Collector Wind Farm

View toward the proposed Collector Wind Farm

LANDSCAPE & VISUAL IMPACT ASSESSMENT

Prepared for:

RATCH-Australia Corporation

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Prepared by:

GREEN BEAN DESIGN
landscape architects

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Reference V5 – Final

Green Bean Design – Capability Statement

Green Bean Design is an experienced landscape architectural consultancy specialising in landscape and visual impact assessment. As an independent consultant Green Bean Design provide professional advice to a range of Clients involved in large infrastructure project development.

Green Bean Design Principal Landscape Architect Andrew Homewood is a Registered Landscape Architect and member of the Australian Institute of Landscape Architects. With over 18 years continuous employment in landscape consultancy Andrew has completed numerous landscape and visual impact assessments for a variety of large scale electrical infrastructure and renewable energy projects, including wind energy and solar power developments.

Green Bean Design has participated in fourteen wind energy projects across New South Wales and Victoria including assessments for:

• Silverton Wind Farm	• Boco Rock Wind Farm	• Collector Wind Farm
• Crookwell 3 Wind Farm	• Sapphire Wind Farm	• Willatook Wind Farm
• Eden Wind Farm	• Birrema Wind Farm	• White Rock Wind Farm
• Paling Yards Wind Farm	• Gnotuk Wind Farm	• Port Kembla Wind Farm
• Deepwater Wind Farm	• Rye Park Wind Farm	

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Executive Summary

Green Bean Design (GBD) was commissioned by RATCH Australia Corporation Limited (the Proponent) to undertake a Landscape and Visual Impact Assessment (LVIA) for the Collector Wind Farm and associated development infrastructure (the Project). The Project would include up to 68 wind turbines measuring up to 150m from ground level to tip of blade, associated electrical works including transmission line, substation, facilities building and a small car park.

This LVIA involved a desk top study and field inspection to collect and analyse information to describe and define landscape characteristics of the area in which the Project would be located. This LVIA has determined that the landscape surrounding the Project has an overall medium sensitivity to accommodate change, and represents a landscape that is reasonably typical of landscape character areas that are commonly found in the surrounding area of the New South Wales Southern Tablelands and the NSW/ACT Border Region Renewable Energy Precinct.

As a landscape with an overall medium sensitivity to accommodate change, some recognisable characteristics of the landscape will be altered by the Project, and result in the introduction of visually prominent elements that will alter some perceived characteristics of the landscape. Some changes may be partially mitigated by existing landscape elements and features within the landscape.

In the context of landscape sensitivity, this LVIA has determined that the Project would not be an unacceptable development within the Collector Wind Farm 10km viewshed, which in a wider context also contains built elements such as roads, agricultural industry, aircraft landing strips, communication towers, overhead transmission lines as well as operational wind farms within and beyond the broader area of the Project viewshed.

The Project visibility was determined within the 10 km radius of the wind farm development and illustrated by a series of panoramic photographs and the Zone of Visual Influence (ZVI) diagrams. The ZVI diagrams demonstrate the influence of topography on visibility and identify areas from which the wind farm turbines would be visible. The ZVI diagrams are illustrated in **Figures 3** and **4**, and the panoramic photographs are illustrated in **Figures 9** to **14**.

This LVIA assessed the potential visual impact of the Project for the majority of residential view locations within the Projects 10km viewshed as well as impacts for motorists travelling along highways and local roads surrounding the wind farm. A number of criteria were considered and assessed to determine levels of visual impact.

A total of eighty six residential view locations within the Project 10km viewshed have been determined to have a low or nil visual impact. Eighteen of the residential view locations would have low to moderate or moderate visual impact, and four of the residential view locations would have a moderate to high visual impact. Three of the non associated residential view locations would have a high visual impact and three of the associated residential properties a high visual impact.

Executive Summary

This LVIA assessed the potential visual impact associated with the proposed substation and associated electrical infrastructure and determined that the overall visual impact of these elements would be low due to their location relative to existing view locations together with screening influence of surrounding topography and vegetation.

A cumulative visual impact assessment identified four wind energy developments within, or in close proximity, to the proposed Collector Wind Farm viewshed. These include the operational Cullerin, Capital, Gunning and Woodlawn Wind Farm projects. This LVIA determined that there would be some intervisibility between the proposed Collector Wind Farm and the operational Cullerin Wind Farm; however, 'direct' or 'indirect' views between the Collector Wind Farm and other wind farms within the region are largely limited by separation distance and topography.

This LVIA notes that further to the withdrawal of the CASA Advisory Circular there are no guidelines by which to define criteria for wind farm night time obstacle lighting, and that night time lighting has been determined as not required for the Gullen Range Wind Farm. Night time obstacle lighting has also been removed from the Cullerin Wind Farm to the north of the proposed Collector Wind Farm site. The Proponent does not propose to install night time obstacle lighting on the proposed Collector Wind Farm turbines subject to further advice from CASA.

Although some mitigation measures are considered appropriate to minimise the visual effects for a number of the elements associated with the wind farm, it is acknowledged that the degree to which the wind turbines would be visually mitigated is limited by their scale and position within the landscape relative to surrounding view locations.

Introduction

SECTION 1

1.1 Introduction

This LVIA addresses one of the key requirements of the Collector Wind Farm Environmental Assessment (EA) to be submitted and assessed under Part 3A of the Environmental Planning & Assessment Act 1979 (EP&A Act).

This LVIA methodology adopted by GBD has been applied to a number of similar LVIA for large scale infrastructure projects, including wind energy projects, prepared by GBD, which have been assessed and approved by the New South Wales Department of Planning & Infrastructure (NSW DoPI) under Part 3A of the EP&A Act.

This LVIA addresses and responds to the Director General's Requirements (DGR's) dated 15th October 2010, for the assessment of potential landscape and visual impacts of the project. **Table 1** outlines the relevant landscape and visual impact assessment requirements of the DGR's and the corresponding section in which they are addressed within this LVIA report.

Table 1 Director General's Requirements

DGR's	Report Reference
• provide a comprehensive assessment of the landscape character and values and any scenic or significant vistas of the area potentially affected by the project taking into consideration cumulative impacts from surrounding approved or operational wind farms in the locality (in particular Cullerin and Capital wind farms). This should describe community and stakeholder values of the local and regional visual amenity and quality, and perceptions of the project based on surveys and consultation.	Refer LVIA **Sections 6** and **14**.
• assess the impact of shadow 'flicker', blade 'glint' and night lighting from the wind farm on residents and road users.	Refer LVIA **Section 1.8** and Collector Wind Farm EA **Section 11.5**
• identify the zone of visual influence (no less than 10 kilometres) and assess the visual impact of all project components on this landscape.	Refer LVIA **Sections 7**and **8**.
• include an assessment of the visual impacts from transmission line infrastructure including any cumulative impacts.	Refer LVIA **Section 12.**
• include photomontages of the project taken from potentially affected residences (including approved but not	Refer LVIA **Section 10** and **Figures 20 to 24**.

DGR's	Report Reference
yet developed dwellings or subdivisions with residential rights), where the occupant is assessed as likely to experience a high level of visual impact as well as from settlements and significant public view points. The photomontage must take into account cumulative impacts from surrounding approved or operational wind farms in the locality and include representative views of turbine night lighting if proposed.	
• provide a clear description of proposed visual amenity mitigation and management measures and provide an assessment of the feasibility, effectiveness and reliability of proposed mitigation measures and any residual impacts after these measures have been implemented.	Refer LVIA **Section 15**.

GBD has also reviewed the Upper Lachlan Shire Council's Development Control Plan (2010) for Wind Farms and GBD confirm that this LVIA addresses a number of key DCP requirements with regard to consideration of visual assessment, including provision for:

- The assessment of visual impact and scenic value;
- The assessment of cumulative impact;
- Shadow Flicker Assessment;
- Viewshed mapping; and
- Photomontages.

The assessment of potential visual impact associated with Shadow Flicker has been assessed and included in **Section 11.5** of the EA.

GBD is cognisant of the Australian Wind Energy Association and Australian Council of National Trust's publication Wind Farms and Landscape Values National Assessment Framework, June 2007, and have encompassed the general assessment framework outlined in the National Assessment Framework within the LVIA methodology. In addition to the National Assessment Framework, the preparation of this LVIA has also included a review of the National Wind Farm Development Guidelines (Public Consultation Draft V2.4 July 2010).

This LVIA involved a comprehensive evaluation of the landscape character in which the Collector Wind Farm and ancillary structures would be located, and an assessment of the potential landscape and visual impacts that could result from the construction and operation of the wind farm, taking into account appropriate mitigation measures. This LVIA is based on technical and design information provided by the Proponent to GBD.

1.2 National Assessment Framework

GBD is cognisant of the Australian Wind Energy Association and Australian Council of National Trust's publication Wind Farms and Landscape Values National Assessment Framework (NAF), June 2007, and have encompassed the general assessment framework outlined in the NAF within the LVIA methodology. In addition to the NAF, the preparation of this LVIA has also included a review of the National Wind Farm Development Guidelines (Public Consultation Draft V2.4 July 2010).

Table 2 outlines the relevant requirements of the NAF and the corresponding section in which they are addressed within this LVIA report.

Table 2 NAF Requirements

NAF Tasks (through Steps 1 to 4)	LVIA Reference/Response
Step 1 Assess the Landscape Values **1A Preliminary Landscape Assessment** • 1A.1 Desktop Review • 1A.2 Seek information from Local Authority • 1A.3 Identify potential community and stakeholder interests • 1A.4 Site survey • 1A.5 Preliminary assessment of landscape values **1B Full Landscape Assessment** • 1B.1 Define the study area for assessment, including the zone of visual influence • 1B.2 Landscape Character Analysis • 1B.3 Natural and cultural values analysis • 1B.4 Involve communities and stakeholders in identifying landscape values • 1B.5 Document values and analyse significance	This LVIA has been prepared through a comparable methodology to that outlined in the NAF and has included a desktop review (pre site inspection) to determine potential view locations as well as establishing the extent and types of landscape characteristics within the 10km viewshed. A review of Upper Lachlan Council's planning documents determined that no additional wind farm developments were current other than those notified on the DoPI website: (http://majorprojects.planning.nsw.gov.au/page/project-sectors/transport--communications--energy---water/generation-of-electricity-or-heat-or-co-generation/) Community and stakeholder interests have been identified by an ongoing process of direct consultation between the Proponent and relevant stakeholders. The results of the consultative process are included in this LVIA as well as other relevant sections of the **EA**. Site survey and preliminary assessment work has been undertaken and incorporated into this LVIA. The preparation of a separate preliminary assessment of landscape values is not a requirement under the NSW DoPI DGR's. This LVIA addresses the requirements of Step 1B and presents an analysis of key considerations included in the NAF.
Step 2 Describe and Model the Wind Farm in the Landscape • 2.1 Describe the development • 2.2 Model the development	This LVIA has described and modelled the Collector Wind Farm development and selected view points from a range of view locations including residential dwellings, road corridors and public lookouts within the 10km viewshed.

NAF Tasks (through Steps 1 to 4)	LVIA Reference/Response
• 2.3 Prepare a visual assessment report	
Step 3 Assess the Impacts of the Wind Farm on Landscape Values • 3.1 Seek community input to potential impacts • 3.2 Identify and describe impacts • 3.3 Identify potential cumulative impacts • 3.4 Identify other relevant factors • 3.5 Evaluate impacts	Community and stakeholder interests have been identified by an ongoing process of direct consultation between the Proponent and relevant stakeholders. The results of the consultative process are outlined and included in this LVIA as well as other relevant sections of the **EA**. This LVIA has identified and described potential landscape and visual impacts associated with the Collector Wind Farm development as well as potential cumulative impacts resulting from other wind farm projects within the NSW/ACT Border Region Renewable Energy Precinct.
Step 4 Respond to Impacts • 4.1 Changes to location or siting of the wind farm or ancillary infrastructure • 4.2 Layout and design considerations • 4.3 Minor changes and mitigation measures • 4.4 Recommend changes to the development	The development of the Collector Wind Farm turbine layout has been reviewed and adjusted throughout the preparation of this LVIA. Changes to the layout have occurred as a result of stakeholder consultation and specific concerns directed toward the visual impact of the wind farm from surrounding view locations. Significant changes have occurred throughout the development of the current proposed design layout including the removal and repositioning of turbines within the Collector Wind Farm layout.

The NAF is noted by its authors as a framework document and does not set out a detailed or prescribed method to undertake an assessment of landscape values. This LVIA has; however, followed the majority of techniques and has tested and determined outcomes for the principal issues that have been raised in the NAF.

1.3 Draft NSW Planning Guidelines Wind Farms (December 2011)

The NSW DoPI issued the Draft Planning Guidelines Wind Farms in December 2011, which provide guidance and information for wind farm applicants, consent authorities as well as communities and stakeholder groups. The draft guidelines set out key considerations for the upfront assessment of landscape and visual impact for residential dwellings within a 2km radius of proposed wind turbines (through the Gateway Process and Site Compatibility Certification) and specific assessment requirements that may be set out in the NSW DoPI Director Generals Requirements on a project by project basis. Whilst the draft guidelines are on public exhibition until 14th March 2012, this LVIA has regard to the draft guidelines and prepared photomontages from two of the three non associated residential dwellings within 2km of a wind turbine within the Collector Wind Farm. The Landscape and

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Visual Assessment Requirements set out in the draft guidelines are included in Appendix A of this LVIA.

1.4 Draft National Wind Farm Development Guidelines (July 2010)

The Draft National Wind Farm Development Guidelines, originally issued October 2009, have been revised following a first round of public consultation and comment. The revised Guidelines were re-issued in July 2010 for a second round of comments. The Guidelines aim to offer best practice advice and are not a mandatory requirement for wind farm developments within Australia.

The Guidelines adopt a staged approach to the assessment of landscape values and impacts. A Preliminary Stage is summarised by the following activities:

- Defining the scope and policy context;
- Preliminary landscape character and significance analysis;
- Preliminary view analysis;
- Preliminary community values analysis; and
- Identification of possible cumulative impacts.

1.5 Auswind Best Practice Guidelines (December 2006)

The Auswind Best Practice Guidelines were developed to assist wind farm proponents to implement best practice in regards to the location and siting of wind energy facilities and to conduct wind farm investigations and impact assessments. The guidelines have been subject to revisions following technical reviews and consultation with both industry and broader stakeholder input.

The Guidelines, developed between (the former) Auswind and the National Trust, provide a landscape assessment approach to describe, assess and evaluate the potential landscape and visual impact of a proposed wind energy project. A summary of the approach includes:

- Consultation with experts in the analysis of the environments visual characteristics e.g. Landscape Architects;
- Preparation of 'Zone of Visual Influence' or 'Seen Area Diagrams';
- Preparation of photomontages (also referred to as Visual Simulations);
- Determination of cumulative impact from existing wind energy projects;
- Investigation of impacts with associated infrastructure elements, including substation, service roads and power lines; and
- Assessment of Shadow Flicker.

The Auswind Best Practice Guidelines offer best practice advice and are not a mandatory requirement for wind farm developments within Australia.

1.6 Methodology

This LVIA methodology included the following key activities:

- Desktop study addressing visual character and identification of view locations within the surrounding area;
- Preparation of ZVI diagrams;
- Fieldwork and photography;
- Assessment and determination of landscape sensitivity;
- Assessment and determination of visual impact; and
- Preparation of photomontages and illustrative figures.

1.7 Desktop study

A desktop study was carried out to identify an indicative viewshed for the Project. This was carried out by reference to 1:25,000 and 1:50,000 scale topographic maps as well as aerial photographs and satellite images of the surrounding landscape. A preliminary ZVI diagram was also produced prior to the commencement of fieldwork in order to inform the likely extent and nature of areas within the nominated 10km viewshed of the Project.

Topographic maps and aerial photographs were also used to identify the locations and categories of potential view locations that could be verified during the fieldwork component of the assessment. The desktop study also outlined the visual character of the surrounding landscape including features such as landform, elevation, landcover and the distribution of settlements.

1.8 Preparation of ZVI Diagrams

GL-Garrad Hassan Pacific Pty Ltd (GL Garrad Hassan) prepared ZVI Diagrams to illustrate the potential visibility of the wind turbines within the Project 10km viewshed. ZVI Diagrams included visibility from tip of blade and hub height and are illustrated in **Figures 3** and **4**, and detailed in **Section 4** of this LVIA.

1.9 Fieldwork and Photography

The fieldwork involved:

- Site inspection to determine and confirm the potential extent of visibility of the Project and ancillary structures;

- Determination and confirmation of the various view location categories and locations from which the Project and ancillary structures could potentially be visible; and
- Preparation of a record for each view location inspected and assessed.

1.10 Assessment of Landscape Sensitivity

The potential impact of the Project on the sensitivity of the landscape surrounding the Project would result primarily from the capability of the landscape to integrate with, or to accommodate the wind farm.

The capability of the landscape to accommodate the wind farm would result primarily from the nature and degree of perceptual factors that can influence interpretation and appreciation of the landscape, including landform, scale, topographic features, landcover and human influence or modifications.

1.11 Assessment of Visual Impact

The potential visual impact of the Project on surrounding view locations would result primarily from a combination of the potential visibility of the wind turbines and the characteristics of the landscape between, and surrounding, the view locations and the Project. The potential degree of visibility and resultant visual impact would be partly determined by a combination of factors including:

- The category and type of situation from which people could view the Project (examples of view location categories include residential dwellings or road corridors);
- The visual sensitivity of view locations surrounding the Project;
- The potential number of people with a view toward the Project from any one location;
- The distance between view locations and the Project; and
- The duration of time people could view the Project from any particular static or dynamic view location.

An underpinning rationale for this LVIA is that if people are not normally present at a particular location, such as agricultural areas, or they are screened by landform or vegetation, then there is likely to be a very low or nil visual impact at that location.

If, on the other hand, a small number of people are present for a short period of time at a particular location then there is likely to be a low visual impact at that location, and conversely, if a large number of people are present then the visual impact is likely to be higher.

Although this rationale can be applied at a broad scale, this LVIA also considers, and has determined, the potential visual impact for individual view locations that would have a higher degree of sensitivity to the wind farm development, including the potential impact on individual residential dwellings

situated in the surrounding landscape. The determination of a visual impact is also subject to a number of other factors which are considered in more detail in this LVIA.

Whilst this LVIA addresses a number of static elements associated with the Project, the assessment acknowledges and has considered the potential visual impact associated with the movement of the wind turbine rotors.

1.12 Photomontages

The Proponent commissioned Truescape to prepare photomontages from 5 public view locations to illustrate the potential visibility of the Collector Wind Farm within the 10km viewshed. The Collector Wind Farm photomontages also include views toward the existing Cullerin Wind Farm where visible.

A number of additional photomontage have also been prepared from adjoining non associated residential dwellings but have not been included or presented in this LVIA at the request of individual landowners. The photomontage locations are illustrated in **Figure 19** and the photomontages in **Figures 20** to **26**.

1.13 Shadow Flicker & Sunlight Glint

The Proponent prepared a shadow flicker assessment and report for the Project. The results of the shadow flicker assessment are included elsewhere in the EA.

Sunlight glint is a phenomenon that results from the direct reflection of sunlight (also known as specular reflection) from a reflective surface that would be visible when the sun reflects off the surface of the wind turbine at the same angle that a person is viewing the wind turbine surface. Glint may be noticeable for some distance, but usually results in a low impact due to frequency of occurrence and the potential influence of local environmental factors including cloud cover.

The surfaces of the wind turbines, including the towers and blades, are largely convex, which will tend to result in the divergence of light reflected from the surfaces, rather than convergence toward a particular point which will also reduce the potential for blade glint.

Location

SECTION 2

2.1 Location

The Collector Wind Farm would be located in the NSW/ACT Border Region Renewable Energy Precinct and within the Upper Lachlan Shire Local Government Area. The Project would be around 55km north east of Canberra and 230km south west of Sydney.

The Project is around 3.5km to the north west of the Collector village and around 12km to the south east of Gunning. The Goulburn regional centre is around 25km to the north east. Collector, with a population of around 329 people, was first settled by Europeans around 1829. The village acted as a staging post between Goulburn and Southern Tableland towns to the south and west; however, the village was by-passed by the Federal Highway in 1988.

There are a number of historic buildings within the Collector village that are listed as heritage items within the Upper Lachlan Council Local Environment Plan and include the:

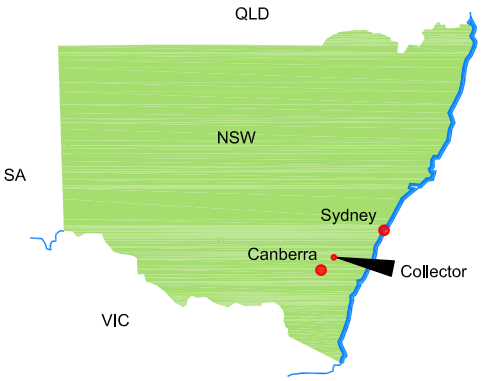
- Collector Memorial Hall;
- St Bartholomew's Roman Catholic Church;
- Uniting Church and Cemetery;
- Bushrangers Hotel;
- Collector Public School Building B00A and School Residence;
- Wheat Sheaf Inn; and
- Collector Inn.

The Project would extend across seven participating agricultural properties (the project area), covering an area around 6,216 hectares, administered by the Upper Lachlan Shire Council. The location of the Project is illustrated in **Figure 1**.

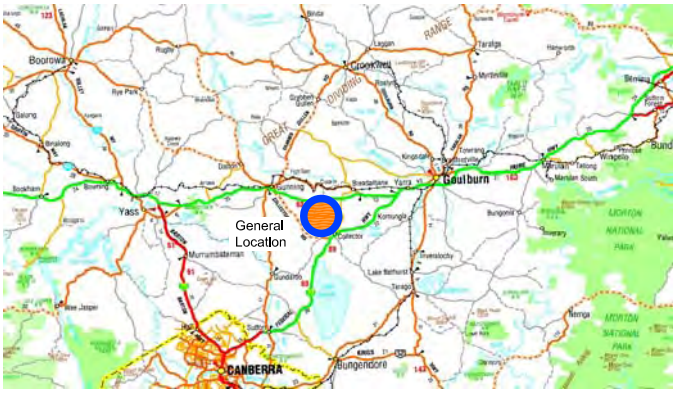
The Upper Lachlan Shire Council covers around 710,200 hectares covering large tracts of the NSW Southern Tablelands. The Project footprint would therefore occupy a very small proportion of the Councils administered area.

The Project would be located on several low undulating ridgelines and hills trending north south along the Cullerin Range, and toward the northern point of the Lake George escarpment. The project area is bounded by agricultural land and the Hume Highway to the north and Gunning Collector road to the south and south west.

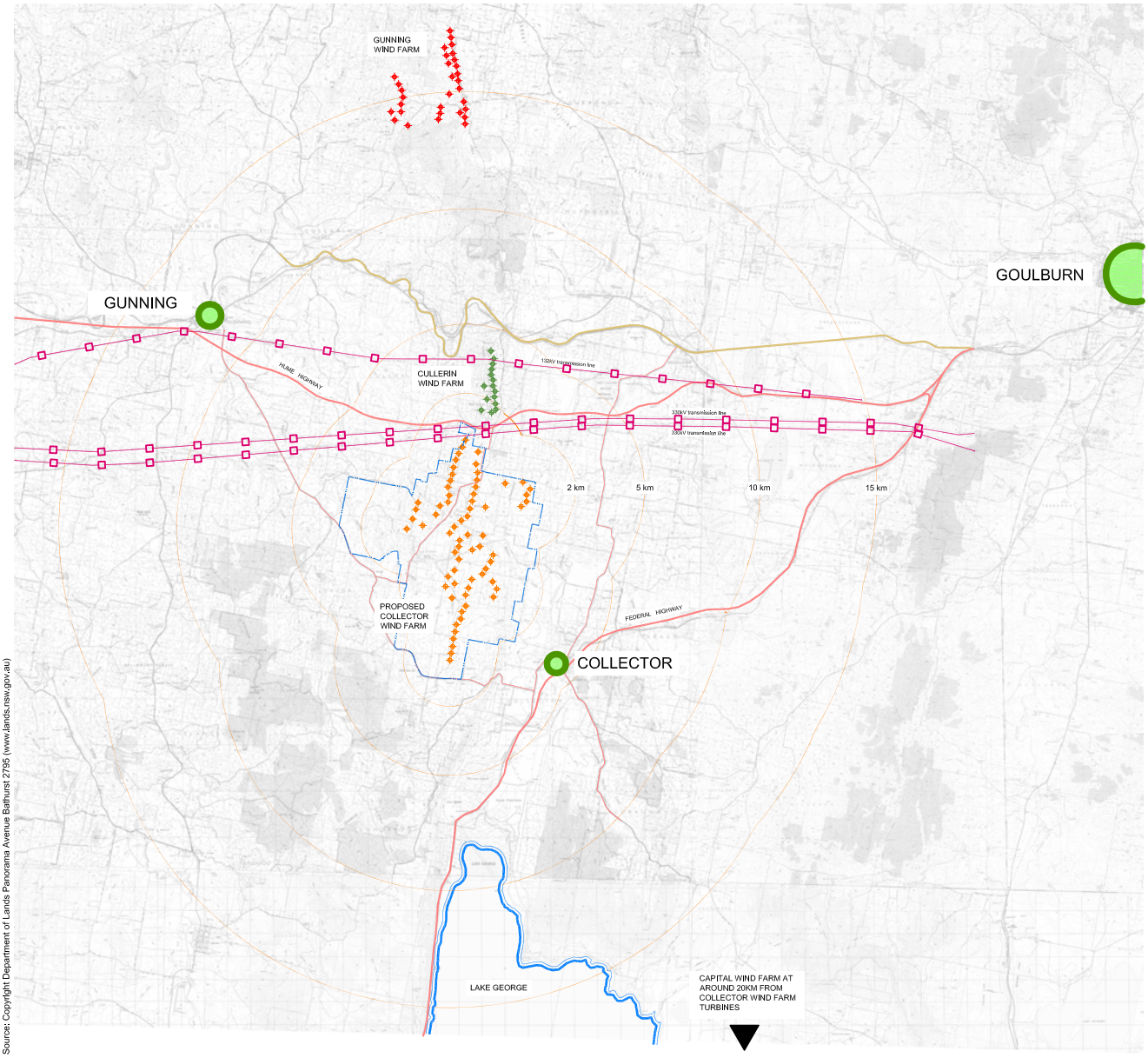
The project area is bisected by the Lerida Road South which runs approximately north south connecting the Gunning Collector road to the Hume Highway. The Lerida Road South is also the route



COLLECTOR WIND FARM -
LOCATION PLAN, STATE CONTEXT (Not to scale)



COLLECTOR WIND FARM -
LOCATION PLAN, REGIONAL CONTEXT (Not to scale)



COLLECTOR WIND FARM
LOCATION PLAN, LOCAL CONTEXT

0km 5km

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for a small section of the Bicentennial National Trail, a multi use route extending 5,330 km from Healesville in Victoria to Cooktown in northern Queensland.

The operational Cullerin Wind Farm is located along the Cullerin Range ridgeline to the north of the proposed Collector Wind Farm site. The closest Cullerin and Collector wind turbines would be around 1.3 km apart and separated by the Hume Highway road corridor and the dual 330kV transmission line easement.

A section of the Main Southern Railway (and Old Hume Highway) follows a meandering route across the Cullerin Range to the north of the Cullerin Wind Farm and would be around 3.6km at its closest point to the proposed Collector Wind Farm.

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3.1 Project description

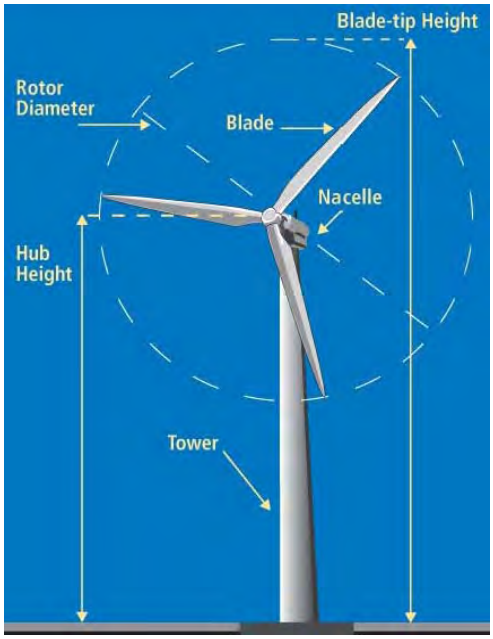
The key visual components of the Project would comprise:

- Up to 68 wind turbines (transformer equipment would be integrated within the nacelle);
- Individual transformers and switchgear with associated control systems to be located in the vicinity of the wind turbine towers (in some turbine models transformer equipment would be integrated within the tower or nacelle);
- Underground electrical and communication cable network linking turbines to each other within the site boundary;
- On site substation, internal 33kV reticulation and transmission line connection to the grid;
- Control room and facilities building;
- Up to 4 wind monitoring masts; and
- On site access tracks for construction, operation and ongoing maintenance.

Temporary works associated with the Project that may be visible during construction and operational stages include:

- Crane hardstand areas; and
- Mobile concrete batching plant.

The following diagram identifies the main components of a typical wind turbine:



Configuration and components of a typical wind turbine

3.2 Wind turbines

The specific elements of the wind turbines comprise:

- Concrete foundations;
- Tubular tapering steel towers;
- Nacelles at the top of the tower housing the gearbox and electrical generator (although not all turbine models include electrical generators within the nacelle);
- Rotors comprising a hub (attached to the nacelle) with three blades; and
- Three fibreglass blades attached to each hub.

Table 3 outlines the main design parameters for the proposed Collector wind turbines:

Table 3 Collector wind turbines

Element	Description
Tower height	94m
Rotor Diameter	112m
Overall height from ground level to tip of blade	150m
Proposed number of Collector wind turbines	**68 turbines**

The design layout of the Collector Wind Farm is illustrated in **Figure 2.**

3.3 Wind Monitoring Masts

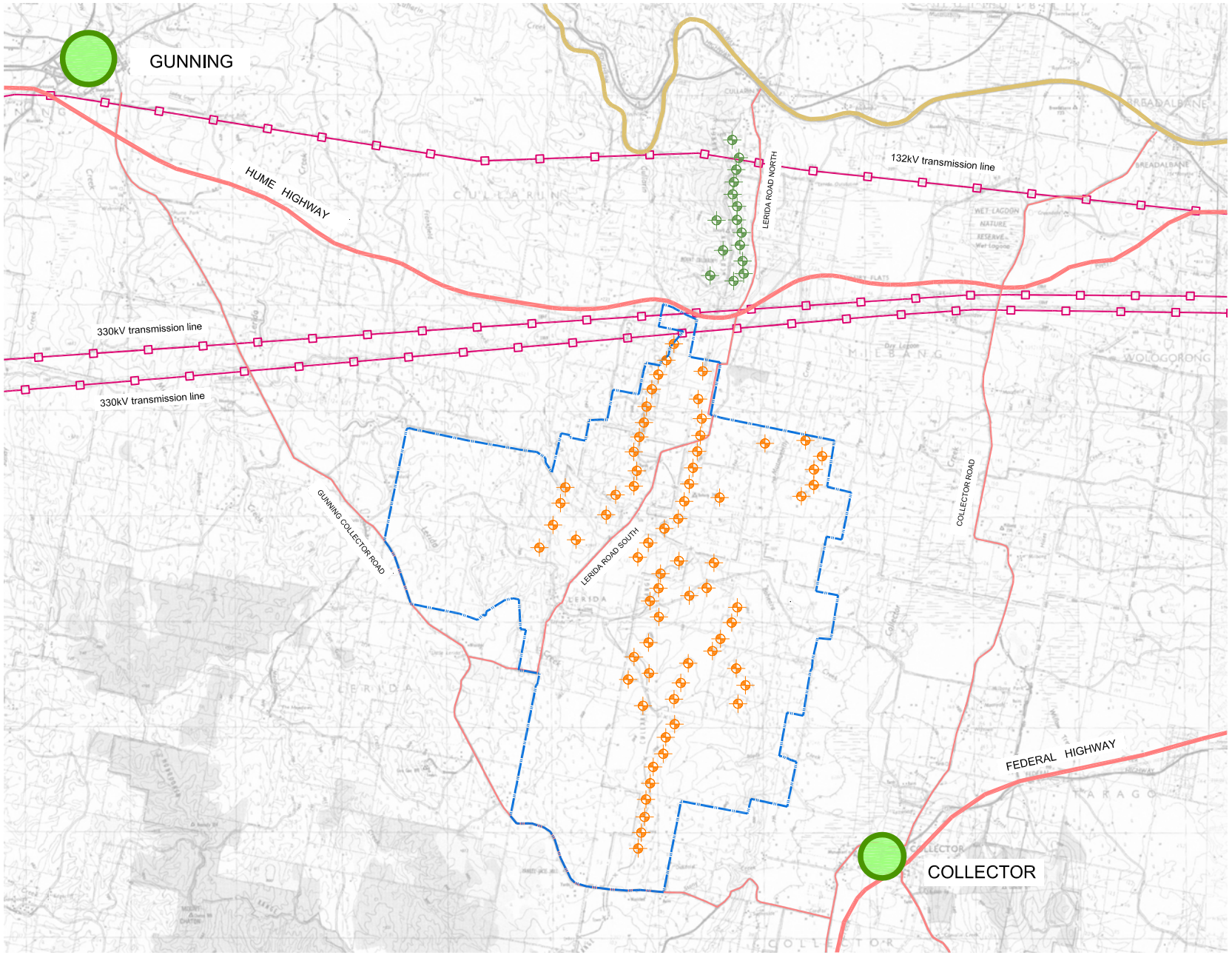
Up to four wind monitoring masts would be installed on-site, extending to around 94m in height. The wind monitoring masts would be of a guyed, narrow lattice or tubular steel design.

The wind monitoring masts would be unlikely to create a significant visual impact, and are similar in scale, or smaller than a number of surrounding communication masts visible in the landscape surrounding the Project area.

3.4 On-site access tracks

On-site access tracks would be constructed to provide access to turbine locations across the site during construction and operation. During construction the majority of access tracks would be approximately 8m wide to allow for vehicle manoeuvring, but may be increased up to 10m wide to allow for crane access if necessary. Following construction the width of the access tracks would be reduced to around 6m to facilitate access for maintenance vehicles during the operational phase.

The final access track design would be developed on a number of environmental grounds, including minimising the potential for visual impact by considering:



Legend

- Proposed Collector Turbine
- Cullerin Turbine (Operational)
- Collector Wind Farm Site Boundary
- Highway or Local Road
- Main Southern Railway
- Existing 132/330kV transmission line

0km 2km

Figure 2
Collector Wind Turbine Design Layout

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- the overall length and extent;
- the need for clearing vegetation;
- the potential for erosion;
- the extent of cut and fill; and
- the potential to maximise rehabilitation at the completion of the construction phase.

3.5 Electrical cabling

The majority of electrical cabling works, including the installation of control cables linking the turbines to the control building would be installed underground within the project area. The Collector wind turbines would be connected to an on-site single substation, control room and facilities for the grid connection.

Grid connection would be achieved via an overhead transmission line connection for approximately 250m from the proposed substation to the existing TransGrid 330kV transmission line which bypasses the north portion of the Project area.

The proposed electrical works are described in **Section 12**.

Viewshed, Zone of Visual Influence and Visibility SECTION 4

4.1 Introduction

A key component of this LVIA is defined by the description, assessment and determination of the viewshed, zone of visual influence and visibility associated with the Project. It is a combination of these issues that sets out the framework for determining the significance and magnitude of potential visual impact of the Project on view locations within the landscape.

In order to clarify and explain this component of this LVIA, the relationship between viewshed, zone of visual influence and visibility is outlined and defined in **Table 4**.

Table 4 – Definitions

	Definition	Relationship
Viewshed	An area of land surrounding and beyond the project area which may be potentially affected by the Project.	Identifies the majority of this LVIA study area that incorporates view locations that may be subject to a degree of visual impact.
Zone of Visual Influence (ZVI)	A theoretical area of landscape from which the Project structures may be visible.	Determines areas within a viewshed from which the wind turbines may be visible.
Visibility	A relative determination at which a wind turbine or group of wind turbines can be clearly discerned and described.	Describes the likely number and relative scale of wind turbines visible from a view location.

An overview of viewshed, zone of visual influence and visibility is discussed in the following sections.

4.2 Viewshed

For the purpose of this LVIA the viewshed is defined as the area of land surrounding and beyond the project area which could be potentially affected by the Collector Wind Farm. In essence, the viewshed defines this LVIA study area. The viewshed for the Project has been illustrated as a series of concentric bands (at 2km, 5km and 10km distance offsets) extending across the landscape from the wind turbines. The viewshed extent can vary between wind farm projects, and be influenced or informed by a number of criteria including the height of the wind turbines together with the nature, location and height of landform that could limit visibility.

It is important to note that the wind turbines would be visible from some areas of the landscape beyond the nominated viewshed; however, within the general parameters of normal human vision, a wind turbine at a maximum height of 150m to the tip of the rotor blade would occupy a relatively small proportion of a person's field of view from distances in excess of 10km.

The viewshed is used as a framework and guide for visibility assessment, as the degree of visual impacts would tend to be gradated with distance although there are unlikely to be any distinct or abrupt noticeable changes between the nominated distance bands. For the purpose of this LVIA, the viewshed assumptions for the Project are outlined in **Table 5**.

Table 5 – Viewshed Descriptors

Distance from turbine	Potential Viewshed Descriptors
>20km	Wind turbines become indistinct with increasing distance. Rotor movement may be visible but rotor structures are usually not discernable. Turbines may be discernable but generally indistinct within viewshed resulting in **Low** level visibility and **Nil** where influenced or screened by surrounding topography and vegetation.
10km – 20km	Wind turbines noticeable but tending to become less distinct with increasing distance. Blade movement may be visible but becomes less discernable with increasing distance. Turbines discernable but generally less distinct within viewshed (potentially resulting in **Low** level visibility).
5km – 10km	Wind turbines visible but tending to become less distinct depending on the overall extent of view available from the potential view location. Movement of blades discernable where visible against the skyline. Turbines potentially noticeable within viewshed (potentially resulting in **Low to Moderate** level visibility).
3 – 5km	Wind turbines clearly visible in the landscape but tending to become less dominant with increasing distance. Movement of blades discernable. Turbines noticeable but less dominant within viewshed (potentially resulting in **Moderate** level visibility).
1 – 3km	Wind turbines would generally dominate the landscape in which the wind turbine is situated. Potential for high visibility depending on the category of view location, their location, sensitivity and subject to other visibility factors. Turbines potentially dominant within viewshed (potentially resulting in **Moderate to High** level visibility).
<1km	Wind turbines would dominate the landscape in which they are situated due to large scale, movement and proximity. Turbines dominant and significant within viewshed (potentially resulting in **High** level visibility).

4.3 Zone of Visual Influence (ZVI)

The ZVI diagrams are used 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 Collector wind turbines could be visible from surrounding areas.

Two ZVI diagrams have been prepared by the GL-Garrad Hassan including:

- Diagram 1 - ZVI from any part of the wind turbine (tip of blade); and
- Diagram 2 - ZVI from half the swept path of rotor (hub height);

The ZVI diagrams are illustrated in **Figures 3** and **4.**

4.4 ZVI Methodology

The methodology adopted by GL-Garrad Hassan is a purely geometric assessment where the visibility of the proposed Collector Wind Farm is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain.

Calculations have been made to determine the visibility of the wind turbines:

- blade tips (essentially a view toward any part of the wind turbine rotor, including views toward the tips of blades above ridgelines); and
- hub height (essentially a view toward half the swept path of the wind turbine blades).

The calculations also take into account the terrain relief and earth curvature.

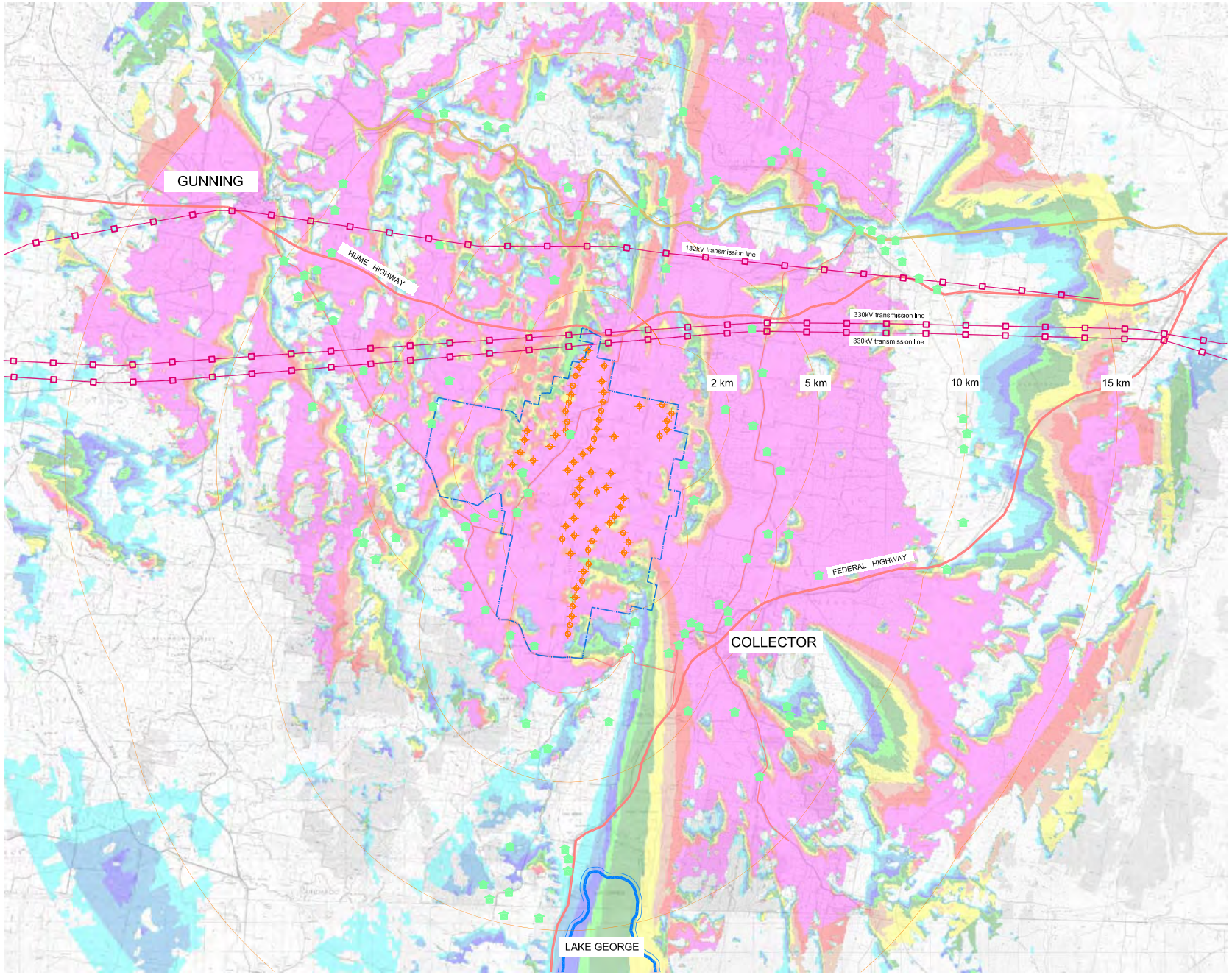
This assessment methodology is conservative as:

- The screening affects of any structures and vegetation above ground level are not considered in any way. Therefore the Collector Wind Farm 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.
- Additionally, the 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 proposed wind project.

Accordingly, while the ZVI diagrams are a useful visualisation tool, they are very conservative in nature.

4.5 ZVI Summary

The most extensive and continuous area of visibility toward the Collector wind 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 Project, and are generally visually negligible from medium to longer distance view locations.



Legend

- Site boundary
- Proposed Collector turbine
- 10km — Distance from proposed turbine location
- Local road/Highway
- Residential dwelling or structure

Legend (ZVI Tips visible)

- 1 to 5 turbines
- 6 to 10 turbines
- 11 to 15 turbines
- 16 to 20 turbines
- 21 to 30 turbines
- 31 to 40 turbines
- 41 to 50 turbines
- 51 to 60 turbines
- 61 to 68 turbines

0km 4km

Figure 3 ZVI Diagram 1
Collector - Tip of blade

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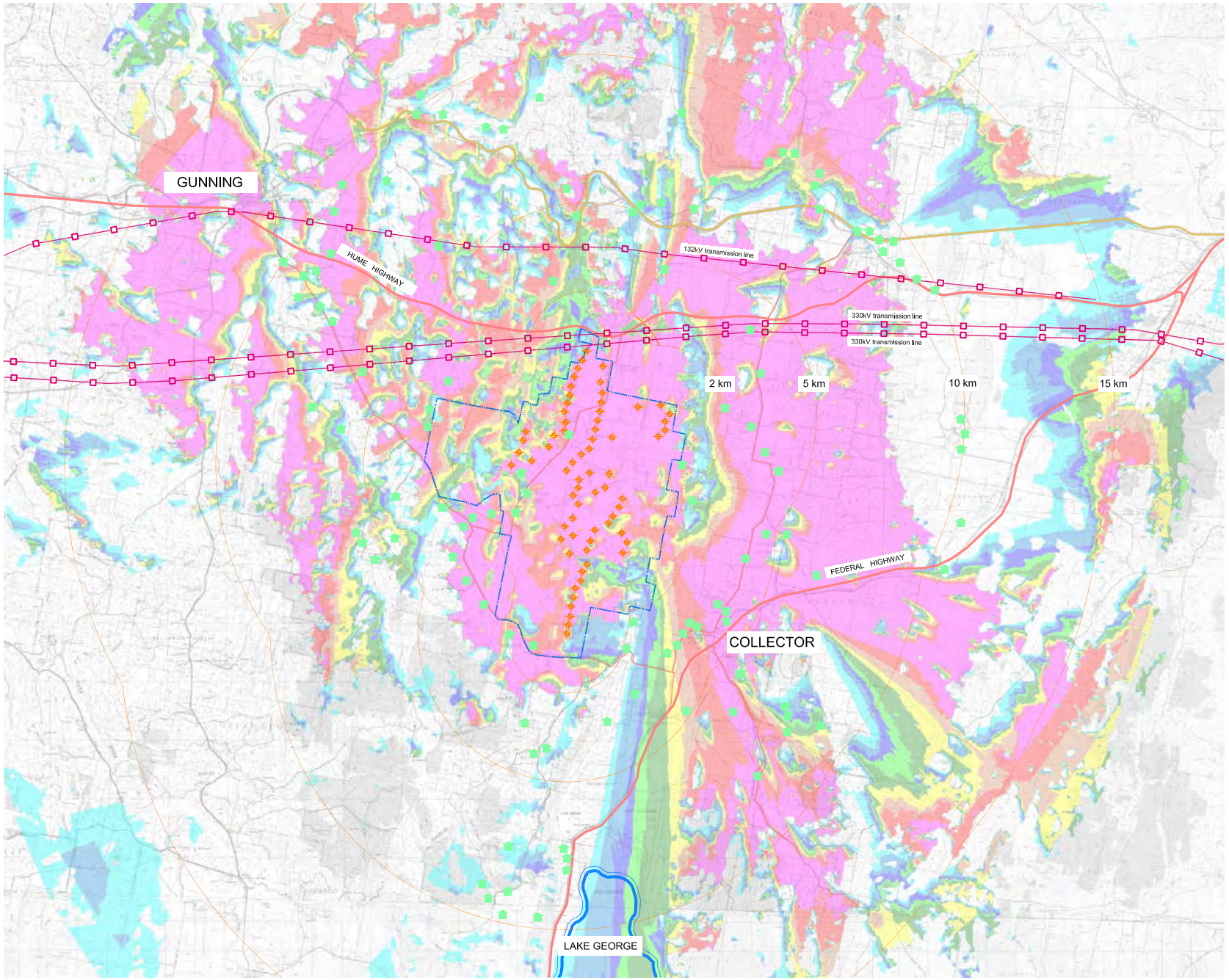

Legend

- Site boundary
- Collector turbine
- 10km — Distance from proposed turbine location
- Local road/Highway
- Residential dwelling or structure

Legend (ZVI Hubs visible)

- 1 to 5 turbines
- 6 to 10 turbines
- 11 to 15 turbines
- 16 to 20 turbines
- 21 to 30 turbines
- 31 to 40 turbines
- 41 to 50 turbines
- 51 to 60 turbines
- 61 to 68 turbines

0km 4km

Figure 4 ZVI Diagram 2
Collector - Hub height

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COLLECTOR WIND FARM

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 10km of the nearest wind turbine. The number and distribution of turbines visible between 'tip' and 'hub' height is influenced by the Cullerin Range to the north of the Project as well as the Lake George Range and adjoining hills within a number of areas between the3km to 5km and 10km distance offsets.

The ZVI diagrams illustrate areas of landscape which are likely to provide a view toward a greater number of wind turbines generally occur within private property and across tracts of unoccupied rural landscape, including land belonging to associated landowners.

Areas of land that also offer an opportunity to view a greater number of wind turbines do, however, extend across neighbouring and non associated properties to the west to northwest and east of the Project.

The ZVI diagrams also illustrate a small number of discrete pockets within the northern and north western portion of the 3km to 10km distance offset from which the wind turbines would not be visible, although this band of the viewshed also represents areas within which a greater number of turbines could also be visible.

The ZVI diagrams illustrate the influence of surrounding hills and ridgelines that begin to interrupt visibility toward the Project from areas of the landscape beyond 3km of the wind turbines, although opportunities to view a large number of turbines from elevated (but moderately distant and generally uninhabited) areas exist within this portion of the viewshed, including areas east of the Project along the Collector Road.

It should be noted that the wind turbines, when viewed from distances of around, or greater than 15km, will generally be less distinct from other distant elements within the same field of view, and that the majority of land within the viewshed comprises rural agricultural land.

4.6 Visibility

The level of wind turbine visibility within the Collector 10km viewshed can result from a number of factors including, but not limited to:

- Distance
- Movement; and
- Relative Position.

4.6.1 Distance

With an increase in distance the proportion of a person's horizontal and vertical view cone occupied by a visible turbine structure, or group of turbine structures, would decline. In order to demonstrate this a series of single frame photographs were taken from pre-set distances (1.5km, 4km, 7km and

10km) toward wind turbines within the operational Capital Wind Farm. The photographs, illustrated in **Figure 5**, demonstrate the degree to which the apparent visible height of a wind turbine decreases with increasing distance (in an indirectly proportional relationship), and the increasing amount of horizontal skyline visible with an increasing distance (in a directly proportional relationship).

As the view distance increases so do the atmospheric effects resulting from dust particles and moisture in the atmosphere, which makes the turbines appear to be grey thus potentially reducing the contrast between the wind turbines and the background against which they are viewed.

Whilst the distance between a view location and the wind turbines is a primary factor to consider when determining potential visibility, there are other issues which may also affect the degree of visibility.

4.6.2 Movement

The visibility of the wind turbines would vary between the categories of static and dynamic view locations. In the case of static views the relationship between a wind turbine and the landscape would not tend to vary greatly. The extent of vision would be relatively wide as a person tends to scan back and forth across the landscape.

In contrast views from a moving vehicle are dynamic as the visual relationship between wind turbines is constantly changing as well as the visual relationship between the wind turbines and the landscape in which they are seen. The extent of vision can be partially constrained by the available view from within a vehicle at proximate distances.

4.6.3 Relative position

In situations where the view location is located at a lower elevation than the wind turbine most of it would be viewed against the sky. The degree of visual contrast between a white coloured turbine and the sky would depend on the presence of background clouds and their colour. Dark grey clouds would contrast more strongly with white turbines than a background of white clouds.

The level of contrast is also influenced by the position of the sun relative to the individual wind turbines and the view location. Where the sun is located in front of the viewer, the visible portion of the wind turbine would be seen in shadow and if the background to the wind turbine is dark toned the visual contrast would be reduced. Conversely where the sun is located behind the view location then the visible portion of the wind turbine would be in full sun. If the background is also light toned, such as white clouds, then the contrast would be less when compared to a dark background.

This LVIA has determined that levels of visibility (toward hub height) for the Collector wind turbine layout would be:

Capital Wind Farm - View distance 1.5km

Capital Wind Farm - View distance 4km

Capital Wind Farm - View distance 7km

Capital Wind Farm - View distance 10km

Figure 5 Visibility and Distance

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Low – up to 30% of the overall Collector Wind Farm visible to any portion of the wind turbine (1 to 22 turbines);

Medium – between 31% to 60% of the overall Collector Wind Farm visible to any portion of the wind turbine (23 to 45 turbines); and

High – 61% to 100% of the wind turbines visible to any portion of the wind turbine (46 to 68 turbines).