

Chapter 2: Site Selection and Design

Site Selection and Design

2. Site Selection and Design2

2.1 Site Selection2

2.2 Grid Connection.....2

2.3 Site and Context Analysis3

2.4 Surrounding Land Uses6

2.5 Topography and Geomorphology.....6

2.6 Wind Characteristics.....7

2.7 Settlements and Housing.....7

2.8 Infrastructure and Access8

2.9 Design Response8

2.10 Turbine Density10

2.11 Detailed Design Process.....11

2.12 Site Suitability Statement11

2. Site Selection and Design

This chapter outlines information with respect to the site characteristics of the proposed Keyneton Wind Farm site. This includes an overview of the reasons the site was identified as suitable for wind farm development, a description of the surrounding land use practices, settlements and infrastructure and an overview of the wind farm design process.

2.1 Site Selection

Pacific Hydro has investigated a number of sites throughout South Australia for their suitability for wind farm development and has developed and now operates Clements Gap Wind Farm just south of Port Pirie. Sites are initially selected on the following broad criteria after which further specialised investigations are carried out in order to inform the development process:

- Suitable wind speeds
- Proximity to grid
- Terrain / Topography
- Land availability
- Accessibility
- Distance from areas designated for nature conservation, cultural heritage or landscape values
- Distance from sensitive land uses

Pacific Hydro has been gathering wind data from a 50 m meteorological mast erected on site in 2004. The site's strong and consistent winds, initial assessment of environmental factors and the existence of the 275kV transmission line (with sufficient capacity) which runs through the site, indicated the site's suitability for wind farm development. This initial suitability assessment prompted Pacific Hydro to commence the more detailed environmental impact assessment of the site and community consultation as detailed in this Development Application.

2.2 Grid Connection

One of the primary drivers within the site selection process was the existence of the 275kV Robertstown – Tungkillo transmission line which runs directly through the site. The early studies carried out by Pacific Hydro indicated that a wind farm of up to 150 MW could be safely connected to the network.

The bulk of the 275kV transmission network around the eastern Adelaide region was established in the early to mid 1970's, with the South Australia – Victoria interconnection constructed in 1989/90 and Robertstown substation commissioned in 1985. Pacific Hydro's early investigations show that the network has reasonable capacity in this area and connection of new generation to the South Australian system may be absorbed at various points throughout this part of the network.

Pacific Hydro's further assessment has shown that:

- A connection to the SA 275kV electricity network is feasible by cutting into the existing Robertstown - Tungkillo double circuit transmission line
- The 275kV connection would require establishment of a 275kV substation at Keyneton
- Sufficient thermal network capacity of the 275kV system exists to allow connection of up to 150MW generation without adversely affecting network operation

2.3 Site and Context Analysis

The proposed wind farm site is located along the ridgeline of the Eastern Mount Lofty Ranges, approximately 6km north-west of Cambrai, 8km west of Sedan, 4km east of Keyneton and 12km south east of Angaston. The linear site boundary runs north to south along the Mount Lofty Ranges for approximately 16km (with the project layout within this of approximately 15km north to south). Figure 1.1 shows the general site location, whilst Figure 2.1 illustrates the region's topography and elevation. The site is situated within the eastern hills of the Mount Lofty Ranges and is generally bound by: the Marne River to the south, the townships of Cambrai (to the south-east), Sedan (east), Towitta (north-east), Moculta (north-west), Keyneton (west) and Keynes Gap (south-west). The Eden Valley township is located approximately 8km to the south west on the opposite side of Keynes Gap.

The site is located wholly within the Mid Murray Council area, although immediately adjacent to the Barossa Council.

Since European settlement and the associated extensive land clearing, the site and surrounding area has been used predominantly for agricultural and pastoral purposes. On site- fencing has been erected, including sections of historic dry-stone wall, and access tracks have been created across the site. Dams are scattered across the site.

The land within the project site itself is currently owned by six separate landowners, with the land being used predominantly for grazing sheep.

A site context map is provided as Figure 2.5.



Photo 2.1 : View within the site, to north of Angaston-Sedan Road (with existing met mast centre shot and the existing 275kV transmission line to the right)



Photo 2.2: View south of the site and the existing 275kV transmission line from Angaston-Sedan Road (high point in background is near Mons Hill)



Photo 2.3: View north from Pine Hut Road of the area generally comprising the gap between the northern and southern clusters. The existing 275kV transmission line is also evident.



Photo 2.4: Southern met mast (identified as Cambrai 2 mast on Figures 1.2 and 1.3) and view north across plateau. High point in background “behind” the mast is Mons Hill

2.4 Surrounding Land Uses

The site is located on a prominent ridgeline which marks the transition between two distinctly different areas and topography with the flat, sparsely vegetated Murray River Plains to the east and the more undulating Barossa and Eden Valley areas to the west. The escarpment itself in this area is largely devoid of remnant native vegetation, although pockets remain in gullies and along creek lines.

As denoted by the presence of the Rural Zone¹ surrounding the site, agricultural land uses such as cropping and grazing are the predominant land use in the surrounding area.

To the west of the site the land cover is characterised by areas of woodland, open paddocks and vineyards. Large mature gums, particularly along roadsides, significantly contribute to the landscape character. Land within this area is predominantly used for grazing livestock, cropping and viticulture. Interspersed amongst larger scale agriculture and viticulture land uses are isolated pockets of smaller allotments (e.g. - along Keyneton Estate Road), smaller scale farms and small rural settlements such as Graetz Town and Keyneton.

The site lies adjacent to the world famous wine producing areas of the Barossa and Eden Valley which supports 750 grape growing families and more than 170 wine companies². The Marne River to the south of the site rises around Eden Valley and Springton before passing through Cambrai and flowing into the Murray River at Wongulla.

To the east of the Mount Lofty Escarpment are the low lying plains of the Murray River. The absence of vegetation on the Murray Plains creates an exposed landscape character that reinforces the agricultural character of the area. The area is characterised by flat open paddocks with vegetation belts and isolated tree groups predominantly along fenceline and properties boundaries. This creates a distinctly rural landscape character that is typical of the Mid Murray Council area. The main settlements to the east of the site are Cambrai and Sedan.

2.5 Topography and Geomorphology

The proposed wind farm site is located along the Mount Lofty Ranges ridgeline. The ridgeline's elevation generally runs between approximately 350 and 450m above sea level (Refer to Figure 2.2).

The landform and geomorphology on which the proposed wind farm will be situated has been influenced by a number of distinct geologies, which in turn have led to a number of defined landforms and landscape characters. The Eastern Mount Lofty Ranges is formed by the Kanmantoo Geological Group, which includes a range of sedimentary and metamorphic deposits of sandstone and limestone, as well as areas of Delamerian granite to the Murray Plains. The land form is created by the geophysical effects of the Bremer Fault and other minor faults along the eastern edge of the Mount Lofty Ranges. Extended periods of erosion have subsequently

¹ Mid Murray Council Development Plan (Consolidated 19 April 2012)

² <http://www.barossa.com/wine/default.aspx>

resulted in the gullies and hills that form the topographic character that surrounds the proposed Keyneton Wind Farm development site.

2.6 Wind Characteristics

The Australian Wind Atlas provided by 3Tier³ identifies the Keyneton project area offering an above South Australian average wind resource⁴ (Figure 2.3).

The Keyneton project has an expected average annual long term wind speed across the site of 7.7m/s at 80m above ground level, based on data from two wind 50m meteorological masts operated on site by Pacific Hydro since 2004. The prevailing winds are westerlies and this supports the general development area orientation from north to south. The wind turbulence level is determined to be low to moderate and this strengthens the general high suitability for potential wind farm operation.

2.7 Settlements and Housing

The proposed site is within a Rural Zone, surrounded predominantly by large land parcels used for various forms of agriculture.

The following small settlements and townships surround the site, population figures are provided from the Australian Bureau of Statistics 2006 census:

- Keyneton – population of around 317 located approximately 4km to the west of the site.
- Eden Valley – population of around 430 people approximately 8km south west of the site.
- Moculta – population of around 299, just over 7.5 km north west of the site.
- Towitta⁵ – population estimated at 30 - 40 located approximately 4.5km west of the northern part of the site.
- Sedan – located just over 8km from the site.
- Cambrai – pop 501 (including Sedan) located just over 6.5km from the site.

Located to the west of the site is an area of smaller rural land parcels along Keyneton Estate Road. The nearest house along Keyneton Estate Road is located approximately 2.4km from the nearest turbine. The properties within this sub-division are primarily used as small-scale hobby farms with the nearest property being used primarily for horse breeding and training.

³ Independent wind analysis consultant

⁴ http://www.renewablessa.sa.gov.au/files/wind_1984-88study_map.pdf provides an indication of wind speeds at other wind farms in SA

⁵ Population figures not available on ABS

The closest dwellings to the proposed wind farm are to the east of the site's southern section, over 1.5 km from the nearest turbine. Dwelling locations and separation distances are shown in Figure 2.4

2.8 Infrastructure and Access

An existing 275kV high voltage overhead transmission line runs generally north-south through the project site. An underground high pressure gas pipeline easement crosses the northern section of the project site in an east-west direction. This easement also contains fibre optic cables. Underground water pipes run for a small portion of the southern section of the site and have been avoided in the layout. The turbine layout has maintained a suitable clearance distance from all assets.

During consultation the Bureau of Meteorology (BoM) identified an aboveground rain gauge transmitter operating on the site (See Chapter 11), however BoM have confirmed that the proposed wind farm will not interfere with this transmitter.

The Angaston-Sedan Road bisects the northern section of the site and will provide direct access for Over Dimensional (OD) vehicles to the northern part of the site (See Chapter 10 and Figure 10.1). The Angaston-Sedan Road is a gazetted B-double route managed by the DPTI.

Pine Hut Road to the south is a local road managed by Mid Murray Council. This road bisects the southern part of the site and connects Jutland Road to the west with the Cambrai – Sedan Road to the east. Pine Hut Road is unsealed and to the east of the site is characterised by a narrower steep section onto the ridgeline, the presence to large mature gums adjacent to the roadside and several creek crossings. As such Pine Hut Road will be used by OD vehicles exiting the site to travel west back to Rhine Park Road from the southern section of the wind farm site.

2.9 Design Response

The following summarises how Pacific Hydro's proposed design of the Keyneton Wind Farm derives from and responds to the site's characteristics (See Figure 2.5).

In reaching the proposed wind farm layout, Pacific Hydro has adopted an iterative design process which has taken into account the site context and the following range of factors:

- Wind regime
- Turbine minimum spacing requirements with respect to energy yield and turbulence effects
- Land availability and capacity to connect to the National Electricity Grid
- Environmental factors such as native vegetation, cultural heritage, proximity to dwellings and associated potential amenity impacts
- Physical constraints such as topography
- Technical factors such as turbine characteristics and spacing requirements
- Community responses

Pacific Hydro's general process with respect to turbine layout is as follows. Initially, the preliminary layout is set out based entirely on technical spacing and in response to the topography of the site, any known grid capacity constraints, and the location of surrounding residential dwellings. From this point the layout will go through a number of iterative changes as additional constraints are identified through the environmental assessment process and also to address issues raised by the community living around the proposed wind farm. In this way the design submitted for planning purposes represents the best design in terms of balancing technical performance (energy production), avoiding or minimising potential environmental impacts and impacts on the local community amenity.

Environmental assessment is conducted in order to identify potential effects and inform the design such that impacts can be avoided in the first instance. If these impacts cannot be completely avoided, the design and associated environmental management and mitigations proposed will minimise impacts in order to reduce their extent and consequence.

Table 2.1 below summarises the evolution of the proposed Keyneton Wind Farm layout (See Chapter 5, Table 5.1 for further detail).

Table 2.1: Design Process Evolution

Layout	Turbines	Design Comments
July 2009	60	31 turbines sited in the northern section, five in the middle section and 24 turbines in the southern section
		Layout based on: <ul style="list-style-type: none"> • wind resource • required turbine spacing • site topography • surrounding dwellings • immediate grid proximity and grid capacity
March 2011	57	31 turbines in the north and 26 in the south
		Community: <ul style="list-style-type: none"> • In response to feedback from residents on Keyneton Estate Road, concerned about the turbines in the middle section of the site, three turbines were deleted and two others relocated – all in the middle section. Flora and fauna: <ul style="list-style-type: none"> • Following initial flora and fauna surveys, areas of

Layout	Turbines	Design Comments
		conservation significance were avoided and 300 metre buffers around Wedge-tailed Eagle nests were adopted as recommended by EBS Ecology.
Dec 2011	42	22 turbines in the northern cluster and 20 turbines in the south.
		<p>15 turbines were deleted in order to accommodate the following design goals:</p> <ul style="list-style-type: none"> • Deletion of visually prominent “outlier” turbines and from other visually prominent locations • Deletion of turbines causing visual complexity from certain locations • Deletion of most visually prominent turbines • Response to visual impact/amenity concerns from residents • Avoidance of sensitive site of Aboriginal cultural heritage significance • Adoption of buffers around Wedge-tailed Eagle and Peregrine Falcon sites • Avoidance of native vegetation and mature gum trees • Avoidance of preferred bat habitat • Practicality of construction

2.10 Turbine Density

The initial aim, with respect to wind farm design, is to maximise the energy generation over the lifetime of the project within the environmental constraints. As such the turbine spacing presented within this application represents a balance between maximising energy output, assuring reliable and efficient operation and ensuring that whilst the wider benefits of renewable energy are realised that local environmental impacts are minimised and appropriate throughout.

In order to maximise the energy output from each turbine they are generally proposed in areas of sufficient wind resource (usually on elevated parts of a site), reasonably spaced from each other to avoid excessive turbulent wind flow conditions in between the generators (which would increase component stress and lowers turbine efficiency) and are located in areas which are ultimately constructible, accessible and free of significant environmental constraints. The density of turbines within a site should consider energy yield efficiency and design life expectancy of a wind turbine generator.

In order to appreciate the relative density of the proposed turbine layout at the Keyneton Wind Farm, a comparison of the turbines has been made with other operational and approved wind farms in South Australia. The table below shows the density of a number of wind farms in South Australia.

Table 2.2: Comparison of turbine density at various wind farm projects

Wind Farm	No. of Turbines	Distance between turbines			
		Min	Max	Ave (m)	Ave (Rotor Diameters)
Keyneton	42	432	1022	560	6.1
Clements Gap	27	343	507	381	4.3
Carmody's Hill	70	405	877	497	4.1
Snowtown	47	261	1059	364	3.1
Waterloo	37	236	348	281	6.1

Figure 2.6 also illustrates the relative layout and density of these projects. Clements Gap, Snowtown and Waterloo are operational, Carmody's Hill is approved but has not as yet been constructed.

2.11 Detailed Design Process

This application seeks approval for 42 turbines with a maximum turbine tip height of 145.5m. This represents the maximum turbine numbers and dimensions. The wind farm design process requires the position of the wind turbines to be finalised during the detailed design phase, following selection of the final turbine model. The final turbine model will be selected based on technical and commercial considerations following planning approval.

Turbines will be micro-sited (i.e. within the extent allowed by conditions of approval) where necessary to address any constructability constraints identified during the geotechnical investigations or cultural heritage sites identified during surveys proposed to coincide with detailed design (See Chapter 8). Through detailed design and micro-siting, impacts on cultural heritage sites will be avoided wherever possible. Where impacts cannot be avoided, site impacts will be minimised. Pacific Hydro will continue to consult with the relevant Aboriginal group (Peramangk), qualified archaeologists and ecologists throughout this process.

2.12 Site Suitability Statement

The extensive environmental assessments, including flora and fauna, cultural heritage, landscape and wind monitoring have confirmed the site's suitability for wind farm development: The site is suitable for development of a wind farm because of the following:

- Strong, consistent winds with expected average annual wind speed of 7.7m/s (See Section 2.6 and Figure 2.3).
- Immediate on-site access to the existing local National Electricity Grid negating need to construct an off-site overhead transmission line.

- The size and location of the site (i.e. over 1.5 km to the nearest dwelling, that allow potential amenity impacts such as noise and shadow flicker to be avoided, minimised or sufficiently mitigated (Chapters 9, 11 and 12).
- Existing land practices which can co-exist with the turbines, thus maintaining and further diversifying the agricultural income stream.
- Site characteristics – suitable terrain and space provide flexibility to avoid remnant native vegetation (Chapters 2 and 6) and significant cultural heritage (Chapter 8).
- Suitable clearance distance can be provided from telecommunications infrastructure to avoid any signal interference (Chapter 11).
- Good access from the public road network (Chapter 10).
- Supports various Federal and State renewable energy and climate change mitigation policies (Sections 4.2 and 4.3).
- Supports implementation of the State, Regional and Local planning policy (Section 4.3. 4.4 and Chapter 13).
- The wind farm will contribute to the local economy by diversifying the agriculture income base, by creating direct and indirect employment opportunities and economic stimulus (Sections 4.6, and 4.7).
- Supports a trend towards a more diversified mix of electricity sources. Decentralised electricity generation such as the Keyneton Wind Farm contribute towards diversity of supply and will help lessen our reliance on large conventional generating units. Local, regional and Adelaide's demand is expected to benefit from the proximity of renewable power generation at Keyneton.

Chapter 2 Figures

Figures 2.1: Site Elevations

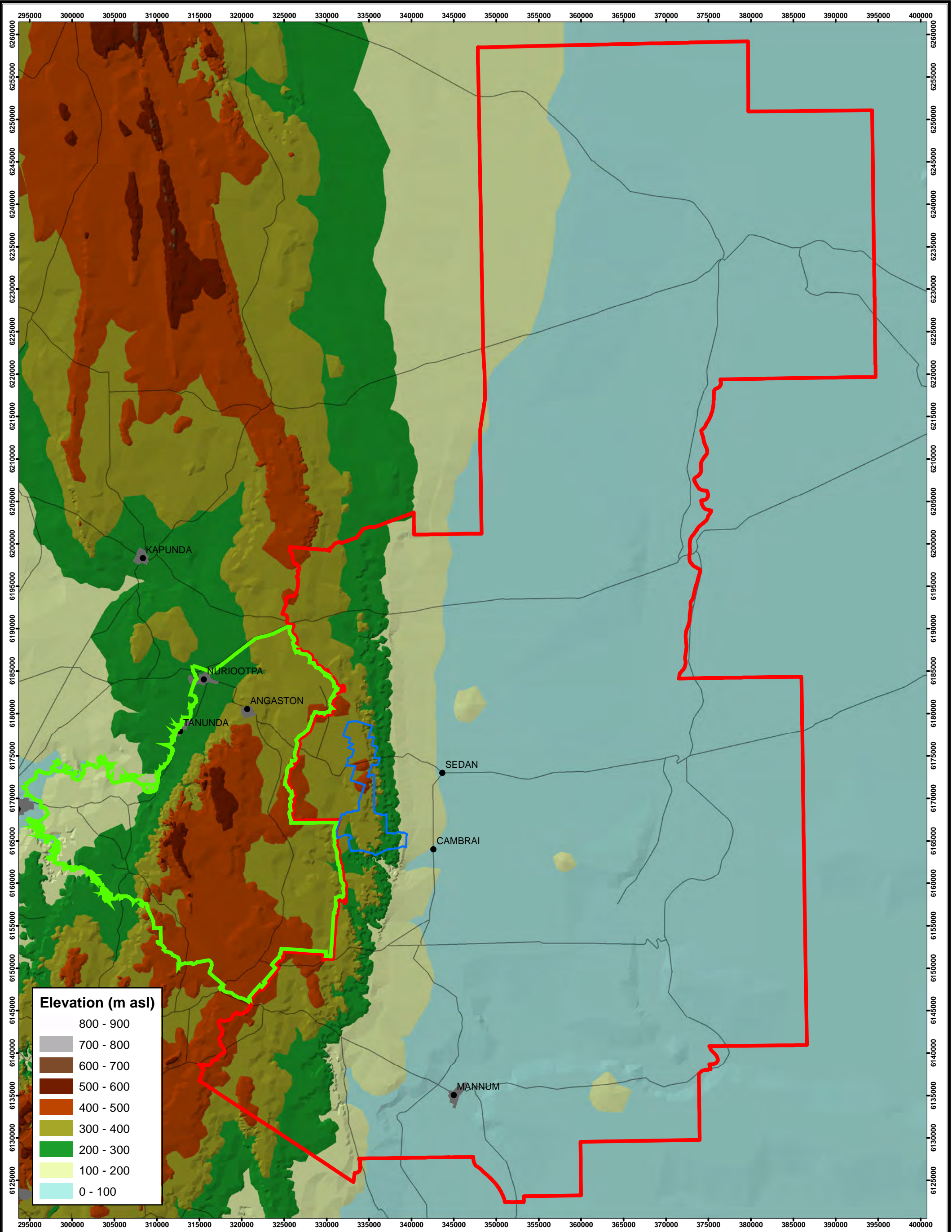
Figures 2.2: Site Contours and Elevations

Figures 2.3: SA Wind Resource Map

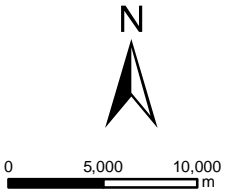
Figures 2.4: Layout and Houses

Figures 2.5: Site Context Map

Figures 2.6: Project Density and Comparison



- Township
- Site Boundary
- Mid Murray Council Area
- Barossa Council Area
- Roads



PROJECT		Keyneton, South Australia		DATUM		MGA94 (z54)	
TITLE		Figure 2.1 Site Elevation		SCALE		1:400,000 A3	
		FOR EXTERNAL DISTRIBUTION		DATE		15/06/12	
		CREATED		A.Liu		DRAWING NO	
		CLEARED		E.Zorondo		PH-0894	
		APPROVED		M.Barnett		REV	
						A	



Spot Elevations (Metres Above Sea Level)

Site Boundary

10m Contour Lines

N

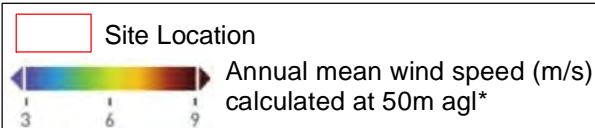
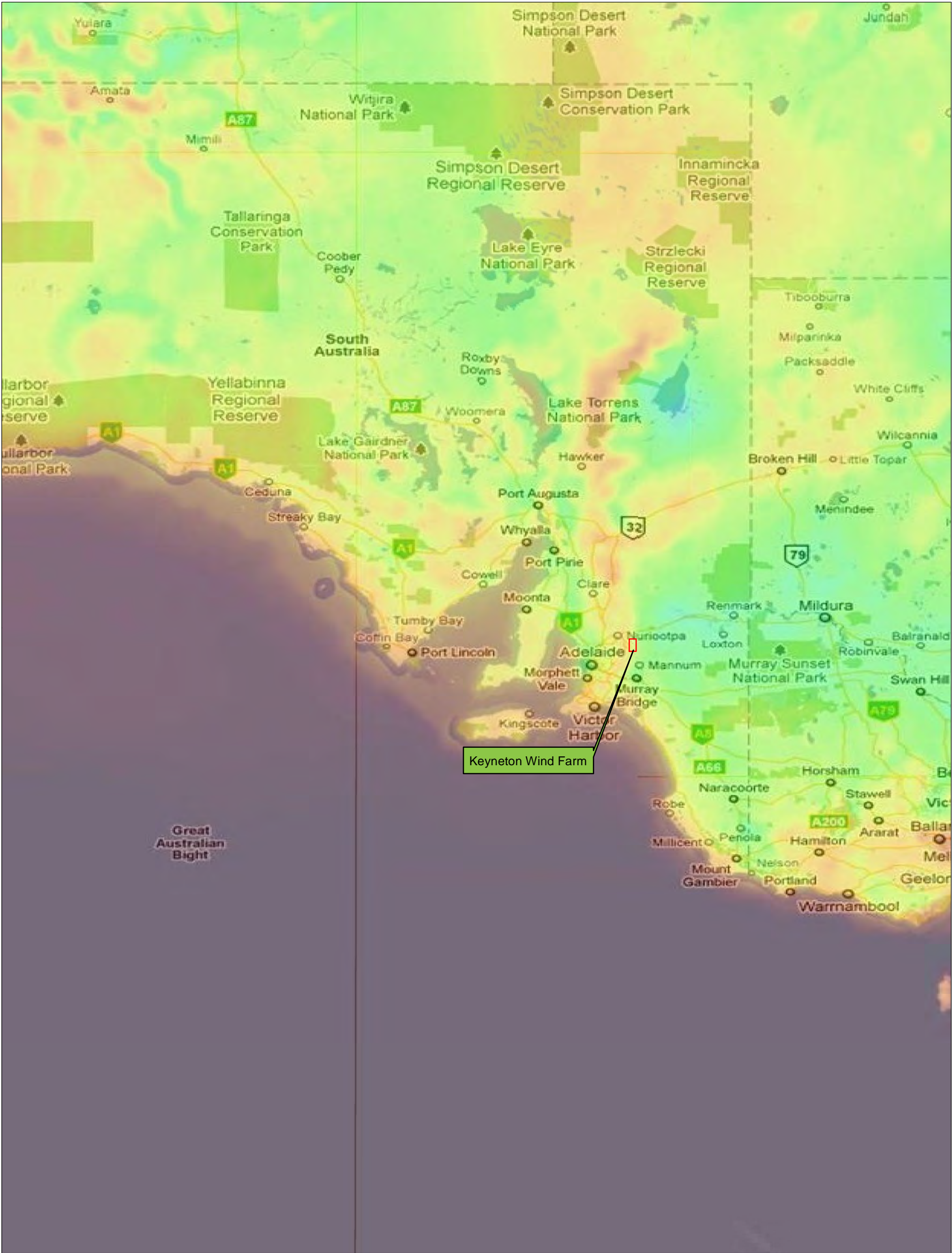
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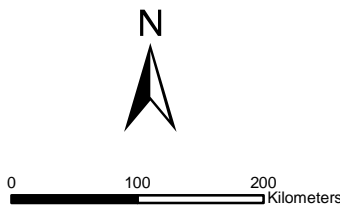
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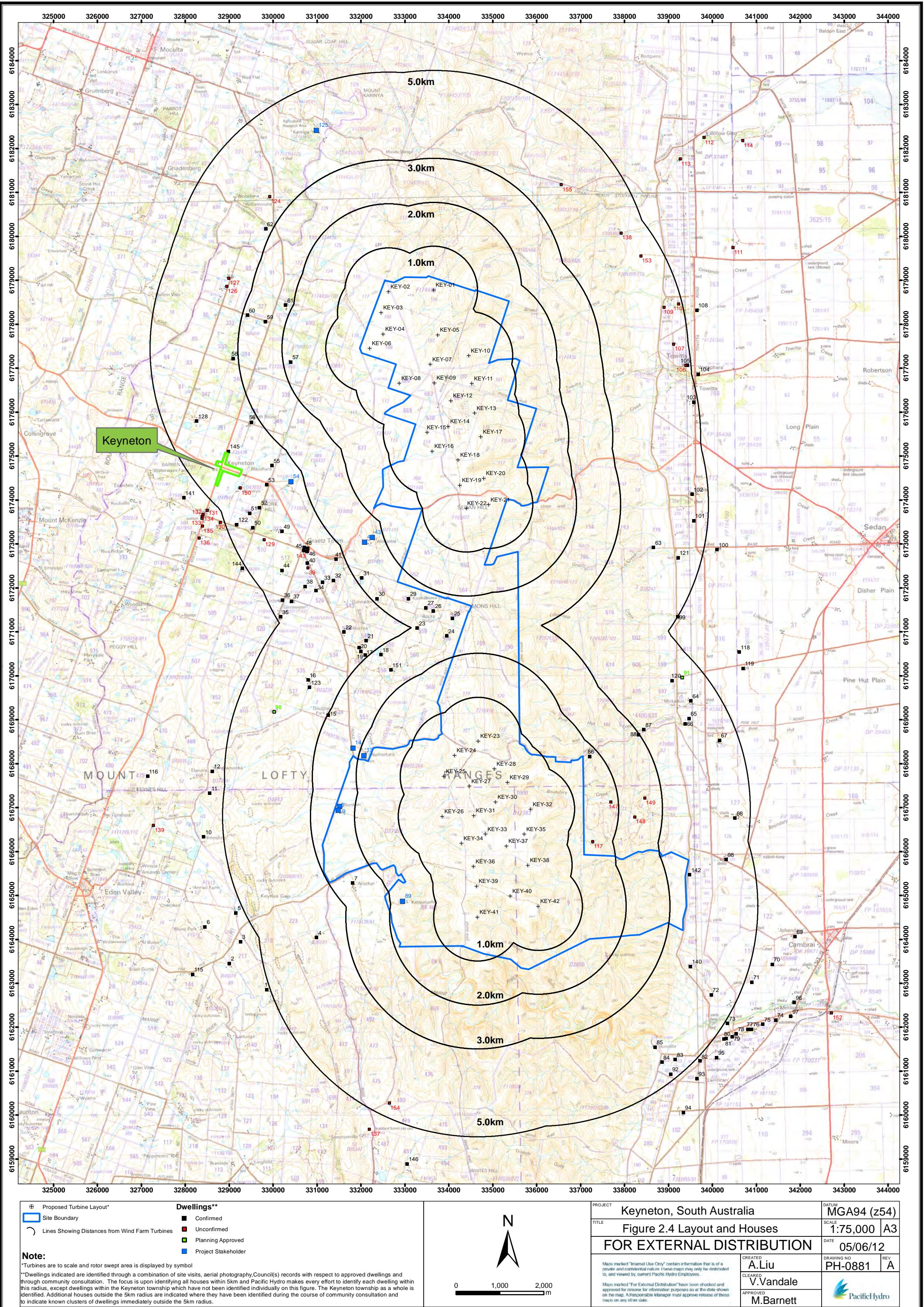
PROJECT		Keyneton, South Australia		DATUM		MGA94 (z54)	
TITLE		Figure 2.2 Site Contours & Elevations		SCALE		1:50,000 A3	
FOR EXTERNAL DISTRIBUTION				DATE		05/06/12	
CREATED		A.Liu		DRAWING NO		PH-0879	
CLEARED		E.Zorondo		REV		A	
APPROVED		M.Barnett					

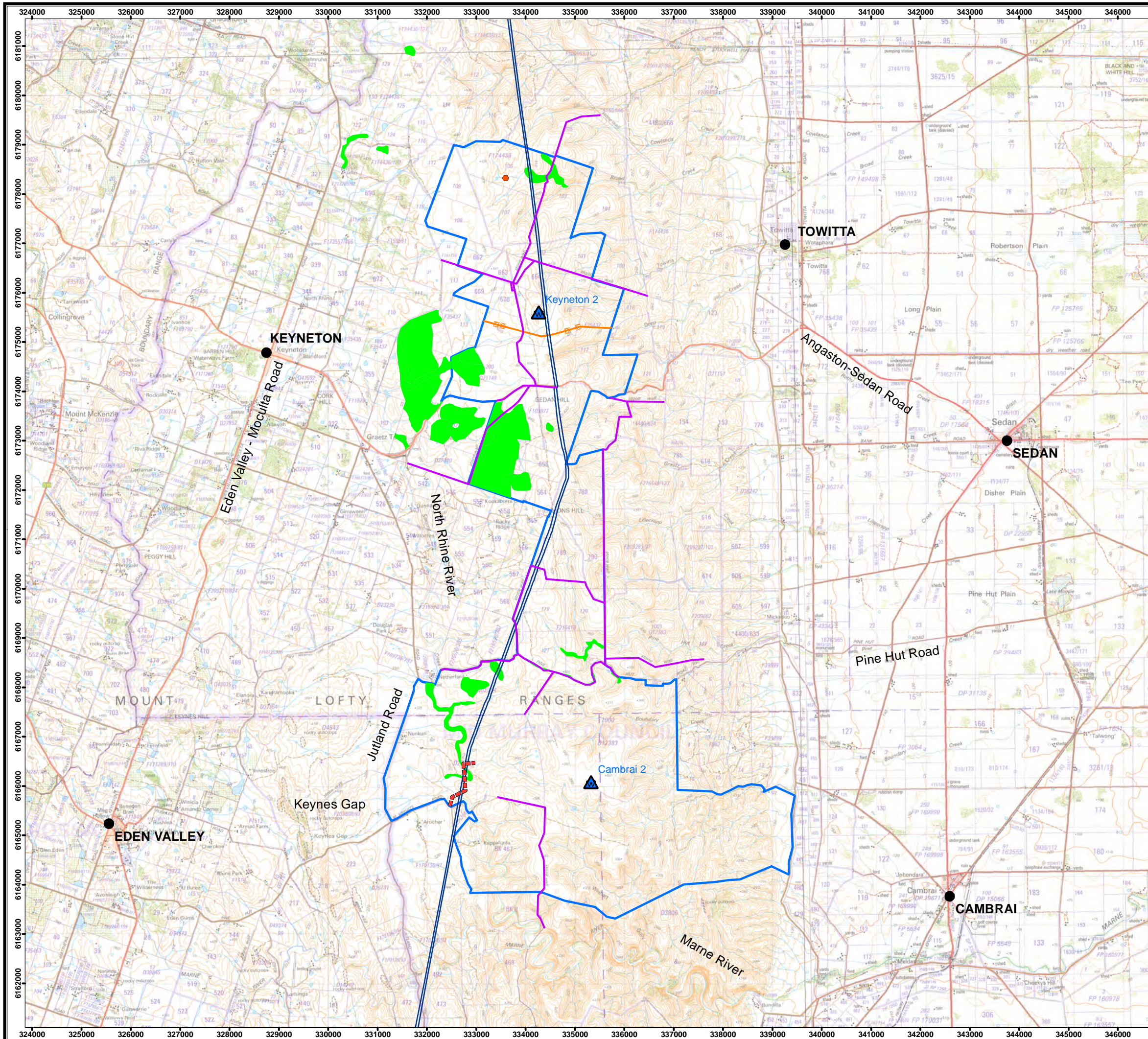


*Source: 3 Tier 5km wind resource grid. Dataset was created through the application of advanced NWP (Numerical Weather Prediction) models and incorporates publicly available observations from meteorological towers worldwide.




PROJECT		Keyneton, South Australia		DATUM	MGA94 (z54)
TITLE		Fig 2.3 South Australia Wind Resource		SCALE	1:6,000,000
		FOR EXTERNAL DISTRIBUTION		DATE	05/06/12
		CREATED A.Liu		DRAWING NO	PH-0880
		CLEARED V.Vandale		REV	A
		APPROVED M.Barnett			





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PROJECT		Keyneton, South Australia			
TITLE		Figure 2.5 Site Context Plan			
FOR EXTERNAL DISTRIBUTION					
<p>Maps marked "Internal Use Only" contain information that is of a private and confidential nature. These maps may only be distributed to, and viewed by, current Pacific Hydro Employees.</p> <p>Maps marked "For External Distribution" have been checked and approved for release for information purposes as at the date shown on the map. A Responsible Manager must approve release of these maps on any other date.</p>		CREATED			
		A.Liu			
		CLEARED			
		E.Zorondo			
		APPROVED			
		M.Barnett			
		DATE			
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		1:75,000			
		DATUM		MGA94 (z54)	
		DRAWING NO	REV		
	PH-0891	A			
<div><div><div>PacificHydro</div></div><div><div>Level 11, 474 Flinders Street, Melbourne Victoria 3000 Australia</div><div>Telephone +61 3 8621 6000 Facsimile +61 3 8621 6111</div><div>www.pacifichydro.com.au</div></div></div>					

- Site Boundary
- Natural Spring
- Existing 50m Monitoring Mast
- Township
- Stone Wall
- Electricity Overhead Line (Easement)
- Gas Pipeline / Fibre Optic
- Telecommunication Line
- Native Vegetation - Areas of Conservation Significance

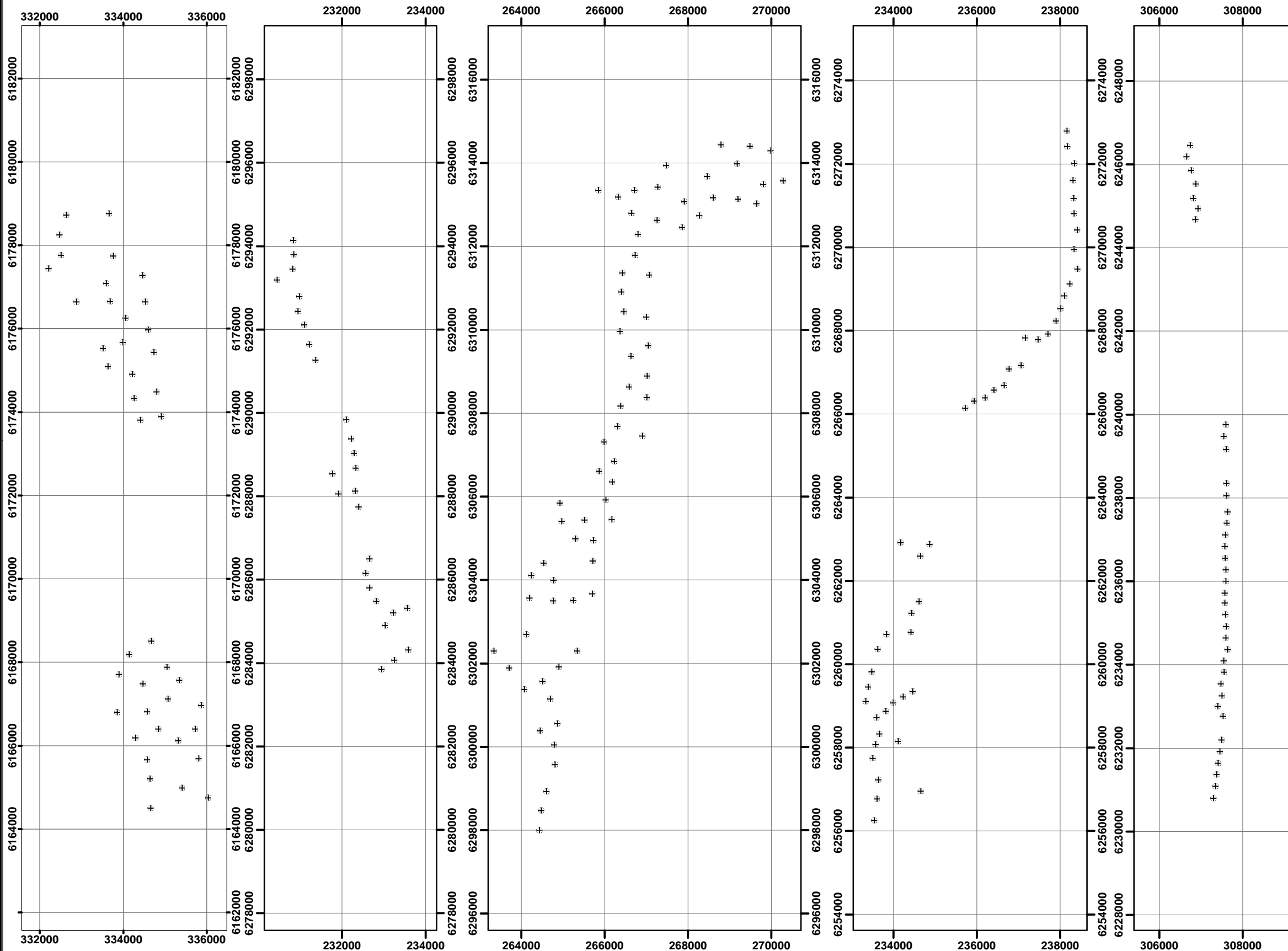
Proposed
Keyneton
Wind Farm

Clements Gap

Carmody's Hill

Snowtown*

Waterloo*



PROJECT

Keyneton, South Australia

TITLE

Figure 2.6 Site Density

FOR EXTERNAL DISTRIBUTION

CREATED

A.Liu

CLEARED

V.Vandale

APPROVED

M.Barnett

DATE

15/06/12

SCALE

1:100,000

A3

DATUM


MGA94 (z54)

DRAWING NO

PH-0895

REV

A

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Telephone +61 3 8621 6000 Facsimile +61 3 8621 6111
www.pacifichydro.com.au

Wind Farm	No. of Turbines	Rotor Diameter RD (m)	Distance between turbines			
			Min (m)	Max (m)	Ave (m)	Ave (RD)
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Snowtown	47	88	261	1059	364	4.1
Waterloo	37	90	236	348	281	3.1

*Turbine layouts for Snowtown and Waterloo wind farms have been identified using Google Earth imagery and therefore minor accuracy errors may be present.

Clements Gap, Snowtown and Waterloo wind farms are operational.Carmody's Hill is approved, but has not been constructed to date.