste.

The equipment required for decommissioning will be similar to that utilised during the construction phase. As such, the impacts of dismantling infrastructure will be similar in nature to construction phase impacts. However, decommissioning impacts will be smaller in magnitude due to the following factors:

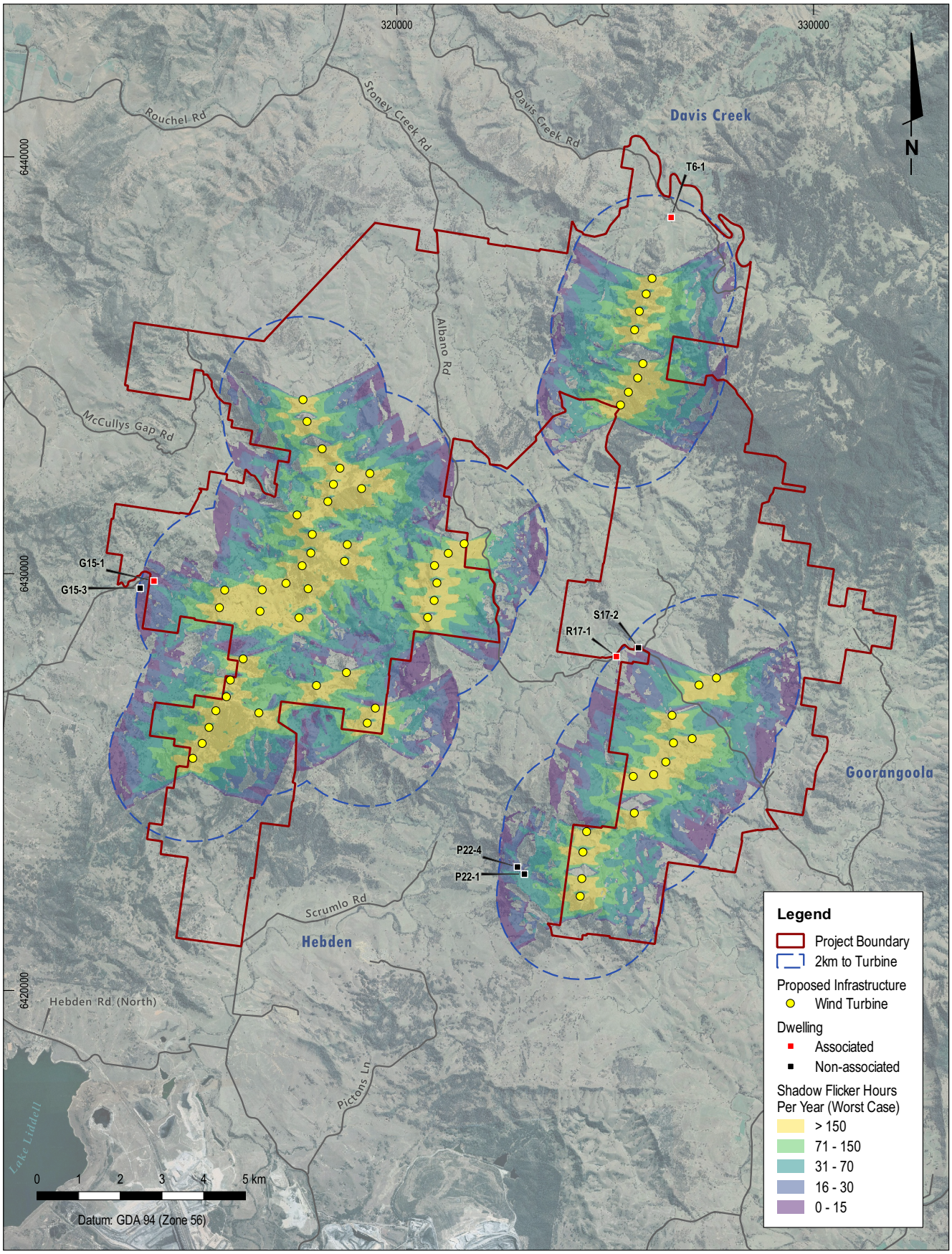
- Access tracks and laydown areas will already be in place, thereby avoiding the need for further disturbance;
- Buried infrastructure (such as footings and cables) will generally be retained in situ, thereby reducing the magnitude of earthworks;
- No concrete batching is required;
- Upgrades to the public road network to facilitate OSOM vehicles will already be in place; and
- The decommissioning phase will be shorter in duration.

The waste generated by decommissioning will be managed as described in **Section 7.17**.

A Decommissioning and Rehabilitation Plan will be prepared in consultation with land owners prior to the cessation of operations. This Plan will identify the infrastructure that will be retained for the benefit of external stakeholders. Based on current market conditions, the scrap value of WTGs and other equipment is expected to be more than sufficient to cover the costs of decommissioning and rehabilitation.

Source: Aerial ©2019 Google

Note: This model indicates a worst case scenario, assuming no cloud cover (from sunrise to sunset), turbines are always operating and the rotor oriented perpendicular to the receiver. See table 53 for results at receiver locations.



Bowmans Creek Wind Farm | Fig55_Shadow Flicker | 11 03 2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Shadow Flicker

FIGURE 55

7.23 SOCIAL

7.23.1 Overview

The SIA considers the potential social impacts and benefits of the Project across its life, and identifies appropriate strategies to avoid, mitigate or manage the negative impacts and to enhance the positive benefits presented by the Project. It addresses the requirements set out in the SEARs for the Project. Additional supporting information is included in **Appendix Q**.

The Project is subject to the following NSW regulatory requirements and guidelines relating to the conduct of the SIA:

- NSW DPIE SEARs for the Project; and
- Wind Energy Framework as described in **Section 1.6**.

Although not applicable to wind projects, the NSW *'Social Impact Assessment Guidelines for State Significant Development'* (September, 2017) was considered in the preparation of this SIA. The SIA is informed by the findings of a comprehensive SEP undertaken for the Project as described in **Section 5.2**.

7.23.2 SIA Scope

This section describes the scope of the SIA with reference to key project workforce characteristics and the Social Area of Influence (AOI).

The scope of the SIA is to provide:

- An overview of the regulatory requirements and associated corporate governance relating to local and regional socio-economic planning in the Project's AOI;
- A description of the socio-economic baseline of the communities within the Project's AOI;
- Identification of the potential socio-economic impacts and opportunities associated with the Project;
- An analysis of the significance of the potential impacts using a risk-based approach; and
- Identification of strategies to manage or enhance the potential socio-economic impacts and benefits of the Project.

Consistent with the 'Wind Framework', the SIA does not focus on the impact of the Project on Associated landholders that have a commercial interest in the Project proceeding.

Social Area of Influence

The Project's AOI consists of the people and/or areas that will potentially be impacted (adversely or positively) by Project activities.

The Project's AOI (defined in **Table 53**) incorporates the Primary Assessment Area (Primary AA) and the Regional Assessment Area (Regional AA). The AOI extends beyond the Project Boundary, to the communities and LGAs that may experience changes to social conditions as a result of the Project. The AOI includes those neighbours who are at risk of experiencing adverse impacts as a result of the Project.

Table 53
SIA Study Area Components

SIA Study Area Component	Description
Primary AA	The area within an approximate 5 km radius of the Project Boundary and transmission line. The Primary AA includes portions of the following Australian Bureau of Statistics State Suburbs (ABS State Suburbs): Hebden, Muscle Creek, McCully's Gap, Rouchel Brook, Bowmans Creek, Goorangoola, Davis Creek and Greenlands. An estimated 106 private dwellings are located within the Primary AA. The estimated population of the Primary AA is 265*. The Primary AA includes all landowners located within the Project Boundary and other landowners outside the Project Boundary who are considered 'Associated Landholders' (20 landowners).
Regional AA	Combined LGAs of MSC, SSC, and UHSC

**See Appendix Q SIA Study Area Components for population calculation method.*

Project Workforce Characteristics

This section describes the Project workforce characteristics including the size of the workforce, workforce origins, proposed recruitment strategies and workforce accommodation arrangements. Figures presented within this section are based on initial Project workforce planning and are subject to change. The construction phase workforce is expected to peak at 156 FTE personnel. The operations phase workforce is expected to be approximately 15 FTE personnel. Additional contractors will be utilised as required in all Project phases.

Table 54 describes the anticipated hiring arrangements for the Project workforce. A Local Hire (LH) is defined as a person residing in the Regional AA. The LH for operations assumes that the Non-Local Hire (NLH) construction workforce will remain for operations.

The anticipated geographical distribution of the locally hired construction workforce is shown in **Table 55**. During construction, it is anticipated that the majority of local hires will reside in either SSC or MSC in their existing dwellings. All NLHs associated with the construction phase will reside temporarily in short-term accommodation (e.g. hotels and motels in the Regional AA). Due to the short duration of the construction phase, the transient nature of construction work and the proximity of the Project to neighbouring centres with skilled and capable workforces, it is assumed that families will not accompany NLH construction workers to the Regional AA.

The operations phase workforce (approximately 15 people) will be drawn from the three LGAs in the Regional AA. The occupational requirements of the Project workforce will vary according to the different Project phases. During construction, the majority of the workforce will be employed as technicians and trade workers. The required workforce will be sourced through a range of recruitment processes, including seeking to provide local and regional recruitment, apprenticeships and/or traineeships and contract labour. A recruitment strategy will be developed following Project determination, consistent with detailed construction planning.

Table 54
Anticipated Number of Local Hires and Non Local Hires

Phase	FTE Persons			
	Local Hire		Non Local Hire	
	%	No.	%	No.
Construction	80	125	20	31
Operations	100	15	0	0

Table 55
Project Construction Workforce by Anticipated Residential Location

Residential Location	% of Workforce	Number of FTE Persons	
		LH	NLH
SSC LGA	50	63	16
MSC LGA	45	56	14
UHSC LGA	5	6	1
Total Construction Workforce	**100**	**125**	**31**

7.23.3 SIA Methodology

Summary of SIA Methodology

Table 56 provides a summary of the SIA methodology against key phases in the SIA process. The ABS statistical geography used in this SIA is shown in **Appendix Q**.

Table 56
SIA Approach and Methodology

Phase	Methodology
Phase 1 – Preparation	
SEP	• Identify and analyse stakeholders • Develop Project stakeholder engagement strategy
Phase 2 – Scoping	
Profiling	• Define social baseline and context in which the Project is located
Scoping of stakeholder impacts and opportunities	• Understand Project activities • Undertake preliminary impact scoping • Engage with community in the identification of landscape values, as required by the "Wind Energy: Visual Assessment Bulletin • Engage with landholders about the proposed Project (considering Associated and Non-Associated properties)

Phase	Methodology
Identification of AOI	• Identify AOI • Analyse spatial and temporal dispersion of potential impacts and opportunities
Phase 3 – Community Profiling of AOI	
Socio-economic analysis	• Collate and analyse ABS Census data and other relevant social and community statistical data sets to describe the AOI
Guidelines analysis	• Review regional and local strategic, community and economic planning documents, policies and programs relevant to the SIA
Phase 4 – Impact Assessment and Management	
Identification and analysis of impacts and opportunities	• Identify and assess potential social impacts and opportunities • Assess unmitigated significance of impacts/opportunities
Social Impact Management	• Identify and develop management strategies to minimise impacts and enhance opportunities
Impact significance assessment	• Evaluate residual social impact significance using a risk matrix • Identify further management strategies, where necessary

7.23.4 Primary Assessment Area

This section provides a description of the Primary AA. It includes a discussion of population, amenity, resident values, health and wellbeing and accessibility. It draws on the findings of consultation conducted with residents as described in **Section 5.4**.

Population and Demography

An estimated 106 private dwellings are located within the Primary AA, including 19 within the Project Boundary (see **Figure 6**). The estimated population of the Primary AA is 265. Outside of the Project Boundary the majority of proximate dwellings are located to the west in the: Muscle Creek ABS State Suburb, along Muscle Creek Road and Beggary Creek Road, and McCullys Gap ABS State Suburb, along Stoney Creek Road in the eastern portion of MSC.

Appendix Q presents selected population and demographic statistics for the component ABS State Suburbs of the Primary AA. The information is drawn from the 2016 ABS census, however due to the small resident populations in each ABS State Suburb, limited statistical data is available.

It is notable that of the ABS State Suburbs of interest (**Appendix Q**) Muscle Creek and McCullys Gap have the largest resident populations (315 and 247 persons respectively, representing 63 % of the total population of the component ABS State Suburbs). Muscle Creek also has the highest median weekly household income of the ABS State Suburbs of interest, likely attributable to the proportion of resident working age population employed in the mining sector. Muscle Creek, as the ABS State Suburb in closest proximity to Muswellbrook, is likely to be an attractive residential location for mine employees seeking a combination of rural lifestyle, proximity to mine employment and regional centre facilities and services.

Character

The Primary AA is characterised by undulating landscape with scattered acreage and rural lifestyle blocks. There are no defined centres within the Primary AA. Muswellbrook is the closest town to the Primary AA, located approximately 25 km via road from the proposed O&M Facility. Portions of the Primary AA were settled in the early 1800's and the area is known for its beef cattle properties and for mining, although these mining activities are located on the edge of the Primary AA. A scattering of rural country roads, majority unsealed, dissect the Primary AA and provide access to rural properties located in the north, south, east and west of the Primary AA.

A few built community assets are present across the Primary AA and include the McCully's Gap and Hebden Community Halls, a children's playground at McCullys Gap Hall and Community Noticeboards. There are also various communications infrastructure within and surrounding the Project Boundary.

Agricultural operations such as fertiliser application, pest and crop spraying are routinely undertaken within the Project Boundary. Aerial firefighting and emergency service operate within the Project Boundary as required.

Lifestyle

The predominant land use within the Project Boundary is beef cattle grazing as described in **Section 2.2**.

Outside of the Project Boundary, land use is varied and includes coal mining and extractive industries, tourism, defence, power generation, renewable energy projects and transport corridors.

Residential Amenity

Residents within the Primary AA generally have a high residential amenity attributable to a combination of low background noise, fair air quality and moderate visual amenity. During consultation, the Primary AA was regarded as a quiet area by participants, valued for its landscape and rural characteristics.

The LVIA (**Section 7.1**) provides a detailed description of the existing visual setting and the views within the Primary AA. Many views from within the Primary AA comprise undulating agricultural/ grazing lands with some landform peaks and high points characteristic of rural farming areas in this part of NSW. The overall character of the Project Boundary is one of a gentle to moderate undulating rural landscape with moderate visual amenity. However, the broader landscape contains many examples and elements of low visual amenity associated with large scale open pit mining and heavy industry.

Consultation findings and an analysis of 2016 ABS data indicates that residents of the Primary AA have generally lived in the area for a long period of time. 2016 ABS data for Muscle Creek SSC and McCullys Gap ABS State Suburbs shows very low rates of mobility (65% and 76% respectively of the resident population recorded the same usual residence as 5 years ago) (ABS, 2017b and 2017c).

Values and Aspirations

Residents of the Primary AA who participated in consultation undertaken to inform this EIS, identified a number of valued natural assets within the area including rural vistas, open spaces, creeks and mountains. During consultation residents of the Primary AA indicated that they value the serenity of the area, privacy (few visitors or passers-by), the presence of a community even though the resident population is dispersed and less accessible to the regional centres such as Muswellbrook.

Health and Wellbeing

There is no specific statistical information available as to the health and wellbeing of the residents of the Primary AA. However, the findings of community consultation in **Section 5** indicates:

- Some residents, particularly the residents of McCully's Gap and Muscle Creek localities are experiencing stress and anxiety due to the anticipated impacts of the Project, specifically potential visual impacts and perceived impacts to property values;
- Project related stress and anxiety is affecting everyday life for some residents of the Primary AA; and
- Some residents within the Primary AA have existing health conditions. These residents expressed concern that the Project may exacerbate pre-existing health conditions.

Local Accessibility

Public transport does not service the Primary AA. However, a school bus service operates on the northern side of the NEH. Mitigation and consultation will be undertaken as described in **Section 7.4**.

7.23.5 Regional Assessment Area

This section presents a socio-economic description of the LGAs of the Regional AA.

Regional Planning Context

The Project is located within the Upper Hunter portion of the Hunter Region. The Regional Plan provides a framework to guide land use planning priorities and decisions to 2036. See **Section 2.6.3** for further discussion.

Nearby Communities

Key communities in proximity to the Project Boundary include Muswellbrook, Singleton and Scone (see **Figure 2**). The closest centres to the Project Boundary are Muswellbrook and Singleton and both centres are located within daily commute distance of the Project Boundary.

Regional Values and Aspirations

In 2015, the OEH undertook a study 'Community Attitudes to Renewable Energy in NSW' (OEH, 2015) (Community Attitudes Study) to develop an understanding of community attitudes toward renewable technologies.

Environmental benefits were the dominant perceived advantage of renewable energy technologies (Section 2.2.2, OEH, 2015) including:

- Many survey respondents said that renewables were cleaner or created less 'pollution' or fewer greenhouse gases (52%);
- Some (39%) mentioned sustainability and reduced reliance on non-renewables such as coal;
- Some said renewables would help 'save the planet' for future generations (7%); and
- Others saw benefits in the preservation of the landscape and agricultural land (e.g. by not digging up the landscape (5%)).

In the Hunter / Central Coast Region, 210 people were asked for their views about renewable technologies which are summarised as follows (Section 3.2, OEH, 2015):

- 93% supported using renewables to generate electricity in NSW;
- 85% believed NSW should increase the use of renewables over the next five years;
- Most common perceived advantages of renewables:
  - Environmental benefits 79%; and
  - Lower cost 34%.
- Most common perceived disadvantages:
  - Higher cost 36%;
  - Concerns about efficiency and reliability 14%; and
  - No disadvantages 40%.
- 65% were prepared to use renewables "*provided I don't have to pay more for my electricity*" and 30% were prepared to pay more to support them.

Survey respondents were asked whether they supported or opposed the building of a wind farms in NSW, in the local region and within 1-2 km of where they lived. As shown in **Figure 56,** 79% of respondents supported the use of wind farms in NSW, 71% in their local region, and 57% within 1–2 km of where they lived (Section 3.2, OEH, 2015).

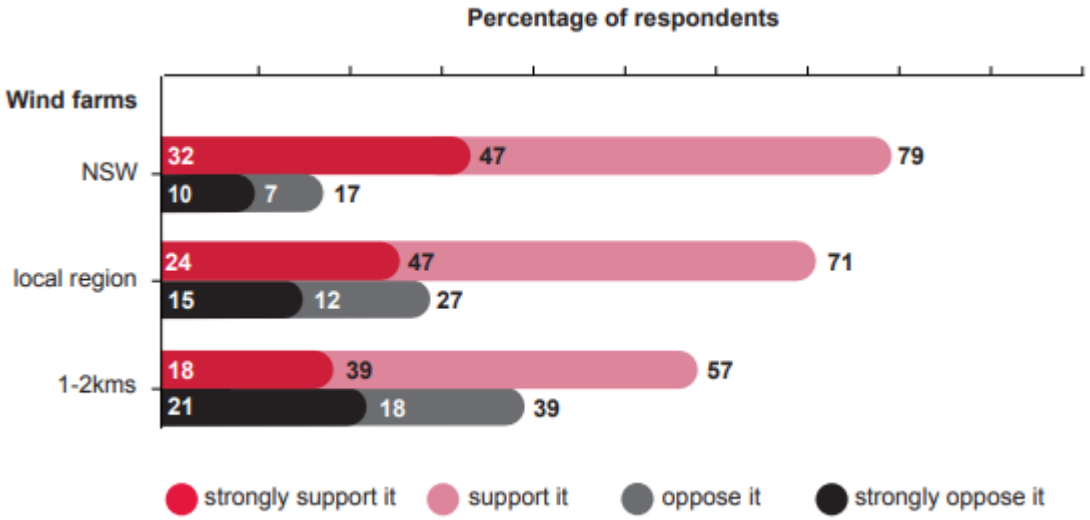


Figure 56
Hunter/Central Coast Attitudes to Wind Farms

Among the 39% who opposed a wind farm within 1–2 km of where they lived, concerns most commonly raised were noise (58%) and visual impact (47%). Only 2% of respondents raised concerns over property value (2%).

Respondents were asked about their level of concern with regards to noise and health issues caused by wind farms. Twenty six percent of respondents were greatly concerned about the noise issues caused by wind farms while 17% either had little or no concern. Twenty eight percent of respondents had little / no concern about the health issues caused by wind farms.

Population Characteristics

In 2018, the Estimated Resident Population (ERP) of the UHSC LGA was approximately 14,220 people (UHSC, 2020a). At this time, MSC LGA had a similar ERP to that of the UHSC LGA (approximately 16,384 people) (MSC, 2020a). Of the Regional AA LGAs, the SSC LGA had the largest ERP of approximately 23,422 people in 2018 (SSC, 2020a).

Between 2008 and 2018, the population of the UHSC LGA experienced a population increase of 4.6%, representing slow but steady population growth. Similarly, MSC LGA increased by 4% over this period of time. Comparatively, SSC LGA experienced a small increase of 2.5% between 2008 and 2018.

Housing Setting

An analysis of the housing market trends (ABS 2017; SQM Research 2020) across the three component LGAs show dynamic housing market conditions closely associated with productivity changes in the mining industry.

The Project is located within an easy daily commute of the regional centres of Singleton and Muswellbrook. The Project construction phase could generate demand for housing and accommodation in these centres. Housing demand will be limited and likely negligible during the Project operations phase due to the small size of the workforce (approximately 15 persons).

Further detailed information on key housing market characteristics is provided in **Appendix Q**.

Housing availability and vacancy rates in Muswellbrook, Scone and Singleton are provided in **Appendix Q**.

An analysis of the SQM Research Weekly Rents Index is provided in **Appendix Q.**

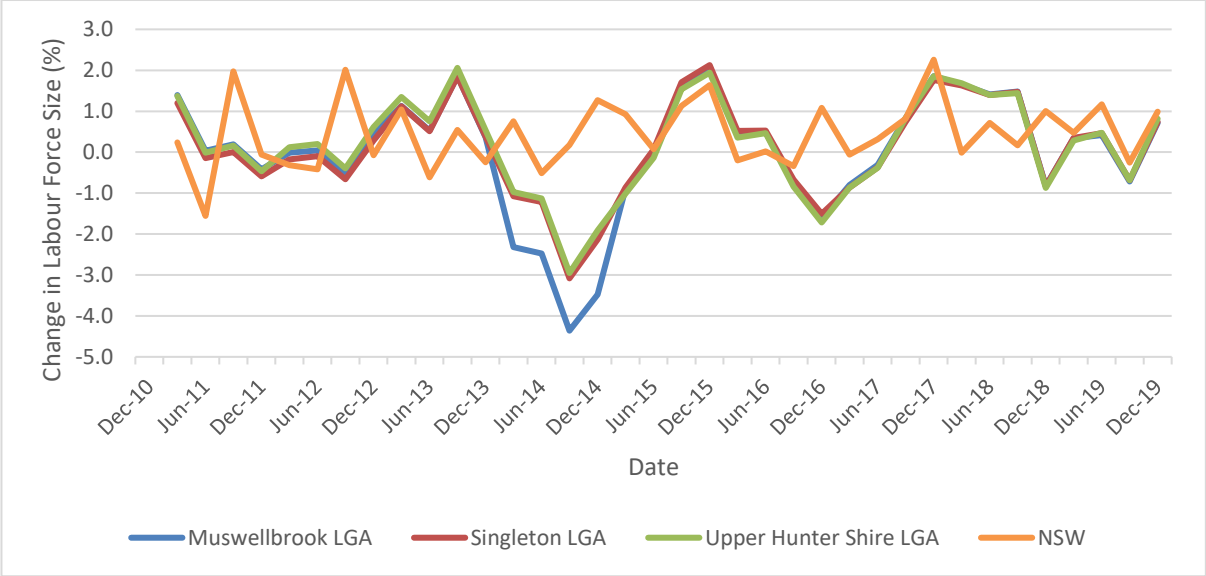
Short-term accommodation options available across the Singleton, Muswellbrook and UHSC are provided in **Appendix Q.**

Labour Market Characteristics

The following section describes the key labour force characteristics of the Singleton, Muswellbrook and UHSC with reference to labour force size and distribution, unemployment and industry of employment.

Labour Force Size

Figure 57 shows the change in labour force size across the component LGAs of the Regional AA and NSW between December 2010 and December 2019. Labour force changes in the Regional AA LGAs have remained consistent. There is a strong alignment of labour conditions across the Regional AA, indicating that this area operates as a labour region, within which labour likely reallocates in order to equalise. The presence of relatively consistent shift arrangements across the mining sector in the Upper Hunter may also contribute to labour alignment. Localised labour force disruptions are not evident within the data. The labour force size in the LGAs of the RAA fluctuate over longer periods of time compared to the NSW trend.



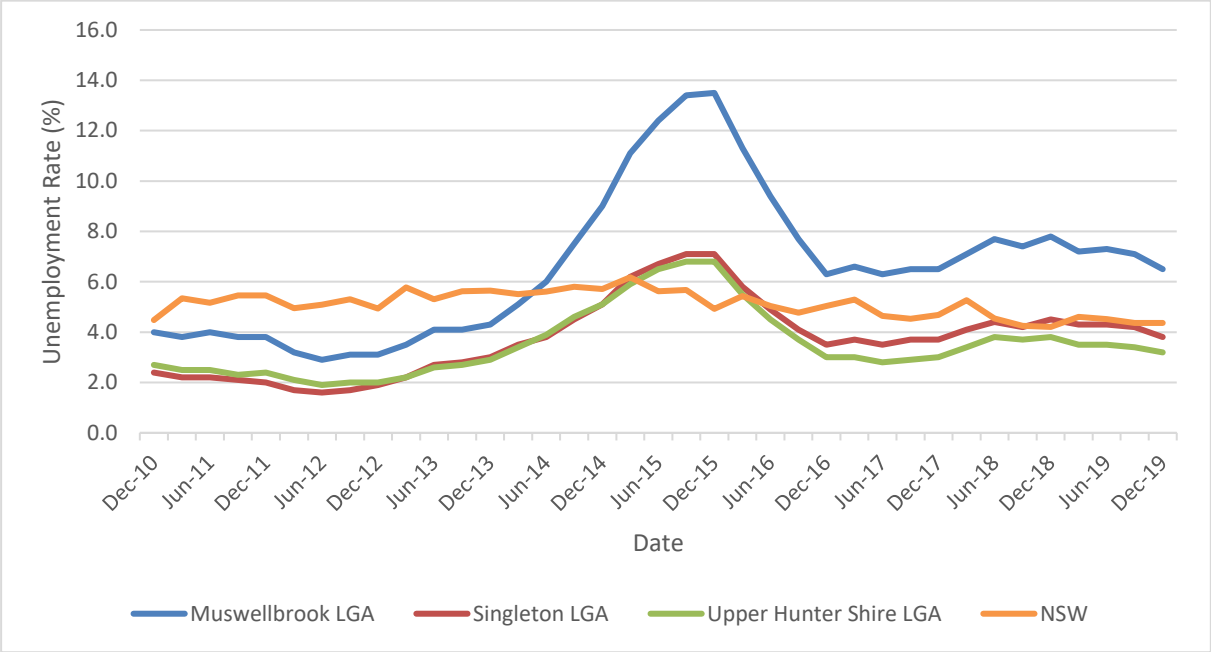
Source: (DESE, 2020 and ABS, 2020)

Figure 57
Labour Force Change Regional Assessment Area 2010-2019

Unemployment

Figure 58 shows trends in unemployment for component LGAs of the Regional AA for the period 2010 to 2019. Trends in unemployment rates across the Singleton and UHSC are generally consistent, with MSC maintaining a higher unemployment rate (approximately 667 people as at December 2018). This is surprising given that the LGA imports a significant number of workers (~4,000 people). This suggests that the unemployment pool in the MSC does not have the skills and capability required to fill roles within the LGA.

The trend data shows evidence of strong alignment of labour conditions across the Regional AA. However, of the LGAs of interest, Muswellbrook experienced the greatest impact from labour market adjustments that occurred in 2015. Muswellbrook is likely to experience further labour market adjustments when the Liddell Power Station is closed by 2023 (see **Section 2.3.4**).



Source: (DESE, 2020 and ABS,2020)

Figure 58
Unemployment Rate Regional Assessment Area 2010-2020

Industry of Employment

An analysis of employment by industry (MSC 2020b, SSC 2020b, UHSC 2020b) shows that the mining sector is the largest employment sector in both the SSC and MSC (40.6% and 31.2% of all jobs respectively). In contrast, the mining sector in UHSC accounts for less than 1% of all jobs in the LGA. The Agricultural, Forestry and Fishing industry sector is the largest employment sector in the UHSC, accounting for 25.6% of all LGA jobs. There is greater employment diversity evident in the UHSC than both SSC and MSC.

Of interest is employment in the electricity, gas, water and waste services industry sector in the three LGAs. This is the sector in which employment in renewable energy is counted. Jobs in this sector accounted for less than 1% of all jobs in the LGAs of SSC and UHSC (0.7% and 0.3%). However, this sector is the second largest industry sector of employment in the MSC, yet it accounts for just 8.9% of all jobs in the LGA. The majority of jobs in this sector are likely to be attributable to the presence of the Liddell Power Station in the MSC.

Liddell Power Station is scheduled to commence closure in 2022 with final closure by April 2023 (AGL, 2019) suggesting that the number of jobs in this sector in the MSC is likely to decrease sharply in the future. The timing of the Liddell Power Station closure aligns with the construction phase for the Project, suggesting available labour in the LGA for the Project.

Social Indicator Summary

Table 57 presents a summary of the relevant social indicators for the component LGAs of the Regional PAA and NSW based on 2016 ABS census data.

Table 57
Social Indicator Summary 2016

Social Indicator		MSC	SSC	UHSC	NSW
Population and Demography					
Population		16,086	22,987	14,112	7,480,228
Median Age		35	36	41	38
Country of Birth (Australian)	%	84.7	84.0	82.0	65.5
Indigenous Persons	%	8.3	5.7	5.1	2.9
Household Characteristics					
Family Households	%	70.1	75.6	68.8	72
Mobility					
Lived at same address 1 year ago	%	75.1	77.1	77.4	77.4
Lived at same address 5 years ago	%	49.4	55.1	56.7	53.8
Housing					
Fully owned	%	26.3	30.6	35.5	32.2
Owned with a mortgage	%	31.3	38.0	31.9	32.3
Rented (total)	%	38.9	28.4	29	31.8
Income and Advantage					
Median Household Income ($weekly)		250	280	220	380
SEIFA Score		917	974	958	1,000
Labour Market Characteristics					
Labour force size	No.	7,331	11,531	6,615	3,605,872
Labour force participation	%	58.8	63.6	59.1	59.2
Unemployment rate	%	8.2	6.1	4.8	6.3
Selected Key Industries of Employment					
Employment in Mining	%	21.9	23.4	11.6	0.9
Health Care and Social Assistance	%	8.2	7.7	7.7	12.5
Electricity, Gas, Water and Waste Services	%	4.7	2.7	1.8	0.9
Employment in Agriculture, Forestry and Fishing	%	6.9	3.8	18.7	2.1
Selected Occupations					
Technicians and Trades Workers	%	20.0	17.8	16.8	12.7

Social Indicator		MSC	SSC	UHSC	NSW
Machinery Operators and Drivers	%	17.9	17.3	13.1	6.1
Labourers	%	12.9	9.9	16.0	8.8
Professionals	%	10.7	12.3	12.2	23.6

Source: ABS Census, 2016 and ABS, 2016

Social Infrastructure Accessibility

A summary of key services and facilities available in the Regional AA is presented in **Appendix Q**. All LGAs are serviced with health and education facilities, a range of recreation facilities and retail and commercial enterprises.

Social capital in the Regional AA is high and is demonstrated through the proliferation of community groups and organisations, sporting clubs, industry bodies and support networks. Historically, all three LGAs have experienced service delivery issues due to rapid temporary and permanent population growth associated with the mining sector.

Current issues in service delivery include:

- Air quality (dust) health related issues;
- Decreased availability of housing and accommodation in MSC; and
- Increased traffic on local roads.

7.23.6 Impact Assessment and Opportunities – Regional Assessment Area

This section describes the predicted opportunities and impacts of the Project within the Regional AA. A range of measures are identified to avoid, mitigate or manage the predicted impacts and enhance opportunities.

The significance of each social impact (mitigated) and opportunity for the Regional AA is identified using a risk-based approach (**Table 59**). The outcomes of each significance evaluation is presented in tabulated format at the end of **Section 7.23.8**.

Amenity and Character

Visual

Residents within the Regional AA and tourists are likely to experience visual amenity impacts during the operations phase associated with visibility of WTGs from public viewpoints mainly from key transport corridors. These impacts will be limited in extent due to the relatively short exposure time when passing the Project during travel. The Project is not expected to impact the character of the Regional AA as views toward the Project are largely shielded due to topography and existing vegetation.

No key public view locations were identified within 4.4 km of turbine locations. However, the assessment of scenic locations has been undertaken as part of the LVIA for 16 public view-points and scenic locations to a distance of at least 8 km. Most key public view locations, scenic areas or lookouts are located at considerable distance from the wind turbines (and generally beyond the 8 km threshold). Whilst wind turbines will be visible from key public view locations, their scale will not dominate the landscape.

The LVIA has assessed key public view locations within 8 km of a turbine location against the performance objectives in the Visual Bulletin and determined that the Project will achieve all performance objectives from identified viewpoints. As such, the residual social impact of the Project on residential amenity in the Regional AA is assessed as low.

Economic Development

The Project will generate revenue at the federal, state and local level. The economic benefits of the Project are described in the EIA at **Section 7.8**. Benefits will primarily be accrued to the LGAs of the Regional AA through the generation of employment opportunities and supply arrangements with local businesses (i.e. those required for construction materials/activities).

In the peak construction year (Year 1), the Project is estimated to contribute up to $19M in annual direct and indirect household income and 236 direct and indirect jobs to the Regional AA. The Proponent will seek to prioritise local supply for the Project, where relevant services and skills are available.

The Project will support employment in the construction and energy sector for a portion of workers who already reside in the Regional AA. Construction and operations phase employment associated with the Project will permit households to remain in the Regional AA, thus maintaining social contributions to the regional community and economy.

Employment Opportunities

Employment Generation

The direct and indirect employment opportunities associated with the Project are described in **Section 7.8**.

Over the 18-month construction phase, direct and indirect economic benefits will accrue to the LGA's of the Regional AA. These benefits will primarily be accrued through the creation of employment opportunities and supply arrangements with local businesses (i.e. those required for construction materials/activities).

It is however, acknowledged that the majority of the construction workforce will likely already reside in the LGA's of the Regional AA, so additional demand on services will be unlikely.

The peak construction year (Year 1) of the Project is estimated to contribute up to 236 direct and indirect jobs to the economy of the Regional PA.

The operations phase workforce of 15 is anticipated to be sourced from within the Regional AA. The employment benefits of the operations phase are more long-term than the construction phase, but smaller in size.

Labour Force Impacts

The labour supply in the MSC, SSC and UHSC is described in **Section 7.8**.

The Economics Assessment identified that the main sector most likely to be impacted is the "heavy and civil engineering construction sector, construction services sector and electricity transmission, distribution, on selling and electricity market operation sector".

Flow-on impacts from the construction of the Project are likely to affect a number of different sectors of the regional economy including "wholesale and retail trade, professional, scientific and technical services, employment, travel agency and other administrative services, food and beverage services and road transport".

The Regional AA is one of the primary coalfields in NSW containing power stations and multiple mining projects. There are thousands of employees associated with existing and proposed mining development within the Regional AA, with the timing of each development varying depending on development consent.

As at 2020, at least two projects within 10 km of the Project (see **Section 2.3**) are scheduled to cease during the proposed construction phase of the Project (around 2022 which would release suitably skilled personnel into the existing labour market within the Regional AA to assist in construction.

To support local employment preparation for the Project would include:

- Prioritisation of construction phase employment within the LGAs of the Regional AA;
- Advertising long term employment opportunities within the Regional AA; and
- Seeking to provide apprenticeship and/or traineeship opportunities across the construction and operations phase of the Project, given the Project life of approximately 25 years provides continuity in employment.

The Proponent will endeavour to source employees with appropriate skills from within the MSC, SSC and UHSC to support the Project. This includes any apprenticeships, traineeships, graduate programs and/or contract labour.

A Recruitment Strategy document will be developed prior to the commencement of construction.

Population Change

The Project will not result in any significant or sustained population change in the Regional AA. The construction phase is predicted to result in a temporary and medium-term (estimated 18 months) increase (albeit low) in population in the Regional AA. An estimated 31 NLHs are anticipated to move to the regional AA during the construction phase, representing negligible growth in regional population.

The operations workforce of 15 people is anticipated to be largely drawn from within the Regional AA, hence the operations phase will not result in any noticeable increase in population in the Regional AA.

There have not been any social concerns raised by stakeholders in relation to an increased population (see **Section 5**). Further consideration of this issue is not considered necessary.

Access to Housing and Accommodation

The primary driver of Project impacts on the housing market and short-term accommodation provision during all phases of the Project is the number of NLHs who will require accommodation.

There are 31 NLHs anticipated to reside in the Regional AA during the construction phase, therefore an estimated 31 beds of short-term accommodation will be required during the 18-month construction phase. Accommodation demand is anticipated to generate 16 beds in Singleton, 14 beds in Muswellbrook and 1 bed in Scone.

There are a number of short-term accommodation rooms available in the MSC (227 rooms), SSC (294 rooms) and Scone (117 rooms) as well as a supply of available private rental accommodation (**Appendix Q**). Based on mining sector experience, the construction contractors will rent three and four-bedroom rental properties in order to accommodate multiple workers at the one time. As the construction phase is temporary, workers normally do not bring their partners or family to their place of work. This means that one construction worker can generally be accommodated in each bedroom within a house.

Although a relatively tight rental market, as at March 2020, there was a sizeable pool of longer term rental accommodation in the MSC (64 rental properties), SSC (38 rental properties) and Scone (22 rental properties).

Given the available private rental accommodation, the supply of housing stock and the likelihood that the private rental accommodation supply will remain consistent in the future, it is highly likely that there will be sufficient private rental accommodation to meet the demands of the Project. The potential social impact of the Project on the supply of short-term accommodation and private rental accommodation is assessed as low.

Access and Connectivity

The construction phase of the Project has the potential to impact on traffic volumes, road safety and access. These impacts are expected to occur during construction only, and mainly impact residents within the Primary AA.

Select local roads will be upgraded to allow for delivery of WTG components and installation of the powerline. These road upgrades will require some temporary changes to the local road network as described in **Section 7.4**.

The average total daily movements and public safety on roads during construction are described in **Section 7.4**.

Consultation was undertaken with local Councils and TfNSW during the preparation of this EIS as described in **Section 5**.

A TMP will be developed to address the short-term impacts associated with traffic movements as described in **Section 7.4.4.**

With the implementation of these management measures the residual social impact of the Project on access and connectivity in the Primary AA is assessed as low. Additionally, the residents of the Primary AA are expected to benefit from the maintenance and / or improvements to the local road network. This is considered a moderate opportunity to the community.

Public Safety and Security

During EIS consultation a number of concerns were raised in relation to public safety and security. Participants in consultation expressed significant concern in relation to the potential public risks of the Project citing:

- An increased risk to bushfire threat due to the potential explosion of a WTG (discussed in **Section 7.10.3**);
- Bushfire management (discussed in **Section 7.10**);
- Aircraft safety (discussed in **Section 7.3**);

- WTG rate of failure (discussed in **Section 7.11**);
- Public safety during the assessment process (**Section 5**); and
- Blade throw (discussed in **Section 7.11**).

With the implementation of the management measures described in each relevant section, the residual social impact of the Project on public safety and security of property in the Primary AA is assessed as low.

Aboriginal and Non-Indigenous Cultural Heritage

The Project is located within the area identified as the traditional country of the Wonnaruah / Wonnarua people. The cultural values are described in **Section 7.6**.

The non-Aboriginal heritage values of relevance to the SIA are described in **Section 7.7**.

7.23.7 Impact Assessment and Opportunities – Primary Assessment Area

This section describes the predicted social opportunities and impacts of the Project within the Primary AA. A range of measures are identified to avoid, mitigate or manage the predicted impacts and enhance opportunities.

The significance of each social impact (mitigated) and opportunity for the Primary AA is identified using a risk-based approach (see **Table 59**). The outcomes of each significance evaluation is presented in tabulated format at the end of **Section 7.23.8**.

Amenity and Character

Participants in EIS consultation, particularly residents of the Primary AA expressed concern in relation to the potential impact of the Project on visual and acoustic amenity. These stakeholders, particularly those located in the Muscle Creek and McCullys Gap localities were concerned that:

- The towers, once constructed would, interrupt the natural rural vistas currently afforded residents in the Primary AA; and
- Noise associated with construction activity and noise generated by the operation of the wind farm disrupt the use and enjoyment of their private property.

Visual

As described in **Section 7.1**, the Project is predicted to have a low to moderate visual impact to dwellings located in the Primary AA during operation. Impacts are described in detail in **Section 7.1.3**.

A range of measures are proposed to reduce the visual impact of the Project for residents of the Primary AA as described in **Section 7.1.3** and **Section 7.1.4**.

The provision of accessible and transparent information to residents of the Primary AA about the results of the EIS, proposed management commitments and outcomes of future monitoring activities should also address community concerns regarding potential impacts to amenity and character. In this regard the Proponent will continue to:

- Support the continued operation of the Project CCC in accordance with the 'Community Consultative Committee Guidelines for State Significant Projects' (DPIE, 2016). The CCC provides a forum to share and discuss the environmental performance of the Project;

- Provision of regular community updates to residents on issues of interest such as Project construction and operations, visual management objectives and implementation timeline. This will partially be achieved through the Community Consultative Committee but also through other meetings and the proponent's website;
- Create opportunities to engage further with residents of the Primary AA such as through ongoing community information days to provide an opportunity for residents to meet face-to-face with the Proponent, ask questions and clarify Project related technical information; and
- Reproduce and supply photomontages for any updates to Project layout.

With the implementation of these management measures the residual social impact of the Project on residential amenity in the Primary AA is assessed as moderate – low.

Noise Amenity

The NIA (**Section 7.2**) has assessed the impact of the construction and operations phase of the Project on the acoustic amenity of the Primary AA. The findings of the NIA determined that operational noise generated by the Project was compliant with the relevant noise criteria at all surrounding residential dwellings excepting one (further mitigation has been proposed in **Section 7.2.4** to meet the criteria). As such, the operation of the Project is not expected to impact on the acoustic amenity of properties within the Primary AA.

The NIA also included an assessment of the potential construction noise and vibration, including road traffic noise during construction.

A range of measures have been implemented to reduce the intrusiveness of noise generated during construction and operation as described in **Section 7.2.4**.

With the implementation of these management measures the residual social impact of noise generated by the Project during operation and construction on residential amenity in the Primary AA is assessed as low.

Rural Character

Residents of the Primary AA expressed concern that the Project would detract from the rural character of the locality. One stakeholder suggested that the local scenic quality and rural character was being sacrificed to facilitate the development.

The LVIA prepared for the Project included consideration of the impact of the Project on views into the Project and from key locations (see **Section 7.1.3** for a description and summary of key findings).

The Proponent acknowledges the community's concerns in relation to changes in rural character. Any potential change in rural character is closely associated with changes in rural vistas. A range of actions (see **Section 7.1.3** and **Section 7.1.4**) have been taken by the Proponent to reduce the visual impact of the Project during operations.

With the implementation of these management actions, the residual social impact of the Project on rural character in the Primary AA is assessed as low.

Livelihood Impacts

Impacts to Aerial Operations

The safe operation of aircraft within the Primary AA is considered important for agricultural operations (fertiliser application, pest and crop spraying), aerial firefighting and emergency services (Westpac Rescue helicopter and Royal Flying Doctor).

The impact of the Project on aerial operations was assessed as part of the AIA (**Section 7.3**) and consultation was undertaken with aerial and aircraft operators, owners of private aerodromes and emergency services (discussed in **Section 5** or in **Appendix G**).

As described in **Section 7.3.3**, the Project is predicted to have a low impact on aerial operations during operation.

With the implementation of the management measures the residual social impact of the Project on aerial operations in the Primary AA is assessed as low.

Impacts to Communications

The Project has the potential to interfere with communications services such as (radiocommunications, VHF and UHF, mobile and satellite links, GPS farming guidance systems). Communications services (radio communications links) were assessed as part of the Telecommunications Assessment (**Section 7.9**). Consultation was undertaken with the communications operators identified in the assessment (discussed in **Section 5**).

The Project is predicted to impact on the 400 MHz NSW Rural Fire Service link in the Primary AA during operation. A range of measures are proposed to reduce the impact of the Project as described in **Section 7.9.4**.

With the implementation of the management measures the residual social impact of the Project on aerial operations in the Primary AA is assessed as low.

Property Values and Land Rates

One of the issues raised most frequently by residents of the Primary AA during EIS consultation was the potential for the Project to impact property values. Some residents expressed concern that that the Project may have already adversely impacted both property values and the level of buyer interest in the location.

Residents within the Primary AA were concerned that if they wanted to move from the location due to the impacts of the Project, they:

- Would be unable to sell their property; or
- The value they received for the property would be below market value.

The impact of the Project on surrounding property values is considered in **Section 7.12**. The Project is predicted to have no impact to property values within the Primary AA.

Health and Wellbeing

During EIS consultation some residents at Muscle Creek and McCully's Gap expressed concern in relation to the potential health risks associated with the Project. Specific concerns were expressed in relation to the potential health risks associated with the operation of the WTGs. Potential health concerns raised during consultation related to:

- Noise (including low frequency) discussed in **Section 7.2**;
- Epilepsy caused by shadow flicker discussed in **Section 7.21**;
- EMF discussed in **Section 7.18**; and
- Mental health discussed below and **Section 7.19**.

Mental Health

During consultation, a number of residents within the Primary AA indicated that they were experiencing elevated levels of stress and anxiety due to the anticipated visual impacts of the Project (**Section 5**). As discussed above, these stakeholders were very concerned about the extent to which the visual impact of the Project would affect the use and enjoyment of their property as well as the value of their property in the event that they want to sell.

Anxiety is the most common mental health condition in Australia (Beyond Blue, 2018), and can have a temporary or prolonged effect on a person's quality of life and day-to-day functioning. There is potential for project induced stress amongst nearby residents to also affect family wellbeing. The dominant land use within the Primary AA is agriculture (cattle grazing). Within the Primary AA, drought has been a particular driver of anxiety and has strained the emotional resources of many local farmers. This is likely to make some residents of the Primary AA more sensitive to any Project induced stress.

The primary strategy to manage resident stress and anxiety in relation to the Project is for the Proponent to continue to engage in and maintain transparent, evidence-based and ongoing dialogue with concerned landholders and other community members, based on the results of this EIS.

As described in **Section 5.7**, the Proponent will continue to consult with stakeholders during all Project phases.

With the implementation of these management measures the residual social impact of the Project on mental health in the Primary AA is assessed as low to moderate.

Community and Liveability

Community Cohesion

The Proponent has offered Agreements to various landholders as described in **Section 2.5**. Not all residents of the Primary AA have benefited from these agreements. Consultation with different residents in the Primary AA indicates some animosity between those residents that have benefited and those that have not. Some stakeholders expressed concern that the agreements had the potential to erode existing social connections between residents of the Primary AA.

The Proponent's community engagement strategies and complaints framework (see **Section 5.7**) will seek to ensure that any unanticipated social impacts on the communities within the Primary AA are identified and addressed.

With the implementation of the management described in the respective EIS sections, the residual social impact of the Project on public safety and security property in the Primary AA is assessed as low.

Culture

Indigenous Cultural Values

Aboriginal people are generally concerned about development that might impact upon Aboriginal heritage and other values on traditional land.

The Project has the potentially to impact on heritage sites within the Primary AA. These sites and how they will be managed are described in **Section 7.6**.

The Proponent is committed to involving the local Aboriginal community as integral participants in the management of Aboriginal cultural heritage values for the Project. The Proponent will continue to involve the RAPs in cultural heritage processes. In particular, the recording, collection, curation and storage of Aboriginal objects will occur with the participation of the RAPs.

With the implementation of the management described in **Section 7.6.4**, the residual social impact of the Project on Aboriginal cultural values in the Primary AA is assessed as low.

Historic Heritage Values

Concern was raised during consultation in relation to the impact of the Project on heritage items. Impacted heritage sites and how they will be managed are described in **Section 7.7**.

With the implementation of the management described in **Section 7.7.4**, the residual social impact of the Project on Historic heritage values in the Primary AA is assessed as low.

Access to Services and Facilities

Predicted population increases during construction within the LGAs of the Regional AA are anticipated to have a negligible impact on demand and supply of existing services and facilities within the Regional AA.

Key regional centres (i.e. Muswellbrook, Singleton and Scone) within the Regional AA are anticipated to experience negligible increase in demand for health and emergency services due to the small size of the NLH construction workforce (31 people in total spread across three LGAs).

As it has been assumed that families will not accompany the NLH construction workers to the Regional AA, additional demand placed on childcare services or primary and secondary school enrolments is unlikely.

There are police stations, ambulance and fire services within each urban centre of the Regional AA. During the construction phase of the Project, there may be a temporary increase in demand for police services (specifically with respect to oversize load escorts).

There is no predicted impact to services from the operations workforce as all employees are anticipated to be sourced locally.

Local investment facilitated through the Project (as described in **Section 3.1**) will support improvements in and possible expansion of existing services in the Regional AA (at the discretion of each council).

Community Fund

To mitigate potential social impacts, the Proponent will establish a VPA with each of MSC, UHSC and SSC (see **Section 3.1.1**). The VPA is proposed to be distributed via a "Community Fund" mechanism administered by each individual Council.

The intent will be for the Community Fund distribution mechanism to mitigate any residual socio-economic impacts identified in this EIS and support the Primary AA and wider communities in the Singleton, Muswellbrook and Upper Hunter Shires. The Community Fund established in each LGA may be used to support local community projects such as:

- Funding to sporting clubs, infrastructure or education;
- Funding to local environment and cultural heritage projects; and
- Variable funding to groups based on their proximity to the Project.

7.23.8 Social Impact Significance Assessment Summary

Section 6 includes an environmental risk assessment which was used to identify the level of assessment required for inclusion in this EIS for various aspects.

This section presents the outcomes of the social impact and opportunities significance assessment. The Social Risk Matrix is shown in **Table 58** has been used to quantify the significance of each identified potential social impact.

The same social risk rating was applied to opportunities, with the social risk rating related to the scale of improvement or benefit likely to be experienced (i.e. 'red' for a significant improvement or benefit). The assessment presented in **Table 59** describes each impact, its nature (i.e. whether an impact or opportunity), the phase of the Project which the impact or opportunity is expected to occur (i.e. pre-construction, construction, operation, decommissioning or all stages), and an impact significance assessment for the impact prior to and following mitigation.

Table 58
Social Risk and Opportunity Rating Matrix

			Consequence Level				
			1	2	3	4	5
			Minimal	Minor	Moderate	Major	Catastrophic
Likelihood Level	A	Almost Certain	A1	A2	A3	A4	A5
	B	Likely	B1	B2	B3	B4	B5
	C	Possible	C1	C2	C3	C4	C5
	D	Unlikely	D1	D2	D3	D4	D5
	E	Rare	E1	E2	E3	E4	E5
Social Risk Rating							
	Low		Moderate		High		Significant

Source: Department of Planning and Environment (2017)

Table 59
Social Impact and Opportunities Significance Assessment Summary

Impact	Nature	Phase	Impact Significance	
			Unmitigated	Mitigated
Regional Assessment Area				
Visual amenity / character	Impact	Operation	Moderate	Low
Noise amenity / character	Impact	Operation	Moderate	Low
Economic Development	Opportunity	Construction	Moderate	Moderate
Employment Generation	Opportunity	Construction and Operation	Moderate	Moderate
Labour Force	Opportunity	Construction and Operation	Low	Low
Population Change	Opportunity	Construction and Operation	Low	Low
Access to Housing and Accommodation	Opportunity	Construction	Low	Low
Access and Connectivity	Impact	Construction	Moderate	Low
Access and Connectivity	Opportunity	Construction	Moderate	Moderate
Public Safety and Security	Impact	Operation and Operation	Moderate	Low
Cultural Heritage	Impact	Construction	Low	Low
Primary Assessment Area				
Visual amenity / character	Impact	Operation	Moderate	Moderate – low
Noise amenity / character	Impact	Construction and Operation	Low	Low
Rural character	Impact	Operation	Moderate	Low
Livelihood – Aerial Operations	Impact	Operation	Moderate	Low
Livelihood – Communications	Impact	Operation	Low	Low
Property Values	Impact	Operation	Low	Low
Health and Wellbeing	Impact	Construction and Operation	Moderate	Low
Community Cohesion	Impact	Construction	Moderate	Low
Culture	Impact	Construction	Moderate	Low
Access to Services and Facilities	Impact	Construction	Low	Low
VPA	Opportunity	Operation	Significant	Significant

7.24 CUMULATIVE

The impact assessments undertaken in **Section 7** consider cumulative impacts of other industry, where relevant.

As the closest constructed wind farm is over 100 km away and approved but not yet constructed is around 35 km away cumulative wind farm impacts will not occur with the Project.

7.25 ENVIRONMENTAL MANAGEMENT SYSTEM

A site EMS will be developed and adopted for the Project.

The mitigation and management measures summarised in **Section 8** will be included in the Project CEMP, OEMP and other management plans as required by conditions of Development Consent.

Strategies, programs and plans will include adaptive management strategies, contingency measures to address residual impacts and a program to monitor and report on the environmental performance of the Project.

An internal “Land Disturbance Procedure” will be employed during the construction of the Project which will review any proposed disturbance and confirm that impacts are generally consistent with this EIS and any conditions of development consent.

8 MANAGEMENT AND MITIGATION SUMMARY

A summary of adaptive management and mitigation strategies that the Proponent will undertake during the construction, operation, maintenance and decommissioning of the Project is summarised in **Table 60**. It also indicates the section of this EIS where additional detail is provided.

Written approval by DPIE or conditions of any development consent issued will take precedence over the commitments in **Table 60**.

Table 60
Project Mitigation and Management Summary

Ref	Aspect	Commitment	Section
1.	Development	Construct, operate, maintain and decommission the Bowmans Creek Wind Farm generally in accordance with the 'Project Description'.	**3**
2.	Development	Develop and utilise: • An Environmental Management System • Internal 'Land Disturbance Procedure' during the construction of the Project • A Construction Environmental Management Plan • An Operations Environmental Management Plan	**7.25**
3.	Development	Conduct monitoring as required by conditions of consent.	**7**
4.	Development	Seek Agreements with Associated (host) landholders and neighbouring landholders where this EIS has predicted exceedances of relevant criteria.	**Section 2.4**
5.	Development	Implement a Neighbour Benefit Program.	**Section 2.4**
6.	Statutory	Seek relevant approvals and post-approvals in accordance with Table F1 of **Appendix F**.	**4.6**
7.	Stakeholder Engagement	During detailed design, the Proponent will consult with the Lake Liddell Recreation Area Trust and the manager of the Lake Liddell Recreation Area to ensure the best placement of power poles in the vicinity of Trust managed land and to avoid the placement of power poles within Lot 2 DP 238862.	**5.7**
8.	Stakeholder Engagement	Conduct ongoing stakeholder engagement during the Project generally in accordance with **Section 5.7**.	**5.7**
9.	Stakeholder Engagement	During detailed design of the Project, the Proponent will consult with the owner of the Queensland-Hunter Gas Pipeline to resolve any interaction issues.	**5.7**
10.	Stakeholder Engagement	Prior to construction, consult with Glencore in relation to the realignment of Hebden Road if not completed prior to construction.	**5.7**

Ref	Aspect	Commitment	Section
11.	Landscape and Visual	Undertake the following management and mitigation measures: • Screening mitigation to non-Associated dwellings as summarised in **Table 17**; • Additional mitigation to non-Associated dwellings as summarised in **Table 18**; and • Conduct additional refinement and considerations during detailed design.	**7.1.4**
12.	Landscape and Visual	During the detail design process, the following will be undertaken where reasonable and feasible: • Refinement in the design and layout to assist in the mitigation of bulk and height of proposed structures; and • A review of materials and colour finishes for selected components including the use of non-reflective finishes to structures.	**7.1.4**
13.	Landscape and Visual	During construction, where reasonable and feasible: • Minimise tree removal and protect mature trees (consistent with **Section 7.5**); • Avoid temporary light spill beyond the construction site where temporary lighting is required; and • Progressively rehabilitate disturbed areas.	**7.1.4**
14.	Landscape and Visual	During operations, where reasonable and feasible: • Ongoing maintenance and repair of constructed elements; • Replacement of damaged or missing constructed elements; and • Long term maintenance (and replacement as necessary) of vegetation within the Project site to maintain visual filtering and screening of external views where appropriate.	**7.1.4**
15.	Noise	Undertake noise management and mitigation measures during construction to meet relevant criteria in **Section 7.2.4:** • Restrict construction hours and days; • Only undertake work outside these hours under strict conditions; • Implement feasible and reasonable work practices outside of standard work hours; • Consider dwelling when locating fixed noise sources; • Implement acoustic screens or mounding to mitigation noise from fixed plant; • Provide acoustic enclosures for site compressors and generators; • Undertake active site management for plant and machines;	**7.2.4**

Ref	Aspect	Commitment	Section
		• Consider noise during equipment selection; and • Conduct induction training including noise.	
16.	Noise	Traffic management measures will include access only via approved routes, delivered scheduled to be dispersed where practicable, and truck noise managed.	**7.2.4**
17.	Noise	A vibration monitoring program will be undertaken if blasting undertaken in accordance with the Assessing Vibration Guideline.	**7.2.4**
18.	Noise	A written Agreement will be sought with P22-1 prior to the commencement of construction. If an agreement with residence P22-1 cannot be sought, the Noise Bulletin criteria can be achieved by operating WTG T23 in a *Sound Optimised Mode S02* at integer wind speeds of 9m/s.	**7.2.4**
19.	Noise	The final noise operating strategy will be determined during a pre-construction noise assessment which will consider the final WTG selection and layout, guaranteed sound power levels for the WTG, and final agreements with landowners.	**7.2.4**
20.	Noise	The procurement process includes a guarantee from the WTG manufacturer that the final WTG selection is free of excessive levels of tonality.	**7.2.4**
21.	Aviation Safety	"As constructed" details of WTGs; and wind monitoring tower coordinates and elevations will be provided promptly to ASA.	**7.3.4**
22.	Aviation Safety	Notifications to NOTAM will occur where obstacles are greater than 110 m AGL and crane operational details during construction.	**7.3.4**
23.	Aviation Safety	Notifications to local and regional aircraft operations will occur prior to construction and VFR transit routes.	**7.3.4**
24.	Aviation Safety	WTGs will be painted off-white/grey (unless otherwise agreed by the Secretary).	**7.3.4**
25.	Aviation Safety	Wind monitoring towers will be marked according to the requirements set out in MOS 139.	**7.3.4**
26.	Aviation Safety	Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations will be identified in consultation with local aerial agriculture operators and marked in accordance with MOS 139.	**7.3.4**
27.	Aviation Safety	Micro-siting will occur generally within 100 m (except where noted in **Section 7.9.4**).	**3.3.2**
28.	Aviation Safety	Following detailed design and final location of WTGs, consult with land hosts of ALA 1 to address potential impacts on the aerodrome's circuit operations.	**7.3.4**

Ref	Aspect	Commitment	Section
29.	Aviation Safety	For aerial agriculture impacts to ALAs, implement reasonable measures including: • Funding the cost difference between pre-development aerial agricultural activities and a suitable alternative; and/or • Temporarily stopping WTGs during aerial agricultural activities.	**7.3.4**
30.	Aviation Safety	To facilitate the flight planning of aerial application operators, details of the Project will be provided to landowners as well as engagement to develop relevant procedures.	**7.3.4**
31.	Aviation Safety	The EIS Aviation Risk Assessment will be reviewed and revised if necessary.	**7.3.4**
32.	Traffic	Schedule OSOM vehicular movements to meet the restrictions on the NEH and Hunter Expressway.	**7.4.4**
33.	Traffic	A Traffic Management Plan will be developed in consultation with relevant regulators which: • Minimises the traffic safety impacts of the development and disruptions to local road users; • Finalises the works required from the preliminary swept path analyses; • Excludes removal of two established trees on the eastern side of Scrumlo Road on the north of the dog leg corner; • Includes a drivers Code of Conduct; • Consider future projects such as M1 to Raymond Terrace and the Hexham Road Straight projects; • Includes access protocols to minimise disruption to the local community; • Describes proposed Stakeholder Engagement; and • Include a detailed program to monitor and report on the effectiveness of traffic measures.	**7.4.4**
34.	Biodiversity	A Biodiversity Management Plan will be prepared in consultation with relevant regulators.	**7.5.4**
35.	Biodiversity	To reduce impacts to native vegetation and habitat: • Clearly delineate clearing limits in a two-stage process; • Undertake Pre-clearance surveys; • Conduct further threatened flora searches; • Conduct weed management; • Undertake erosion and sediment control; • Implement controls to limit impacts due to vehicle strike; and • Conduct detailed design surveys to adjust and minimise impacts to threatened fauna.	**7.5.4**

Ref	Aspect	Commitment	Section
36.	Biodiversity	To offset the impacts from the Project: • Recalculate the preliminary Project biodiversity credits utilising additional survey effort and the final project layout including requisite credit calculations for any impacted threatened flora species; and • Retire the credits in accordance with any conditions of consent.	**7.5.4**
37.	Biodiversity	A Bird and Bat Adaptive Management Plan will be prepared in consultation with relevant regulators.	**7.5.4**
38.	Aboriginal Heritage	An Aboriginal and Cultural Heritage Management Plan (ACHMP) will be prepared in consultation with relevant regulators and Registered Aboriginal Parties (RAPs).	**7.6.4**
39.	Aboriginal Heritage	All newly-recorded Aboriginal sites will be registered with AHIMS.	**7.6.4**
40.	Aboriginal Heritage	As part of the Project detailed design phase, avoid harm to certain Aboriginal sites where practical, particularly along the transmission line.	**7.6.4**
41.	Aboriginal Heritage	Implement recommendations for the nine sites including for either: if the site can be avoided during detailed design, or if the site is to be harmed as described in the approved ACHMP.	**7.6.4**
42.	Aboriginal Heritage	Prior to construction commencing, assess the Disturbance Area within 200 m of Fish Hole Creek and any additional sites included in the ACHMP.	**7.6.4**
43.	Historic Heritage	Rock Lily Gully (HS01) will be fenced during construction and/or plantings conducted in consultation with the landowners.	**7.7.4**
44.	Historic Heritage	Hilliers Creek (HC01) site will be fenced during construction and avoided. No impacts will occur within 20 m of the transmission line and 10 m of the access tracks.	**7.7.4**
45.	Historic Heritage	The Local Environment Plan listed Item, Former Roman Catholic Church will not be impacted within the lot.	**7.7.4**
46.	Historic Heritage	Following detailed design, a Community-based Heritage Study will be undertaken that will document and archivally record any items held to be considered significant by the local community.	**7.7.4**
47.	Economics	• Employ regional residents where practicable; • Participate, as appropriate, in business group meetings, events or programs in the regional community; • Purchase local non-labour inputs to production, preferentially where local producers can be cost and quality competitive, to support local industries; • Design the Project infrastructure so that the continued agricultural productivity of the Associated landholdings is maintained to the maximum extent practicable; and	**7.8.4**

Ref	Aspect	Commitment	Section
		• Enter into a VPA with the Singleton, Muswellbrook and Upper Hunter Councils for the provision of social infrastructure, commensurable with the Project's impacts.	
48.	Telecommunications	A pre-construction TV survey will be undertaken at a sample of dwellings out to 5 km from the closest WTG to establish a benchmark of TV reception to compare with any potential interference during operations.	**7.9.4**
49.	Telecommunications	Should TV reception of the two main stations be impacted by WTGs located in the direction of the main TV stations (confirmed through the benchmarking above), the VAST Satellite service will be investigated and implemented by the Proponent in consultation with the affected dwelling.	**7.9.4**
50.	Telecommunications	During Project detailed design consideration will be given to micro-siting T70 and T69 to achieve the required clearance zone for the impacted link. If this cannot be achieved, consultation with RFS will occur to relocate its 400 MHz communications equipment. If this cannot be resolved to RFS's satisfaction, T70 will either not be constructed or the link may be rerouted via the installation of a repeater station. T69 may also be relocated in consideration of this constraint during micro-siting (by around 160 m). Should this be required, additional due diligence inspections will be conducted as part of the 'Land Disturbance Procedure' to ensure unacceptable impacts to archaeology and ecology do not occur.	**7.9.4**
51.	Bushfire	Controls will be implemented to minimise the risk of bushfire being ignited due to the Project.	**7.10.4**
52.	Bushfire	A Bushfire Management Plan will be developed in consultation with the relevant emergency services and regulatory authorities.	**7.10.4**
53.	Bushfire	Relevant bushfire protection measure for proposed developments on bushfire prone land will be implemented including: • The provision of clear separation of buildings and bush fire hazards in the form of fuel reduced APZ; • Construction standards and design; • Appropriate access standards for residents, fire fighters, emergency service workers and those involved in evacuation; and • Adequate water supply and pressure; • Emergency management arrangements for fire protection and/or evacuation; and • Suitable landscaping, to limit fire spreading to a building.	**7.10.4**

Ref	Aspect	Commitment	Section
54.	Blade Throw	The risk of blade throw will be effectively managed by reducing the likelihood of a component failure through: • International safety and structural integrity standards that govern the manufacture of WTG components; • Ongoing monitoring of structural integrity, through both automated systems and manual inspections; • Routine maintenance of WTG components; • Immediate replacement or repair of components that exhibit signs of damage or excessive wear; and • Operational controls that enable the rotors to be slowed down (or fully stopped) during extreme wind conditions.	**7.11.3**
55.	Blade Throw	As the risk of blade or ice throw within 175 m of the proposed WTGs cannot be completely eliminated, the residual risk will be managed through administrative controls to be developed in consultation with host landowners.	**7.11.3**
56.	Greenhouse Gas	Appropriate measures will be implemented during the construction phase to reduce emissions, such as: • Selection of fuel and energy efficient equipment and vehicles; • Routine maintenance of equipment and vehicle to optimise efficiency; and • Sourcing equipment and materials from local suppliers (where practicable) to reduce delivery distances.	**7.13.3**
57.	Air Quality	Implement measures to reduce visible dust emissions during: • Construction: minimise active surface area, progressive rehabilitation, stockpile management, speed restrictions, manage activities in unfavourable weather conditions, undertake regular inspections, and minimise dust emissions from exposed areas by application of water and/or dust suppressants; and • Operations: application of water and dust suppressants, speed restrictions on unsealed areas, limiting maintenance in unfavourable weather and regular inspections.	**7.14.3**
58.	Water Resources	Implement erosion and sediment controls.	**7.15.3**
59.	Water Resources	Retain erosion and sediment controls for the operational phase, where required.	**7.15.3**
60.	Water Resources	Potential areas of flooding will be considered during detailed design.	**7.15**
61.	Water Resources	Creek crossings for cables and access tracks will be confirmed during detailed design if “controlled activities” (as under Section 91 of the WM Act) and if so, undertaken in accordance with the ‘Guidelines for Controlled Activities on Waterfront Land’.	**7.15.3**

Ref	Aspect	Commitment	Section
62.	Water Resources	The Project will not involve any taking of water via landholder dams or bores except as described in accordance with **Section 4.4.7**.	**4.4.7**
63.	Agriculture and Soils	Minimise impacts on surrounding agricultural activities will be minimised through: • Water will be sourced from host farm dams or off-site to avoid impacts on landowners' supplies; • Fencing to exclude livestock from operational areas; and • Weed and feral animal controls undertaken in consultation with landowners.	**7.16.3**
64.	Agriculture and Soils	A soil survey of the final disturbance area will be undertaken prior to construction to identify steep gradients and erodible soils present, establish baseline conditions for future rehabilitation, define topsoil and other soil resources for future use in rehabilitation.	**7.16.3**
65.	Agriculture and Soils	Associated Landholder Agreements will include a condition that the Proponent rehabilitate the land.	**7.16.3**
66.	Agriculture and Soils	Excavated soil will be reused as soon as practicable. If soils cannot be reused in a timely manner, it will be stockpiled and temporarily rehabilitated.	**7.16.3**
67.	Agriculture and Soils	Controls to reduce potential Biosecurity impacts will be implemented to minimise the risk. These will be implemented in consultation with the landholder and relevant regulators (where statutorily required).	**7.16.3**
68.	Agriculture and Soils	Vegetation removed to facilitate the Project will be stockpiled and disposed of in consultation with the landholder (except as stipulated).	**7.16.3**
69.	Agriculture and Soils	Disturbed areas that are not required for ongoing operations will be progressively rehabilitated.	**7.5.4**
70.	Agriculture and Soils	During decommissioning: • The land occupied by operational infrastructure will be rehabilitated and generally restored to its pre-disturbance class in consultation with the landowner; and • A regular rehabilitation monitoring program will be undertaken for at least 2 years following decommissioning.	**7.16.3**
71.	Waste	The principles of "reduce, reuse, recycle" will be applied wherever practicable to minimise waste generation generally as described in **Table 49** and incorporated into a Waste Management Plan.	**7.17.3**
72.	Electro Magnetic Fields	The risk of exposure to EMFs will be minimised through siting of infrastructure and the implementation of best practice design standards for electrical equipment.	**7.18.3**

Ref	Aspect	Commitment	Section
73.	Hazardous Materials	Detonators and explosives may be required during construction for blasting of bedrock and will be transported to the site as required, rather than stored in bulk.	**7.20**
74.	Shadow Flicker	If shadow flicker is found to be a nuisance at a particular Non-Associated residence: • At a known location, a physical screen will be placed between the location and the wind turbines. Additional trees or other vegetation will be used to accomplish this; and/or • Conditions will be pre-programmed into the control system so that individual wind turbines automatically shut down whenever these conditions are present.	**7.21.4**
75.	Shadow Flicker	Shadow flicker effects on motorists will be monitored following commissioning and any remedial measures to address concerns would be developed in consultation with TfNSW and DPIE.	**7.21.4**
76.	Decommissioning	A Decommissioning and Rehabilitation Plan will be prepared in consultation with Associated landowners prior to the cessation of operations.	**7.22**
77.	Social	Develop a Recruitment Strategy document prior to the commencement of construction which seeks to: • Prioritise local supply, where relevant services and skills are available; • Provide apprenticeship and/or traineeship opportunities; and • Endeavour to source employees with appropriate skills from within the MSC, SSC and UHSC to support the Project.	**7.23**
78.	Social	Continued consultation through: • Support the continued operation of the CCC; • Provision of regular community updates to residents on issues of interest; • A complaints and response framework; • Create opportunities to engage further with residents; and • Reproduce and supply photomontages for any updates to Project layout.	**5.7**
79.	Social	Establish a 'Community Fund' in the form of a VPA with each of the Muswellbrook, Singleton, and Upper Hunter Councils which mitigates any residual socio-economic impacts identified in this EIS commensurate with impacts.	**3.1**

9 MERIT EVALUATION

This section includes an evaluation of the merits of the Project as a whole as required by this EIS Guidelines and the SEARs.

In accordance with Section 4.15 of the EP&A Act, this section describes the provisions of relevant EPIs, a VPA under Section 7.4 and the relevant Regulations that apply to the land to which the DA relates. It further describes the likely impacts of the Project on both the natural and built environment, the Projects social and economic impacts and the suitability of the site for the development.

This section also provides a review against the objects of the EP&A Act including an evaluation of the merits of the Project as a whole, how ESD has been incorporated into the design of the Project and confirm that the Project is in the public interest.

9.1 PROJECT DESIGN

The following section provides a project overview, describes the feasible alternatives to the Project (and its key components) that were considered, includes a brief description of the need for the Project and summarises the Project for which approval is sought.

9.1.1 Overview

The Proponent is seeking approval under each of the EP&A Act and EPBC Act for the construction, operation, maintenance and decommissioning of the Project.

The Project is generally located at Bowmans Creek, approximately 10 km east of Muswellbrook and 120 km north-west of the Port of Newcastle in NSW.

The Project has an estimated capital investment value of $569 M and involves up to 60 WTG sites with an indicative generation capacity of 336 MW. The Project also includes electrical infrastructure, other temporary and permanent ancillary infrastructure, local road network upgrades and the construction of a transmission line connecting to the existing Liddell Power Station substation.

The Project will generate up to 150 FTE jobs during its 18-month construction period and up to 15 FTE jobs over its operational life.

The Project Boundary extends predominantly across two LGAs, being the MSC and SSC LGAs. A small number of WTGs are also proposed in the UHSC.

The region is a significant power generating area accommodating active thermal coal mines and two operating coal fired power stations. The renewable energy sector is emerging with one solar, one pumped hydro and one wind farm project under consideration. Further, in November 2020, the Hunter Region was identified as one of four Renewable Energy Zones in NSW to support the NSW Government's Electricity Infrastructure Roadmap.

The Project is located primarily on private freehold land in the Hunter River catchment. Land within the Project Boundary is zoned RU1 – Primary Production (where electricity generation is permissible with consent). The dominant agricultural pursuit within 5 km of the Project Boundary is beef cattle grazing.

The Proponent is one of the most experienced wind energy development companies in NSW with 570 MW of approved wind energy projects currently operating in NSW, as well as being a significant developer of solar projects across Australia. The Proponent is a founding signatory to the Clean Energy Council's 'Best Practice Charter for Renewable Energy Developments' and commits to honouring the Charter for the Project.

9.1.2 Alternatives Considered

The "Do Nothing" approach would lead to a missed opportunity for the state of NSW, Federal Government of Australia and its people in relation to:

- Provision of additional generation capacity into the NSW grid to assist in meeting load demand as a result of retiring thermal generators;
- Reducing greenhouse gas emissions and contributing to cleaner electricity generation under the Federal Paris Agreement commitment;
- Supply of renewable energy to assist in meeting State targets under the 'Net Zero Plan Stage 1 2020-2030'; and
- Providing an opportunity for regional investment as the renewable energy sector grows in NSW and the Hunter Valley.

Additionally, the 'Do Nothing' approach (or not carrying out the Project) will create missed opportunities for the environment and local community including:

- Reducing a significant amount of greenhouse gas emissions through the avoidance of carbon dioxide from coal fired power stations;
- Direct injection of funds into the local economy through the provision of jobs, use of local services, ongoing landowner payments and contributions under the VPA;
- The production of 336 MW of clean, renewable energy, equivalent to the consumption of around 145,000 homes (greater than the total existing houses in the LGAs); and
- Improvements to the local road network.

The Project design has been further refined since the SEARs were issued on 23 July 2019. The modifications have occurred in response to community and regulatory engagement, findings from field studies (to avoid sensitive features) and preliminary engineering design following ground-truthing of topographic features and geotechnical conditions.

The following changes were made between the preliminary layout presented in the Scoping Report and the development for which approval is sought and as assessed in this EIS:

- A nominal 72 WTGs were reduced to 60;
- Two proposed batch plants were relocated to reduce noise impacts at receivers;
- Two northern transmission line options were discounted as a suitable powerline corridor could not be secured.
- The preferred southern transmission line includes two design changes due to stakeholder engagement; and
- Site access transport options were reduced to access via the NEH only (i.e. no OSOM vehicles on Pictons Lane, Goorangoola, McCullys Gap and Muscle Creek Roads) due to stakeholder engagement.

9.1.3 Project Need

The primary need for the Project is to contribute efficient, low cost electricity to the NEM.

The NEM operator, AEMO released its main system planning document, the ISP in July 2020. This document is updated each two years and is described as "*an actionable roadmap for eastern Australia's power system to optimise consumer benefits*."

Through a detailed technical, regulatory and economic analysis of the current electricity system and drawing on extensive consultation with industry participants, the ISP develops a number of scenarios for how electricity demand may be met in the NEM in the period to 2040.

The July 2020 ISP describes several factors which underline the need for the Project. The key elements are:

- Electricity demand in the National Electricity Market is expected to remain generally constant throughout the period to 2040. While there is projected to be underlying growth in consumption across the NEM, this will be offset via continued investment in distributed photovoltaic and extension of the NSW Energy Saving Scheme.
- While overall grid consumption is being held constant, new generation capacity is needed to replace retiring plants. To fill that gap, AEMO forecasts that Australia should invest in a further 26-50 GW of new large-scale variable renewable energy beyond existing, committed and anticipated projects; and
- An optimal split of new solar and wind variable renewable energy would minimise the need for dispatchable storage and generation and therefore keep costs down for consumers.

Therefore, there is a very high level of confidence that there is a need for the Project and that an appropriate technology (wind energy) has been selected.

As well as its contribution to energy demand, the Project meets other needs relating to the continuing development of the regional and State economy and to the achievement of the NSW Government's target for net-zero emissions by 2050.

NSW is currently a net importer of electricity, having to rely on both Queensland and Victoria for its peak power demand. This will be further exacerbated by the pending closure of Liddell Power Station in 2022 and Bayswater Power Station in 2035.

The Hunter Region is the leading regional economy in NSW and currently accounts for 44% of NSW power generation. The main industries in the Upper Hunter Valley are currently coal mining and fossil fuel power generation followed by the agricultural pursuits of the equine, viticulture and livestock grazing industries.

A change in Government policy settings, coupled with innovation and technological advancements, is driving the growth and diversification of the Hunter Region's energy industries with a focus on both energy efficiency and the generation of renewable energy. In the Upper Hunter Valley in particular, with the scheduled closure of Liddell and Bayswater power stations in 2022 and 2035 respectively, a successful transformation in the energy sector will be critical to the Upper Hunter's socio-economic wellbeing.

As well as assisting in the diversification and transformation of the Hunter Region, the Project will assist local, state and the Australian governments in meeting sustainability commitments as described below.

Internal and National Policies

Australia's current NDC commits it to reducing GHG emissions to 26-28% below 2005 levels by 2030. To satisfy its NDC, Australia will need to reduce its annual GHG emissions to between 263 and 272 Mt of CO_2-e. Australia's total emissions for 2018 were 383 Mt of CO_2-e. Material reductions in GHG emissions are required over the next decade to achieve the target under Australia's NDC.

The Project will contribute to achieving the Australian government's key policy, the RET which aims at increasing electricity generation from sustainable or renewable energy sources and will therefore assist in fulfilling Australia's international commitments.

NSW Policies

The 'NSW Climate Change Policy Framework' outlines the NSW Government's role in reducing and managing the impacts of climate change. The Framework sets the aspirational long-term objective of achieving net-zero emissions by 2050. The 'Net Zero Plan Stage 1: 2020-2030' outlines four priorities over the next decade to achieve this objective. The Project is entirely consistent with and will contribute to these priorities particularly within the Upper Hunter Valley:

- An emission reduction technology that will grow the economy, create jobs and reduce the cost of living;
- Empower consumers and businesses to make sustainable choices;
- Providing the next wave of emissions reduction innovation to ensure economic prosperity from decarbonisation beyond 2030; and
- Assist the NSW Government in "*leading by example*".

The HR Plan outlines the NSW Government's land use planning priorities for the Hunter Region over the next 20 years. The Project will assist in meeting the following goals from the HR Plan:

- Become the leading regional economy in Australia through the provision of employment, VPA and associated economic benefits of the Project;
- In additional to the existing coal and energy exports from the Hunter, continue to support the growth and diversification of the regional economy and employment base.
- Provide alternative energy resources to enable the Upper Hunter to take advantage of new and emerging opportunities;
- Enable opportunities for renewable energy industry;
- Promote new opportunities arising from the closure of coal-fired power stations that enable long term sustainable economic and employment growth in the region.

Local Government

The Project is consistent with the UHSC's key sustainable development policies and strategies and will assist to:

- Encourage and support sustainable development and *"to encourage a diverse economy whist promoting and preserving agriculture";*
- Attract a range of new opportunities in industries such as renewable energy production and to attract a skilled workforce to support this economic growth;
- Develop rural areas to accommodate renewable energy generation and distribution infrastructure. The HR Plan recognises the UHSC as part of the Upper Hunter Green Energy Precinct which has the potential to support renewable energy projects that will assist in the State-level direction to grow and diversify the energy sector;
- Fulfil UHSC's "Climate Emergency" declaration and commitment to be carbon neutral by 2030; and
- Support the renewable energy sector throughout the region.

The Project is consistent with MSC's key policies and strategies and will assist in:

- Diversifying the local economy to reduce volatility caused by a high reliance on the resources sector;
- Supporting state and federal climate change initiatives;
- Creating an opportunity for the development of new power generation facilities, including wind as a potential cost-effective replacement energy source as the contributions of the mining and power generation industries to the local economy reduce over the next 10 years.

The Project is consistent with SSC's key policies and strategies and will assist in:

- Retaining options for alternative land use strategies so that flexibility to allow economic, social and environmental change can be accommodated; and
- Promoting increased use of renewable energy sources and partner with industry to create Singleton as an alternate energy hub.

9.1.4 Project for Which Approval is Sought

Consideration of the feasible alternatives considered and the need for the Project has culminated in the Project for which approval is sought, which conceptually comprises:

- Up to 60 WTG sites;
- Electricity infrastructure;
- Ancillary infrastructure;
- Minor upgrades to the road network to facilitate delivery of OSOM loads to the site; and
- Administrative activities (including boundary adjustments and subdivisions).

9.2 STRATEGIC CONTEXT

The following section provides a summary of the strategic context within which the Project is proposed. It demonstrates the suitability of the site including its compatibility with adjacent existing and proposed land use including: rural villages, subdivisions, land of high scenic value, conservation areas, Strategic Agricultural Land, State Forests, mineral resources, trigonometric stations, tourism facilities, other renewable developments and the existing electricity transmission network.

9.2.1 Existing and Future Land Use Conflict

Existing land uses within and immediately external to the Project Boundary include: agricultural cattle grazing and rural dwellings. There are neither extractive industries nor any existing mining tenements held under the *Mining Act 1992* within the Project Boundary. Other industry in the vicinity is discussed at **Section 2.3**.

Muswellbrook is the closest township located over 15 km to the west of the Project Boundary and Singleton over 25 km to the south-east.

The majority of land within the Project Boundary is privately owned, cleared agricultural land with small areas of remnant bushland.

The two predominant land classes within the Project Boundary are: Class 5 which is generally used for grazing; and Class 7 land which is generally not suitable for agriculture due to steep gradients, rockiness and/or erodible soils (OEH, 2012). It is acknowledged that within this large-scale mapping, some areas are currently utilised for grazing activities.

Whilst there will be minor direct impacts to agricultural activity during the life of the Project, this represents 0.01% of the total agricultural activity in the region. The impacts proposed will not impact the capability of the land in perpetuity and when the Project is decommissioned, the land will be able to be returned to its former agricultural productivity. The minor impacts to foregone agricultural productivity will be borne by the Associated landholders, for which they will be compensated. The regional economic activity impacts of foregone agriculture are therefore materially less than those of the construction and operation of the Project.

There are a number of rural communities within 5 km of the Project Boundary including Bowmans Creek, Davis Creek, Goorangoola, Greenlands, Hebden, McCullys Gap, Muscle Creek and Rouchel Brook. All communities consist of rural dwellings on larger properties with the exception of the rural villages of Muscle Creek; and McCullys Gap.

No known subdivisions are proposed within 4 km of the closest WTG.

The Project will not impact subdivisions as none are proposed and due to SSC and MSC zoning restrictions, limited opportunities for this exists in the vicinity of the Project. Where potential land use conflicts with rural villages and rural dwellings were identified, adequate mitigation measures for residual impacts have been committed to by the Proponent as described in ***Section 8****.*

9.2.2 Land of High Scenic Value

There are no National Parks or State Forests within or immediately adjoining the Project Boundary. Mount Royal National Park is the closest and located at least 13 km to the north-east of T10.

Key recreation areas are at a significant distance from the Project with Lake St Clair over 10 km from T7, Glenbawn Dam 13 km north-west of T12 and the Lake Liddell Recreation Area over 8 km from T67.

No RMS signposted Tourist routes are located within 20 km of the Project Boundary.

No areas of significant conservation value occur within the Project Boundary.

The Main Northern Rail Line is 4 km south of the Project Boundary with this section of line being an integral part of the Hunter Valley Coal Chain. It also facilitates freight as well as regional passenger trains. The NEH is located south and is the main road that connects Muswellbrook and Singleton in a north-south direction.

The Project will not impact conservation areas or tourism facilities. Where impacts to land of high scenic value were identified, adequate mitigation measures for residual impacts have been committed to by the Proponent as described in ***Section 8****.*

9.2.3 Other Industries

There are several approved coal mines within 10 km of the Project Boundary including Muswellbrook Coal Mine to the north-west, and Liddell Mine and Mount Owen Complex to the south. Two existing quarries occur to the south of the Project Boundary with another proposed (however there is no publicly available information on the latter).

A Trigonometry Station (see **Section 4.4.8**) is located within crown land within the Project Boundary. Project infrastructure is proposed within the reserve on which the station is located however no direct impact will occur to it.

There is no mapped SAL or CIC located within the Project Boundary. The Project will not extract any water from streams or groundwater aquifers.

No existing or approved wind farms are located in proximity to the Project, with the closest wind farm being the Upper Hunter Energy Park at over 35 km to the north-west. Although there is enormous potential for the expansion of renewable energy projects in the Upper Hunter Valley and government policy is in place to support this, there are currently none in operation.

The closest State Forest is Ravensworth State Forest located adjacent to the Mt Owen Complex, approximately 6 km to the south of the Project Boundary.

The Project will not impact SAL, state forests, mineral resources, trigonometry stations, or existing or approved wind farms.

9.2.4 Existing Electricity Transmission Network

The Liddell Power Station is scheduled for closure in 2022 and Bayswater Power Station in 2035, as such 1,680 MW and 2,640 MW respectively, of electricity a year will be lost from the NSW generating system, respectively.

With these closures, and the potential increase in the NSW deficit of power generation to meet its needs identified in the ESOO 2019, the Federal and State governments have committed to financially supporting an upgrade of the transmission lines between NSW and Queensland.

In November 2018, TransGrid published a report proposing options to expand the NSW and Queensland transmission transfer capacity. As part of this process, on 28 April 2020, the Australian Energy Regulator published a decision to support TransGrid's 'QNI Minor Upgrade Contingent Project' which will go some way towards expanding the transmission transfer capacity between the two states.

TransGrid's QNI minor upgrade project was identified as a priority investment in the Australian Energy Market Operator's 2018 ISP and the 2020 Integrated System Plan. TransGrid's upgrade is consistent with the preferred investment option identified through the 'Expanding NSW-QLD Transmission Transfer Capacity Regulatory Investment Test for Transmission (*RIT-T*)' process. This investment will benefit consumers and producers of electricity by deferring the need to build new generation and storage capacity in NSW, as well as allowing for more efficient sharing of generation across the NEM and supporting the ongoing energy market transition.

The two existing TransGrid 330 kilovolt Liddell to Tamworth transmission lines are located west of the Project Boundary approximately 3 km from the Project.

In consideration of the proposed closure of the Liddell Power Station prior to or within the early operational life of the Project, over 1,680 MW of generational capacity will be lost from the existing NSW system. The 336 MW from the Project's 60 WTGs, when fully operational will have the potential to contribute to this loss of generating capacity.

Adequate capacity exists in the adjacent transmission network for the Project. The further proposed upgrades by TransGrid to the NSW electricity transmission system will ensure that there will not only be capacity for the Project but for multiple other projects to be progressed.

9.3 REGULATORY CONTEXT

This section addresses the relevant matters for consideration described in Section 4.15 of the EP&A Act, including: the objects of the Act, evaluation of the merits of the Project as a whole and how the principles of ESD have been incorporated in the design, construction, operation and decommissioning of the Project.

9.3.1 Consistency with Objects of the EP&A Act

Section 1.3 of the EP&A Act lists the Objects of the Act, which are the outcomes that the legislation seeks to achieve. The following Objects are relevant to the Project and include a description of how these Objects are satisfied.

> *"(a) to promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources,"*

The Project will facilitate the development of land for the generation of relatively low-cost renewable energy, thereby satisfying the energy needs of the community. The Project has been designed to minimise land disturbance, particularly disturbance of native vegetation. As such, it represents the proper development and conservation of natural resources. The Project will generate additional employment within the region which will assist in sustaining the socio-economic viability of the three LGAs.

"(b) to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment,"

The Project is a sustainable development. This EIS provides the consent authority with a comprehensive assessment of the potential environmental, economic and social impacts and benefits of the Project.

The Project has been developed through a comprehensive planning, stakeholder engagement and environmental assessment process to ensure that the principles of ESD are addressed. The Project's form has been determined by careful consideration of a number of alternatives. The impacts of the Project have been predicted with certainty in a detailed assessment process outlined in this EIS. Management measures to address the impacts that will occur have been incorporated into the Project as required, thus addressing the Precautionary Principle.

The Project is consistent with the principles of ESD as discussed further in **Section 9.3.2**.

"I to promote the orderly and economic use and development of land,"

The Project will generate employment and economic stimulus during its construction and operations. Further, it has been designed to minimise disturbance to land, promote dual land use and increase the economic returns from the land that is part of the development.

The Project will generally stimulate the economy with regional spending for production related costs and with wages for labour which will also contribute to the regional economy.

Further, the Associated and Neighbour Landholder Agreements, Neighbour Benefit Program and proposed VPA with Councils will provide an ongoing regional economic stimulus from the use of the land greater than its current productive capacity.

"(e) to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats,"

The Project has been designed to minimise disturbance to native vegetation. The Project will still result in the loss of some CEEC, EEC and habitat for threatened species. In accordance with Part 6 of the BC Act, the Proponent has committed to establishing a biodiversity offset to compensate for clearing of native vegetation and impacts to threatened species.

In accordance with the BAM, to achieve a no net-loss of biodiversity values, Project impacts on biodiversity values were initially avoided, minimised and mitigated to the greatest extent possible. Beyond this, any residual impacts will be offset by the retirement of the required number of biodiversity credits for the 18 impacted PCTs, the Large-eared Pied Bat and Brush-tailed Phascogale.

Revised biodiversity offset calculations, utilising additional survey effort and the final project layout will include requisite credit calculations for any impacted threatened flora species:

"(f) to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage."

The Project is a sustainable development and has been designed in consultation with the landowners and the keepers of the Cultural Heritage knowledge of the land. Aboriginal heritage values present at the site were assessed in consultation with Aboriginal stakeholders. Both the built and cultural heritage of the site will be carefully considered during the micro-siting of infrastructure with any residual impacts minimised during construction".

> *"(j) to provide increased opportunity for community participation in environmental planning and assessment."*

Extensive engagement with the landowners and other local community (both individuals and stakeholder groups) has been undertaken to identify key issues relating to the Project. These issues have been comprehensively addressed in this EIS.

9.3.2 Consistency with Principles of ESD

The objects of the EP&A Act adopt the principles of ESD in the application of the Act. These principles are articulated in Section 6(2)(a) of the *Protection of the Environment Administration Act 1991* where it is stated that:

> "*ecologically sustainable development requires the effective integration of economic and environmental considerations in decision-making processes. Ecologically sustainable development can be achieved through the implementation of the following principles …*".

Each Principle which is relevant to the Project is discussed below.

Precautionary Principle

> "*that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation*.
>
> *In the application of the precautionary principle, public and private decisions should be guided by:*
>
> *(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and*
> *(ii) an assessment of the risk-weighted consequences of various options,*"

Adherence to the precautionary principle requires avoiding serious or irreversible environmental damage by properly assessing potential impacts and taking the necessary mitigation measures. This EIS identifies, with certainty, the environmental impacts from the development of the Project, which has been designed to avoid serious or irreversible environmental damage.

To ensure this, actions involving unquantifiable and unacceptable environmental consequences have been avoided. Further environmental consequences have been assessed on a "*worst-case scenario*" basis, where if potential serious or irreversible damage was identified, an appropriate re-design of the Project was implemented to avoid those consequences. Additionally, this EIS adopted a risk-based approach to assessment to ensure certainty over the predicted impacts of the Project.

Intergenerational Equity

> *"that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations".*

The Project design, determined through extensive consultation and the examination of the alternatives, will operate to ensure that there is no significant effect on the environment as a result of the Project which will diminish the health, diversity or productivity of the locality for future generations. This will be reinforced by the commitments to environmental management systems and the management and mitigation measures proposed in this EIS.

The immediate cost of the environmental effects will be borne through the Project life and will not be left to be borne by future generations.

This has been achieved by limiting the scale of the Project and excluding development where visual and noise impacts exceeded relevant Government Guideline expectations. The Project will not result in *"serious or irreversible"* impact to biodiversity. Long term ecological conservation areas will be established under the NSW Biodiversity Assessment Method as a consequence of the Project to ensure no net loss of biodiversity occurs as a result of the Project.

Biodiversity Conservation

> *"conservation of biological diversity and ecological integrity – namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration"*

The design of the Project excludes, where possible, areas of native vegetation and impacts to endangered species. The biodiversity offset committed to by the Proponent demonstrates adherence to this principle. These actions will ensure that the Project will not threaten the preservation of biodiversity and ecological integrity of the area and that the biodiversity and ecological value of the area is maintained and potentially improved in the longer term.

Improved Valuation

> *"improved valuation, pricing and incentive mechanisms—namely that environmental factors should be included in the valuation of assets and services, such as:*
>
> *(iii) polluter pays—that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,*
> *(iv) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,*
> *(v) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems."*

The generation of waste has been considered in this EIS and appropriate management strategies identified for construction, operation and decommissioning. Most of the waste associated with the Project will be classified as general solid waste (non-putrescible). With the exception of some metal and plastic items, most general solid waste (non-putrescible) is capable of being reused or recycled.

A lifecycle assessment was undertaken which concluded that the proposed wind turbine generators will offset their energy expenditure in less than one year, assuming an average capacity factor for Australian wind farms. The proposed wind turbine generators will have an operational life of approximately 25 years. As such, the energy produced by a wind turbine generator over its lifespan will substantially outweigh the energy required for its construction.

Even with this principle applied in its entirety the economic and environmental benefits of the Project will far outweigh any residual environmental costs and temporary loss of agricultural activities.

9.4 STAKEHOLDER ENGAGEMENT INTEGRATION

9.4.1 Overview

Wind farms in NSW are limited to sites on elevated land with above average wind speeds that have good transmission line access. The Project is within the NSW Governments 'Wind Farm Map' within a high wind speed area that is in proximity to transmission line infrastructure.

Such sites are relatively rare, and often, these sites are located in the vicinity of rural dwellings and in some cases in the vicinity of small to medium sized regional communities. This can cause conflict where local community members feel impacted by the Project and yet do not see any direct benefits from the Project.

The limited number of appropriate wind farm sites means that this conflict is often unavoidable and cannot be eliminated by moving the wind farm to a different location.

Accordingly, community engagement is focused not only on the careful positioning of WTGs and other project elements to reduce direct impacts, but to also understand and mitigate the impacts of the Project whilst maximising the socio-economic benefits of the Project to the local community.

The Wind Energy Guideline outlines the expectation for early and meaningful consultation with the local community and other stakeholders to enable feedback that can be incorporated into the design of the Project. Extensive consultation has been undertaken over the Project resulting in many elements of it being carefully redesigned and any identified residual impacts further mitigated.

9.4.2 Stakeholder Engagement Plan

A SEP was prepared and implemented during the Scoping Report and revised for the EIS stage of the Project. The following key objectives were identified in the SEP relevant to the community:

- Maintain and further develop cooperative landowner and community relationships with both associated and non-associated landholders;
- Identify further key stakeholders, their potential issues and concerns and appropriate engagement opportunities so that their concerns and aspirations were heard and understood;
- Ensure the community continues to be fully informed about the Project, its likely impacts, its likely benefits, opportunities for input and the planning approval's process;
- Facilitate the development and implementation of response and feedback strategies to address identified stakeholder concerns;
- Ensure the community continues to be informed about the Project, its likely impacts, its likely benefits, opportunities for input and the planning approval's process;

- Provide multiple opportunities for dialogue in various forms to allow the community to receive information and provide feedback about the Project; and
- Where appropriate incorporate feedback into the Project design to address concerns and issues raised.

9.4.3 Issue Response

Project Changes

In response to stakeholder engagement, various changes to the Project for which approval is sought were made and is described in **Section 3.10**.

Community

Between 2018 and 2019, there were over 100 meetings with community members consisting of email, telephone, face-to-face meetings and letters. Of these, the majority of concerns raised were in relation to potential impacts from landscape and visual, noise and property value.

A comprehensive list of over 40 issues is collated in **Appendix G** and each has been addressed in this EIS.

Regulatory Agencies

Offers of briefings were made to regulatory agencies as stipulated in the SEARs. Briefings included presentation of the Project description, confirming the proposed methodologies for assessment and providing updates on the results of environmental studies. Submissions to the SEARs were also considered and addressed.

A comprehensive list of over 30 technical issues is collated in in **Appendix G** and each has been addressed in this EIS.

Aboriginal Community

Consultation with the Aboriginal community for the Project was conducted by Ozark in accordance with the Aboriginal Consultation Guidelines.

Twenty-nine RAPs registered to be involved in the Project. Four fieldwork sessions were held in November 2019, March 2020, November 2020 and February 2021 with RAPs represented during the fieldwork.

All RAPs were afforded an opportunity to provide comment on the fieldwork methodology and reviewed the draft ACHAR. 14 comments were received and are addressed in the ACHAR.

A revised draft was provided to the RAPs on 11 March 2021 for review following a design change to the transmission line. Any comments arising from the review of the revised ACHAR are due by 26 March 2021.

9.4.4 Ongoing Engagement

The Proponent is committed to effective engagement with identified stakeholders and will continue to implement a SEP through the approvals process and beyond.

9.5 PROJECT IMPACTS AND BENEFITS

This section describes the environmental and social costs of the Project. It also describes the socio-economic benefits with regard to electricity demand in NSW, the NEM, the Commonwealth RET and the greenhouse gas savings of the Project.

9.5.1 Environmental Impacts

This EIS has been conducted in accordance with the objects of the EP&A Act including the principles of ESD and leading practice environmental and social standards. The process included:

- Environmental Risk Assessment (**Section 6**);
- Stakeholder engagement to identify issues to be addressed in this EIS (**Section 5**);
- Technical assessments conducted in accordance with industry best practice and the SEARs (**Section 7**);
- Quantification of impacts with certainty (**Section 7**); and
- Application of and commitment to environmental management and mitigation measures for any residual issues (**Section 8**).

Project impacts are stipulated in **Section 7** and a summary presented below for key issues.

Landscape and Visual

Most dwellings within 4.4 km of wind turbines are considered compliant with the Visual Bulletin performance objectives including visual magnitude and multiple wind turbine effects. Where impacts do not meet all the visual performance objectives (generally against multiple wind turbine effect or visual magnitude) the Proponent has committed to a range of mitigations measures including neighbour agreements, relocation and/or removal of wind turbines.

Although the Bulletin performance objectives can be achieved for the majority of dwellings, vegetative screening will be offered at all dwellings within 4.4 km of wind turbines resulting from site specific assessments (e.g. where few wind turbines are visible, where no significant tree cover surrounds the dwellings or curtilages, existing vegetation indicates partial screening of the Project or there are views of blades only.

No key public view locations were identified within 4.4km of the turbines. However, the assessment of scenic locations has been undertaken for 16 public view-points and scenic locations to at least 8 km. Key public view locations, scenic areas or lookouts are located at considerable distance from the wind turbines (and generally beyond the 8 km threshold).

Where impacts do not meet all the visual performance objectives, residual impacts are possible. The Proponent has committed to offering additional mitigation to non-associated landowners. In addition to vegetative screening, a neighbour agreement will be offered to affected landholders.

Should Agreements not able to be finalised with three owners of four dwellings, some of the following turbines would not be constructed: 60, 61, 22, 23, 9 and 10.

Noise

The maximum equivalent noise levels generated by the wind turbines under conditions most conducive to noise propagation (such as temperature inversions) will comply with the criteria established by the SEARs at all non-Associated dwellings (excepting P22-1 by 1 dBA).

Should an Agreement with P22-1 not be gained, a curtailment strategy will be implemented (where relevant operating turbine(s) will operate in a “sound optimised” mode at the wind speeds where the predictions indicate that the criteria will be exceeded) to achieve compliance with criteria at P22-1.

Aviation Safety

The Project is located within 55 km of three registered airports; Cessnock Airport, Maitland Airport and Scone Airport. The Project will not penetrate any Obstacle Limitation Surfaces or PAN-OPS surfaces and is located beyond the required horizontal extent of each of the airports circling areas.

Four Aircraft Landing Areas (ALA) will be impacted by the Project of which three are located on land associated with the Project. Take-off and landing from each would not be impacted but the associated circuit may be.

Based on previous studies and subject to the results of consultation with the Aerial Agricultural Association of Australia and local aerial application operators, it is reasonable to conclude that safe aerial application operations will remain possible on properties within and neighbouring the Project Boundary.

Aerial firefighting and emergency aviation services organisations have formal risk management programs to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained.

The highest wind turbine is T46 is below the lowest safe altitude minimum obstacle clearance level by approximately 2,612 feet above mean sea level. Therefore, the Project will not affect the grid lowest safe altitude of 6,600 feet above mean sea level.

The Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.

Traffic and Transport

Oversize or overmass vehicle movements are scheduled to occur during month 11-16, during which time a peak of up to 131 one-way daily vehicle movements will occur. The delivery of wind turbines is likely to be grouped to minimise the impact on the road network along its journey and occur outside of peak times during periods accepted by TfNSW and the local Council.

It is estimated that in the AM peak, 66 vehicles will enter the site and 20 vehicles will leave the site. In the PM, 20 vehicles are estimated to enter the project site and 66 vehicles leave the site.

All vehicles will access the site from the New England Highway via Hebden Road north or south. Once light vehicles have entered Hebden Road from the New England Highway, they will access the operations and maintenance facility off Scrumlo Road before dispersing across the site on private tracks“ "SIRA" analysis results and movement summaries indicates the New England Highway / Hebden Road intersection is not detrimentally impacted by the addition of Project construction traffic and therefore would not require any upgrades.

The interaction between school buses to light vehicle construction traffic will be low and will be a minor conflict. The interaction of heavy vehicle construction traffic and oversize or overmass vehicles will be coordinated with operator of the local school bus company.

Biodiversity

The native vegetation extent (including 197 ha of Derived Native Grassland and 133 ha of woodland) within the Disturbance Area occupies 330 ha, which represents approximately 61% of the Disturbance Area. This comprises predominantly remnant vegetation, with some scattered occurrences of planted vegetation within the public road corridor and Crown land.

Habitat connectivity will be reduced by the long-term removal of 133 ha of woody vegetation which forms part of fragmented or stepping-stone habitats.

Collision risk modelling indicates that most avian species have an avoidance rate of 98-99%. Based on the outcome of the Risk Assessment, the risk of blade strike/collision for most birds was rated as negligible.

Identification of the plant community types determined that the native vegetation within the Survey Area aligned with 18 plant community types (with one of the plant community types occurring in two condition states).

Primary and direct impact resulting from the Project is the loss of vegetation and associated habitat within the indicative Disturbance Area of up to 515 ha. The distribution of disturbance across the different types of infrastructure has been estimated. This conservative assessment assumes 100% vegetation clearance beneath overhead reticulation and transmission lines of 186 ha (of which 44 ha is exotic vegetation or dams) and up to 50 m disturbance for access tracks across 295 ha (of which 121 ha is exotic or dams). WTG footings of up to 13 ha, as well as combined construction compounds, O&M Facility, batch plants and substation are conservatively estimated to total 12 ha. External road upgrades of 7 ha have been calculated. Of the remaining 2 ha of underground reticulation disturbance, 1.5 ha is exotic.

Based on the requirement for wind turbines to be placed on the ridge top and the presence of threatened ecological communities and threatened species across the Survey Area, including on ridgetops, opportunities to avoid all impacts are limited. The linear layout of wind turbines along ridgelines, required for the wind farm to function at an economically feasible capacity has limited the extent to which turbines can be moved to avoid impacts.

None-the-less, a number of amendments have been able to be made to the location of the Project infrastructure within the Disturbance Area which have resulted in avoidance or minimisation of impacts on native vegetation and habitat.

Preliminary and conservative offset calculations have been undertaken for the 18 plant community types (total of 12,236 credits required) and two threatened species (2,526 credits required). Revised offset calculations, utilising additional survey effort and the final project layout will include requisite credit calculations for any impacted threatened species.

With the implementation of the proposed avoidance, management and offsetting measures, the Project is considered likely to maintain or improve biodiversity values in the long term and will meet the no net loss standard required under the BAM.

Aboriginal Heritage

There were 16 sites considered, however only nine sites (six newly recorded and three previously recorded) are located within the Survey Boundary. For the 16 sites:

- Eight sites will be avoided by the Project (including ANT 22);
- Eight sites have potential to be impacted by the Project, however:
    - Six individual sites have potential to be avoided during the Transmission Line design;
    - Two sites have a low probability for avoidance along Albano Road.

As part of the project detailed design phase there may be some flexibility to avoid harm to certain Aboriginal sites, particularly with regards to the design of the transmission line.

Consultation with Registered Aboriginal Parties occurred in accordance with the 'Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010'.

Historic Heritage

There are no Commonwealth or National heritage listed places within the Survey Boundary.

There are three places listed on an LEP that are outside the Survey Boundary. The Assessment concludes that there will be no impact on these listed items.

Although not listed on a Local Environment Plan, two historic heritage places were recorded during the survey. Although neither Rock Lily Gully (HS01) or Hilliers Creek (HC01) satisfy the criteria to be considered to have local heritage values, the loss of either item would be regretful, and as such both items will be retained in the landscape.

Telecommunications

The only link potentially impacted by the Project is the 400MHz NSW Rural Fire Service link which intersects with the swept path of the proposed location of Turbine T70. In order to avoid impacts to this link a clearance distance of 160m either side of the ray line will be required. Any micro-siting of other close turbines for example T69 will need to maintain the specified clearance of 160 m.

Two Broadcasting sites were identified with ACMA ID 6361 located 27 kms from the nearest turbine and general coverage will not be impacted, however in some locations close to the wind farm it is used by residents for TV reception. The VAST satellite service would be available to dwellings with no terrestrial cover and some residents would already be using it. It is rare for satellite TV to be interfered with by wind turbines.

9.5.2 Social Impacts

The SIA conducted for this EIS considered the social impacts from the Project at both the regional and local levels. The significance of each social impact (mitigated) and opportunity for the regional was identified using a risk-based approach.

Residents within the regional area and tourists are likely to experience visual amenity impacts during the operations phase associated with visibility of WTGs from public viewpoints mainly associated with transport corridors. These impacts will be limited in extent due to the relatively short exposure time when passing the Project during travel. With the implementation of these management measures the residual social impact of the Project on residential amenity in the Regional AA is assessed as low.

The Project will generate revenue at the federal, state and local level. Benefits will primarily be accrued to the LGAs of the regional area through the generation of employment opportunities and supply arrangements with local businesses i.e. those required for construction materials/activities.

Over the 18-month construction phase, direct and indirect economic benefits will accrue to the LGA's of the regional area. These benefits will primarily be accrued through the generation of employment opportunities and supply arrangements with local businesses. It is anticipated that the majority of the construction workforce will likely already reside in the LGA's of the regional area, so additional demand on services will be unlikely.

To support local employment preparation for the Project would include:

- Prioritisation of construction phase employment within the three LGAs;
- Advertising employment opportunities within the three LGAs; and
- Seeking to provide apprenticeship and/or traineeship opportunities across the construction and operations phase of the Project, given the Project life of approximately 25 years provides continuity in employment.

The construction phase of the Project has the potential to impact on traffic volumes, road safety and access. These impacts are expected to occur during construction only, and mainly impact residents within the immediate area. A TMP will be prepared in consultation with relevant regulators to mitigate impacts.

The provision of accessible and transparent information to residents about the results of the EIS, proposed management commitments and outcomes of future monitoring activities should also address community concerns regarding potential impacts to amenity and character. In this regard the Proponent will continue to:

- Support the continued operation of the Project CCC in accordance with the CCC Guidelines. The CCC provides a forum to share and discuss the environmental performance of the Project;
- Provision of regular community updates to residents on issues of interest such as Project construction and operation updates, visual management objectives and implementation timeline;
- Create opportunities to engage further with residents such as through community information days to provide an opportunity for residents to meet face-to-face with the Proponent, ask questions and clarify Project related technical information; and
- Reproduce and supply photomontages for any updates to Project layout.

The impact of the construction and operations phase of the Project on acoustic amenity determined that operational noise generated by the Project was compliant with the relevant noise criteria at all surrounding residential dwellings, with implementation of relevant mitigation. As such, the operation of the Project is not expected to impact on the acoustic amenity of properties within the Primary AA.

The Project is not predicted to have impacts to property values.

During consultation, a number of residents indicated that they were experiencing elevated levels of stress and anxiety due to the anticipated visual impacts of the Project. The primary strategy to manage stress and anxiety in relation to the Project is for the Proponent to continue to engage in and maintain transparent, evidence-based and ongoing dialogue with concerned landholders and other community members, based on the results of this EIS.

There is no predicted impact to services from the operations workforce as the majority of employees are anticipated to be sourced locally.

To manage potential social impacts, the Proponent will establish a VPA with each of MSC, UHSC and SSC (see **Section 3.1.1**). The VPA is proposed to be distributed via a Community Fund (or similar). An offer has been made to each LGA over the quantum of the VPA.

9.5.3 Minor Issues

Other assessments were undertaken in this EIS for aspects ranked in the Project risk assessment as moderate or low, including: bushfire, blade throw, shadow flicker, electric and magnetic fields, health, property values, greenhouse and life cycle, air quality, water sources, soils and agriculture, waste, hazardous materials, decommissioning and cumulative impacts.

Mitigation and management measures have been committed to for identified impacts and no residual impacts remain for these issues.

9.5.4 Environmental Management System

A site EMS will be developed and adopted for the Project.

The mitigation and management measures summarised in **Section 8** this EIS will be included in the Project CEMP, OEMP and other management plans as required by conditions of Development Consent.

Strategies, programs and plans will include adaptive management strategies, contingency measures to address residual impacts and a program to monitor and report on the environmental performance of the Project.

9.5.5 Socio-economic Benefits

Economics

The EIA found that the Project will provide economic activity to the regional economy of Singleton, Muswellbrook and UHSC, during both the construction and operations phase.

Construction

The IO analysis identified that the peak construction year of the Project (Year 1) is estimated to make up to the following total contribution to the regional economy:

- $114 M in annual direct and indirect output;
- $48 M in annual direct and indirect value-added;
- $17 M in annual direct and indirect household income; and
- 209 direct and indirect jobs.

The peak construction year of the Project (Year 1) is estimated to make up to the following total contribution to the NSW economy:

- $218 M in annual direct and indirect output;
- $99 M in annual direct and indirect value added;
- $58 M in annual direct and indirect household income; and
- 494 direct and indirect jobs.

Operations

The Project is estimated to make up to the following total annual contribution to the regional economy for a period of 25 years:

- $65 M in annual direct and indirect regional output or business turnover;
- $53 M in annual direct and indirect regional value-added;
- $2 M in annual direct and indirect household income; and
- 30 direct and indirect jobs.

The Project is estimated to make up to the following total annual contribution to the NSW economy of 25 years:

- $74 M in annual direct and indirect regional output or business turnover;
- $57 M in annual direct and indirect regional value-added;
- $6 M in annual direct and indirect household income; and
- 58 direct and indirect jobs.

While there will be impacts to agricultural activity over the life of the Project, this was estimated to be less than 0.01% of the total agricultural activity in the region. This economic impact will not impact the capability of the land in perpetuity. If the wind farm does ever become redundant, the land could be returned to its former rate of agricultural productivity.

The impacts to foregone agricultural productivity will be borne by the Associated landholders, for which they will be compensated. The regional economic activity impacts of foregone agricultural activity are far less than those of the construction and operation of the Project.

Social Benefits

The 'EH's 2015 Community Attitudes Study' concluded that the environmental benefits were the dominant perceived advantage of renewable energy technologies, specifically the survey found that:

- Respondents generally supported the notion that Renewables were cleaner or created less 'pollution' or fewer greenhouse gases (52%);
- Respondents supported sustainability and reduced reliance on non-renewables such as coal (39%);
- Renewables would help "save the planet" for future generations (7%); and
- Others saw benefits in the preservation of the landscape and agricultural land (e.g. by not "digging up" the landscape (5%)).

In the Hunter / Central Coast Region, 210 people were asked for their views about renewable technologies which are summarised as follows:

- 93% supported using renewables to generate electricity in NSW;
- 85% believed NSW should increase the use of renewables over the next five years;
- Most common perceived advantages of renewables were environmental benefits and lower cost 34%;
- Most common perceived disadvantages included:
    - Higher cost 36%;
    - Concerns about efficiency and reliability 14%; and
    - No disadvantages 40%.
- 65% were prepared to use renewables "*provided I don't have to pay more for my electricity*" and 30% were prepared to pay more to support them.

Emissions Reductions

- Annual greenhouse gas savings of 813,700 carbon dioxide equivalent (from 1,030 gigawatt hours of generated electricity) is assumed for the Project.
- Assuming an average wind farm capacity factor, The Project has the potential to provide sufficient renewable energy to support the annual electricity needs of approximately 145,000 households.

Contribution to Security and Reliability of the National Electricity Market

NSW participates in the NEM which is managed by the AEMO.

In 2020, the AEMO released its ISP, a road map for the next 20 years to facilitate the smooth transition of Australia's evolving power system to a more sustainable footing. According to the 2019 annual key planning document 'Electricity Statement of Opportunities', operational consumption on the NEM over the next 20 years is expected to remain flat. While there is projected to be underlying growth in consumption across the NEM, partly due to the uptake in electric vehicles, further improvements in energy efficiency, changes in consumer behaviour and more rooftop solar will balance out these projected increases.

In NSW, electricity is mainly supplied by coal-fired power stations. The closure of AGL Energy's Liddell Power Station by April 2022 will reduce the electricity generating capacity of NSW of 1,800 MW. AGL Energy has proposed a number of initiatives including further renewable power generation in the Upper Hunter Valley to lessen the effect of the Liddell closure. The Project will complement these initiatives.

The ESOO describes:

> *"…following the gradual closure of Liddell, a combination of high summer demand and unplanned generator outages will leave NSW exposed to significant supply gaps and involuntary load shedding if no mitigation action is taken. In 2023-24, AEMO forecasts a risk to between 135,000 and 770,000 households in NSW being without power for three hours during an extreme heat event (that is, a 1-in-10 year peak demand event);* and

A forecast reliability gap to meet the proposed refined standard of 375 MW from 2023-24 for NSW, increasing to 480 MW by 2028-29.

In addition to the announced retirement of Liddell Power Station, the remaining coal-fired power stations are forecast to retire over the next 10-15 years. Without additional generation capacity being installed in NSW it is forecast by the network operator that reliability issues will occur by 2022-23 with a noticeable shortfall between supply and demand by 2028.

The ISP takes a wholistic and technology neutral approach when considering the future generation mix of the NEM at the lowest overall consumer expense. Modelling in the ISP shows that once the existing fleet of coal fired power plants reaches retirement age, the most cost-effective replacement generation source is renewables, primarily wind and solar PV. This Project will complement this.

9.6 PUBLIC INTEREST

The Project offers several strategic and long-term benefits to the state of NSW and its people, including to:

- The supply of cost effective renewable energy that will assist electricity retailers to fulfil their obligations under state and federal renewable energy targets;
- Provide replacement energy generation capacity into the NSW grid that will assist in meeting load demand as a result of retiring thermal generators and provide a clean, reliable generation mix;
- Provide an opportunity for regional investment in the renewable energy sector in the Upper Hunter Valley of NSW as is promoted by the relevant NSW Planning Instruments.

The Project offers several specific benefits to the environment and local community by direct injection of funds into the local economy through:

- The provision of jobs in construction and operation;
- Use of local services in both the construction and operation phases; and
- Ongoing landowner payments and financial contributions to the local community being re-injected into the local community.

The Project's social and environmental impacts have been avoided or minimised as far as practicable by implementing all reasonable and feasible management and mitigation measures. As a consequence, the socio-economic benefits of the Project will outweigh its social and environmental impacts.

The Project addresses the principles of ESD, has been assessed in accordance with the EP&A Act, its "objects" and as required by the SEARs. This assessment has determined that it is open for the Minister to conclude that the Project is in the public interest and as such should be approved under the EP&A Act.

10 ABBREVIATIONS

Abbreviation	Description
µT	microTeslas
AAAA	The Aerial Agricultural Association of Australia
Aboriginal Consultation Guidelines	'Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010' (DECCW, 2010a)
ABS State Suburbs	Australian Bureau of Statistics State Suburbs
CEC	Australia's Clean Energy Council
ACHAR	Aboriginal Cultural Heritage Assessment Report
ACHIA	Aboriginal and Cultural Heritage Impact Assessment
ACHMP	Aboriginal Cultural Heritage Management Plan
AEMO	Australian Energy Market Operator
AGL Energy Limited	AGL Macquarie
AGL	above ground level
AHD	Australian Height Datum
AHIP	Aboriginal Heritage Impact Permit
AIA	Aviation Impact Assessment
AIP	The NSW Aquifer Interference Policy
ALAs	Aircraft Landing Areas
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
ARTC	Australian Rail Track Corporation
ASDST	The Aboriginal Site Decision Support Tool
Assessing Vibration Guideline	Vibration under the 'Assessing Vibration: A Technical Guideline' (DEC, 2006)
BAM	Biodiversity Assessment Method
BC Act	*Biodiversity Conservation Act 2016*
BCD	Environment, Energy and Science – Biodiversity and Conservation Division
BCRC	Bowmans Creek Riparian Corridor
BDAR	Biodiversity Development Assessment Report
BFMCs	Bush Fire Management Committees
BFRMPs	Bush Fire Risk Management Plans
biomass	Pumped Hydro, Solar, Wind, Bioenergy
Biosecurity Act	*Biosecurity Act 2015*
BoM	Bureau of Meteorology
BOS	Biodiversity Offsets Scheme
BPMs	Bushfire Protection Measures
CAAP	The Civil Advisory Publication
CAAP 166	'CAAP 166-01 v4.2 – Operations in the vicinity of non-controlled aerodromes' (CAAP 166)
CAAP 92-1(1)	'CAAP 92-1(1) Guidelines for aeroplane landing areas' (CAAP 92-1(1))
CAO	Civil Aviation Orders
CAR	*Civil Aviation Regulations 1988*
CAS Regulations	*The Civil Aviation Safety Regulations 1998*
CASA	Civil Aviation Safety Authority

Abbreviation	Description
CASR	*Civil Aviation Safety Regulations 1998*
CCC	Community Consultative Committee
CCC Guideline	'Community Consultative Committee Guideline State Significant Projects' (DPIE, 2019)
CEFC	Clean Energy Finance Corporation
CEMP	Construction Environmental Management Plan
CIC	Critical Industry Clusters
CIV	Capital Investment Value
CLM Act	*Crown Land Management Act 2016*
CM Act	*Coastal Management Act 2016*
CO_2-e	Carbon Dioxide Equivalent
Code of Practice	'Code of Practice for the Investigation of Aboriginal Objects in 'SW' (DECCW, 2010)
Consultation Guideline's	'Guide to investigating, assessing and reporting on Aboriginal cultural heritage in 'SW' (OEH, 2011)
COVID - 19	Coronavirus disease
DAWE	Federal Department of Agriculture, Water and the Environment (formerly Department of Energy and the Environment (DoEE))
dB(A)	A-weighted decibels
Delivery Program	Muswellbrook Shire Council Delivery Program 2017-2021
Disturbance Area	Areas subject to direct physical works and vegetation clearing, including buffers for work zones
DISER	Department of Industry, Science, Energy and Resources
DoD	Department of Defence
DoEE	Department of Energy and the Environment
DoI	Department of Industry (DoI)
DPIE	NSW Department of Planning, Industry and the Environment (formerly Department of Planning and Environment (DPIE))
DPOP	Draft Delivery Program & Operations Plan 2020/2021
EC	Electrical Conductivity
EES	Environment, Energy and Science
EIA	Economic Impact Assessment
EIS	Environmental Impact Statement
EIS Guidelines	Draft 'Preparing an Environmental Impact Statement' (DPE, 2019)
ELF	Extremely Low Frequency
EMFs	Electric and Magnetic Fields
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	Environment Protection Authority
EPA Regulation	*Environmental Planning and Assessment Regulation 2000*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPBC Approval	Approval sought under Section 75 of the EPBC Act
EPBC Referral	Project EPBC Referral 2020/8631
EPHC	Environment Protection and Heritage Council
EPI	Environmental Planning Instrument
EPL	Environment Protection Licence

Abbreviation	Description
ERF	Emissions Reduction Fund
ERP	Estimated Resident Population
ESCP	Erosion and Sediment Control Plan
ESOO	Electricity Statement of Opportunities (AEMO, 2019)
ESOO	Electricity Statement of Opportunities (AEMO, 2020)
ETL	Electricity Transmission Line
FM Act	*Fisheries Management Act 1994*
FTE	Full Time Equivalent
GHG	Greenhouse Gas Emissions
GWEC	Global Wind Energy Council
ha	Hectares
HCRCMA	Hunter-Central Rivers Catchment Management Authority region
Heritage Act	*Heritage Act 1977*
HIA	Historic Heritage Impact Assessment
HML	Higher Mass Limits
Hunter Unregulated WSP	*Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*
ICAO	International Civil Aviation Organisation
ICNG	Interim Construction Noise Guideline (DECC, 2009)
ICNIRP Guidelines	'ICNIRP Guidelines for Limiting Exposure to Time-varying Electric and Magnetic Fields' (ICNIRP, 2010)
Idemitsu	Idemitsu Australia Resources
IEA	International Energy Agency
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
IO	Input-Output
IPCN	Independent Planning Commission NSW
ISP	Integrated System Plan
kg	Kilogram
Koala SEPP	*State Environmental Planning Policy (Koala Habitat Protection) 2019*
kv	Kilovolt
kV/m	Kilovolts Per Metre
LAeq	Equivalent Continuous Sound Pressure Level
LCO	Liddell Coal Operations
LCOE	Levelised Cost of Electricity
LEP	Local Environmental Plan
LGA	Local Government Areas
Liverpool Range BFMC, 2009	Liverpool Range Bush Fire Risk Management Plan
LLS	Local Land Service
LSALT	Air Routes and Lowest Safe Altitude
LVIA	Landscape and Visual Impact Assessment
M	Million
MCC	Muswellbrook Coal Company

Abbreviation	Description
MEG	Mining, Exploration and Geoscience
mG	milliGauss
Micro-siting	Indicative turbine locations have accounted for known constraints. However, turbines may need to be relocated during detailed design or construction due to geotechnical, environmental and other technical requirements, up to 100 m from the specified GPS co-ordinates.
Mining SEPP	*State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*
MNES	Matters of National Environmental Significance
MOCO	Mount Owen Continued Operations
MOS	Manual of Standards
Mtpa	Million Tonnes Coal Per Annum
Muswellbrook BFMC, 2011	Muswellbrook Bush Fire Risk Management Plan (Muswellbrook BFMC, 2011)
Muswellbrook LEP	Muswellbrook Local Environmental Plan 2009
Muswellbrook LEP Review	Muswellbrook Local Environmental Plan (LEP) 2009 Review: Draft Discussion Paper
MW	Megawatts
MWh	Megawatt Hours
NASF Guideline D	'National Airports Safeguarding Framework Guideline D: Managing Wind Turbine Risk to Aircraft' (DITRDC ,2012)
ND	Not dated
NDC	Nationally Determined Contribution
NEH	New England Highway
NEM	National Electricity Market
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
NHMRC	The National Health and Medical Research Council
NIA	Noise and Vibration Impact Assessment
Noise Bulletin	'Wind Energy: Noise Assessment Bulletin' (DPE, 2016c)
North Coast WSP	*Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016*
NPfI	Noise generated by ancillary infrastructure in accordance with the 'NSW Noise Policy for Industry' (EPA, 2017)
NPW Act	*National Parks and Wildlife Act 1974*
NT Act	*Native Title Act 1993*
O&M Facility	Operation and Maintenance Facility
OEM	Original Equipment Manufacturer
OEMP	Operation Environmental Management Plan
OLS	Obstacle Limitation Surfaces
OSOM	Oversize and Overmass
OS	Oversize
Ozark	Ozark Environment and Heritage Management Pty Ltd
PBP	'Planning for Bushfire Protection' (RFS, 2019a)
PCT	Plant Community Type
PHP	Pumped Hydro Project

Abbreviation	Description
POEO Act	*Protection of the Environment Operations Act 1997*
Primary AA	Primary Assessment Area
PSR	Primary Surveillance Radar
RAPs	Registered Aboriginal Parties
RAV	TfNSW Restricted Access Vehicles
RBL	Rating Background Level
Regional AA	Regional Assessment Area
Regional Plan	'Hunter Regional Plan 2036' (DPE, 2016d)
RET	Renewable Energy Target
RF Act	*Rural Fires Act 1997*
RFDS	Royal Flying Doctor Service
RIA	Radiocommunications Services Impact Assessment
RIA Study Area	Study Area using a 50 km radius used in the Telecommunications Assessment
RMS	Roads and Maritime Services
RN Policy	Traffic noise under the 'NSW Road Noise Policy' (DECCW, 2011)
Roads Act	*Roads Act 1993*
ROM	Run of Mine
RSA	Rotor Swept Area
RSR	Route Surveillance Radar
RTS	Response to Submissions
SAII	Serious and Irreversible Impact
SAL	Strategic Agricultural Land
SAP	Sustainability Action Plan
SARPs	ICAO's Standards and Recommended Practices
Scoping Report	'Bowmans Creek Wind Farm Scoping Report' (Epuron, 2019)
SCS Plan	Singleton Community Strategic Plan
SEARs	Secretary's Environmental Assessment Requirements
SEP	Stakeholder Engagement Plan
SEPP 33	*State Environmental Planning Policy 33 – Hazardous and Offensive Development*
SEPPs	State Environmental Planning Policies
SHR	State Heritage Register
SIA	Social Impact Assessment
Singleton BFMC, 2011	Singleton Bush Fire Risk Management Plan (Singleton BFMC, 2011)
Singleton LEP	*Singleton Local Environmental Plan 2013*
SLU Strategy	Singleton Land Use Strategy 2008
SMA	Singleton Military Area
SoDAR	Sonic Detection and Ranging
SOHI	Statement of Heritage Impact
SOP	Singleton Operational Plan 2019-2020
SPLs	Sound Power Levels
SRD SEPP	*State Environmental Planning Policy (State and Regional Development) 2011*
SSC	The Singleton Shire Council
SSD	State Significant Development

Abbreviation	Description
SSR	Secondary Surveillance Radar
Subject Land	The land subject to the BDAR assessment as required under the BAM
Survey Area	Areas which have been subject to detailed assessment related to the Project (comprises conservative survey buffers around the disturbance area and subject land)
Survey Unit 1	The hill and valley landforms in the north
Survey Unit 2	The lowland landforms in the south
TBDC	Threatened Biodiversity Database Collection
TEC	Threatened Ecological Community
TfNSW	Transport for NSW
Convention	Chicago Convention on International Civil Aviation
Project	Bowmans Creek Wind Farm (SSD 10315)
TMP	Traffic Management Plan
TSC Act	*Threatened Species Conservation Act 1995*
TTIA	Traffic and Transport Impact Assessment
UH LEP	*Upper Hunter Local Environmental Plan 2013*
UHCS Plan	Upper Hunter Community Strategic Plan 2027
UHLU Strategy	Upper Hunter Land Use Strategy 2017
UHSC	Upper Hunter Shire Council
UNFCCC	United Nations Framework Convention on Climate Change
VFR	Night Visual Flight Rules
Visual Bulletin	'Wind Energy: Visual Assessment Bulletin' (DPE, 2016b)
VPA	Voluntary Planning Agreement
WAL	Water Access Licence
WARR Act	*Waste Avoidance and Resource Recovery Act 2001*
WHO	World Health Organisation
WHO Guidelines	World Health Organisation (WHO) Guidelines for Community Noise
Wind Energy Framework	'Wind Energy Guideline' (Wind Guideline) (DPE, 2016a) 'Wind Energy: Visual Assessment Bulletin' (Visual Bulletin) (DPE, 2016b) 'Wind Energy: Noise Assessment Bulletin' (Noise Bulletin) (DPE, 2016c) 'Standard Secretary's Environmental Assessment Requirement' 'Wind Energy Framework Q&As'
Wind Framework	'NSW Wind Energy Framework'
Wind Guideline	'Wind Energy Guideline' (DPE, 2016a)
WM Act	*Water Management Act 2000*
WMT	Wind Monitoring Tower
WSP	Water Sharing Plan
WTGs	Wind Turbine Generators

11 REFERENCES

- ABS (2016*). Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia, 2016. Retrieved from* https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/2033.0.55.001~2016~Main%20Features~IRSAD%20Interactive%20Map~16
- ABS (2017a). *2016 Census QuickStats* for various SSCs at https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/SSC12540?opendocument
- ABS (2017b). *2016 Census of Population and Housing GCP McCullys Gap (SSC12540)* at https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/communityprofile/SSC12540?opendocument
- ABS (2017c). 2016 Census of Population and Housing GCP Muscle Creek (SSC12867) at https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/communityprofile/SSC12867?opendocument
- ABS (2019). *4610.0 Water Account, Australia, 2016-17*
- ABS (2020). Table 2 Labour Force Status by State, Territory, Greater Capital City and Rest of State (ASGS) and Sex. Retrieved from: https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6291.0.55.001Mar%202020?OpenDocument
- AECOM (2019). *Powering Sydney' Future: Potts Hill to Alexandria transmission cable project Environmental Impact Statement*.
- AGL (12 August 2016). *Lake Liddell closed permanently for public safety*. AGL ASX and Media release retrieved from https://www.agl.com.au/about-agl/media-centre/asx-and-media-releases/2016/august/lake-liddell-closed-permanently-for-public-safety#:~:text=AGL%20Macquarie%20confirms%20that%20effective,Naegleria%20fowleri%20in%20the%20lake.
- AGL (2019). *ASX and Media Releases, Schedule for the closure of ALG plants in NSW and SA* at https://www.agl.com.au/about-agl/media-centre/asx-and-media-releases/2019/august/schedule-for-the-closure-of-agl-plants-in-nsw-and-sa
- AGL (2019b). *MoU signals next step in proposed Bells Mountain Pumped Hydro Project.* Retrieved from: https://www.agl.com.au/about-agl/media-centre/asx-and-media-releases/2019/july/mou-signals-next-step-in-proposed-bells-mountain-pumped-hydro-project
- AusGrid (2019). *Distribution and Transmission Annual Planning Report*
- Australian and New Zealand Environment Council (1990). *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*
- Australian Communications and Media Authority (ACMA) (2020). *MySwitch online tool.* Retrieved from https://myswitch.digitalready.gov.au/
- Australian Energy Market Operator (AEMO) (2019). *Electricity Statement of Opportunities*
- Australian Radiation Protection and Nuclear Safety Agency (2014). *Measurement of Extremely Low Frequency Electric and Magnetic Fields Associated With Electricity Supply and Distribution Infrastructure*
- Australian Radiation Protection and Nuclear Safety Agency (n.d.), *What is non-ionising radiation?*, viewed 17 April 2020, https://www.arpansa.gov.au/understanding-radiation/what-radiation/what-non-ionising-radiation

- Australian Radiation Protection and Nuclear Safety Agency (n.d.). *Measuring Magnetic Fields*, viewed 1 March 2021, *https://www.arpansa.gov.au/understanding-radiation/radiation-sources/more-radiation-sources/measuring-magnetic-fields*
- Australian Renewable Energy Agency (ARENA) (2018). *Wind Energy*. Retrieved from https://arena.gov.au/renewable-energy/wind/#:~:text=At%20the%20end%20of%202018,with%20utility%2Dscale%20solar%20PV.
- Australian Wind Energy Association (2001). *Fact Sheet 11 – Wind Farm Safety Issues*
- Beyond Blue (2018). *Mental Health Facts, at* https://www.beyondblue.org.au/the-facts/anxiety *accessed 6 April 2020*
- Biosis Research (2006). *Wind farm collision risk for birds: Cumulative risks for threatened and migratory specie - report prepared for Department of Environment and Heritage, Australia*
- Bioregional Assessment Programme (BAP) (2014). *HUN Alluvium (1:1m Geology)*, accessed 6 April 2020,
- BL&A (2017). *White Rock Wind Farm Stage 1: Bird and Bat Adaptive Management Program*
- Bureau of Meteorology (BOM) (2020). *Newcastle Information.* Retrieved from http://www.bom.gov.au/australia/radar/info/nsw_info.shtml#newcastle04
- Carter P.J. & Gammidge L.C. (compilers) 2019. *Renewable energy map of NSW* (3rd edition). Geological Survey of NSW, Maitland
- CASA (1992). '*CAAP 92-1(1) Guidelines for aeroplane landing areas' (CAAP 92-1(1))*
- Clean Energy Regulator (CER) (2020a), *Electricity sector emissions and generation data 2018-2019.* Retrieved from http://www.cleanenergyregulator.gov.au/NGER/National%20greenhouse%20and%20energy%20reporting%20data/electricity-sector-emissions-and-generation-data/electricity-sector-emissions-and-generation-data-2018-19
- Clean Energy Council (CEC) (2018). *Best Practise Charter*
- Clean Energy Council (2020). *Clean Energy Australia Report 2020.* Accessed 17 March 2021 from https://assets.cleanenergycouncil.org.au/documents/resources/reports/clean-energy-australia/clean-energy-australia-report-2020.pdf
- Clean Energy Regulator (2020). *Renewable Energy Target.* Retrieved from the Clean Energy Council website https://www.cleanenergycouncil.org.au/advocacy-initiatives/renewable-energy-target
- CSIRO (2011). *Climate Change Science and Solutions for Australia*
- CSIRO (2000). *Embodied and life time energies in the Built Environment.*
- CSIRO (2019). *GenCost 2018. Updated projections of electricity generation technology costs.*
- Department of Climate Change and Water (DECCW) (2011), *NSW Road Noise Policy*
- Department of Education, Skills and Employment (DESE), (2020). *LGA Data tables – Small Area Labour Markets* – December quarter 2019 at https://docs.employment.gov.au/documents/lga-data-tables-small-area-labour-markets-december-quarter-2019
- Department of Environment & Climate Change (DECC) (2009), *Interim Construction Noise Guideline*
- Department of Energy and Conservation (DEC) (2006). *Assessing Vibration: A Technical Guideline'*
- Department of Industry (DoI) Water (2018). *Greater Hunter Regional Water Strategy.* Retrieved from https://www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/greater-hunter-region

- Department of Industry, Science, Energy and Resources (DISER) (2020), *National Greenhouse Accounts Factor*. Accessed 1 March 2021 from https://www.industry.gov.au/data-and-publications/national-greenhouse-accounts-factors
- Department of Land and Water Conservation (DLWC) (n.d.), *On the Surface, What kind of Soil Are You Farming?*
- DPE (2016a). *Wind Energy Guideline for State significant wind energy development*
- DPE (2016b). *Wind Energy Visual Assessment Bulletin for State significant wind energy development*
- DPE (2016c). *Wind Energy Noise Assessment Bulletin for State significant wind energy development*
- DPE (2016d). *Hunter Regional Plan 2036*
- DPE (2019). *Preparing an Environmental Impact Statement. Guidance for State Significant Projects (Draft).*
- DPIE (2019a). *Environmental Planning Instrument – Acid Sulfate Soils*. Open Data retrieved from https://www.planningportal.nsw.gov.au/opendata/dataset/epi-acid-sulfate-soils
- DPIE (2019b). *Land and Soil Capability Mapping for NSW.* Dataset retrieved from https://data.nsw.gov.au/data
- DPIE (2019c). *NSW Electricity Strategy.*
- EES (2020a). *BioNet Atlas.* Retrieved from http://www.bionet.nsw.gov.au/
- Environment Protection Authority (EPA), (2017). *NSW Noise Policy for Industry*
- Environment, Energy and Science (EES) (2016). *Bioregions of NSW*. Retrieved from https://www.environment.nsw.gov.au/bioregions/Bioregions.htm
- Environment Protection and Heritage Council (EPHC) (2010). *National Wind Farm Development Guidelines*
- Explore the Hunter (ETH) (ND), *Hunter Valley Facts and Maps*
- Franks, DM, Brereton, D, Moran, CJ, Sarker, T and T, Cohen. (2010). *CUMULATIVE IMPACTS - A GOOD PRACTICE GUIDE FOR THE AUSTRALIAN COAL MINING INDUSTRY.* Centre for Social Responsibility in Mining & Centre for Water in the Minerals Industry, Sustainable Minerals Institute, The University of Queensland. Australian Coal Association Research Program. Brisbane
- GBD Pty Ltd (2018a), *Typical Wind Farm Infrastructure, Sapphire Wind Farm*
- GBD Pty Ltd (2018b), *Internal Access Roads at Crookwell 2 Wind Farm*
- GHD for NSW Farmers Association (2012), *Wind farm guide for host landholders*
- Global Wind Energy Council (2018), *Wind in Numbers.* Retrieved from https://gwec.net/global-figures/wind-in-numbers/
- Green Bean Design (GBD) Pty Ltd (2015), *Typical substation facility, Boco Rock Wind Farm*
- Habiballah. I, Dawoud. M, Al-Balawi. K & Farag. A (2003). '*Magnetic Field Measurement & Simulation of A 230 kV Substation', Proceedings of the International Conference on Non-Ionizing Radiation at UNITEN*
- Harding. G, Harding, P & Wilkins. A (2008), '*Wind turbines, flicker, and photosensitive epilepsy: Characterizing the flashing that may precipitate seizures and optimising guidelines to prevent them'*, Epilepsia, Vol 49(6), pp. 1095-98.
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) (2010). *ICNIRP Guidelines for Limiting Exposure to Time-varying Electric and Magnetic Fields (1 Hz to 100 kHz)*

- International Energy Agency (IEA) (2020), *Data and Statistics,* viewed 14 May 2020, https://www.iea.org/data-and-statistics?country=WORLD&fuel=CO2%20emissions&indicator=CO2%20emissions%20by%20energy%20source
- Independent Planning Commission NSW (ICPN) (2019). *Statement of reasons for decision: White Rock Wind Farm (10_0160 MOD6)*
- Isbell (1996). *The Australian Soil Classification*
- Israel. M, Ivanova. P & Ivanova. M. (2011). *'Electromagnetic fields and other physical factors around wind power generators (pilot study)', The Environmentalist*, Vol. 31, pp. 161-168
- Jacobs (2020). *Bayswater Water and Other Associated Operational Works Project EIS*
- Liverpool Range Bush Fire Management Committee (2009). *Bush Fire Risk Management Plan*
- Malabar Coal (2018), *Maxwell Solar.* Retrieved from: https://malabarcoal.com.au/projects/maxwell-solar
- Muswellbrook Coal Company (MCC), (2020). *2019 Annual Environmental Management Report*
- Muswellbrook Bush Fire Management Committee (2011). *Bush Fire Risk Management Plan*
- Muswellbrook Shire Council (MSC) (2016). *Muswellbrook Shire Council Community Locality Snapshots 2011-2016*
- MSC (2020a). *Remplan Economy Profile Muswellbrook Shire Council*. Retrieved from https://app.remplan.com.au/muswellbrook/economy/trends/population?state=Xb8WHZ!W70JSEzRqSX1GN2TNqDqyIJFehJvyUahJhbao on 6 April 2020
- MSC (2020b). *Remplan Economy Profile Muswellbrook Shire Council Employment by Industry Sector.* Retrieved from https://app.remplan.com.au/muswellbrook/economy/industries/employment?state=KL6QFA!b0G7CkRjVUrl17LTY3b34uYFOhbaRFDR418HJ4vKDf9h7SPPk6iO6Q on 6 April 2020
- NASA (2001), *ASRS Launches Aviation Security Study.*
- National Grid (2020a). *Statistics of power line fields,* viewed 24 April 2020, http://www.emfs.info/sources/overhead/summaries/statistics/
- National Grid (2020b). *Screening fields from underground cables*, viewed 24 April 2020, http://www.emfs.info/sources/underground/screening-ug/
- National Grid (2020c). *Underground power cables,* viewed 12 February 2020, https://www.emfs.info/sources/underground/
- National Health and Medical Research Council (NHMRC) (2015). *Information Paper: Evidence on Wind Farms and Human Health*
- National Parks and Wildlife Service (NPWS) (2003), *The Bioregions of NSW: their biodiversity,* conservation and history'
- NSW Department of Finance, Services and Innovation (2017). *NSW Hydrography,* accessed 31 March 2020, https://datasets.seed.nsw.gov.au/dataset/nsw-hydrography
- NSW Department of Primary Industries (DPI) (2016). *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources: Background document*
- NSW Department of Primary Industries (2012). *NSW Aquifer Interference Policy: NSW Government policy for the licensing and assessment of aquifer interference activities*

- NSW Government (2019). *Ensuring the future of reliable electricity supply for NSW*. Retrieved from https://www.nsw.gov.au/media-releases/ensuring-future-of-reliable-electricity-supply-for-nsw
- NSW Rural Fire Service (2008). *Bush Fire Risk Management Planning Guidelines for Bush Fire Management Committees*
- NSW Rural Fire Service (2015). *Guide for Bush Fire Prone Land Mapping*
- NSW Rural Fire Service (2019a). *Planning for Bush Fire Protection.*
- NSW Rural Fire Service (2019b). *Community Protection Guideline*
- Office of Energy Efficiency and Renewable Energy (EERN) (ND), *The Inside of a Wind Turbine.* Retrieved from https://www.energy.gov/eere/wind/inside-wind-turbine
- Office of Environment and Heritage (OEH) (2012). *The land and soil capability assessment scheme: second approximation*
- OEH (2015). *Community Attitudes to Renewable Energy in NSW*. Retrieved from: https://www.environment.nsw.gov.au/resources/actionmatters/community-attitudes-renewable-energy-150419.pdf
- Pamada (2020). Upper Hunter Energy Park. Retrieved from https://pamada.com/project/upper-hunter-energy-park-owens-gap-scone-nsw-2337/
- Preston Rowe Patterson (2009). *Preliminary Assessment of the Impact of Wind Farms on Surrounding Land Values in Australia,* prepared for the NSW Valuer General
- Puliyapang (2019). *Traffic and Transport Impact Assessment for Glendell Continued Operations Project*
- Rash. C (2004), *'Awareness of Causes and Symptoms of Flicker Vertigo Can Limit Ill Effects', Human Factors and Aviation Medicine*.
- REA Group LTD (2020). *Realestate.com.au website.* Retrieved from: https://www.realestate.com.au/
- Roth, James. (1985). Cortisol as Mediator of Stress-Associated Immunosuppression in Cattle. 10.1007/978-1-4614-7544-6_13.
- Safigianni. A, & Tsompanidou. C (2009). 'Electric- and Magnetic-Field Measurements in an Outdoor Electric Power Substation', IEEE Transactions on Power Delivery, Vol. 24(1), pp. 38-42
- Singleton Bush Fire Management Committee (2011). *Bush Fire Risk Management Plan*
- Smales, I. (2006). *Impacts of avian collisions with wind power turbines: an overview of the modelling of cumulative risks posed by multiple wind farms. 1 - 22*
- Smales, I. e. a. (2013). *A description of the biosis model to assess risk of bird collisions with wind turbines. Wildlife Society Bulletin, 37(1), 59 – 65*
- Smile, V. (2016). *'What I see when I see a wind turbine [Numbers Don't Lie]',* IEEE Spectrum*, Vol. 53, No. 3, p. 27.*
- SSC (2013). Singleton Town Centre Masterplan, available on the SSC website Publications, Plans and Strategies
- SSC (2020a). *Remplan Economy Profile Singleton Shire Council.* Retrieved from https://app.remplan.com.au/singleton/economy/trends/population?state=Row5Hv!mNbzFMyJkhLArEDudnkKdhrF5fGgmcgfqfvpD on 6 April 2020

- SSC (2020b). *Remplan Economy Profile Singleton Shire Council Employment by Industry Sector.* Retrieved from https://app.remplan.com.au/singleton/economy/industries/employment?state=LXgLFm!MLvNF01dGFNpmD5Io4LpocBFZfeoVc3EzJ5frO854i1fOIvvmBh2jZ on 6 April 2020
- TransGrid (ND). TransGrid Projects Network Map. Retrieved from https://www.transgrid.com.au/news-views/lets-connect/consultations/Documents/Appendix_P_-_Network_Map.pdf
- TransGrid (2014), Transgrid's 330 kV *Macarthur Substation in western Sydney* (as shown in the Liverpool Range Environmental Assessment)
- TransGrid (2016). *Review of Trans Grid 2016 STPIS Performance*. Retrieved from the Australian Energy Regulator website here https://www.aer.gov.au/system/files/TransGrid%202016%20STPIS%20performance%20-%20NCC.pdf
- TransGrid (2018). Expanding NSW Queensland Transmission Transfer Capacity. Project Specification Consultation Report Summary
- TransGrid (2019). *Expanding NSW Queensland Transmission Transfer Capacity*. Project Assessment Draft Report
- UHSC (2020a). *Remplan Economy Profile Upper Hunter Shire Council.* Retrieved from https://app.remplan.com.au/upperhunter/economy/trends/population?state=M2qJFN!L2RvFqGd6FjWZ8rsX3L2AHnFkhLk5CAhPhvPm on 6 April 2020
- UHSC (2020b). *Remplan Economy Profile Upper Hunter Shire Council Employment by Industry Sector.* Retrieved from https://app.remplan.com.au/upperhunter/economy/industries/employment?state=p4DpFd!nWLmFlNrPfOoX16c4a1vAs4Fjhdg4CBw2PRs9ArJofzhWS11qwT3Vw on 6 April 2020.
- UHSC (2020c). UHSC website retrieved from https://upperhunter.nsw.gov.au/
- United Nations Framework Convention on Climate Change (UNFCCC), (2020), Paris Agreement – Status of Ratification. Retrieved from: https://unfccc.int/process/the-paris-agreement/status-of-ratification
- Urbis (2016). *Review of the Impact of Wind Farms on Property Values*, State of NSW and the Office of Environment and Heritage
- Visit NSW (2020a). *Muswellbrook.* Retrieved from https://www.visitnsw.com/destinations/hunter/upper-hunter/muswellbrook
- Visit NSW (2020b). Scenic Drives in the Upper Hunter webpage
- Visit NSW (2020c). Singleton. Retrieved from: https://www.visitnsw.com/destinations/hunter/hunter-valley/singleton
- West, G. (1993). *Input-Output Analysis for Practitioners, Version 7.1, User's Guide*
- Water NSW (2020). *Glenbawn Dam webpage*. Retrieved from https://www.waternsw.com.au/supply/visit/glenbawn-dam

EPURON

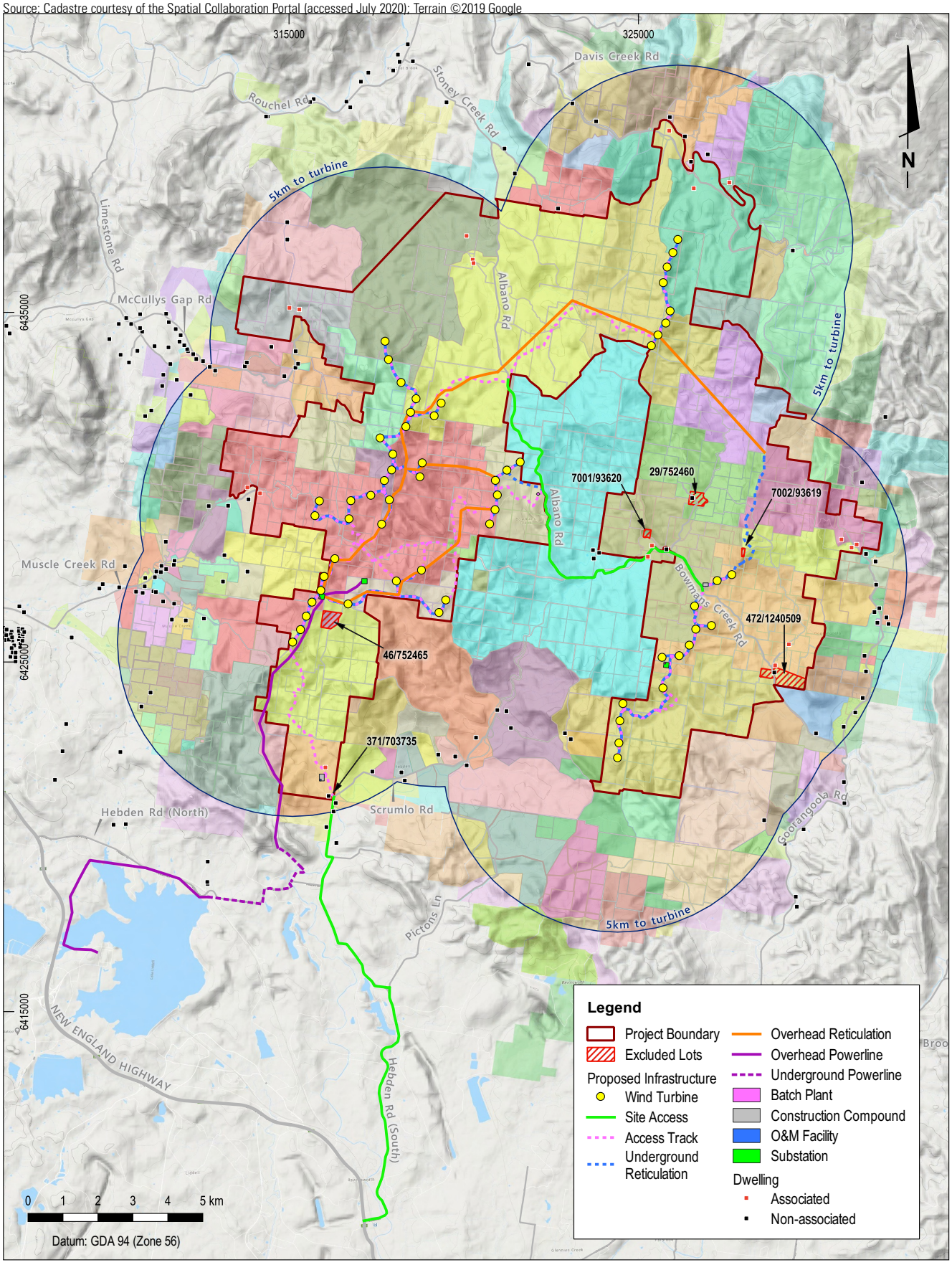
APPENDIX A

Schedule of Land to which this EIS Applies

BOWMANS CREEK
WIND FARM

environmental impact statement

Source: Cadastre courtesy of the Spatial Collaboration Portal (accessed July 2020); Terrain ©2019 Google



Bowmans Creek Wind Farm | Fig1a_Schedule of Lands | 23 03 2021

BOWMANS CREEK WIND FARM

Hansen Bailey ENVIRONMENTAL CONSULTANTS | EPURON

Schedule of Lands

FIGURE A1

Lot/DP	Type
PROJECT BOUNDARY	
352/727683	Crown
299/752460	Crown
125/752465	Crown
7001/93621	Crown
159/752444	Private
55/752460	Private
41/752460	Private
148/752465	Private
12/752465	Private
160/752444	Private
163/752444	Private
48/752465	Private
154/752465	Private
49/752465	Private
245/752460	Private
107/752460	Private
106/752460	Private
186/752444	Private
177/752444	Private
198/752465	Private
204/752465	Private
238/752460	Private
222/752460	Private
22/752460	Private
2/1167323	Private
3/752460	Private
87/752465	Private
56/752465	Private
171/752465	Private
22/752465	Private
34/752465	Private
39/752465	Private
50/752465	Private
33/752465	Private
100/752465	Private

Lot/DP	Type
101/752465	Private
170/752465	Private
90/752465	Private
41/752465	Private
197/752465	Private
24/752465	Private
86/752465	Private
47/752465	Private
162/752465	Private
97/752465	Private
98/752465	Private
169/752465	Private
91/752465	Private
327/752444	Private
189/752444	Private
242/752465	Private
241/752465	Private
112/752465	Private
113/752465	Private
107/752465	Private
155/752444	Private
106/752465	Private
260/752460	Private
298/752460	Private
353/752460	Private
352/752460	Private
248/752460	Private
253/752460	Private
257/752460	Private
11/127321	Private
201/752465	Private
200/752465	Private
145/752465	Private
315/752444	Private
232/752460	Private
264/752460	Private

Lot/DP	Type
263/752460	Private
259/752460	Private
42/752465	Private
199/752444	Private
149/752465	Private
150/752465	Private
173/752444	Private
13/752444	Private
194/752444	Private
306/752444	Private
215/752490	Private
78/752490	Private
A/374425	Private
60/752444	Private
61/752444	Private
177/752465	Private
166/752465	Private
44/752465	Private
196/752444	Private
140/752444	Private
195/752444	Private
62/752444	Private
C/374425	Private
45/752465	Private
165/752465	Private
283/752495	Private
282/752495	Private
47/752495	Private
255/752495	Private
6/113759	Private
280/752495	Private
70/752490	Private
47/752490	Private
251/752460	Private
6/127321	Private
2/127321	Private

Lot/DP	Type
290/752495	Private
286/752495	Private
284/752495	Private
285/752495	Private
288/752495	Private
10/127321	Private
270/752460	Private
272/752460	Private
269/752460	Private
8/127321	Private
9/127321	Private
302/752460	Private
250/752460	Private
5/752460	Private
104/752460	Private
100/752460	Private
123/752460	Private
284/752460	Private
148/752460	Private
2/752460	Private
40/752460	Private
82/752460	Private
268/752460	Private
127/752460	Private
103/752460	Private
105/752460	Private
216/752460	Private
138/752460	Private
109/752460	Private
12/752460	Private
108/752460	Private
44/752460	Private
64/752460	Private
30/752460	Private
351/752460	Private
164/752465	Private

Lot/DP	Type
123/752465	Private
122/752465	Private
161/752460	Private
230/752462	Private
219/752460	Private
52/752460	Private
1/520171	Private
4/520171	Private
178/752490	Private
174/752490	Private
176/752490	Private
181/752490	Private
195/752490	Private
175/752490	Private
92/752465	Private
1/909957	Private
252/752490	Private
251/752490	Private
255/752490	Private
256/752490	Private
168/752490	Private
1/127321	Private
147/752460	Private
142/752460	Private
241/752460	Private
277/752460	Private
121/752460	Private
61/752471	Private
77/752460	Private
96/752465	Private
74/752460	Private
1/971994	Private
49/752460	Private
1/752460	Private
4/752460	Private
141/752460	Private

Lot/DP	Type
140/752460	Private
143/752460	Private
163/752465	Private
2/752465	Private
21/752465	Private
23/752465	Private
231/752465	Private
25/752465	Private
3/752465	Private
340/752465	Private
96/752460	Private
97/752460	Private
167/752490	Private
250/752490	Private
69/752490	Private
37/752471	Private
160/752465	Private
161/752465	Private
60/752460	Private
63/752460	Private
79/752460	Private
80/752460	Private
81/752460	Private
9/752460	Private
93/752460	Private
94/752460	Private
246/752460	Private
27/752460	Private
283/752460	Private
303/752460	Private
304/752460	Private
35/752460	Private
46/752460	Private
1/974685	Private
4/127321	Private
1/1037682	Private

Lot/DP	Type
2/1084779	Private
1/1088686	Private
5/1098856	Private
3/1098856	Private
1/1098856	Private
30/752444	Private
31/752444	Private
313/752444	Private
319/752444	Private
324/752444	Private
42/752444	Private
55/752444	Private
56/752444	Private
161/752444	Private
162/752444	Private
187/752444	Private
188/752444	Private
197/752444	Private
206/752444	Private
28/752444	Private
29/752444	Private
37/752465	Private
5/752465	Private
1/558324	Private
1/184469	Private
12/752444	Private
156/752444	Private
157/752444	Private
158/752444	Private
287/752495	Private
7/113759	Private
60/752495	Private
30/752495	Private
5/113759	Private
258/752495	Private
153/752465	Private

Lot/DP	Type
287/752460	Private
273/752460	Private
252/752460	Private
271/752460	Private
5/127321	Private
299/752495	Private
7/127321	Private
3/127321	Private
32/752495	Private
138/752444	Private
247/752460	Private
229/752460	Private
226/752460	Private
301/752460	Private
224/752460	Private
225/752460	Private
256/752460	Private
152/752465	Private
38/752465	Private
151/752465	Private
43/752465	Private
316/752444	Private
63/752444	Private
164/752444	Private
139/752444	Private
20/752460	Private
21/752460	Private
23/752460	Private
231/752460	Private
233/752460	Private
235/752460	Private
242/752460	Private
244/752460	Private
122/752460	Private
125/752460	Private
129/752460	Private

Lot/DP	Type
144/752460	Private
146/752460	Private
149/752460	Private
184/752460	Private
19/752460	Private
11/752495	Private
3/856279	Private
4/856279	Private
511/870216	Private
512/870216	Private
1/925048	Private
B/398697	Private
110/752460	Private
239/752460	Private
221/752460	Private
2/113520	Private
1/940488	Private
1/973976	Private
372/703735	Private
233/752465	Private
43/752460	Private
42/752460	Private
472/1240509	Private
471/1240509	Private
474/1240509	Private
473/1240509	Private
2/1098856	Private
4/1098856	Private
2/323413	Private
1/1174004	Private
1/1084779	Private
2/511365	Private
3/511365	Private
1/345566	Private
37/752460	Private
36/752460	Private

Lot/DP	Type
136/752460	Private
223/752460	Private
130/752460	Private
267/752460	Private
65/752460	Private
132/752460	Private
308/752460	Private
290/752460	Private
306/752460	Private
137/752460	Private
134/752460	Private
185/752460	Private
281/752460	Private
131/752460	Private
227/752460	Private
191/752460	Private
186/752460	Private
162/752460	Private
31/752460	Private
25/752460	Private
54/752460	Private
76/752460	Private
203/752465	Private
136/752465	Private
119/752465	Private
120/752465	Private
121/752465	Private
124/752465	Private
192/752460	Private
201/752444	Private
99/752465	Private
167/752465	Private
105/752465	Private
135/752465	Private
230/752465	Private
118/752465	Private

Lot/DP	Type
120/752460	Private
1/323413	Private
60/752471	Private
105/752444	Private
74/752444	Private
326/752444	Private
232/752465	Private
168/752465	Private
126/752460	Private
286/752460	Private
285/752460	Private
124/752460	Private
56/752460	Private
95/752460	Private
240/752460	Private
139/752460	Private
135/752460	Private
6/752460	Private
128/752460	Private
350/752460	Private
296/752460	Private
297/752460	Private
279/752460	Private
98/752460	Private
238/752465	Private
234/752465	Private
165/752444	Private
190/752444	Private
341/752465	Private
237/752465	Private
240/752465	Private
239/752465	Private
32/752444	Private
154/752444	Private
354/752460	Private

Lot/DP	Type
TRANSMISSION LINE	
39/6842	Private
1/1022827	Private
1/1126279	Private
1/233020	Private
1/247944	Private
1/532671	Private
1/532672	Private
102/1218648	Private
106/1218648	Private
157/752486	Private
162/752486	Private
163/752486	Private
2/1022827	Private
2/567124	Private
25/752486	Private
26/241179	Private
27/241179	Private
28/241179	Private
31/1156562	Private
313/752486	Private
34/6842	Private
35/1193430	Private
37/1193430	Private
38/1193430	Private
38/6842	Private
4/236869	Private
4/532671	Private
45/241179	Private
8/247944	Private
2/238862	Crown
2/556370	Crown
30/1193430	Crown
9/250890	Crown

Lot/DP	Type
TRANSPORT ROUTE	
1/151176	Private
12/825904	Private
2/38725	Private
2291/1203350	Private
3/38725	Private
31/6842	Private
34/6842	Private
351/853217	Private
352/867083	Private
355/867083	Private
39/6842	Private
4/38725	Private
5/1077004	Private
5/38725	Private
143/752465	Private
144/752465	Private
146/752465	Private
147/752465	Private
187/752460	Private
188/752460	Private
190/752460	Private
193/752460	Private
209/752460	Private
210/752460	Private
215/752460	Private
3/1120432	Private
3/1120433	Private
4/1120432	Private
6/1120433	Private
11/6842	Private
2/730978	Private
OTHER	
Creeks or streams located within, between or adjacent to the above parcels of land	Crown Watercourse
Main Rail Line	Crown State Rail Authority
Public and unformed roads within, between or adjacent the above lands	Crown MSC
Public and unformed roads within, between or adjacent the above lands	Crown SSC
Any identified or unidentified historical title residues located within, between or adjacent to the above parcels of land	Freehold Private
Any unidentified Crown land or Crown land historical title residues located within, between or adjacent to the above Freehold parcels of land	Crown

EPURON

APPENDIX B

SEARs and Regulatory Input to the SEARs

BOWMANS CREEK
WIND FARM

environmental impact statement

Table B1
Secretary's Environmental Requirements and where Addressed

Issue	Description	Section
General Requirements	The Environmental Impact Statement (EIS) for the development must comply with the requirements in Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*.	App B Table B4
	In particular, the EIS must include: • a stand-alone executive summary;	Executive Summary
	• a full description of the development, including: − details of construction, operation and decommissioning, including any proposed staging of the development or refurbishing of turbines over time;	3
	− all infrastructure and facilities, such as substations, transmission lines, construction compounds, concrete batching plants, internal access roads, and road upgrades (including any infrastructure that would be required for the development, but the subject of a separate approvals process);	3
	− plans for any buildings;	3
	− site plans and maps at an adequate scale with dimensions showing: ○ the location and dimensions of all project components including coordinates in latitude / longitude and maximum AHD heights of the turbines;	3
	○ existing infrastructure, land use, and environmental features in the vicinity of the development, including nearby dwellings and approved residential developments or subdivisions within 4 km of a proposed turbine and coordinates in latitude / longitude, and any other existing, approved wind farms in the region; and	2 App F 7.24
	○ the development corridor that has been assessed, including any allowance for micro-siting of turbines and identification of the key environmental constraints that have been considered in the design of the development;	3.1.3 3.3.2 3.10
	− details of the progressive rehabilitation of the site;	7.16.3
	• a list of any approvals that must be obtained before the development may commence;	App F Table F1
	• the terms of any proposed voluntary planning agreement with the relevant local council;	3.1.1

Issue	Description	Section
	• an assessment of the likely impacts of the development on the environment, focusing on the specific issues identified below, including: − a description of the existing environment likely to be affected by the development using sufficient baseline data;	7
	− an assessment of the likely impacts of all stages of the development, taking into consideration any relevant legislation, environmental planning instruments, guidelines, policies, plans and industry codes of practice and including the *NSW Wind Energy Guideline for State Significant Wind Energy Development* (2016);	7
	− a description of the measures that would be implemented to avoid, mitigate and/or offset residual impacts of the development and the likely effectiveness of these measures, including details of consultation with any affected non-associated landowners in relation to the development of mitigation measures, and any negotiated agreements with these landowners; and	7 & 8
	− a description of the measures that would be implemented to monitor and report on the environmental performance of the development, including adaptive management strategies and contingency measures to address residual impacts;	8
	• a consolidated summary of all the proposed environmental management and monitoring measures, identifying all the commitments in the EIS; and	8
	• the reasons why the development should be approved having regard to: − relevant matters for consideration under the *Environmental Planning and Assessment Act* 1979, including the objects of the Act, evaluation of the merits of the Project as a whole and how the principles of ecologically sustainable development have been incorporated in the design, construction and ongoing operations of the development;	4.1.1
	− an evaluation of the merits of the Project having regard to the requirements in Section 4.15 of the *Environmental Planning and Assessment Act* 1979; and	9.3.1
	− the environmental, economic and social costs and benefits of the development, having regard to the predicted electricity demand in NSW and the National Electricity Market, the Commonwealth's Renewable Energy Target Scheme, and the greenhouse gas savings of the development;	9.5

Issue	Description	Section
	− a detailed consideration of the capability of the Project to the security and reliability of the electricity system in the National Electricity Market, having regard to local system conditions and the Department's guidance on the matter;	9.5
	− the suitability of the site with respect to potential land use conflicts with existing and future surrounding land uses, including rural villages, rural dwellings, subdivisions, land of high scenic value, conservation areas (including National Parks / Reserves), strategic agricultural land, state forests, mineral resources, triangulation stations, tourism facilities, existing or approved wind farms, and the capacity of the existing electricity transmission network to accommodate the development; and	9.2
	− feasible alternatives to the development (and its key components), including the consequences of not carrying out the development.	3.10
	While not exhaustive, Attachment 1 contains a list of some of the environmental planning instruments, guidelines, policies, and plans that may be relevant to the environmental assessment of this development.	4
	In addition to the matters set out in Schedule 1 of the *Environmental Planning and Assessment Regulation 2000*, the development application must be accompanied by a signed report from a suitably qualified person that includes an accurate estimate of the capital investment value of the development (as defined in Clause 3 of the *Environmental Planning and Assessment Regulation 2000*).	Provided separately to DPIE
Key Issues	The EIS must address the following specific matters for both the wind farm and associated infrastructure: **Landscape and Visual** – the EIS must include a detailed assessment of the visual impacts of all components of the Project (including turbines, transmission lines, substations, lighting and any other ancillary infrastructure) in accordance with the *Wind Energy: Visual Assessment Bulletin* (DPE, 2016);	7.1
	Noise and Vibration – the EIS must: • assess wind turbine noise in accordance with the NSW Wind Energy: Noise Assessment Bulletin (EPA/DPE, 2016); • assess noise generated by ancillary infrastructure in accordance with the NSW Noise Policy for Industry (EPA, 2017); • assess construction noise under the Interim Construction Noise Guideline (DECC, 2009); • assess traffic noise under the NSW Road Noise Policy (DECCW, 2011); and	7.2

Issue	Description	Section
	• assess vibration under the Assessing Vibration: A Technical Guideline (DECC, 2006);	
	Biodiversity – this 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 Biodiversity Conservation Act 2016 (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 Biodiversity Conservation Act 2016 (NSW); • 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); • 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;	7.5
	Traffic and Transport – the EIS must: • assess the construction, operational and decommissioning traffic impacts of the development; • provide details of traffic volumes (both light and heavy vehicles) and transport and haulage routes during construction, operation and decommissioning, including traffic associated with sourcing raw materials (water, sand and gravel); • assess the potential traffic impacts of the Project on road network function including intersection performance, site access arrangements, site access and haulage routes and road safety, including school bus routes and school zones; • assess the capacity of the existing road network to accommodate the type and volume of traffic generated by the Project (including over-mass / over-dimensional traffic haulage routes from port) during construction, operation and decommissioning; • an assessment of the likely transport impacts to the site access and haulage routes, site access point, any rail safety issues, any Crown land, particularly in relation to the capacity and conditions of the roads; • provide details of measures to mitigate and / or manage potential impacts including a schedule of all required road upgrades (including resulting from over mass / over dimensional traffic haulage routes), road maintenance contributions, and any other traffic control measures, developed in consultation with the relevant road authority;	7.4

Issue	Description	Section
	Hazard / Risks – the EIS must include an assessment of the following: • *Aviation Safety*: − assess the impact of the development under the National *Airports Safeguarding Framework Guideline D: Managing Wind Turbine Risk to Aircraft*, − provide associated height and co-ordinates for each turbine assessed; − assess potential impacts on aviation safety, including cumulative effects of wind farms in the vicinity, potential wake / turbulence issues, the need for aviation hazard lighting, considering, defined air traffic routes, aircraft operating heights, approach/departure procedures, radar interference, communication systems, navigation aids; − identify aerodromes within 30 km of the turbines and consider the impact to nearby aerodromes and aircraft landing areas; − address impacts on obstacle limitation surfaces, and	7.3
	• assess the impact of the turbines on the safe and efficient aerial application of agricultural fertilisers and pesticides in the vicinity of the turbines and transmission line;	7.3.3
	• *Telecommunications* – identify possible effects on telecommunications systems, assess impacts and mitigation measures including undertaking a detailed assessment to examine the potential impacts as well as analysis and agreement on the implementation of suitable options to avoid potential disruptions to radio communication services; which may include the installation and maintenance of alternative sites;	7.9
	• *Health* – consider and document any health issues having regard to the latest advice of the National Health and Medical Research Council, and identify potential hazards and risks associated with electric and magnetic fields (EMF) and demonstrate the application of the principles of prudent avoidance;	7.19
	• *Bushfire* – identify potential hazards and risks associated with bushfires / use of bushfire prone land, including the risks that a wind farm would cause bush fire and any potential impacts on the aerial fighting of bush fires and demonstrate compliance with *Planning for Bush Fire Protection 2006* (if located on bushfire prone land); and	7.10
	• *Blade Throw* – assess blade throw risks;	7.11

Issue	Description	Section
	Battery Storage – including a preliminary risk screening in accordance with *State Environmental Planning Policy No.33 – Hazardous and Offensive Development and Applying SEPP 33* (DoP, 2011), and if the preliminary risk screening indicates the development is "potentially hazardous", a Preliminary Hazard Analysis (PHA) must be prepared in accordance with *Hazard Industry Planning Advisory Paper No.6 – Guidelines for Hazard Analysis* (DoP, 2011) and *Multi-Level Risk Assessment* (DoP, 2011).	No battery storage proposed as part of the Project PHA for other aspects: Section 4.3.3
	Heritage – the EIS must: • assess the impact to Aboriginal cultural heritage impact under the *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage* in NSW (OEH, 2011) and the *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW* (DECCW, 2010); • provide evidence of consultation with Aboriginal communities in determining and assessing impacts, developing options and selecting options and mitigation measures (including the final proposed measures), having regard to *the Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010); and • assess the impact to historic heritage items under the *NSW Heritage Manual*.	7.6 5
	Water & Soils – the EIS must: • quantify water demand, identify water sources (surface and groundwater), including any licensing requirements, and determine whether an adequate and secure water supply is available for the development; • access potential impacts on the quantity and quality of surface and groundwater resources, including impacts on other water users and watercourses; • where the Project involves works within 40 metres of the high bank of any river, lake or wetlands (collectively waterfront land), identify likely impacts to the waterfront land, and how the activities are to be designed and implemented in accordance with the *DPI Water Guidelines for Controlled Activities* (DPI, 2012) and (if necessary) *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (DPI, 2003); and • describe the measures to minimise surface and groundwater impacts, including how works on steep gradient land or erodible soil types would be managed and any contingency requirements to address residual impacts.	7.15 7.16

Issue	Description	Section
	Waste – the EIS must: • identify, quantify and classify the likely waste streams to be generated during construction and operation, and describe the measures to be implemented to manage, reuse, recycle and safely dispose of this waste.	7.17
	Social & Economic – the EIS must include an assessment of the social and economic impacts and benefits of the Project for the region and the State as a whole, including consideration of any increase in demand for community infrastructure services.	7.8 7.23
Consultation	During the preparation of the EIS, you must consult with relevant local, State and Commonwealth Government authorities, service providers, community groups and affected landowners. However, you must: • establish a Community Consultative Committee for the Project in accordance with the *Community Consultative Committee Guidelines for State Significant Projects*, and consult with the committee during the preparation of the EIS; and	5
	• Carry out detailed consultation with the following: − Muswellbrook Shire Council; − Upper Hunter Shire Council; − Singleton Council − Office of Environment and Heritage; − Environment Protection Authority; − Division of Resources and Geoscience; − Department of Industry − Roads and Maritime Services; − TransGrid − Department of Finance, Services and Innovation – Telco Authority; − Local Land Services; − NSW Rural Fire Service; − Department of Defence; − Civil Aviation Safety Authority; and − Airservices Australia.	5
	The EIS must include a description of what consultation was carried out during the preparation of the EIS, identify the issues raised during this consultation, and explain how these issues have been addressed in the EIS.	5
Further consultation after 2 years	If you do not lodge a Development Application and EIS for the development within 2 years of the issue date of these SEARs, you must consult further with the Secretary in relation to the preparation of the EIS.	N/A

Issue	Description	Section
References	The assessment of the key issues listed above must take into account relevant guidelines, policies, and plans as identified. While not exhaustive, the following attachment contains a list of some of the guidelines, policies, and plans that may be relevant to the environmental assessment of this proposal.	7
Attachment 1	Appended to the *"Planning Secretary's Environmental Assessment Requirements*"	4 & 7

Table B2
DAWE Assessment Requirements

Ref	Description
	Introduction
3.	The proponent must undertake an assessment of all protected matters that may be impacted by the development under the controlling provision identified in paragraph 1. The Commonwealth Department of Agriculture, Water and the Environment considers that the proposed action is likely to have a significant impact on threatened species and communities and migratory species listed in Appendix A.
4.	The proponent must consider each of the protected matters under the triggered controlling provisions that may be impacted by the action. Note that this may not be a complete list and it is the responsibility of the proponent to undertake an analysis of the significance of the relevant impacts and ensure that all protected matters that are likely to be significantly impacted are assessed for the Commonwealth Minister's consideration.
	General Requirements *Relevant Regulations*
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.
	Project Description
6.	The title of the action, background to the action and the current status.
7.	The precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on Matters of National Environmental Significance (MNES).
8.	How the action relates to any other actions that have been, or are being taken in the region affected by the action.
9.	How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts on MNES.
	Impacts
10.	The EIS must include an assessment of the relevant impacts of the action on the matters protected by the controlling provisions, including:
10(i)	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;

Ref	Description
10(ii)	a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;
10(iii)	analysis of the significance of the relevant impacts; and
10(iv)	any technical data and other information used or needed to make a detailed assessment of the relevant impacts.
	Avoidance, mitigation and offsetting
11.	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:
11(i)	a description and an assessment of the expected or predicted effectiveness of the mitigation measures;
11(ii)	any statutory policy basis for the mitigation measures;
11(iii)	the cost of the mitigation measures;
11(iv)	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;
11(v)	the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.
12.	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.
13.	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:
13(i)	conservation advice or recovery plan for the species of community;
13(ii)	relevant threat abatement plan for the species;
13(iii)	wildlife conservation plan for the species; and
13(iv)	any strategic assessment.
Note: the relevant guidelines and policy statements for each species and community are available from the Department of Agriculture, Water and the Environment Species Profile and Threats Database. http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl	
	Key Issues **Biodiversity (threatened species and communities and migratory species)** *Assessment Requirements*
14.	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.

Ref	Description
15.	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:
15(a)	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;
15(b)	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;
15(c)	description of the relevant impacts of the action having regard to the full national extent of the species or community's range; and
15(d)	description of the specific proposed avoidance and mitigation measures to deal with relevant impacts of the action;
15(e)	identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account;
15(f)	description of any offsets proposed to address residual adverse significant impacts and how these offsets will be established.
15(g)	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; and
15(h)	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 occurring on proposed offset sites;
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.	
16.	Any significant residual impacts not addressed by the NSW Biodiversity Assessment Methodology may need to be addressed in accordance with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offset Policy. http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy
	Other approvals and conditions
17.	Information in relation to any other approvals of conditions required must include the information prescribed in Schedule 4 Clause 5 (a) (b) (c) and (d) of the EPBC Regulations 2000.
	Environmental Record of person proposing to take the action
18.	Information in relation to the environmental record of a person proposing to take action must include details as prescribed in Schedule 4 Clause 6 of the EPBC Regulations 2000.

Ref	Description
	Information Sources
19.	For information given in the EIS, the EIS must state the source of the information, how recent the information is, how the reliability of the information was tested, and what uncertainties (if any) are in the information.
	REFERENCES
	• *Environment Protection and Biodiversity Conservation Act 1999* - section 51-55, section 96A(3)(a)(b), 101A(3)(a)(b), section 136, section 527E • *Environment Protection and Biodiversity Conservation Regulations 2000 Schedule 4* • Amending Agreement No.1 (2020) - Item 18.1, Item 18.5, Schedule 1 • *Matters of National Environmental Significance - Significant impact guidelines 1.1* (2013) EPBC Act • *Environment Protect and Biodiversity Conservation Act 1999* Environmental Offsets Policy October 2012
	Appendix A **Proposed site** Based on the information in the referral documentation, the location of the action, species records and likely habitat present in the area, there are likely to be significant impacts to: · • White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community listed as critically endangered. · • Central Hunter Valley eucalypt forest and woodland listed as critically endangered. · • Regent Honeyeater (*Anthochaera phrygia*) listed as critically endangered. · • Swift Parrot (*Lathamus discolor*) listed as critically endangered. · • Koala (*Phascolarctos cinerus*) listed as vulnerable. Additionally, the proposed action may have a significant impact on the following migratory species: • Fork-tailed swift (*Apus pacificus*). · • White-throated Needletail (*Hirundapus caudacutus*). Additionally, there is some risk that there may be significant impacts on the following matters and levels of impact should be further investigated: · • Austral Toadflax (*Thesium australe*) listed as vulnerable. · • Slaty Red Gum (*Eucalyptus glaucina*) listed as vulnerable · • Leek-orchid (*Prasophyllum sp. Wybong* (C. Phelps ORG 5269) listed as critically endangered. · • Eastern Bristlebird (*Dasyornis brachypterus*) listed as endangered. · • Large-eared Pied Bat (*Chalinolobus dwyeri*) listed as vulnerable. • Spotted-tailed Quoll (*Dasyurus macalutus macalatus*) listed as endangered. · • Grey-headed Flying-fox (*Pteropus poliocephalus*) listed as vulnerable. · • Green and Golden Bell Frog (*Litoria aurea*) listed as vulnerable.
	Note: uncertainty around the extent and number of protected matters that may be impacted will need to be resolved through the assessment process once final alignment and construction plans have been completed.
	Note: this may not be a complete list and it is the responsibility of the proponent to ensure any protected matters under these controlling provisions are assessed for the Commonwealth decision-maker's consideration.

Table B3
Regulators Submissions to SEARs and where Addressed

Ref	Department	Issue	Section
1	Department of Defence	Air craft safety, military low flying and radar interference. Consider RAAF Base Williamstown and the Singleton Military Training Centre	**7.3**
2	EPA	EIS commitments may be formalised into any EPL	**4.4.1**
3	DoI - Water	Identify adequate and secure water supply which is authorised and reliable. Include an assessment of the current market depth where water supply entitlement is required to be purchased	**4.4.7**
4	DoI - Water	Detailed and consolidated site water balance	**7.15.2**
5	DoI - Water	Assessment of SW and groundwater sources (quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, water courses, riparian land and GDEs, measures to reduce and mitigate impacts	**7.15**
6	DoI - Water	Proposed SW and GW monitoring activities and methodologies	**7.15.3**
7	DoI - Water	Consideration of legislation: AIP, Guidelines for Controlled Activities on Waterfront Land and WSPs	**4.4.7**
8	DoI - Crown Lands	Paid search to confirm all Crown Land (lot and DP) and Crown roads within Project site, including Travelling Stock Reserves (TSRs)	**4.4.8**
9	DoI - Crown Lands	Identify all potential impacts on Crown land. Identify how any use of occupation of Crown land will be authorised under the CLM Act	**4.4.8**
10	DoI - Crown Lands	Reference to the *Roads Act 1993* must be provided for the purpose of providing the legislative context within which any Crown Roads are to be managed and used consistent with achieving long-term strategic management outcomes. Dependent on the identification of the long-term strategic use of these roads, management outcomes should be road closures and purchase or road transfer to Local Government, prior to works commencing.	**4.4.6**
11	DoI - Crown Lands	It is the preference of DoI Crown Lands that all impacted Crown Roads within the Project site that are not required for public access should be closed and purchased by the proponent. This will require consultation with DoI Crown Lands regarding the appropriate protocols and fees associated with the closure and purchasing of Crown Roads. If Crown roads located within the Project site are required for public access then the only appropriate means to facilitate access is for these Crown Roads to be transferred to Local Government, prior to works commencing.	**4.4.8**
12	DoI - Crown Lands	The Project must consider the impact of the NSW *Aboriginal Land Rights Act 1983* and identify any Aboriginal land claims within the Project site. Consultation regarding the Project must occur with any affected claimants, prior to works commencing.	**4.5.3**

Ref	Department	Issue	Section
13	NSW - Agriculture	Site suitability - consistency with SEPPs, plans and LEP requirements in relation to land use conflicts with existing and future surrounding land uses (rural residential development and subdivisions)	**4**
14	NSW - Agriculture	Complete a Land Use Conflict Risk Assessment to identify land use conflict, map to scale showing operational infrastructure to sensitive receptors	**6** & **7.16**
15	DoI - Agriculture	Impacts to agricultural resources and land - current status and productivity of development, impacts on current and potential developments can be avoided or mitigated, cumulative effectives, life span of development, strategies to manage aerial spraying, sharing with agriculture	**2.3** **7.8** **7.16**
16	DoI - Agriculture	Impacts to water use from agriculture	**7.16.3**
17	DoI - Agriculture	Biosecurity risk assessment, response plan for risks and contingency plans, monitoring and mitigation measures in weed, disease and pest plans, adequate fencing to keep livestock out	**7.16.3**
18	DoI - Agriculture	Route for movements to minimised impacts on sensitive receptors including TSRs and movement of livestock on affected roads	**4.4.8**
19	DoI - Agriculture	Visual amenity - night lighting, glare and amenity	**7.1**
20	DoI - Agriculture	Land stewardship - management of stockpiled material, total material, use of material, total footprint	**7.17.2** **7.16**
21	DoI - Agriculture	Soil survey for benchmark for rehabilitation for agriculture	**7.16.3**
22	DoI - Agriculture	Rehabilitation and Decommissioning Closure Management Plan	**7.22**
23	DoI - Agriculture	Remediation in accordance with SEPP 55	**4.3**
24	DoI - Agriculture	For land with cropping historic or land with capability of Cat 3 or better, all cables/pipes to be buried at depth > 500 mm	**3.4.1**
25	DoI - Agriculture	Consultation - impacts and mitigation, complaints register	**5**
26	DoI - Agriculture	Contingency Plans with emergency situations (e.g. bushfire threats and disease outbreak)	**7.16**
27	DPIE - DRG	Ensure proposal does not affect access to resources or exploration, including electricity transmission infrastructure	**2**
28	DPIE - DRG	Biodiversity offsets	**7.5.4**
29	DPIE - DRG	Land use conflict with operating mines, extractive industries, mineral or petroleum resources, exploration activities during operation and decommissioning	**2**
30	DPIE - DRG	Compatibility with existing land uses, onsite and adjacent	**2**
31	DPIE - DRG	Check for new source titles at various EIS stages	**2**
32	DPIE - DRG	Consultation with DRG upon finalising strategy for the transmission line network connection	**5**

Ref	Department	Issue	Section
33	DPIE - DRG	Consultation on offsets to ensure no sterilisation or reduction to resources	**2**
34	MSC	Requirements of LEP 2009, Draft Discussion Paper on the MSC LEP February 2018	**4.3.6**
35	MSC	Consultation in relation to over dimensional traffic, additional to road authority	**5**
36	MSC	The catchment has high expression of salinity in a number of riparian areas, and has a number of off-stream, dry land salinity discharge sites. All proposed earthworks need to be planned to ensure their long term stability (the soils in this catchment are highly dispersible).	**7.15**
37	MSC	The Muswellbrook Hydrological Landscape Map and Report, undertaken by Department of Primary Industry provides guidance on the salinity issues in the catchment and provides recommendations on the land use limitations and remedial works	**7.15**
38	MSC	Identify workforce requirements which identifies: projected construction workforce and composition by LGA for construction	**7.23**
39	MSC	Whether project provides opportunity for apprentices and trainees to be engaged over Project life	**7.23**
40	MSC	Information on removal of infrastructure and rehabilitation to return sites to a sustainable landform for agriculture or environmental management	**3.8**
41	MSC	The assessment should include information about the potential for the turbines to be an ignition source for fire, and an assessment in accordance with the *Rural Fires Act 1997* generally. For example, due to lightning strike, mechanical parts/breakdown and overhead electrical cabling. The locations of the proposed turbines are steep, isolated and bush fire prone. The extreme fire danger days in the area are usually a result of very high temperatures and very high wind, and the area is also known for summer electrical storms.	**7.10.3**
42	OEH	See attachment 1 on BAM and BDAR	**7.5**
43	OEH	Aboriginal Cultural Heritage Assessment Report (ACHAR)	**7.6**
44	OEH	Impacts on Aboriginal cultural heritage values are to be assessed and documented in the ACHAR.	**7.6**
45	OEH	See attachment 1 on details to be included in heritage assessment, including significance assessment)	**7.6**
46	OEH	The EIS must map the following features relevant to water and soils including:	**-**
47	OEH	(a) Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map).	**7.16.2**
48	OEH	(b) Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method).	**7.5**

Ref	Department	Issue	Section
49	OEH	(c) Wetlands as described in s4.2 of the Biodiversity Assessment Method.	**7.5**
50	OEH	(d) Groundwater	**7.15**
51	OEH	(e) Groundwater dependent ecosystems	**7.5.3**
52	OEH	(f) Proposed intake and discharge locations	**7.15.3**
		This EIS must describe background conditions for any water resource likely to be affected by the development, including:	-
53	OEH	(a) Existing surface and groundwater	**7.15**
54	OEH	(b) Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations	**7.15**
55	OEH	(c) Water Quality Objectives (as endorsed by the NSW Government represent the community's uses and values for the receiving waters	**7.15**
56	OEH	(d) Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government	**7.15**
	-	This EIS must assess the impacts of the development on water quality, including:	-
58	OEH	The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction	**7.15**
59	OEH	Identification of proposed monitoring of water quality	**7.15**
60	OEH	Flooding and coastal erosion - see detail following preliminary mapping	**7.15**
61	OEH	*Costal Management Act 1916* re: climate change and sea level rise	**7.15**
62	Heritage	Does not require any further consultation as no SHR items within vicinity	**N/A**
63	DRG	No comment	**N/A**
64	RMS	Refer to relevant guidelines	**7.4**
65	RMS	Traffic study in accordance with 'Guide to Traffic Generating Developments 2002' - current traffic counts	**7.4**
66	RMS	Construction management plan	**7.4.4**

Ref	Department	Issue	Section
67	RMS	Impacts on regional and state road network including pedestrian, cyclist and public transport facilitates and provision for service vehicles	**7.4**
68	Safework	None	N/A
69	SSC	Clarify whether construction and maintenance traffic will be utilised local roads in SSC LGA. Also consider the likely impacts on existing road infrastructure along Bridgman Road, Goorangoola Road and Old Goorangoola Road	**3.6**
70	SSC	VPA – need to consult and agree to a VPA	**3.1.1**
71	SSC	Consider SSC Strategic Plan to 2027 which provides strategic future for Singleton	**2.6.4**
72	SSC	Confirm if SEPP33 applies and follow PHA if required	**4.3.3**
73	UHSC	Welcomes further consultation with the Project and updates	**5**
74	TransGrid	Work with Connection Enquiry and Connection Application process to determine the feasibility and scope of the proposed wind farm connection to TransGrid's network	**5**
75	TransGrid	Adhere to Easement Guidelines, Fencing Guidelines	**7.4**

Table B4
Clauses 6 and 7 of Schedule 2 of the EPA Regulations and where Addressed

Clause	Section
6 Form of environmental impact statement An environmental impact statement must contain the following information (a) the name, address and professional qualifications of the person by whom the statement is prepared,	EIS Statement
(b) the name and address of the responsible person,	EIS Statement
(c) the address of the land— (i) in respect of which the development application is to be made, or	EIS Statement
(ii) on which the activity or infrastructure to which the statement relates is to be carried out,	EIS Statement
(d) a description of the development, activity or infrastructure to which the statement relates,	**3**
(e) an assessment by the person by whom the statement is prepared of the environmental impact of the development, activity or infrastructure to which the statement relates, dealing with the matters referred to in this Schedule,	**7**

Clause				Section
(f)	a declaration by the person by whom the statement is prepared to the effect that—			EIS Statement
	(i)	the statement has been prepared in accordance with this Schedule, and		
	(ii)	the statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure to which the statement relates, and		
	(iii)	that the information contained in the statement is neither false nor misleading.		
7	**Content of environmental impact statement**			Executive Summary
(1)	An environmental impact statement must also include each of the following—			
	(a)	a summary of the environmental impact statement,		
	(b)	a statement of the objectives of the development, activity or infrastructure,		**3**
	(c)	an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure, having regard to its objectives, including the consequences of not carrying out the development, activity or infrastructure,		**3.10**
	(d)	an analysis of the development, activity or infrastructure, including—		
		(i)	a full description of the development, activity or infrastructure, and	**3**
		(ii)	a general description of the environment likely to be affected by the development, activity or infrastructure, together with a detailed description of those aspects of the environment that are likely to be significantly affected, and	**2**
		(iii)	the likely impact on the environment of the development, activity or infrastructure, and	**7**
		(iv)	a full description of the measures proposed to mitigate any adverse effects of the development, activity or infrastructure on the environment, and	8
		(v)	a list of any approvals that must be obtained under any other Act or law before the development, activity or infrastructure may lawfully be carried out,	4.6
	(e)	a compilation (in a single section of the environmental impact statement) of the measures referred to in item (d)(iv),		**8**
	(f)	the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development set out in subclause (4).		**3.10**
(2)	Subclause (1) is subject to the environmental assessment requirements that relate to the environmental impact statement.			Noted
(3)	Subclause (1) does not apply if—			N/A
	(a)	the Planning Secretary has waived (under clause 3(9)) the need for an application for environmental assessment requirements in relation to an environmental impact statement in respect of State significant development, and		N/A

Clause	Section
(b) the conditions of that waiver specify that the environmental impact statement must instead comply with requirements set out or referred to in those conditions.	
Note: *A cost benefit analysis may be submitted or referred to in the reasons justifying the carrying out of the development, activity or infrastructure.*	**7.8**
(4) The principles of ecologically sustainable development are as follows— (a) the ***precautionary principle***, namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certain should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by— (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and (ii) an assessment of the risk-weighted consequences of various options,	**7.5**
(b) ***inter-generational equity***, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations,	**7.5**
(c) ***conservation of biological diversity and ecological integrity***, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,	**7.5**
(d) ***improved valuation, pricing and incentive mechanisms***, namely, that environmental factors should be included in the valuation of assets and services, such as (i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement, (ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste, (iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.	**7.5**

EPURON

APPENDIX C

Study Team

BOWMANS CREEK
WIND FARM

environmental impact statement

Section	EIS Component / Role	Team Member and Company	
Project Management			
	General Manager, Wind	Andrew Wilson	Epuron
	Project Manager	Julian Kasby	
EIS Management			
	Project Director	James Bailey	Hansen Bailey
	Project Manager	Dianne Munro	
	Project Coordinator	Theresa Folpp	
Stakeholder Engagement			
	Stakeholder Liaison	Brett Peterkin	Peterkin Consulting
	Project Manager	Julian Kasby	Epuron
	Development Manager	Grant Alderson	
	Executive Director	Martin Poole	
EIS Sections			
	Executive Summary	Dianne Munro	Hansen Bailey
1	Introduction	Theresa Folpp	
2	Strategic Context	Theresa Folpp	
3	The Development	Dianne Munro	
4	Statutory Context	Andrew Wu	
5	Stakeholder Engagement	Theresa Folpp	
6	Risk Assessment	Dianne Munro	
7	Impacts, Management and Mitigation	Dianne Munro, Andrew Wu, Bronwyn Pressland and Theresa Folpp	
8	Management and Mitigation Summary	Dianne Munro	
9	Merit Evaluation	Dianne Munro	
10	Abbreviations	Theresa Folpp	
Appendices			
Appendix A	Schedule of Land to which this EIS Applies		Epuron
Appendix B	SEARs and Regulatory Input to the SEARs		Hansen Bailey
Appendix C	Study Team		Hansen Bailey
Appendix D	WTG Towers, Coordinates & Maximum Heights		Epuron
Appendix E	Assessed Associated, Neighbour and Non-Associated Landholders		Epuron
Appendix F	Statutory Compliance Table		Hansen Bailey

Section	EIS Component / Role	Team Member and Company	
Appendix G	Stakeholder Engagement Issues and Where Addressed	Theresa Folpp	Hansen Bailey
Appendix H	Landscape and Visual	Andrew Homewood	Green Bean Design
Appendix I	Noise and Vibration	Jason Turner & Mathew Ward	Sonus
Appendix J	Aviation Safety	Keith Tonkin & Pavel Davidyuk	Aviation Projects
Appendix K	Traffic and Transport	Hayden Calvey	Cardno
Appendix L	Biodiversity	David Robertson & Gitanjali Katrak	Cumberland Ecology
Appendix M	Aboriginal and Cultural Heritage	Ben Churcher	Ozark
Appendix N	Historic Heritage	Ben Churcher	Ozark
Appendix O	Economics	Rob Gillespie	Gillespie Economics
Appendix P	Telecommunications	Lawrence Derrick	Lawrence Derrick & Associates
Appendix Q	SIA Supporting Information	Bronwyn Pressland	Hansen Bailey
Drafting and Graphics Design by: Virgil Robinson and John Noonan at Epuron, Bree Dansie at Hansen Bailey. Figures are correct to scale at A4.			

EPURON

APPENDIX D

Wind Turbine Generator Towers, Coordinates and Maximum Heights

BOWMANS CREEK
WIND FARM

environmental impact statement

ID	Easting	Northing	Latitude	Longitude	Base elevation (AHD m)	Tip elevation (AHD m)
6	326641	6425938	-32.2899	151.159	400	620
7	327090	6426042	-32.2891	151.164	416	636
8	326607	6426600	-32.2840	151.159	448	668
9	327253	6427327	-32.2775	151.166	377	597
10	327671	6427498	-32.2760	151.170	408	628
12	326127	6437085	-32.1893	151.156	527	747
13	325782	6434694	-32.2109	151.151	635	855
14	325907	6435040	-32.2078	151.153	622	842
15	325709	6435849	-32.2004	151.151	571	791
16	325821	6436296	-32.1964	151.152	591	811
17	325986	6436709	-32.1927	151.154	566	786
18	326167	6425180	-32.2967	151.154	435	655
19	325701	6424256	-32.3050	151.149	436	656
20	326457	6425481	-32.2940	151.157	405	625
21	325559	6434354	-32.2139	151.149	618	838
22	324402	6422259	-32.3228	151.135	435	655
23	324441	6422683	-32.3189	151.135	459	679
24	324468	6423318	-32.3132	151.135	413	633
25	324556	6423809	-32.3088	151.136	467	687
26	320963	6429776	-32.2544	151.099	560	780
27	320742	6428949	-32.2619	151.097	557	777
28	320897	6429356	-32.2582	151.099	523	743
29	320906	6430194	-32.2507	151.099	553	773
30	321236	6430487	-32.2481	151.102	515	735
31	321617	6430718	-32.2460	151.107	509	729
32	319486	6426773	-32.2813	151.083	457	677
33	319292	6426414	-32.2845	151.081	525	745
34	318636	6432530	-32.2292	151.075	616	836
35	317972	6430942	-32.2434	151.068	684	904
36	317607	6431408	-32.2392	151.064	674	894
37	318345	6431731	-32.2364	151.072	657	877
38	319354	6432404	-32.2305	151.083	528	748
39	319155	6432041	-32.2337	151.081	621	841
40	318479	6432142	-32.2327	151.074	673	893
41	317652	6428942	-32.2614	151.064	495	715

ID	Easting	Northing	Latitude	Longitude	Base elevation (AHD m)	Tip elevation (AHD m)
42	317341	6429767	-32.2539	151.061	589	809
43	317872	6429637	-32.2552	151.067	599	819
44	318747	6430296	-32.2494	151.076	604	824
45	318812	6430696	-32.2458	151.077	579	799
46	317729	6430189	-32.2502	151.065	691	911
47	317937	6430494	-32.2475	151.067	688	908
48	316690	6426659	-32.2819	151.053	593	813
49	318072	6427316	-32.2762	151.068	562	782
50	318791	6427627	-32.2735	151.076	498	718
51	317846	6433652	-32.2190	151.067	606	826
52	318208	6432995	-32.2250	151.071	617	837
57	317749	6434174	-32.2143	151.066	548	768
58	316718	6429096	-32.2599	151.054	526	746
59	316312	6427955	-32.2701	151.050	532	752
60	315743	6429184	-32.2589	151.044	472	692
61	315870	6429605	-32.2552	151.045	526	746
63	316770	6429613	-32.2552	151.055	539	759
64	315658	6426711	-32.2812	151.043	560	780
66	315104	6425568	-32.2914	151.036	497	717
67	315329	6425926	-32.2882	151.039	521	741
68	315493	6426309	-32.2848	151.041	555	775
69	315911	6427045	-32.2782	151.045	573	793
70	316004	6427446	-32.2746	151.046	553	773
71	325370	6434047	-32.2166	151.147	543	763
72	325676	6425133	-32.2970	151.149	425	645

EPURON

APPENDIX E

Assessed Associated, Neighbour and Non-Associated Dwellings

BOWMANS CREEK
WIND FARM

environmental impact statement

Table E1
Assessed Associated, Neighbour and Non-Associated Dwellings

Residence ID	Closest WTG to Residence	Distance to closest WTG (m)
P22-1	23	1,381
T6-1*	12	1,533
P22-4	23	1,569
G15-1*	60	1,696
S17-2	9	1,705
R17-1*	8	1,942
G15-3	60	1,958
G17-1	64	2,041
G15-2*	60	2,096
S17-1*	8	2,116
V20-2*	7	2,148
U6-1*	12	2,197
V20-1	7	2,246
T6-9	12	2,256
T15-2	10	2,273
W20-1*	7	2,279
T15-1	10	2,467
F16-1	60	2,501
H12-3	57	2,570
H11-1	57	2,574
F18-1	68	2,580
T6-2	12	2,582
H10-2*	57	2,616
F19-1	66	2,626
H12-2	51	2,672
F17-1	60	2,827
H10-1*	57	2,898
T5-1	12	2,954
H12-1	51	3,016
Q17-2	28	3,031
F16-2	60	3,052
E19-1	66	3,119
O22-1	23	3,119
S5-1*	12	3,122
Q17-3	8	3,126
Q17-1	27	3,140
N21-1	33	3,252
N21-2	24	3,258
H11-2	57	3,259
X17-2*	10	3,296
W8-1	12	3,305
M9-1*	57	3,377
S15-1*	9	3,396

Residence ID	Closest WTG to Residence	Distance to closest WTG (m)
M9-2*	57	3,424
S4-1	12	3,508
X17-3*	10	3,515
P7-1	17	3,519
E18-2	66	3,564
X17-1*	10	3,677
I23-1*	66	3,706
N22-1	33	3,733
M8-1*	57	3,811
E18-1	66	3,884
Y17-2	10	3,887
G11-1	57	4,001
H8-1	57	4,034
E17-5	66	4,055
L23-1	33	4,065
G12-1	57	4,076
E17-3	68	4,087
Q5-1	12	4,109
Y17-1	10	4,133
Y18-1	10	4,142
M23-2	33	4,146
D18-3	66	4,167
W14-1	10	4,172
E17-1	66	4,180
Y19-5	10	4,222
D18-2	66	4,239
E17-4	66	4,268
W22-1	7	4,299
D21-2	66	4,314
M23-1	22	4,322
Y19-3	10	4,330
E17-6	60	4,333
E17-2	66	4,342
K23-1	66	4,350
D18-1	66	4,357
D17-2	66	4,390
Y19-4	10	4,390
H7-1	57	4,406
D21-4	66	4,411
Y20-1	10	4,453
D18-4	66	4,515
I24-2	66	4,522
D18-6	66	4,523
V25-2	22	4,562
Y15-1	10	4,566
D17-3	66	4,569

Residence ID	Closest WTG to Residence	Distance to closest WTG (m)
D16-1	60	4,570
Y19-2	10	4,591
D18-7	66	4,598
Y20-2	7	4,614
K23-2	33	4,699
Y19-1	10	4,703
D18-5	66	4,706
X22-1	7	4,767
E12-5	61	4,772
F12-2	61	4,773
Y21-3	7	4,800
X21-1	7	4,808
L23-2	33	4,905
P4-1	12	4,926
F12-1	61	4,954
F11-2	61	5,205
E12-2	61	5,354
F11-1	61	5,375
D13-1	61	5,462
E11-7	57	5,503

** Associated dwelling*

EPURON

APPENDIX F

Statutory Compliance Table

BOWMANS CREEK
WIND FARM

environmental impact statement

Table F1
Statutory Compliance Table

Aspect	Summary	Legislation
Power to grant approval	The Project is declared to be SSD	Schedule 1 of SRD SEPP
	The consent authority for SSD is the IPCN or Minister for Planning and Public Spaces	Section 4.5 of the EP&A Act Clause 8A of SRD SEPP
Permissibility	Electricity generating works are permissible on land is a prescribed rural zone	Clause 34 of the Infrastructure SEPP
	Infrastructure SEPP prevails over LEPs where there is an inconsistency	Clause 8 of the Infrastructure SEPP
Pre-conditions to granting of approval	An application for SSD must be accompanied by an EIS	Section 4.12 of the EP&A Act
	A development application for SSD must be placed on public exhibition for a minimum of 28 days	Schedule 1 of the EP&A Act
	Landowner's consent is required to lodge the application in respect of the Project	Clause 49 of the EP&A Regulation
	A BDAR must be prepared	Part 7 of the BC Act
Mandatory considerations	A preliminary hazard analysis is not required because the Project is not a potentially hazardous industry	Clause 13 of SEPP 33
	The consent authority must consider whether the land is core koala habitat or contains feed tree species	Clause 9 of Koala SEPP
	The consent authority must consider whether the land is contaminated	Clause 7 of SEPP 55
Other requirements	Duty to control the spread of noxious weeds and feral animals	Section 22 of the Biosecurity Act
	Duty to notify CASA of structures that are taller than 110 m	Regulation 139.365 of the CAS Regulation
Post Approvals	Development Consent	Division 4.7 of Part 4 of the EP&A Act
	Subdivision Works Certificate(s)	Division 2A of Part 8 of the EP&A Act
	An EPL is required for the Project due to meeting scheduled activity threshold. An EPL must be granted in accordance with Section 4.42 of the EP&A Act	Section 48 of the POEO Act Section 4.42 of the EP&A Act
	Consent of the Roads Authority is required for proposed upgrades to local roads. Consent must be granted in accordance with Section 4.42 of the EP&A Act	Section 138 of the Roads Act Section 4.42 of the EP&A Act

Aspect	Summary	Legislation
	Special purpose lease or special purpose licence is required to carry out development on Crown land	Section 5.30 of the CLM Act
	A 'bushfire safety authority' is required for subdivision of bushfire prone land	Section 100B of the RF Act
	Approval under the EPBC Act is required as the Project is declared to be a controlled action. The action is to be assessed via accredited assessment under the EP&A Act	Section 68 of the EPBC Act
	Required if final year greenhouse gas exceeds thresholds of the NGER Act. To be determined.	Section 13 Notification
	Management Plans and other conditions of consent. To be determined	If required by other licences and approvals

EPURON

APPENDIX G

Stakeholder Engagement Issues and Where Addressed

BOWMANS CREEK
WIND FARM

environmental impact statement

Table G1
Stakeholder Issues and Responses – Community and CCC

Ref	Issue	EIS Section
	Noise	
1.	Methodology • Effectiveness and justification of assessment criteria (including Noise Bulletin)	7.2
2.	Background noise / monitoring: • Locations • Effectiveness during "*windy period*" • How is it distinguished from Project noise • Not undertaken in winter	7.2.1
3.	Type of noise: • Produced by turbines based on speed of turbines • Based on turbine model (EIS and Scoping Report)	7.2.3
4.	Impacts (including on animal and human health): • All frequencies (low / infrasound) • Vibration • Air drainage lines will funnel noise into Muscle Creek • Receivers > 3 km	7.2.3
	Ecology	
5.	Survey Methodology • Location (including National Park fauna corridor) • Timing • Species included (bird and microbat)	7.5.2
6.	Impacts • Fauna – native / threatened species and nesting (birds, eagles, owls). Brown Goshawk, Sparrow Hawk, Barn Owl, Powerful Owl, Glossy Black Cockatoo, Lewins Honeyeater • Flora – habitat for threatened species, remnant rainforest, dry rainforest (near T4) (WTGs removed see **Table 7**), cool temperate rainforest (near T13). • Disturbance and offsets • Jolly Springs directly feeds the local ecosystems (WTGs removed see **Table 7**) • High environmental value of the area	7.5.3
	Water	
7.	Water licencing	4.4.7
8.	Impact to Jolly Springs	Table 7

Ref	Issue	EIS Section
	Visual	
9.	Methodology • Process for assessing receivers > 3 km • Include Scottish Visual Guideline • Include Heritage Items and other environmental features • Photomontage locations and accuracy	7.1.2
10.	Impacts • Visual amenity, local scenic quality and National Parks (from turbines, monitoring masts and transmission line) • Visual amenity to the wider community including Muswellbrook • Shadow Flicker hours per year • 220 m high turbine. High visibility at long distance including from Singleton • Lighting	7.1.3
11.	Mitigation and Management • Private receivers and wider community • Turbine colour	7.1.4
	Aviation	
12.	Impacts to application of aerial fertiliser, aviation safety and emergency access (e.g. Westpac Helicopter)	7.3.3
	Heritage	
13.	Impact on Aboriginal and European heritage	7.6 & 7.7
	Hazard	
14.	Firefighting access	7.10.4
15.	Increase to bushfire threat	7.10.3
16.	Management of bushfire	7.10.4
17.	Consultation requirements for bushfire	7.10.4
	Health	
18.	Noise impacts	7.19.2
19.	Transmission line impacts	7.18
20.	Epilepsy caused by shadow flicker	7.19.3
	Project Description	
21.	Project timeline in planning process	1.6
22.	Proponent credentials	1.5
23.	Project Layout • Turbine and transmission line location • Grid connection • Alternatives considered	3

Ref	Issue	EIS Section
24.	Construction • Timeline • Methodology for steep terrain • Civil engineering	3.2
25.	Operation • Maintenance • Wind resource • Energy payback / life cycle benefit	3.3.4 2.7.1 7.13.2
26.	Decommissioning process and waste	3.8
27.	Monitoring masts	2.2
28.	Land use compatibility and land management (impacts to cattle)	7.16.2
29.	Commitments in EIS unable to be adhered to by Proponent as the Proponent will not build wind farm	8
	Traffic	
30.	Accident statistics	3.6.1
31.	Impacts • Access routes for all vehicles (avoid the use of Goorangoola Road) • Heavy vehicle access • Road upgrades (and avoid vegetation on Scrumlo Road) • Traffic movements (NEH and local roads)	3.6 & Table 24
	Economics	
32.	Economic contribution during construction and operation (including employment)	7.8
	Property Value	
	Property value	7.12
	Communications	
33.	Impacts to communications facilities (e.g. NBN)	7.9.3
	Stakeholder	
34.	CCC setup and administration	5.4.1
35.	Availability of project information	5.4.1
36.	Extent of consultation with neighbours, specifically >3 km	5.4.1
37.	Community Information Sessions	5.4.1
38.	Delivery of newsletter (location and timing)	5.4.1
39.	Council briefing of issues	5.4.1
40.	Landholder agreements and benefit sharing	2.5
41.	VPA	3.1
	Social	
42.	Public safety and security and community cohesion	7.23.6 & 7.23.7
43.	Impacts to lifestyle, quality of life, tourism / recreation	7.23.6 & 7.23.7

Table I2
Stakeholder Issues and Responses – Regulator

Stakeholder Category	Issue	Section
Local		
MSC	• Local government road interactions and impacts	3.6
MSC	• Risks of weed infestation	Table 48
MSC	• VPA	3.1
UHSC	• Dwellings which would have view of turbines	7.1.3
UHSC	• Consider UHSC strategic planning documents	2.6.4
UHSC	• VPA	3.1
SSC	• Employment of apprentices and encouragement of local employment	7.23.6
SSC	• Road maintenance regime during operation	7.4
SSC	• Glencore Hebden road realignment (as part of Glendell Proposal)	3.6
SSC	• Local government road interactions and impacts	3.6
SSC	• Community Economic Development Fund	3.1
SSC	• VPA	3.1
State Government Agencies		
DPIE	• Traffic: Assess Port to NEH turnoff with Hebden road, including upgrades	3.6
DPIE	• Zoning: check E3 zones within 10 km and provide for visual assessment	7.1
DPIE	• SEARs Cumulative	7.24
DPIE	• VPA	3.1
DPIE	• Ecology and offsets	5
BCD	• Offset liability in consideration of drought	7.5
BCD	• Survey methodology for bats and bird flying paths	7.5
MEG	• Avoid mining authorisations and coal resources	2
DoI - Crown	• Confirm if ‘trig station’ block to be impacted	4.4.8
DoI - Crown	• Undertake Crown “status search”	4.4.8
DoI - Crown	• Identify impacts to all TSR blocks and paper roads	4.4.8
DoI – Water	• No response	N/A
DoI – Agriculture	• No response	N/A
EPA	• No comment	N/A

Stakeholder Category	Issue	Section
TfNSW	• Speed of OSOM vehicles, swept path for Tarro Bridge, consideration of M1 to Raymond Terrace and Hexham Straight projects	7.4
TransGrid	• Preliminary Technical Assessment received August 2020	N/A
Dept Finance, Services and Innovation – Telco Authority	• No response	N/A
LLS	• None	N/A
DoD	• Written response 13 October 2020. • Obstacle lighting and if LED applied, frequency range within the range of wavelengths 665 to 930 nanometres to allow for visibility to persons using night vision devices; and • Notification of final wind turbine locations.	7.3
CASA	• Proponent must send Vertical Obstacle Notification Form to Air Services Australia	7.3.4
Federal Government Agencies		
DAWE	• Offset liability	7.5.4
DAWE	• Decommissioning options	3.8
DAWE	• *Biodiversity Conservation Regulations NSW 2019*	4.4.4