Hexham Wind Farm

Chapter 5

Assessment of alternatives and design development

WIND PROSPECT

5.1 Overview

This chapter describes the project's development process from the initial identification of the Hexham project site in 2011. The development process started with an extensive search for suitable locations within Victoria to develop a wind farm.

After the selection of the Hexham project site as a preferred location a systematic and risk-based approach was adopted to identify aspects of the design that warrant consideration of alternatives, then identifying and comparing feasible alternatives. The approach considered:

- the type of infrastructure
- the location of infrastructure
- the scale of project
- construction method(s)
- the timing of construction activities, including proposed staging
- materials selection
- options for transport of equipment and materials to site.

Many alternatives have been considered during the project's development process, including the assessment of several wind turbine layouts, and of different grid connection options, site access and transport routes.

Avoidance and minimisation of impacts have been central to the development of the project. The approach has been to firstly avoid potential impacts, if possible, then, where avoidance was not practicable, to minimise the severity of the impact over space and time. This is followed by applying targeted mitigation and management measures to protect environmental and social values.

Figure 5.1 presents a summary of the design development process to date.

Project identification and refinement | **Constraints considered**

Project identification and refinement	Constraints considered
Extensive search for suitable wind farm locations within Victoria with a short list of potential sites selected	**Preliminary assessment of locations based on:** ▪ Wind resource ▪ Proximity to grid connection with capacity ▪ Low dwelling density ▪ Environmental constraints
Following detailed analysis to establish the suitability of the sites, Hexham was selected as the preferred project location with an initial design developed	**Detailed analysis to establish the suitability of the sites considering:** ▪ Supportive host landowners ▪ Potential for significant environmental effects ▪ Condition of road network ▪ Transport route to port for turbine components ▪ Avoidance of coastal areas (high amenity value and usually higher population density) ▪ Appropriate planning zone(s)
Concept design developed based on preliminary investigations, which was referred to State and Commonwealth Governments	**Preliminary on-site assessments of site constraints including:** ▪ Flora and fauna ▪ Aboriginal heritage ▪ Stakeholder engagement
Further project refinement based on technical assessments concluding with the design presented within the EES	**Detailed assessments of site constraints including:** ▪ Noise ▪ Landscape and visual amenity ▪ Flora and fauna ▪ Aboriginal heritage ▪ Historical heritage ▪ Traffic and transport ▪ Social and economic ▪ Hydrology and hydrogeology ▪ Aviation ▪ Electromagnetic interference ▪ Shadow flicker ▪ Landform and soils ▪ Air quality ▪ Land use and planning

Figure 5.1 Project identification and refinement

5.2 Design development

From the first concept design to the current project design detailed in Chapter 6 – ***Project description***, the project has undergone constant revisions and design iterations. These have ranged from entire re-designs to micro-siting of project infrastructure in response to environmental constraints, landowner negotiations, technology improvements, and changes to government policy.

5.2.1 Key design criteria

Key criteria driving the design development include:

- Wind speed – sufficient electricity generating potential is a fundamental requirement for any wind farm and therefore wind speed is a core element of the project design. Optimising the conversion of wind energy to electricity is influenced by the positioning and spacing of wind turbines.
- Access to land – contracts were completed with landowners that agreed to participate in the project, enabling a wind farm to be developed on their land.
- Constraints – there are a range of constraints that must be considered including:
  - the location of existing dwellings
  - potential noise and shadow flicker impacts
  - historical and Aboriginal cultural heritage within and near the project site
  - patches of native vegetation on the project site, including Victorian Wetland Inventory mapped wetlands
  - fauna habitats such as the state listed Brolga *(Grus rubicunda)* and nationally listed Southern Bent Wing Bat *(Miniopterus orianae bassanii)*
  - confirmed and potential Wedge-tailed Eagle (*Aquila audax*) nests
  - visual sensitivity of the landscape
  - creeks, rivers and Groundwater Dependent Ecosystems.

Wind turbine micro-siting

Wind turbine micro-siting is the process through which the optimal location of wind turbines is determined during the detailed design phase. Each position must consider the existing wind resource, topography, proximity to other turbines and distances to neighbours and other environmental constraints.

These constraints were updated iteratively through development of the project, reflecting the results of specialist studies and engagement with stakeholders and Traditional Owner groups, and are described further in Table 5.1.

Once these criteria were understood at a sufficient level, the project design could be further developed with greater confidence. The following sections provide more detail about how these criteria were assessed.

5.2.2 Optimising efficiency

The wind turbine layout design seeks to optimise the project's electricity generating potential from the local wind resource, within the bounds of environmental and social constraints of the site. The project could feasibly connect more than one gigawatt of generation to the 500 kilovolt Moorabool to Heywood transmission line at this location but is limited by the availability of constraint-free land. Environmental constraints include areas of protected native vegetation or wetland areas, whereas social constraints include proximity to dwellings (see Section 5.2.4).

Maximising the generation potential of a project is not as simple as fitting as many wind turbines within the unconstrained parts of the site as possible. As energy is captured from the wind by a wind turbine, there is less energy and more turbulence in the wake of (i.e., downstream of) the wind turbine. These wake effects reduce the operational performance of downstream wind turbines, thereby reducing their efficiency and possibly even their viability.

The project was designed to ensure energy efficiency criteria were met for each individual wind turbine (see info box). The design involved the wind turbines being carefully positioned to allow the wake caused by the turbines to 'settle' and the strength of the wind to 'recover' to a level where the downstream turbines can operate above minimum acceptable efficiency levels.

Energy efficiency criteria

Efficiency criterion of a wind turbine is the percentage of the energy production potential of a wind turbine within the wind farm when compared to the maximum energy produced if the wind turbine was installed on its own (i.e., without wake effects reducing its output).

As wind turbine technology has advanced significantly over the time that the project has been in development, there are now larger and more powerful turbines being manufactured. These advancements in technology mean that more energy can be generated from fewer wind turbines, however, these larger turbines need greater separation to ensure the spacing avoids excessive wake-induced inefficiencies.

5.2.3 Access to land

The project has been developed in partnership with 14 landowner families, who will host the project wind turbines. These landowners have agreements in place with the proponent to host wind farm infrastructure on their land in return for an ongoing rental payment for the life of the project, expected to be a minimum of 25 years. These agreements detail the terms and conditions that provide for access and use of the land to construct, operate and maintain the wind farm infrastructure. The involvement of the landholders in the design process ensures that agricultural practices can co-exist with the project and that local knowledge has informed its development.

5.2.4 Limiting impacts

From the earliest point in the design, a range of environmental, social and infrastructure layers have been added to the project's Geographic Information System (mapping program) as constraints that influence the location of wind farm infrastructure. These constraints have been refined based on the findings of specialist studies and feasibility investigations. In many cases, buffers have been applied to known or modelled sensitive areas. The purpose of incorporating these constraints and buffers into the planning process was to ensure that potential impacts could be either avoided or minimised.

Known sensitive areas with constraints and buffers incorporated into the design are summarised in Table 5.1. A more detailed rationale about the design response is provided in the impact assessment section of cross-referenced chapters or specialist studies, where required.

These sensitive areas and constraints have been mapped within and around the project site, defining areas that can and cannot host wind turbines and/or other infrastructure (Figure 5.2).

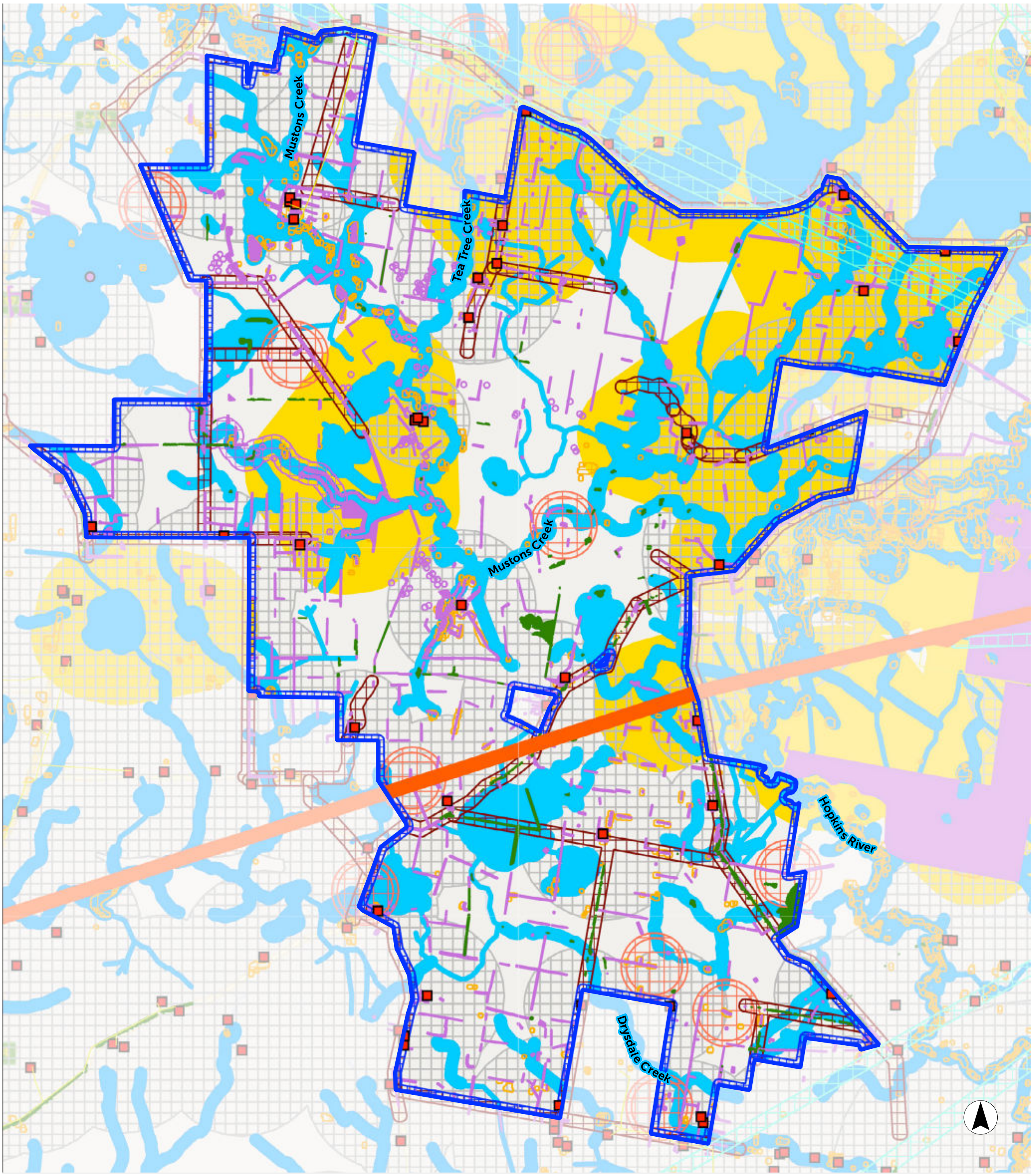
Table 5.1 Sensitive areas with constraints and buffers

Sensitive areas	Potential impact or risk	Design response
Dwellings	The Victoria Planning Provisions prevents wind turbines being sited within 1 kilometre of a dwelling without the written consent of the owner of that dwelling.	A buffer of at least 1.5 kilometres from the centre of wind turbine towers has been applied to all non-participating dwellings that existed when the project was launched publicly in March 2019.
	Operation of the on-site quarry during the construction phase could impact the amenity of dwellings, for example through noise and dust emissions.	The quarry has been proposed in a part of the project site away from occupied dwellings. The closest occupied dwelling is 2.2 kilometres from the quarry boundary and is a stakeholder dwelling.
Neighbouring property boundaries	There is the potential for the wind turbine blades to overhang into the airspace above neighbouring properties or adjoining public land.	A 100-metre buffer has been applied around the perimeter of the site to prevent wind turbine blade overhang into the airspace above neighbouring properties or adjoining public land.
Townships	There is usually an increased density of dwellings in townships and therefore an increased potential for adverse impacts.	As a proactive measure, a 4-kilometre buffer was applied to the Caramut Township Zone and 3-kilometre buffers of both the Hexham and Ellerslie Township Zones. These buffers were based on the relative population and geographic extent of each town.
Brolga breeding habitat	Nesting and foraging Brolga could potentially be disturbed by the construction and operation of wind turbines. There is also a risk of collision if wind turbines are operating too close to where Brolgas are active.	Buffers have been developed by technical experts for potential Brolga breeding and roosting habitats. For a rationale for the buffering method see Chapter 10 – ***Brolga*** and Appendix C1 – ***Brolga Impact Assessment***.

Sensitive areas	Potential impact or risk	Design response
Southern Bent Wing Bat habitat	Roosting bats could potentially be disturbed by the construction and operation of wind turbines. There is also a risk of collision if wind turbines are operating too close to where bats are active.	Buffers have been developed by technical experts for potential Southern Bent Wing Bat habitat. For a rationale for the buffering method see Chapter 9 – ***Bats*** and Appendix C2 – ***Bat Assessment***.
Wedge-tailed Eagle nests	Although not listed as a threatened species in Victoria, the Wedge-tailed Eagle is considered a species of concern and is known to breed within the project site. Individuals are highly vulnerable to disturbance during sensitive phases of the breeding cycle, (Olsen, 2005; Rowe et al., 2018), which can lead to nests being deserted.	Based on investigations by Nature Advisory and research as detailed in *A Best Practice Approach to Electricity Transmission Infrastructure Development* (Energy Grid Alliance, 2021), Wedge-tailed Eagle breeding success near wind turbines, a 500-metre turbine and overhead powerline line exclusion buffer was applied around all known and potential Wedge-tailed Eagle nests.
Native vegetation, threatened flora species and habitat for listed fauna species	The removal of native vegetation in the form of Ecological Vegetation Classes (EVCs) and EPBC Act-listed threatened ecological communities could impact habitat for threatened flora and fauna species.	Significant vegetation has been mapped and ground-truthed and several specific habitats for threatened species also defined and mapped (e.g., Brolga and Southern Bent Wing Bat). This mapping provides the basis for avoidance and minimisation of impacts throughout the design process. See Chapter 8 – ***Biodiversity and habitat*** and Appendix D – ***Flora and Fauna Assessment***.
Aboriginal cultural heritage sites and places	Aboriginal cultural heritage sites and places could potentially be impacted. 112 registered Aboriginal places within the project site were identified on the Victorian Aboriginal Heritage Register (VAHR) during the desktop assessment and field investigations.	All existing and newly identified registered Aboriginal sites have been buffered to avoid any impact. Areas of potential Aboriginal cultural heritage sensitivity defined by heritage specialists were buffered to avoid potential impact. See Chapter 18 – ***Aboriginal cultural heritage*** and Appendix J – ***Aboriginal Cultural Heritage Impact Assessment***.
Wetlands	Wetlands are important for a variety of threatened flora and fauna and are often locations with higher probability of Aboriginal heritage sites and hold intangible values to Aboriginal people.	A 100-metre buffer was applied around mapped wetlands on the Victorian wetland inventory to limit potential impacts to these areas. Buffers developed for potential Brolga breeding and roosting habitats have created significantly larger buffers around modelled wetlands. See Chapter 10 – ***Brolga***.

Sensitive areas	Potential impact or risk	Design response
Watercourses	Watercourses and riparian zones are important for a variety of threatened flora and fauna, are often locations with higher probability of Aboriginal heritage sites and hold intangible values to Aboriginal people.	Crossings of watercourses by access tracks and cable routes have been minimised as part of the design process and watercourses have been buffered as follows to avoid impacts: • 100 metre buffers applied to watercourses (excluding drainage channels) • 30 metre buffers applied to drainage channels. Where watercourse crossings are needed, further mitigation has been developed. See Chapter 12 – ***Surface water*** and Appendix B – ***Surface Water and Groundwater Impact Assessment***.
Potential groundwater dependent ecosystems (GDE)	Groundwater dependent ecosystems could be affected by impacts to groundwater caused by the construction of infrastructure that interferes with groundwater flows. These could include the construction of trenches and the construction of wind turbine foundations.	Potential groundwater dependent ecosystems (GDE) have been identified from the Bureau of Meteorology GDE Atlas and buffers applied as follows: • 100 metre buffers applied to potential aquatic groundwater dependent ecosystems • 25 metre buffers applied to potential terrestrial groundwater dependent ecosystems. Impacts to potential groundwater dependent ecosystems were therefore avoided except where placement of tracks and cables was needed, and for quarrying operations. See Chapter 11 – ***Groundwater*** and Appendix B – ***Surface Water and Groundwater Impact Assessment***.
Existing powerlines	Project infrastructure could interfere with existing powerlines if placed too close.	Existing powerlines were buffered as follows from the centre of the wind turbine towers to minimise potential interference: • 500 kilovolt transmission line buffer easement width plus 200 metres = 230 metres • 66 kilovolt distribution line buffer is easement width plus 100 metres = 115 metres • 22 kilovolt distribution line buffer is easement width plus 100 metres = 110 metres • 12.7 kilovolt distribution lines were not buffered.

Sensitive areas	Potential impact or risk	Design response
Roads	Project infrastructure could interfere with existing roads.	To avoid potential interference to existing roads: • a 100-metre buffer has been applied to public roads • a 25-metre buffer has been applied to access tracks on Crown Land (sometimes called paper roads). Some tracks on private property were not buffered.
Communications links	Wind turbines could interfere with communications links if they are not appropriately buffered.	• Should a communication link crossing the site be identified, a 25-meter buffer will be applied to the radiocommunication tower as recommended by an expect consultant in consultation with the operator of the link. See Chapter 24 – ***Electromagnetic interference*** and Appendix N – ***Electromagnetic Interference Impact Assessment***.
Local airstrips	Wind turbines have the potential to impact the operation of local airstrips.	Buffers would be applied to local airstrips based on Civil Aviation Advisory Publication CAAP 92-1(1), ***Guidelines for aeroplane landing areas*** and advice from an expert aviation consultant. See Chapter 22 – ***Aviation*** and Appendix O – ***Aviation Impact Assessment***.



Legend

- Wind farm boundary
- Wind farm boundary buffer
- Watercourses
- Waterway, wetland, and hydro buffers
- Brolga habitat buffer
- Groundwater dependent ecosystems
- Southern Bent-wing Bat habitat
- Native vegetation
- Communication link buffers
- Road easement buffers
- Aboriginal place buffers
- Wedge-tailed Eagle nest buffers
- Dwelling
- Dwelling and township zone buffers

Powerline easements : Voltage

22 66 500

Scale

5,000 m

Data: State of Victoria (DECCA/Land Use Victoria), Commonwealth of Australia, Wind Prospect, and specialist studies/reports. Data is indicative only; accuracy and completeness are not guaranteed.

Figure 5.2 Sensitive areas and constraints incorporated into the project design

In addition to the constraints outlined in Table 5.1 and displayed in Figure 5.2, noise and shadow flicker have been modelled to ensure that the design adheres to the noise and shadow flicker limits defined in the regulations (refer to Chapter 17 – ***Noise and vibration*** and Chapter 15 – ***Shadow flicker and blade glint*** for more information).

5.3 Design evolution

The current project design is based on the culmination of over 10 years of continual refinement in response to detailed specialist studies, landowner and stakeholder negotiations and technological advancement.

Section 5.3 provides an overview of the factors which influenced design evolution during the initial, revised, and current project design. The importance of considering and selecting reasonable alternatives during appropriate phases of the project is essential to achieving an outcome which balances maximum project benefits and minimised impacts to the environment and community thereby meeting the project's objectives (see Chapter 1 – ***Introduction***).

5.3.1 Initial design

After the initial project identification project in 2011, a concept site boundary was developed based on landowner discussions. The project's design sought to maximise the potential energy production based on the technology available at that time.

The early design consisted of 207 wind turbines with a hub height up to 95 metres and rotor diameter up to 90 metres. At that time the wind turbine technology considered as a basis for specialist studies was the 1.8-megawatt Vestas V90. Site reconnaissance was completed to confirm the selection criteria listed in Chapter 2 – ***Project rationale and benefits*** were satisfied. Extensive consultation was also carried out with potential host landowners culminating in contracts being completed with many of the landowners approached. A range of environmental and cultural heritage investigations were then commissioned to gain a better understanding of the initial project site and surrounds.

5.3.2 Revised concept design

Project development activities between 2013 and 2018 focused on agreements with participating landowners and confirmation of the project site. Detailed wind monitoring data was also collected during this period as well as preliminary information on potential biodiversity and Aboriginal heritage sensitivities within the project site.

In March 2019 the project was publicly launched with a design consisting of 125 wind turbines with a maximum blade tip height of 250 metres (see Figure 5.3). Between 2019 and 2022 the activities focused on developing a more comprehensive understanding of site-specific conditions based on a wide variety of specialist studies as well as significant engagement with stakeholders and the community. These activities resulted in an EES referral design consisting of 108 turbines with a maximum wind turbine blade tip height of 250 metres. The project site did not change during this period.

The revised concept design submitted with the EES referral incorporated findings from assessments on flora and fauna, heritage, preliminary landscape and visual, noise and shadow flicker modelling, and hydrology studies. The project design for the EES referral aimed to avoid or limit impacts to environmental and social values, including:

- listed fauna, including Brolga, Southern Bent-wing Bat, Growling Grass Frog, Tussock Skink, Dunnart, Striped Legless Lizard and fish species
- native vegetation
- Aboriginal heritage sites
- historical heritage
- cumulative visual impacts.

The design also aimed to achieve noise compliance and minimise visual impacts by applying dwelling buffers of 1,500 metres or greater for dwellings constructed prior to the project announcement.

An on-site grid connection was selected as the preferred grid connection option for the project. This would be facilitated by a new on-site terminal station within the project site and connection to the existing 500kV Moorabool to Heywood transmission line which traverses the project site. This preferred option eliminates the need for any electrical infrastructure, including overhead powerlines, to be constructed outside the project site, therefore reducing visual impacts to neighbouring landowners and other people passing through the site. The initial project grid connection option would have required additional overhead powerlines extending from the project site connecting at the Mortlake Terminal Station (see Figure 5.4).

5.3.3 Current project design

Following the EES referral in 2022, the project design has undergone a series of updates and improvements, as follows:

- Buffer zones were created to manage risk associated with Brolga were significantly increased based on extensive field assessments to refine the predictions of potential breeding and foraging habitat of Brolga.
- Potential Southern Bent-wing Bat habitat was identified within the site and to reduce impacts on flight paths and foraging areas the project has sought to minimise turbines within proximity (269 metres) of these habitat areas.
- Native vegetation, flora and fauna surveys progressively refined the understanding of native vegetation coverage and habitat for threatened flora and fauna across the site.
- Tracks and cables and other ancillary infrastructure have been located to avoid and minimise native vegetation removal or disturbance.
- Buffer zones were created around Wedge-tailedail Eagle nests to reduce the potential for disruption to breeding and fatalities.

A proposed on-site quarry was introduced, which would reduce the number of heavy vehicles on local roads transporting materials from other quarry locations.

- The number of site access gates was reduced from 14 to 12 to accommodate local road conditions and in consideration of landowner concerns about traffic volumes on Gordons Lane. The number were then further reduced from 12 to 10 to minimise the impact on native vegetation within road reserves.
- Maximum tip height was increased from 250 to 260 metres to accommodate advancements in turbine technology. The latest wind turbine technology was adopted which maximises energy production and limits noise emissions. Selection of larger turbines required increased turbine spacing to ensure appropriate efficiency is maintained.

The current project design is detailed in Chapter 6 – ***Project description.*** This proposed design for which planning approvals are sought includes 106 wind turbines (see Figure 5.3), five meteorological masts, internal cables, access tracks, on-site terminal station, battery energy storage system, associated construction and site maintenance infrastructure, and temporary infrastructure including the on-site quarry.

5.3.4 Status of assessment of alternatives

Opportunities for input to potential project alternatives will be provided during public exhibition of the EES and public hearing.

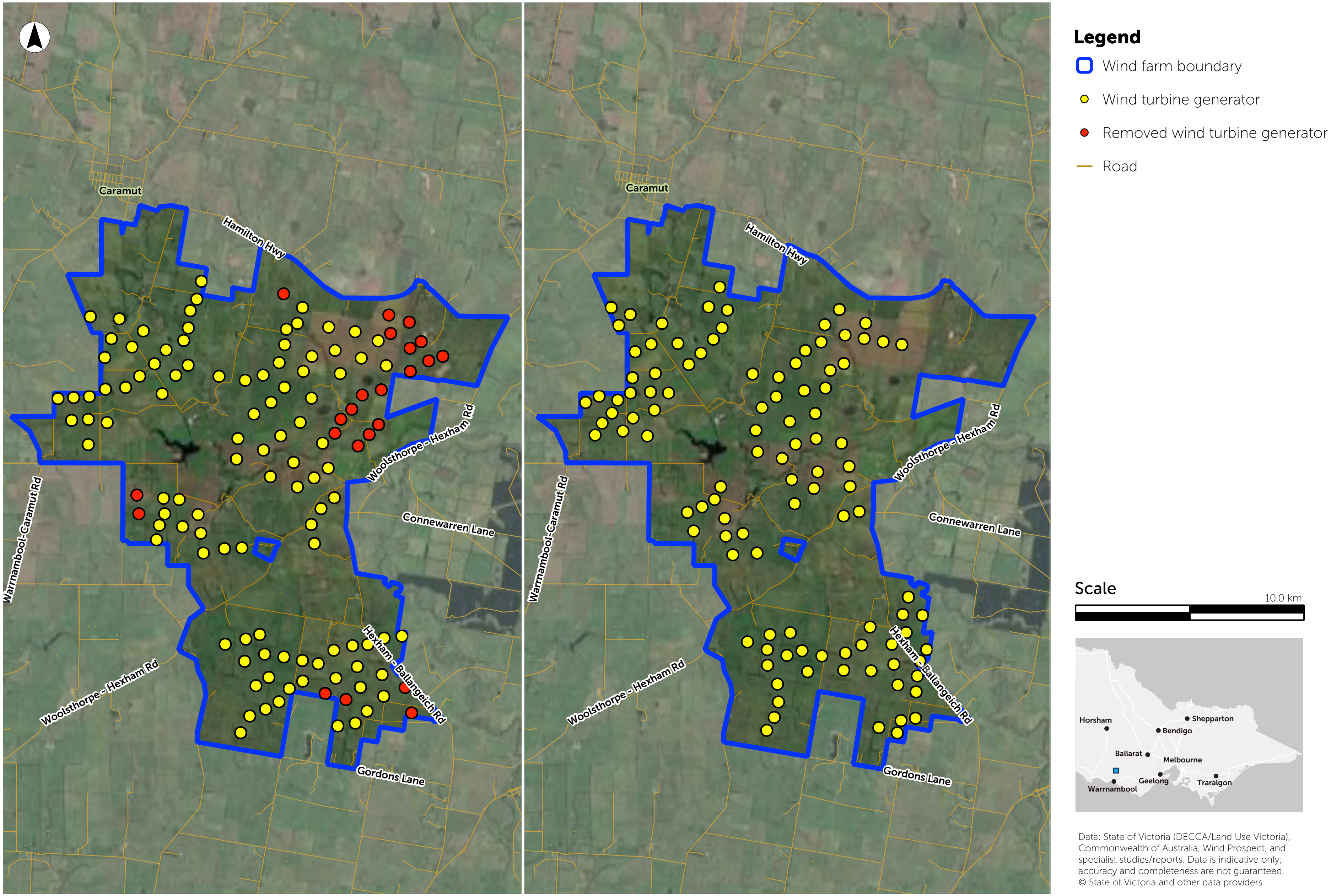


Figure 5.3 Revised concept wind turbine design compared with current proposed wind turbine design

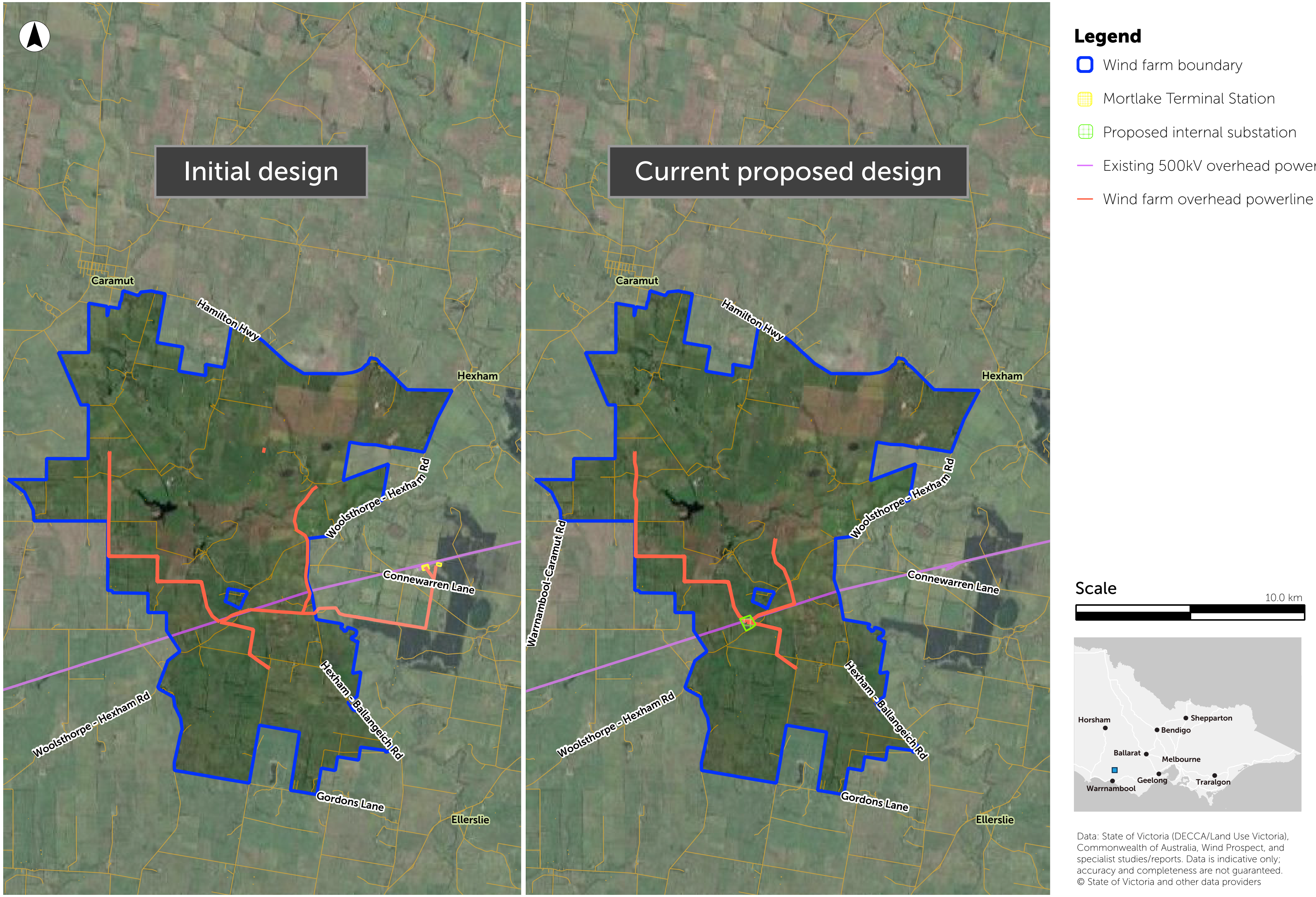


Figure 5.4 Initial compared with current proposed overhead powerlines

5.4 Approach to assessment of alternatives

Reasonable alternatives for the project have been assessed at each stage of its development. For the purposes of this assessment, a reasonable alternative is defined as a modification to the project's design, construction, or operation that demonstrably reduces potential impacts and/or enhances project benefits, without imposing disproportionate financial, technical, or legal constraints. Such alternatives must be capable of being implemented without materially undermining the project's core objectives, including its intended generation capacity and commercial viability.

Alternative infrastructure options are considered during the earlier design phases of the project while construction and operational phase alternatives are considered post design. Section 5.5 provides an overview of the infrastructure options and alternatives which were considered during the earlier project planning phase.

5.5 Alternative infrastructure options

The basic principle of infrastructure placement has been to maximise the energy generation potential of the site while minimising the impacts to environmental and social values. Wind turbines have been placed in an optimal arrangement (subject to micro-siting) that provides the best possible conversion of the site's excellent wind resource to electricity. An on-site terminal station to facilitate grid connection will minimise visual amenity impacts to neighbouring dwellings by restricting all electrical infrastructure including overhead powerlines to the project site. Placement of wind turbines has also considered proximity to dwellings to ensure noise and shadow flicker are compliant with statutory requirements and that visual impacts are minimal or can be mitigated, as far as reasonably practicable.

Connection of turbines and the on-site terminal station by road and electrical cables aims to keep distances to a minimum, to limit both the area impacted and project costs. Values that needed to be avoided were buffered so that low impact areas could be identified and the best routes to connect infrastructure chosen.

The following sections describe the alternative options considered for infrastructure with the potential to impact environmental and social values.

5.5.1 Wind turbine selection

When the project was conceived in 2011, onshore wind turbines had a capacity of about two megawatts and a rotor diameter of about 90 metres. At present, there are wind turbines commercially available with an 8-megawatt capacity and rotor diameter of up to 182 metres.

Given the rapid development of wind turbine technology, a degree of flexibility is sought to accommodate the available wind turbine technology at the time of construction. As such, the turbine envelope dimensions for which planning approval is sought are marginally larger than have been installed in Australia to-date.

The Vestas V162-6.8MW wind turbine has been modelled to demonstrate that a modern turbine can comply with operational noise requirements (see Chapter 17 – ***Noise and vibration***). Other potential impacts have been assessed by specialists based on a theoretically possible future turbine with larger height and rotor diameter (e.g., for shadow flicker, EMI, birds and bats, aviation, and landscape and visual impacts). The model ultimately chosen for construction would be within these dimensions.

5.5.2 Scale alternatives

The current design and scale of the proposed infrastructure have been carefully considered to maximise project benefits and minimise impacts to the surrounding local area. The current design will supply the National Energy Market with over 2,559 gigawatt-hours of renewable electricity per year, equating to approximately 565,000 Victorian households. This means that the loss of a single turbine will result in a loss of approximately 26 gigawatt-hours electricity, or almost 5,800 homes. As such, the reasons for removing a turbine should be weighed against the annual net benefit it is expected to provide.

Scale alternatives are also considered when selecting the size and location of other required site infrastructure such as the proposed quarry, temporary site compounds required during construction, selecting appropriate road widths, and the size and design of hardstand areas around the turbine foundations which are required for safe installation and maintenance of the assets.

5.5.3 Internal cabling

The project design includes a combination of underground cabling connecting individual wind turbines in clusters and then due to the larger electrical distribution distances, overhead distribution lines connect the clusters of wind turbines to the on-site terminal station. The overhead distribution lines which are contained within the project site also minimise potential native vegetation clearance associated with the significantly larger ground disturbance and clearing required for undergrounding cabling of this voltage.

5.5.4 On-site terminal station

A location for an on-site terminal station and associated electrical infrastructure was selected through negotiation with key stakeholders including AusNet Services, AEMO and landowners. The new on-site terminal station will facilitate grid connection by connecting to the 500 kilovolt Moorabool to Heywood transmission line which traverses the southern portion of project site.

This grid connection option has resulted in a more efficient cable route design (all contained within the project site) when compared to the alternative grid connection option at the Mortlake Terminal Station. That alternative would require at least five kilometres of overhead distribution line cabling and poles external to the project site. This would also have greater potential for visual impacts on neighbouring dwellings and landowners as well as people passing through the area.

5.5.5 Quarry selection

This EES presents two options from which to source the stone aggregate material needed for the project access tracks:

- an on-site dedicated project quarry (preferred option)
- one or more existing quarries, the closest of which is the Mt Shadwell quarry, about 20 kilometres to the east of the site.

Preliminary quarry investigations at the project site commenced in November 2022. BCA Consulting conducted a desktop review of geological data to evaluate areas with potential to develop a suitable quarry. Following the desktop review, a site visit was undertaken with participating landowners. The site visits and collaboration with the hydrology and hydrogeology consultants, Water Technology, narrowed down the potential quarry sites to one location in the western portion of the project site. The work authority area is 52.3 hectares with an approximate extraction area of 21.5 hectares, a material stockpile area of approximately 8.6 hectares and an area of approximately 0.5 hectares for amenities and light vehicle parking. The remaining area will be used for stockpiling overburden and for groundwater management infrastructure.

The quarry has been proposed in a part of the project site away from occupied dwellings, with the closest occupied dwelling located approximately 2.2 kilometres from the quarry boundary.

5.5.6 Site access

The design of the site access has attempted to avoid impacts to native vegetation and waterways and to reduce impacts from traffic on the existing road network. Local roads around the project site with considerable native vegetation within road reserves have been avoided, for example on the Hexham-Ballengeich Road.

Site access locations were developed in consultation with the traffic and transport consultant to ensure safe access and maintain safety for all road users. Stakeholders consulted included Department of Transport and Planning (DTP), VicRoads, Moyne Shire Council and participating landowners.

5.5.7 Access tracks

Around 147.5 kilometres of internal access tracks would be needed to provide access to each individual wind turbine and other infrastructure associated with the project. Access tracks would connect all the project infrastructure and provide access for construction and maintenance vehicles, as well as emergency vehicles, and may also be used by the landowners for their farm operations.

To minimise the use of local roads for safety reasons, the project has been designed to maximise access track connectivity within the site. The siting of access tracks has been progressively refined based on specialist studies to prevent potential impacts to native vegetation, waterways, wetlands, and areas of cultural heritage sensitivity. Due to the need to provide direct and efficient access to each turbine and associated infrastructure, whilst avoiding sensitive environmental and cultural features, there are limited feasible alternatives for the siting of access tracks. The layout has been optimised to balance operational requirements with project site constraints, resulting in a configuration that minimises overall disturbance while ensuring safe and practical access.

Access track design has also been informed by specialist studies, particularly Appendix B – ***Surface Water and Groundwater Impact Assessment*** and Appendix D – ***Flora and Fauna Assessment***, to limit environmental impact through the generation of surface water runoff. These design requirements have been included in the management measures nominated for the project, including integrating culverts into access track design to allow for the diversion of flow paths below the roads (detailed in Chapter 28 – ***Environmental management framework)***.

5.6 'No project' alternative

The Hexham Wind Farm would significantly contribute to the local and state economy, consistent with the Victorian Government objectives and policies. The consequences of the project not proceeding are as follows:

- The local area would not benefit from the potential economic boost the project would provide including the $1.3 billion capital investment, direct and indirect employment opportunity creation through project construction, operation and decommissioning, local road network upgrades and maintenance, local skills development, and the Neighbour Benefits Sharing Program.
- More than 2,559 gigawatt-hours of renewable source electricity would not be available in the grid, and the Government would be reliant on filling this void in the transition to a renewables-based grid with other projects, potentially in less optimal locations, or continuing with the fossil fuel sources.

However, if the project did not proceed, then potential environmental and social impacts would be avoided including:

- Impacts to biodiversity values due to the removal and degradation of native vegetation, resulting in direct and indirect habitat loss, and disturbance to threatened and migratory fauna species. These potential impacts will be effectively avoided, minimised and offset in accordance with general and species-specific design mitigations and management measures including the use of habitat buffers, protection zones, monitoring of breeding sites, decontamination bays, and implementation of Attachment V - ***Bat and Avifauna Management Plan***.
- Changes to surface water and groundwater flows and quality due to the construction of project infrastructure, dewatering, and management of wastewater and hazardous substances. These potential impacts will be effectively avoided and minimised through the design of project site drainage and waterway crossings in consultation with Glenelg Hopkins Catchment Management Authority, maintaining wetland and watercourse buffers where practicable, and implementation of a Sediment, Erosion and Water Quality Management Plan and Water Management Plan.
- Temporary construction disturbance impacting amenity associated with the generation of emissions, noise, vibration, and construction traffic. These potential impacts will be effectively avoided and minimised through the implementation of a Construction Environmental Management Plan and Traffic Management Plan.
- Amenity impacts to surrounding landowners associated with operational shadow flicker, noise, electromagnetic interference, and the physical presence of the project within the local landscape and viewpoints. These potential impacts will be effectively avoided and minimised through strategic placement of project infrastructure based on site constraints (as described in Table 5.1), and implementation of an Operational Noise Management Plan, an On-site Landscaping Plan and an Off-site Landscaping Plan.
- Disruptions to agricultural land uses and a reduction of the area available to support agriculture during construction and, to a lesser extent, operation. These potential impacts will be effectively avoided and minimised through designing the wind farm and on-site quarry in consultation with participating landowners, retention of access to properties during the construction phase, and implementation of an Agricultural Management Plan.
- Temporary disturbance associated with the development and extraction of materials from an on-site quarry. These potential impacts will be effectively avoided and minimised through implementation of the Quarry Work Plan and adherence to the requirements of the Work Authority by Resources Victoria.

Further detail of these potential impacts, design mitigations and the management measures nominated for the project is provided in Chapters 8 – ***Biodiversity and habitat*** through Chapter 27 – ***Matters of National Environmental Significance***. A list of the management measures nominated for the project is also provided in Chapter 28 – ***Environmental management framework.***