TrustPower Australia Holdings Pty Ltd
ABN: 15 101 038 331
Snowtown Wind Farm Pty Limited
ABN: 76 109 468 804

ADELAIDE
GPO Box 1512, Adelaide
South Australia, 5001
Phone +61 1300 888 282
Fax +61 1300 660 623
WEBSITE
www.trustpower.co.nz

28h April 2010

Wakefield Regional Council
PO Box 167
BALAKLAVA SA 5461

Attention: Ms Elca McCarthy

Snowtown Wind Farm and Associated Electrical Infrastructure – Application for Planning Variations

Dear Elca,

INTRODUCTION

Having successfully completed Stage 1 of the Snowtown Wind Farm in November 2008, TrustPower Ltd, through its subsidiary Snowtown Wind Farm Pty Ltd, seeks to expand the Snowtown Wind Farm with Stage 2. Stage 2 would build the remainder of the 130 approved turbine locations, and proposes to add another 19 turbines, resulting in a total of 149 turbines across the entire Snowtown Wind Farm site.

This letter is a formal application for four variations to the following Snowtown Wind Farm approvals:

- Provisional Development Plan Consent (Development Number 373/111/03); granted on 29th January 2004, amended on 7th December 2006 and further amended on 16th November 2007
- Provisional Development Plan Consent (Development Number 373/139/04) granted 25th August 2004

FACTS AND BENEFITS OF THE SNOWTOWN WIND FARM

The proposed 214.2 MW Stage 2 expansion of the Snowtown Wind Farm represents a substantial investment in South Australia's Mid North region, and would take the total capital value of the completed Snowtown wind Farm project to approximately $800m.

It will make the Snowtown Wind Farm one of the largest wind farms in Australia, and will make a substantial contribution towards Australia's and South Australia's renewable energy generation targets of 20% by 2020 and 33% by 2020 respectively. Stage 2 of the Snowtown Wind Farm will produce approximately an additional 750 GWh of electricity each year, which is enough to power approximately 130,000 average South Australian homes. It will also contribute significantly to the Commonwealth's emission reduction targets by saving more than 700,000 tonnes of greenhouse gas emissions annually.

It will have substantial direct and indirect benefits for the Mid North region, in terms of landowner royalty payments, construction jobs and ongoing economic activity associated with the wind farm, continuing and extending the benefits accrued by Stage 1.

OVERVIEW OF PLANNING VARIATIONS SOUGHT FOR STAGE 2

TrustPower has undertaken considerable work in anticipation of Stage 2, including ecology surveys, Aboriginal heritage surveys, aviation lighting studies, transmission line studies, overhead line easement negotiations and reaching commercial arrangements for the purchase of land for two proposed new electrical substations. This work has resulted in an optimisation of the proposed turbine locations, and proposed new overhead power line route to connect the Snowtown Wind Farm to ElectraNet SA's transmission network.

We are seeking four variations to alter the planning approvals for the Wind Farm and for its associated Electrical Infrastructure:

- **Variation 1** is to seek approval for minor location changes for 69 of the previously approved turbine locations
- **Variation 2** is to seek approval for 33 new turbine locations: 14 turbines which were previously approved in different locations but need to be moved, and 19 turbines which are new to the Snowtown Wind Farm site
- **Variation 3** is to seek approval for variations to previously approved electrical infrastructure, including the relinquishing of a number of previously approved electrical substations and overhead power lines corridors.
- **Variation 4** is to seek approval for new electrical infrastructure including two proposed new substation locations and new overhead power line corridor.

Variation 1

69 of the Stage 2 turbines locations correspond to previously approved turbine locations, but with minor changes of location resulting from:

- the need to avoid areas of ecological sensitivity identified during further ecological studies undertaken since the original wind farm approval was granted;
- the characteristics of the specific turbine proposed for Stage 2;
- the need to maintain appropriate turbine separation distances between Stage 1 turbines and proposed Stage 2 turbine locations; and
- improved wind modelling on site resulting from 5 years of additional wind monitoring.

Variation 1 is therefore sought for the revised locations for these 69 turbines.

Variation 2

33 turbines proposed for Stage 2 correspond to turbine locations not addressed by the previous approval. These new locations are a consequence of:

- the need to shift 9 turbines away from Bumbunga Hill (at the southern end of the wind farm site) to avoid an electromagnetic exclusion zones associated with the South Australian Government Radio Network (SAGRN);
- the addition of a new landowner, Maro Creek Pty Ltd, to the wind farm site; and
- the need to move turbines out of areas of ecological sensitivity identified during further ecological studies undertaken since the original wind farm approval was granted;
- the need to move turbines out of areas of Aboriginal archaeological and anthropological significance, identified during heritage surveys undertaken since the original wind farm approval was granted;
- the characteristics of the specific turbine proposed for Stage 2; and
- the suitability for wind turbines on some areas not previously proposed, as a result of improved wind modeling across the site, which in turn is a result of five years of additional wind monitoring on site.

Of these proposed 33 new turbine locations, 14 locations replace turbine locations which have been excluded from the wind farm layout by constraints identified after the original approval was granted (namely, the SAGRN exclusion zone at Bumbunga Hill and the areas of ecological sensitivity). 19 turbine locations are new to the proposed Snowtown Wind Farm

Variation 2 is therefore sought for these proposed new 33 turbine locations.

Variations 3 and 4

To accommodate the layout proposed for Stage 2, and to accommodate the fact that transmission capacity is no longer available in the 132kV transmission network at ElectraNet's Brinkworth Substation, TrustPower seeks to vary the approved grid connection infrastructure including the electrical substations, overhead transmission and distribution lines and reticulated underground electrical cables:

Variation 3 is sought for variations to previously approved electrical infrastructure, including the relinquishing of a number of previously approved electrical substations and overhead power lines corridors.

Variation 4 is sought for the addition of new electrical infrastructure, including proposed new substation locations and overhead power line corridors.

Besides the changes highlighted in this planning variation application, the detailed information in the original planning applications still applies.

TURBINES IN STAGE 2

Maps of the proposed Stage 2 layout (overlaid upon the Stage 1 (constructed) layout and the original approved layout) are contained in Appendix A. With reference to those maps:

- The black stars ★ are the 130 original approved turbine locations
- The red dots ● are the 47 turbines constructed in Stage 1
- The blue dots ● are the turbine locations which correspond to Stage 2 turbines which revise original approved turbine locations, addressed by Variation 1.
- The green dots ● correspond to new turbine locations, addressed by Variation 2.

Subject to commercial negotiations currently underway with a range of wind turbine suppliers, the turbines to be used for Stage 2 are expected be the same as those used in Stage 1: Suzlon S88 wind turbines. The S88 turbines have a rated power output of 2.1 MW, will be placed on 80m towers and have rotor diameters of 88m. Detailed characteristics of this turbine are contained in Appendix C. If an alternative turbine is selected it is very likely to have similar physical characteristics to the Suzlon S88 turbine, including the number of blades, tower height and type (tubular steel). If a turbine with materially different physical characteristics or more than minor changes in wind farm layout are proposed, then TrustPower will apply for an additional planning variation.

STAGE 2 CONSTRUCTION TIMEFRAMES

There are several possible options for the construction of the Stage 2 turbines, depending on a number of commercial variables including:

- turbine availability and price
- power offtake arrangements with retailers
- carbon price (through the possible introduction of a Carbon Pollution Reduction Scheme) and
- the availability and cost of project finance.

The combination of these variables will determine whether TrustPower can build all of Stage 2 in a single construction project, or whether it needs to be staged into two or more construction projects. To accommodate this, TrustPower requests the following approval timeframes:

- **Construction Commencement** of the Stage 2 wind farm and electrical infrastructure within 5 years from the approval date(s) of the four planning variations sought in this application, applying to the original wind farm and electrical infrastructure approvals and their subsequent variations; and
- **Completion** of the Stage 2 wind farm and electrical infrastructure five years after Construction Commencement.

VARIATION 1 – REVISED APPROVED TURBINE LOCATIONS

Variation 1 relates to the 69 turbine locations shown by the blue dots in Appendix A. These are the proposed Stage 2 turbine locations which correspond with original approved turbine locations, but with minor location changes resulting from:

- the need to avoid areas of ecological sensitivity, identified during further ecological studies undertaken since the original wind farm approval was granted;
- the need to maintain appropriate turbine separation distances between Stage 1 turbines and proposed Stage 2 turbine locations;
- the characteristics of the specific turbine proposed for Stage 2; and
- improved wind modelling on the site, resulting from 5 years of additional wind monitoring.

Detailed development considerations relating to Variation 1 (including ecology studies, noise compliance, aviation lighting considerations, Aboriginal heritage and the design of access roads and cable tracks) are described below and in the Appendices.

Due to the minor changes proposed in Variation 1, **it is requested that Variation 1 be considered as a minor variation.**

VARIATION 2 – PROPOSED NEW TURBINE LOCATIONS

Variation 1 relates to the 33 turbines proposed for Stage 2 corresponding to turbine locations not addressed by the original wind farm approval. These 33 turbines are shown by green dots in Appendix A.

Of these proposed 33 new turbine locations, 14 locations replace turbine locations which have been excluded from the wind farm layout by constraints identified after the original approval was granted:

- **SAGRN exclusion zone**. After considerable negotiations with Telstra (though the Department of Administration and Information Services), a circular exclusion zone with a radius of 1.2km has been established, centred on the Bumbunga Hill SAGRN transmission tower. This exclusion zone will avoid interference to important emergency services transmissions carried over the SAGRN network, transmitted from Bumbunga Hill. This exclusion zone has required the removal of 9 turbines which had previously been approved for the Snowtown Wind Farm.
- **Aboriginal exclusion zones**. Since the original wind farm layout was approved, detailed Aboriginal cultural surveys have been undertaken on site. These surveys have identified areas of archaeological and anthropological significance, which has required that some turbines be moved from their original approved locations.
- **Ecologically sensitive areas**. Since the original wind farm layout was approved, further ecological studies have been conducted on site, which has identified areas of ecological sensitivity, including areas of critically endangered native grassland and habitat for Wedge Tailed Eagles. Several turbines have been shifted to avoid disturbing these areas of ecological significance.

These 14 replacement locations are predominantly within the overall footprint described in the original wind farm planning approval.

The other new turbine locations in Variation 2 are situated on land owned by Maro Creek Pty Ltd, which has recently been incorporated into the wind farm project. The Certificate of Title and Folio details for the Maro Creek land within the project area are listed in Appendix P.

Detailed development considerations relating to Variation 2 (including ecology studies, noise compliance, aviation lighting considerations, Aboriginal heritage and the design of access roads and cable tracks) are described below and in the Appendices.

Three photomontages have been produced showing the existing visual landscape and the proposed visual landscape with the addition of Stage 2 turbines, specifically in the areas with proposed new turbine locations associated with Variation 2. These photomontages are shown in Appendix D. Note that the new proposed turbines have been digitally “whitened” in the photomontages to make them more clearly visible against the cloudy background. In practice Stage 2 turbines will be the same colour as those in Stage 1 and therefore all turbines will have a similar appearance.

Given the new locations represented by Variation 2, **it is anticipated that Variation 2 would require public consultation**. As part of this public consultation process, TrustPower proposes to conduct a Public Information Day in Snowtown at the start of the formal public consultation period, to describe the Stage 2 infrastructure and to explain the rationale behind the locations selected for this infrastructure.

VARIATION 3 – VARIATIONS TO PREVIOUSLY APPROVED ELECTRICAL INFRASTRUCTURE

The original planning approval for electrical infrastructure associated with the Snowtown (Barunga) Wind Farm was submitted on behalf of TrustPower and ElectraNet SA by ElectraNet SA. This planning variation for the electrical infrastructure is being submitted by TrustPower on behalf of TrustPower and ElectraNet SA. A supporting letter from ElectraNet SA is contained in Appendix K.

The original planning approval for electrical infrastructure included provision for:

- four electrical substations:
  - Substation A (132kv/33kV)
  - Substation B (132kv/33kV)
  - Substation C (132kv/33kV)
  - Substation D (275kV/132kV)
- two possible corridor routes for double circuit 132kV transmission lines to connect the wind farm to an ElectraNet 275kV transmission line and
- a number of overhead and underground 33kV electrical cable corridor routes to connect the wind turbines to the electrical substations.

The original approved electrical infrastructure is shown in Appendix L. The proposed new electrical infrastructure for Stage 2 is show in Appendix B.

Since the original planning approval was obtained in 2004:

- Substation B was constructed during Stage 1
- Single circuit overhead 33kV electrical lines were constructed to connect Stage 1 turbines to Substation B
- A single circuit 132kV electrical line was constructed between Substation B and the existing ElectraNet 132kV transmission line west of Barunga Top Road

A number of changes are now proposed to the approved electrical infrastructure, taking into account the proposed design of Stage 2:

- The two approved overhead power line corridors between the northern part of the wind farm site and existing ElectraNet transmission lines east of the wind farm site are no longer required. These are replaced by a single, proposed, new overhead power line corridor in Variation 4.
- The approved locations of Substations A, C and D are no longer required. (Substations C and D are replaced by proposed new substation locations in Variation 4.)
- The following 132kV overhead power line routes are no longer required:
  - the route between the original Substation A and the original Substation D
  - the route between the original Substation B and the original Substation D
  - the route between the original Substation D and the Brinkworth substation
- A number of changes are sought to the overhead 33kV power line infrastructure to connect the underground 33kV power line circuits from the wind turbines to Substation B and the proposed new Substation C, but all within the corridors approved in the original planning approval.

Given the nature of changes associated with Variation 3, **it is requested that Variation 3 be considered as a minor variation**.

VARIATION 4 – PROPOSED NEW ELECTRICAL INFRASTRUCTURE

Since the original grid connection infrastructure for the Snowtown Wind Farm was approved in 2004, most of the available capacity in the ElectraNet 275kV transmission line passing through the Brinkworth Substation has been secured by other wind farms. A grid connection for Stage 2 is therefore required into a different ElectraNet 275kV transmission line, the Para-Bungama circuit.

A new corridor is therefore proposed for an overhead power line to connect Stage 2 to ElectraNet's transmission network, as shown in Appendix B.

Detailed design for the overhead electrical infrastructure is currently underway, and easement agreements have been entered into with landowners along the proposed 275kV overhead power lines route. A list of landowners and land titles along this route is contained in Appendix O.

To accommodate any issues which may arise from the detailed design process, and to allow the route to be optimized in a manner which maximizes the use of road reserves and avoids disturbance to native vegetation, local dwellings and any possible sites of Aboriginal heritage, a line route corridor is sought with a total width of 1km (500m along either side of the intended overhead line route). This approach was successfully applied in Stage 1, and is sought again for Stage 2.

Whereas the two corridors in the original approved electrical infrastructure were intended for double circuit 132kV overhead power lines, the single corridor now proposed for Stage 2 is intended for single circuit 275kV overhead power lines. Drawings of typical 275kV pole structures are shown in Appendix M. Such poles can be spaced further apart than 132kV power line poles (typically 300m apart) and being single circuit, will contain half the number of wires as compared with the originally proposed double circuit 132kV overhead power poles.

Two new substations are required by the proposed new overhead power line route:

- **Substation C** is proposed in a new location approximately 3.5km south of its original location on the western side of the Barunga range near Barunga Gap. TrustPower (through its subsidiary Snowtown Wind Farm Pty Ltd) has purchased land (Section 477, Hundred of Cameron, being portion of the land comprised in Certificate of Title Volume 5487 Folio 604) to use as Substation C in Stage 2.
- **Substation D** is to be in a new location on Atkinson Rd, approximately 20km south of its original location near the Snowtown–Blyth Road and will now house a 275kV switch yard only. TrustPower (through its subsidiary Snowtown Wind Farm Pty Ltd) has reached commercial arrangements to purchase a portion of Sections 378 and 379, Hundred of Blyth, being a portion of Certificate of Title Volume 5643 Folio 124, currently owned by Robert Arthur Kennett and Suzanne Heather Kennett for use as the Stage 2 switch yard.

Minor changes to the 33kV wind farm electrical reticulation are also required to cater for the change in location of the wind farm substation.

With the proposed changes described above, the electrical infrastructure for Stage 2 will be consistent in all other respects with the approved electrical infrastructure which was described in detail in the original planning application for the electrical infrastructure associated with the Snowtown Wind Farm.

Given the new locations proposed for the overhead power lines and electrical substations, and the change of overhead power lines from double circuit 132kV to single circuit 275kV, **it is anticipated that Variation 4 would require public consultation**. As part of this public consultation process, TrustPower proposes to conduct a Public Information Day in Snowtown at the start of the formal public consultation period, to describe the Stage 2 infrastructure and to explain the rationale behind the locations selected for this infrastructure.

DETAILED DEVELOPMENT CONSIDERATIONS

Ecology

Detailed ecological assessments of the wind farm site and the electrical infrastructure corridors have been undertaken by the consultants Environment and Biodiversity Services (EBS) Pty Ltd, continuing on from assessments undertaken previously by EBS across the entire project area. EBS's reports detailing the outcomes of these assessments are contained in Appendices E and F.

The ecological assessments have enabled TrustPower to design a layout for Stage 2 which minimises the impacts of the wind farm upon local flora and fauna. The assessments also took into account recent changes to the status of several endangered species including the Pygmy Blue Tongue Lizard and Lomandra grasslands.

TrustPower has proposed a 1km wide corridor for the transmission line route specifically to allow the detailed line route designers to minimise or avoid native vegetation impacts from construction of the overhead transmission line (as well as areas of Aboriginal heritage significance). This approach worked very well during Stage 1, and is proposed again for Stage 2.

An Environmental Protection and Biodiversity Conservation (EPBC) referral was made for Stage 2 to the Commonwealth Department of Environment, Water, Heritage and the Arts. This determined that the Snowtown Wind Farm site and transmission line corridor are **not a controlled action**. The EPBC determination is contained at Appendix G.

An application will shortly be made to the Native Vegetation Council (NVC) of South Australian for any clearance of native vegetation required during Stage 2 construction. Native vegetation impacts have been minimised through careful design, and once EBS has quantified the total native vegetation disturbance, TrustPower will satisfy the requirements of the NVC by:

- Initially, attempting to negotiate a native vegetation "set aside area" with a landowner whose land contains suitable areas of high quality native vegetation, on or close to the Snowtown Wind Farm project area.
- If a suitable set aside area cannot be negotiated successfully, the required payment will be made to the NVC for native vegetation protection in South Australia.

Noise compliance

Detailed noise modelling has been undertaken by acoustical experts Sonus Pty Ltd for the proposed Stage 2 layout, and is contained in Appendix H.

The noise modelling for Stage 2 takes into account:

- the revised wind farm noise guidelines issued by the South Australian Environmental Protection Agency (SA EPA) in July 2009 (http://www.epa.sa.gov.au/xstd_files/Noise/Guideline/windfarms.pdf)
- the noise profiles of the Stage 1 and Stage 2 turbines
- background noise modelling undertaken around the wind farm site in 2004 and 2009

As discussed in the noise report, the proposed Stage 2 layout is fully compliant with the SA EPA wind farm noise guidelines.

Access Roads and Cable Routes

Maps showing the locations of indicative access roads and electrical cable routes are contained in Appendix I. The proposed design specifications for the access roads and cable routes are consistent with the roads and cable routes installed in Stage 1 and approved in the original planning applications.

The proposed access roads are 5m in width, in accordance with the Environmental Statement in the original wind farm planning application. However, as was required for Stage 1, extra graded tracks may be required in some locations, offset to the side of the formed access roads, to allow a crawler crane to traverse between turbine locations during construction. The width and offset of these graded tracks will depend on the type of crane which can be secured for the Stage 2 construction: a rubber tyred crane would require less graded width than a tracked “crawler” crane, which is 9-10m across. Larger widths are expected to be necessary at road bends, to accommodate the turning radius of the crane. At worst case, it is not expected that the width of the overall graded area to exceed 5m on one side of the 5m formed road (10-12m width in total). After construction is completed, the formed access road will remain for maintenance access and the graded areas of the offset tracks will be re-grassed.

The cable routes for both the aerial and underground portions of the wind farm 33kV electrical reticulation system are similar to those proposed in the original planning application for electrical infrastructure with amendments generally limited to those required to cater for the alternative substation locations referred to in this variation application. Aerial 33kV lines will be used for the cable routes within the Western 33kV line corridor shown on the Proposed Stage 2 Electrical Grid Connection Infrastructure map in Appendix B. The 33kV reticulation within the wind farm area will be underground 33kV cable indicatively along the cable routes shown on the Indicative Stage 2 Access Roads and Cable Routes map in Appendix I. Final routes for the 33kV reticulation will be determined in the detailed design stage in consultation with the relevant landowners.

Aviation Lighting

Aviation lighting was installed on Stage 1 turbines, as required in the wind farm’s planning approval conditions, and following a lighting assessment conducted by the Civil Aviation Safety Authority (CASA) in accordance with CASA’s Advisory Circular AC 139-18(0).

In mid 2008, CASA withdrew Advisory Circular AC 139-18(0) and commenced an internal review of wind farm aviation lighting requirements. To resolve the uncertainty with respect to an ongoing requirement for wind turbine lighting, and to determine lighting requirements for Stage 2, TrustPower commissioned Hart Aviation Pty Ltd to undertake a

review of lighting requirements at the Snowtown Wind Farm. Hart Aviation's report is contained in Appendix J.

Hart Aviation's detailed study examined the lighting regimes required for wind farms overseas and took into account any specific hazards to aviation posed by the Snowtown Wind Farm. The study concluded that no aviation lighting is required for Stage 1 or Stage 2, due to the following considerations:

- There are no licensed aerodromes within the wind farm area or in the near vicinity. The nearest licensed aerodrome is at Port Pirie, approximately 45km from the most northern wind turbine within the Snowtown Wind Farm. As such, there are no concerns regarding aerodrome operations or any Obstacle Limitation Surfaces (OLS) that are relevant to the Snowtown Wind Farm.
- There are only two unlicensed aerodromes identified as existing at distances varying between 31km & 46km from the Snowtown Wind Farm. Operations to and from these aerodromes are minimal and it is assessed that the presence of the Snowtown wind turbines / wind farm would not have any adverse impact on such operations.
- With the exception of approved low level operations (such as aerial agricultural spraying, search and rescue, etc.) aircraft are required to operate at minimum heights above the highest point of any of the wind turbines.
- Any approved low level operations, by their very nature, are required to check for any obstacles which might impact on such operations, before undertaking any such operations.
- The Snowtown Wind Farm turbines will not affect any sector or circling altitude, nor any approach or departure, or any enroute or grid lowest safe altitudes (LSALT). They will not impact on Precision/Non-Precision Navigational Aids, HF/VHF Communications, Advanced Surface Movement Guidance and Control Systems, Radar or Satellite/Links.
- There are no known low level military flight routes within the area.

Based on the recommendations in the detailed Hart Aviation study and the withdrawal of the CASA Advisory Circular AC 139-18(0), TrustPower seeks planning approval to turn off the existing lighting on Stage 1 turbines and to erect Stage 2 turbines without aviation lighting.

TrustPower is liaising with CASA regarding the Hart Aviation study outcomes and Snowtown Wind Farm lighting, and will submit Stage 1 and Stage 2 layouts to Airservices Aeronautical Information Services (AIS) and the Royal Australian Air Force's AIS, for inclusion on future aviation maps, in accordance with the recommendations of the Hart Aviation study.

Aboriginal Heritage

Following desktop heritage studies in early 2004, agreements were negotiated and signed in late 2004 with three Aboriginal groups: Narungga, Nukunu and Kaurna. Detailed heritage surveys were conducted over the wind farm site with each group, and areas of heritage sensitivity and significance were identified.

Following the addition of Maro Creek land to the wind farm project area, a heritage survey of that land was conducted with all three Aboriginal groups in February 2009. No sites of particular heritage significance were found during this survey.

During construction of Stage 1, extensive monitoring of on-site works was conducted by Aboriginal monitors. Such monitoring is proposed again for Stage 2, to ensure that areas of heritage sensitivity and significance are properly protected.

Aboriginal heritage surveys will be conducted along the overhead transmission line route once power pole locations have been selected and pegged.

Aboriginal surveys and construction works monitoring in Stage 2 will all be covered by existing agreements with the three Aboriginal groups.

Meteorological Masts

The Snowtown Wind Farm site contains a number of meteorological masts for the measurement of wind on site:

- Some of these masts are temporary masts, erected to measure and the wind, to allow the Snowtown Wind Farm to be optimally designed.
- Two of these masts are permanent masts, erected during the construction of Stage 1, to allow the installed wind turbines to be correctly monitored.

A time extension is sought for all temporary wind masts on site, to allow them to remain on site until the completion of the Stage 2 construction activities.

SUMMARY

Stage 2 of the Snowtown Wind Farm represents a substantial investment in South Australia's Mid North region, and would lead to ongoing direct and indirect benefits to the Mid North and its communities, in terms of landowner royalty payments, construction jobs and ongoing economic activity associated with the wind farm. It will make a substantial contribution towards Australia's and South Australia' renewable energy generation targets of 20% by 2020 and 33% by 2020 respectively. It would have substantial direct and indirect benefits for the Mid North.

TrustPower kindly requests that Variations 1 and 3 be considered as minor variations, and anticipates that Variations 2 and 4 would require public consultation. As part of this public consultation process, TrustPower proposes to conduct a public open day in Snowtown at the start of the formal public consultation period, to describe the Stage 2 infrastructure and to explain the rationale behind the locations selected for this infrastructure.

We would be most grateful for your prompt consideration of these variations, to allow us to move on with the commercial arrangements required to implement the project.

Regards

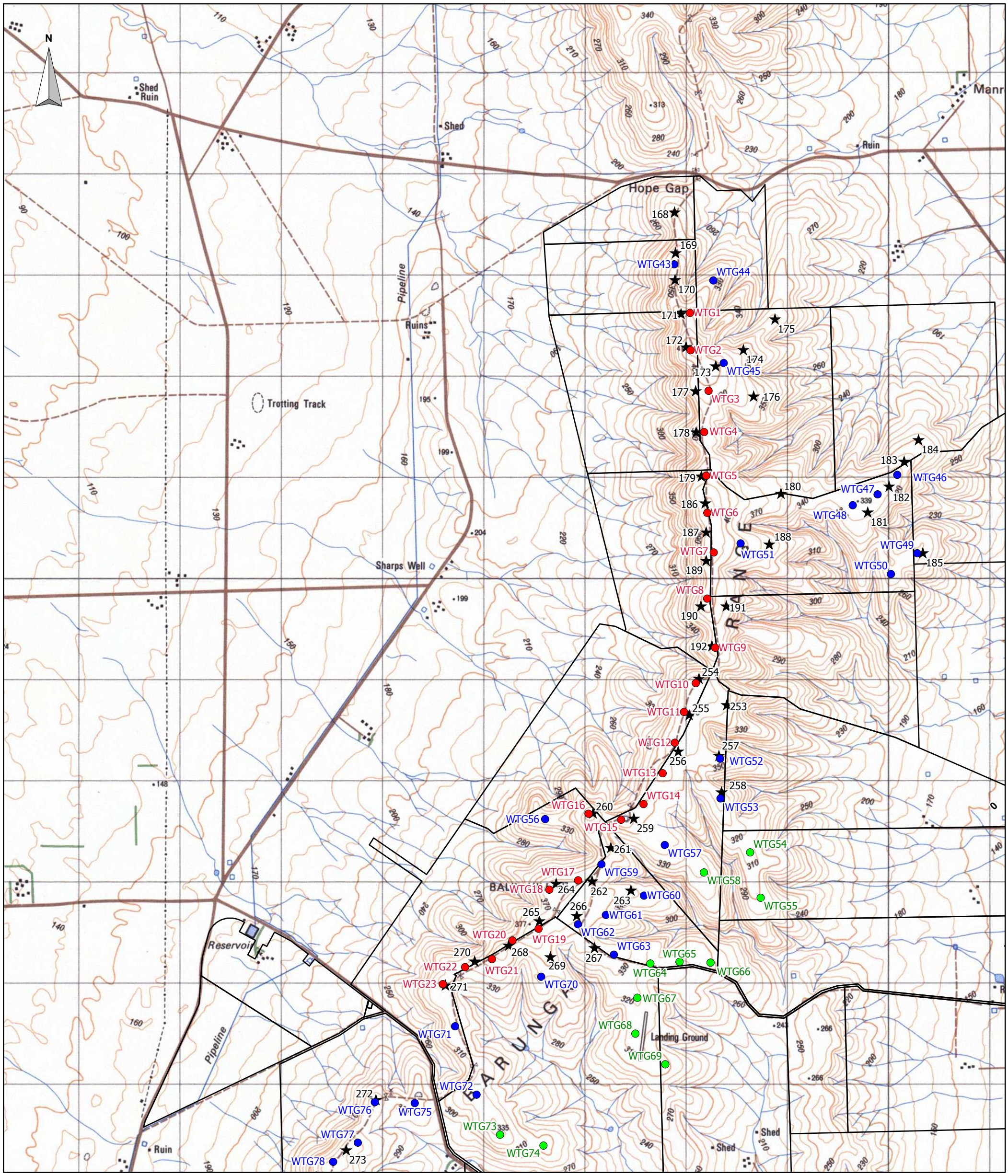
Rodney Ahern
Business Development Manager
TrustPower Limited
New Zealand Mobile: +64 212 721 216
Australia Mobile: +61 409 099 212
Email: rodney.ahern@trustpower.co.nz

APPENDICES:

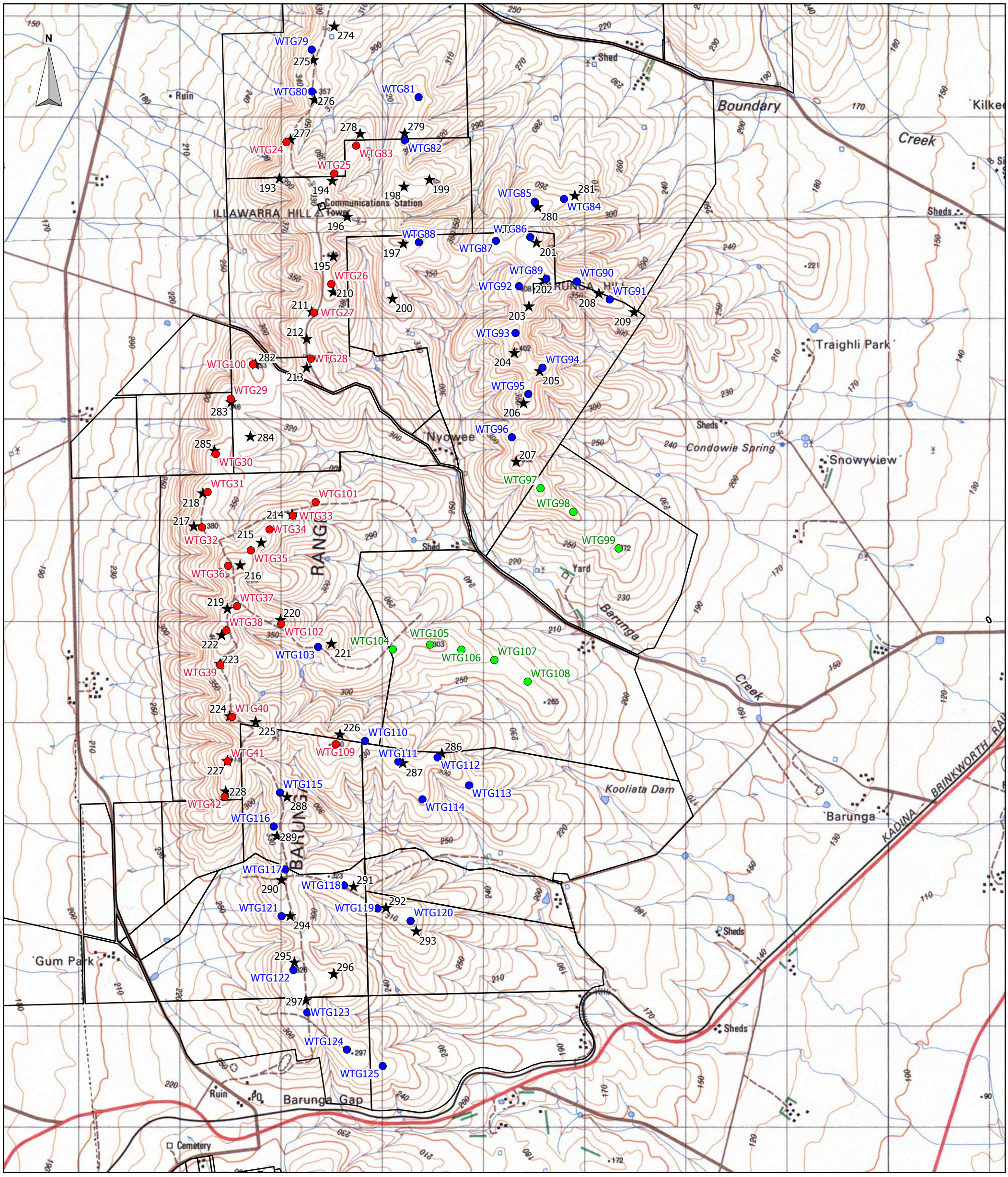
A. Proposed Stage 2 Layout Maps
B. Proposed Stage 2 Electrical Grid Connection Infrastructure
C. Suzlon S88 (2.1MW) Wind Turbine Information
D. Photomontages of Stage 2 Turbines in Areas with Proposed New Turbines
E. Ecological Assessment Report - Wind Farm (Environment and Biodiversity Services Pty Ltd)
F. Ecological Assessment Report - Transmission Corridor (Environment and Biodiversity Services Pty Ltd)
G. EPBC Determination
H. Noise Study Report (Sonus Pty Ltd)
I. Indicative Stage 2 Access Roads and Cable Routes
J. Aviation Lighting Study Report (Hart Aviation Pty Ltd)
K. ElectraNet SA Letter Confirming TrustPower's Interest in the Electrical Infrastructure
L. Original Approved Electrical Grid Connection Infrastructure
M. Typical 275kV Pole Structures
N. Typical 275kV Switching Station Layout
O. Landowners and Land Titles Along 275kV Overhead Power Line Routes
P. Maro Creek Land Titles

APPENDIX A

PROPOSED SNOWTOWN WIND FARM
STAGE 2 LAYOUT



LEGEND	COMPANY			
★ Original Approved Turbine Location ● Constructed Stage 1 Turbine Location ● Amended Stage 2 Turbine Location ● New Stage 2 Turbine Location	WIND PROSPECT PTY LTD			
	TITLE SNOWTOWN CURRENT LAYOUT WITH ORIGINAL APPROVED LAYOUT			
	DATE 18 NOV 2009	SCALE 1:36000	DWG NO 090503_00002	REV 01
SCALE BAR 0 — 2 km	DRAWN BY R. MORETON	CHECKED BY A. DICKSON	SHEET 1 OF 3	SIZE A3



LEGEND	COMPANY			
★ Original Approved Turbine Location ● Constructed Stage 1 Turbine Location ● Amended Stage 2 Turbine Location ● New Stage 2 Turbine Location	WIND PROSPECT PTY LTD			
	TITLE SNOWTOWN CURRENT LAYOUT WITH ORIGINAL APPROVED LAYOUT			
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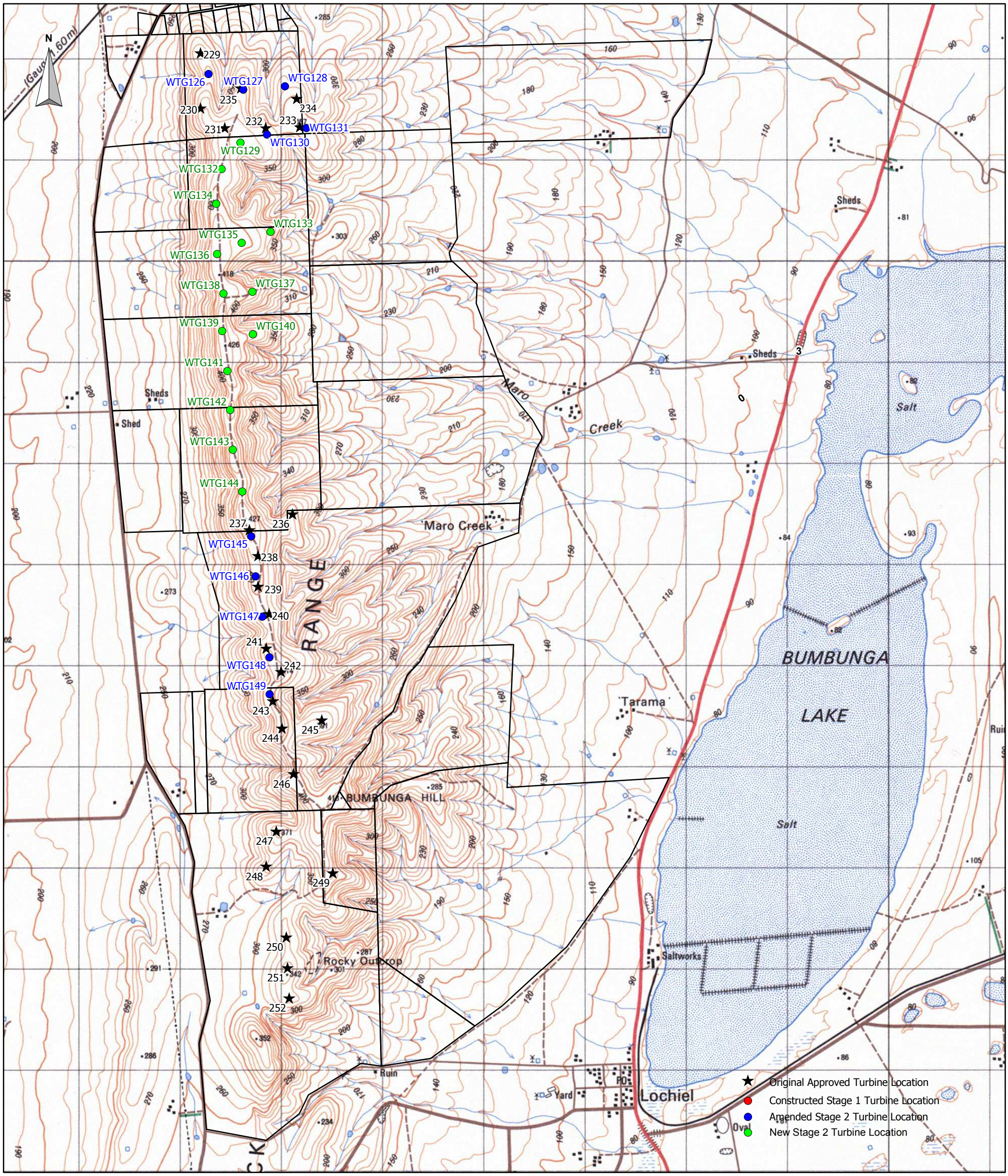
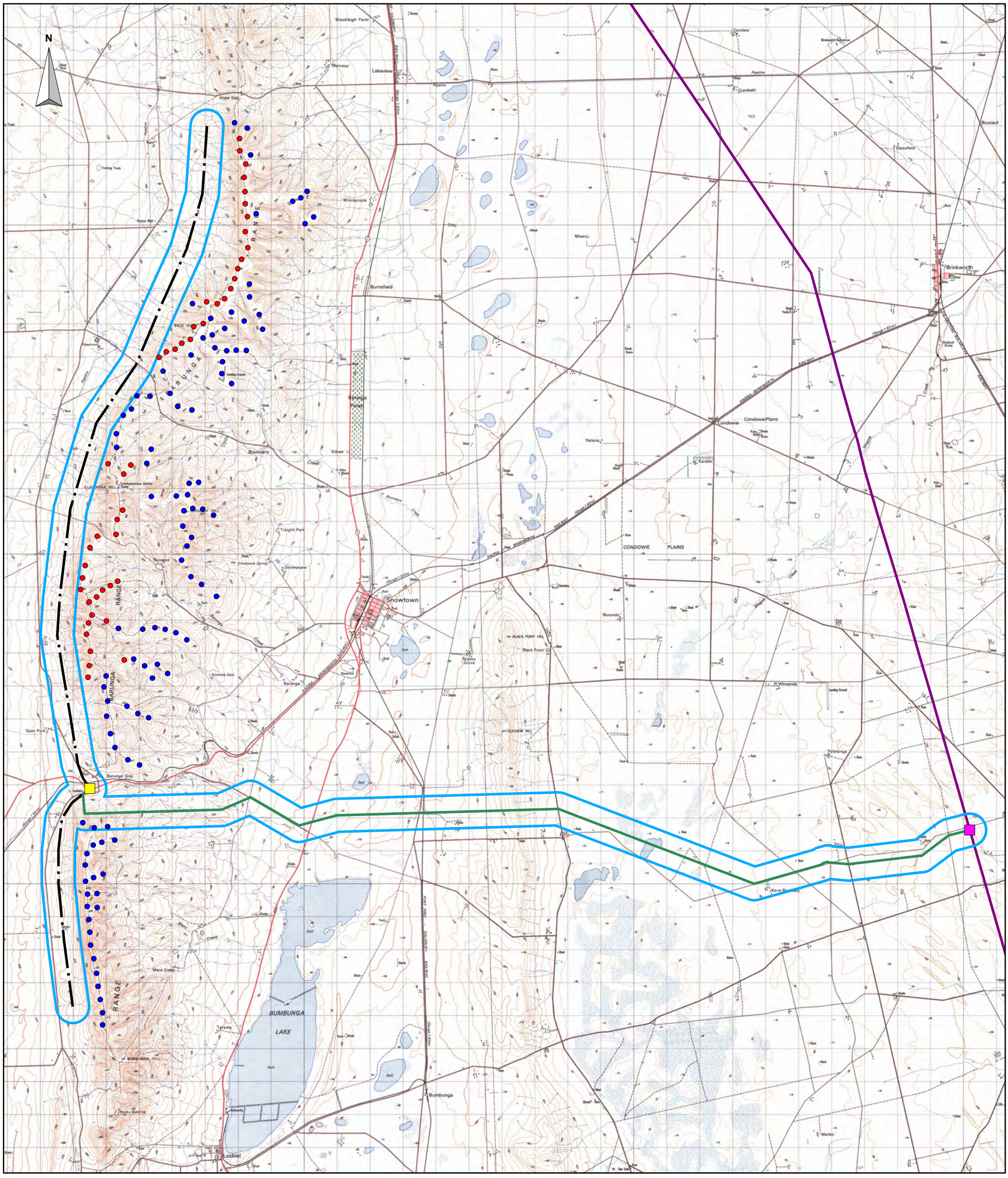


LEGEND	COMPANY			
★ Original Approved Turbine Location ● Constructed Stage 1 Turbine Location ● Amended Stage 2 Turbine Location ● New Stage 2 Turbine Location	WIND PROSPECT PTY LTD			
	TITLE SNOWTOWN CURRENT LAYOUT WITH ORIGINAL APPROVED LAYOUT			
	DATE 18 NOV 2009	SCALE 1:36000	DWG NO 090503_00002	REV 01
SCALE BAR 0 — 2 km	DRAWN BY R. MORETON	CHECKED BY A. DICKSON	SHEET 3 OF 3	SIZE A3

APPENDIX B

PROPOSED STAGE 2 ELECTRICAL CONNECTION INFRASTRUCTURE



LEGEND	COMPANY			
Stage 1 WTG Stage 2 WTG Substation Switching Station 33kV Line Transmission Line 1km corridor Transmission Line Existing 275kV Line	WIND PROSPECT PTY LTD			
	TITLE SNOWTOWN ELECTRICAL INFRASTRUCTURE			
	DATE 10 MAR 2010	SCALE 1:110000	DWG NO 090503_00001	REV D
SCALE BAR 0 — 6 km	DRAWN BY R. MORETON	CHECKED BY A. DICKSON	SHEET 1 OF 1	SIZE A3

APPENDIX C

SUZLON S88 (2.1MW) WIND TURBINE INFORMATION

S88-2.1 MW

Technical overview

Suzlon

S88-2.1 MW is designed for a medium wind speed regime. The wind turbine concept is based on robust design with pitch regulated blade operation, a 3-stage gearbox with 2200 kW rating and flexible coupling to the asynchronous induction generator. The Suzlon flexi-slip system provides efficient control of the load and power control. The turbine operation is efficiently controlled by the Suzlon controller. These technologies are all well-known in the wind power industry and have proven themselves. The S88-2.1 MW is designed to withstand extreme conditions and operate effectively with low maintenance cost.

Blades

As with all other Suzlon blades, the AE43 blade is a fully integrated design. The blade manufacturing system, from mould engineering to state-of-the-art Resin Infusion Moulding (RIM), is implemented in close cooperation between the Dutch design team and the manufacturing plant operators in India. Blades for the world market are manufactured in Suzlon's in-house facilities located in India, China and the USA.

Pitch system

The full-span blade pitching system is based on electrical motors with individual power backup which allows fast and efficient pitching of the blades. With a resolution of 0.1° and a special fast-pitching mode, the S88-2.1 MW allows optimal power output as well as fast and safe braking of the rotor

Gearbox

Suzlon has always placed significant focus on gearbox design. The design philosophy is based on years of experience with wind turbines in harsh environments and our internal design standards well exceed the industry standards. The power rating of the gearbox for the S88-2.1 MW is actually 2.2 MW. With the recent acquisition of Hansen Transmission, Suzlon will also in the future secure in-house design and development of superior gearbox technology for the benefit of our customers.

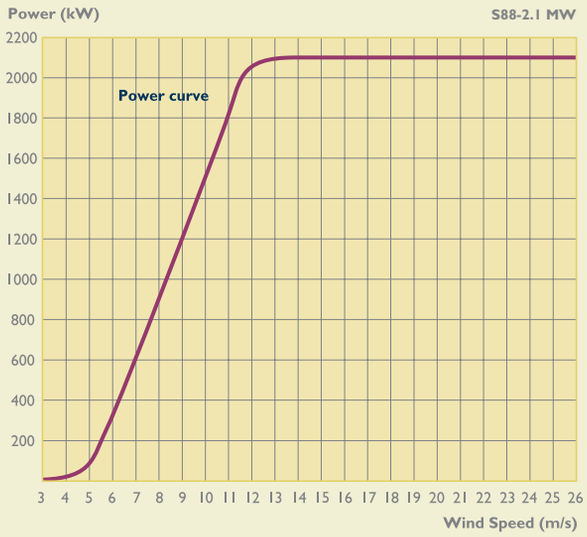
Service

Since 1996, Suzlons' own service teams in India have been operating and maintaining the entire Suzlon wind turbine fleet, which comprises more than 1500 wind turbines across the continent. This institutional knowledge is being passed onto Suzlon's international service teams in the US, Europe, Australia and other parts of Asia. Another benefit from the in-house service teams is the world class corporate learning center in India that provides training for Suzlon's own organization as well as for customers requiring in-depth training programs and troubleshooting knowledge for their own service teams. There are Suzlon training facilities located in China, India and US so far.

Manufacturing

Several new manufacturing facilities have been established in India and the US, with fully-integrated wind turbine production facilities set up in China to service the local markets. An important reason for Suzlon's success is the clear strategy of vertical integration of the wind turbine main components to ensure reliable supply and outstanding quality for the customer's benefit.

Model	S.88 – 2.1 MW
OPERATING DATA	
Rated power	2.1 MW
Cut-in wind speed	4 m/s
Rated wind speed	14 m/s
Cut-out wind speed	25 m/s
50 years gust wind speed	59.5 m/s
Hub height	79 m
Wind Class	IECIIA
Rotational Speed	15.0 - 17.6 rpm
ROTOR	
Pitch system	Pitch regulated, electrical
Diameter	88 m
Swept area	6082 m^2
Blade material type	Fiberglas/Epoxy
GENERATOR	
Type	Asynchronous 4 poles with slip ring
Rated power	2100 kW
Rated voltage	690 / 600 V
Frequency	50 / 60 Hz
Protection	IP 54
Cooling system	Air cooled
Insulation	Class H
Slip control	Unique Flexi-Slip providing slip up to 16.67%
BRAKING SYSTEM	
Aerodynamic brake	3 independent systems with blade pitching
Mechanical brake	Hydraulic fail-safe disc brake system
GEARBOX	
Type	3 stages (1 planetary & 2 helical)
Ratio	1:98.8 / 1:118.1
Nominal load	2200 kW
YAW SYSTEM	
Type	Driven by 3 electrical driven planetary drives
Bearings	Polyamide slide
CERTIFICATIONS	
Design standards	GL 2003
Quality	ISO 9001:2000
TOWER	
Type	Tubular in 4 sections
Corrosion protection	Epoxy/PU coated



Wind speed m/s	Power output [kW]	Wind speed m/s	Power output [kW]
4	14	16	2100
5	138	17	2100
6	312	18	2100
7	546	19	2100
8	840	20	2100
9	1180	21	2100
10	1535	22	2100
11	1856	23	2100
12	2037	24	2100
13	2088	25	2100
14	2100	-	-
15	2100	Air density: 1225 kg/m^3	

venture 0806-AUS

Denmark
Suzlon Energy A/S
Kystvejen 29
DK-8000 Aarhus C
Tel. +45 8943 8943

USA
Suzlon Wind Energy Corporation
8750 Bryn Mawr Ave., Ste. 720
Chicago, IL 60631
Tel. +1 773 328 5077

Palm Springs Sales Office
74980 State Hwy 111, Suite 109
Indian Wells, CA 92210
Tel. +1 760 779 0281

Australia
Level 10,
140 Bourke Street
Melbourne Vic 3000
Australia
Tel. +61 3 8660 6555

New Zealand
Level 28, Majestic Center
100 Willis Street
Wellington
New Zealand
Tel. +64 4 472 9419

China
Room 1407, NCI Tower
A12, Jianguomenwai Avenue
Chaoyang District
Beijing 100022
China
Tel. +86 10 65693244/5/6

Germany
Suzlon Energy GmbH
August-Bebel-Str. 10
18055 Rostock
Tel. +49 381 2037700

The Netherlands
AE-Rotor Techniek
Goudstraat 15
NL-7554 NG Hengelo
Tel. +31 74255 2630

India
5th Floor, Godrej Millennium
9 Koregaon Park Road
Pune 411 001
India
Tel. +91 20 5602 2200

www.suzlon.com

SUZLON

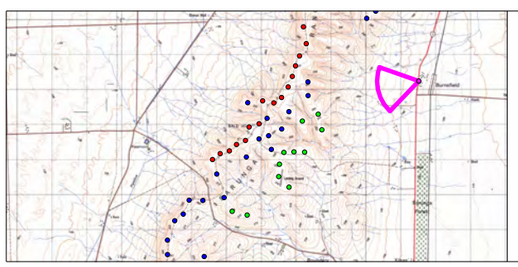
Suzlon S88 2.1MW 50Hz Standard Temperature Version Wind Turbine Generator
Weights and Dimensions of WTG Components

	Length [mm]	Bottom inner Dia [mm]	Top inner Dia [mm]	Weight [kg]	Maximum Wall Thickness [mm]
Tower 80M					
Section 1	23190	4016	2966	31,385	17
Section 2	19705	4024	4016	42,510	24
Section 3	17315	4030	4024	50,361	30
Section 4	17290	4045	4030	63,543	45

	Length [mm]	Width [mm]	Height [mm]	Weight [kg]
Nacelle	9,070	4,000	4,740	72,000
Hub	3,000	3,000	3,440	13,738
Blades	43,500	4,500	2,300	800

APPENDIX D

PHOTOMONTAGES OF STAGE 2 TURBINES IN AREAS WITH PROPOSED NEW TURBINES



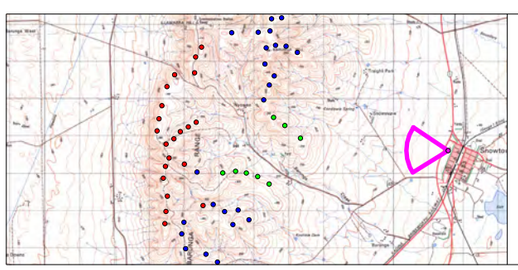
Recommended viewing distance:	350mm	Nearest turbine:	WTG50	Grid reference:	241600E 6268495N
Date/time photograph taken:	08/12/09 11am	Distance to nearest turbine:	2.25km	Viewpoint elevation:	146.5m AHD
Camera height:	1.7m	Turbine blade tip height:	124m	View direction:	224 - 289
		Number of turbines visible:	37	Included angle:	65

Reproduced from SA Government Department for Environment and Heritage digital map data

Stage 2 turbines have been highlighted and oriented to create a worst case visual impact
Existing stage 1 turbines seen in this photo have not been altered
Fifteen of the visible turbines are existing stage 1 turbines

WIND PROSPECT

FIGURE A: VIEWPOINT 1

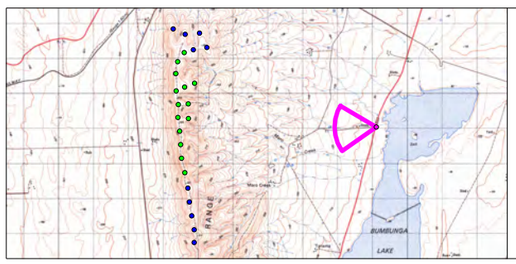


Recommended viewing distance:	350mm	Nearest turbine:	WTG99	Grid reference:	241743E 6258680N
Date/time photograph taken:	08/12/09 12pm	Distance to nearest turbine:	4.29km	Viewpoint elevation:	111m AHD
Camera height:	1.7m	Turbine blade tip height:	124m	View direction:	238 - 303
		Number of turbines visible:	47	Included angle:	65

Reproduced from SA Government Department for Environment and Heritage digital map data

Stage 2 turbines have been highlighted and oriented to create a worst case visual impact
Existing stage 1 turbines seen in this photo have not been altered
Twelve of the visible turbines are existing stage 1 turbines

FIGURE B: VIEWPOINT 2



Recommended viewing distance:	350mm	Nearest turbine:	WTG133	Grid reference:	239218E 6249214N
Date/time photograph taken:	08/12/09 10am	Distance to nearest turbine:	5.35km	Viewpoint elevation:	81m AHD
Camera height:	1.7m	Turbine blade tip height:	124m	View direction:	235 - 300
		Number of turbines visible:	24	Included angle:	65

Reproduced from SA Government Department for Environment and Heritage digital map data

Turbines have highlighted and oriented to create a worst case visual impact

FIGURE C: VIEWPOINT 3

APPENDIX E

ECOLOGICAL ASSESSMENT REPORT – WIND FARM (ENVIRONMENT AND BIODIVERSITY SERVICES PTY LTD)

37 Kent Road
Keswick
SA 5035

Phone: 08 8297 7711

Fax: 08 8297 7722

Email:
info@ebservices.com.au

Web: www.ebservices.com.au

Snowtown Windfarm Stage 2 Ecological Assessment

Snowtown Windfarm Stage 2
Ecological Assessment

November 2008

Prepared by *Environmental and Biodiversity Services* for Wind Prospect Pty Ltd

Document Control

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0	9/12/2008	A. Egan, C. Harrison and L. Einoder	T. How	9/12/2008	First draft
1	9/2/09	A. Egan, C. Harrison and L. Einoder	T. How	9/2/09	Second Draft
2	1/7/09	A. Egan, C. Harrison and L. Einoder	T. How	1/7/09	Final report

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Front cover: Creamy Candles (*Stackhousia monogyna*) found onsite in exotic grasslands

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- Terry Reardon, *South Australian Museum* (bats)
- Mark Hutchinson, *South Australian Museum* (reptiles)
- Joe Quarmby, *Department for Environment and Heritage, Lofty Block Threatened Orchid Recovery Project* (orchids)

Table of Contents

Executive Summary

An ecological assessment was conducted at the proposed Snowtown Wind Farm Stage 2 site, in the Mid-north of South Australia, by Environmental and Biodiversity Services (EBS) on behalf of Snowtown Wind Farm Pty Ltd. The assessment included background research on the flora and fauna expected within the region and a field survey assessing the vegetation and habitat present within the site, including details on specific species present. Vegetation associations were mapped within an expected development corridor and assigned condition ratings. Fauna species present at the site were recorded through a bird survey, bat survey (AnaBat) and the location of tracks, traces and habitat of fauna. Particular attention was given to locating potential habitat for threatened fauna species and Wedge-tailed Eagle nests.

Several vegetation associations were found in addition to those in detected in Stage 1 assessments (EBS 2004), and were further defined. Whilst most vegetation groups are similar to the previous report, some vegetation groups were re-defined, particularly in relation to the upgrading of the conservation status of Iron Grass (*Lomandra spp*) Grasslands to a nationally ***Critically Endangered*** threatened ecological community. A number of vegetation associations were found within the Snowtown Stage 2 survey area. The major associations found include:

- *Allocasuarina verticillata* Low Woodland +/- *Bursaria spinosa* +/- *Lepidosperma viscidum*
- *Austrostipa ssp./ Austrodanthonia spp.* Grassland +/- *Bursaria spinosa*
- *Lomandra spp. / Austrostipa ssp./ Austrodanthonia spp.* Grassland
- *Eucalyptus oleosa +/- Eucalyptus gracilis +/- Eucalyptus porosa* Low Woodland
- Exotic Grassland (grazing land)
- Cropping Land

Some of the more minor associations found during the survey (or that were present on the provided mapping) include:

- *Lomandra effusa* Grassland
- *Gahnia lanigera* Grassland
- *Themeda triandra / Austrodanthonia spp* Grassland
- *Eucalyptus camaldulensis* Woodland
- *Callitris spp.* Woodland

The condition of the project area ranged from Very Poor (condition 5) to Moderate (condition 3) (1=Excellent, 5=Very Poor). The invasion of exotic flora species throughout the site was obvious and the area has historically been utilised for agricultural and pastoral activities, resulting in a highly modified landscape. Most of the Stage 2 proposed areas were in Very Poor (5) to Poor (4) condition, however several Moderate (3) condition areas were found within the proposed alignment, and should be avoided.

No nationally threatened flora species were detected during the survey. Several instances of Long-flower Cryptandra (*Cryptandra sp Long hypanthium*), a state ***Rare*** species, was detected during the survey. Regionally conservation significant flora species detected during this survey include the Cut-leaf Goodenia *(Goodenia pinnaitifida) (**Uncommon)*** and the Black Grass Saw-sedge *(Gahnia lanigera)* (***Not yet assessed – possible conservation significance).*** Additional species of regional conservation significance in the Northern Lofty botanical area have previously been highlighted within the survey area (EBS 2004).

Several areas of Iron Grass (*Lomandra spp.)* Grasslands (including *Lomandra effusa* Grasslands) were found within the Stage 2 survey area (and Stage 1). This ecological community is now listed as threatened at the national level and is rated as ***Critically Endangered*** under the EPBC Act (1999).

Several fauna species were detected during the survey, including 40 bird species and 6-7 bat species. Potential habitat was found within the site for several threatened fauna species, including the nationally ***Endangered*** Pygmy Blue-tongue Lizard (*Tiliqua adelaidensis*) and the nationally ***Vulnerable*** Flinders Worm-lizard (*Aprasia pseudopulchella*).

No bird species of national conservation significance were detected during the survey. Four bird species of state significance (all ***Rare***) were detected including the Peregrine Falcon (*Falco peregrinus*), Elegant Parrot (*Neophema elegans*), Hooded Robin (*Melanodryas cucullata cucullata)* and Jacky Winter (*Microeca leucophaea leucophaea)*.

A total of 10 Wedge-tailed Eagle nests (*Aquila audax*) were found throughout the general survey area. All nests were found within close proximity to Stage 1 and Stage 2 areas (e.g. 100-600 m from existing and proposed turbines). Only four of these nests were active at the time of the survey, containing at least one or two downy chicks.

No bat species of conservation significance were able to be positively identified from the AnaBat calls recorded during the survey. However, several calls of the *Mormopterus* genus were recorded, some of which may be of conservation significance. The areas considered to be of most habitat value for roosting bats are the *Allocasuarina* Low Woodlands and *Eucalyptus* Woodlands. The Drooping Sheoak *(Allocasuarina verticillata)* found as isolated plants in Exotic Grasslands may also be of habitat value, since they are often the only tree in this association. All of these woodlands were found to have large and small hollows suitable for bat roosting.

Impacts discussed within this report include:

- the clearance of remnant native vegetation, with particular reference to nationally threatened ecological community Iron Grass (*Lomandra spp.*) Grasslands and individual threatened species onsite;
- the proliferation of weeds throughout construction and operation of Stage 2;
- fauna habitat loss, particularly for threatened fauna within the area;
- fauna disturbance, particularly for birds and bats;
- bird and bat collisions with wind farm infrastructure; and
- the cumulative effect of wind farms in the mid-north.

The recommendations given regarding the issues raised in this report include:

- submit an EPBC referral for the project;
- assess the proposed area against Native Vegetation Principles to determine if a clearance application is required;
- develop a Significant Environmental Benefit (SEB) to offset impacts of the project;
- undertake further surveys including:
    - nationally threatened reptile survey
    - bird utilisation survey
    - detailed bat survey
    - more detailed flora and fauna surveys when the alignment is finalised;
- avoid remnant vegetation;
- avoid known Wedge-tailed Eagle nest sites and monitor breeding activity;
- position turbines in areas of low bird activity;
- conduct regional surveys of birds and bats;
- implement best practice environmental management measures during construction;
- minimise construction footprint;
- provide staff training; and,
- implement annual monitoring for flora and fauna at the site.

1.0 Introduction

An ecological assessment was conducted at the Snowtown Windfarm Stage 2 site, in the Mid-north of South Australia, by Environmental and Biodiversity Services (EBS) on behalf of Snowtown Wind Farm Pty Ltd. Flora and fauna were assessed across the survey area extending into the surrounding landscape. The assessment focussed on determining vegetation associations and fauna habitat present, detailing their condition and significance, particularly in relation to threatened species and communities that may reside onsite. This report aims to provide an initial ecological assessment of the site, provide discussion of the issues that should be considered and suggest measures to reduce the possible impacts of the proposed Windfarm development at the Snowtown Stage 2 site on flora and fauna.

The Stage 1 area of the Snowtown Windfarm (operational) was also briefly reviewed during the course of this survey, the details of which are in a separate report updating flora and fauna for the area (Stage 1 Ecological Report draft (EBS, in progress)).

1.1 Objectives

The aims of this ecological assessment were:

- to determine the flora and fauna likely to be found on the site, based on a review of existing data and a site inspection;
- to identify vegetation associations and fauna habitat present, detailing their condition and significance;
- to provide advice on the implications for wind farm development, by identifying ecological issues and sensitivities; and
- to make recommendations on avoidance or mitigation of possible impacts.

1.2 Site details

1.2.1 Survey area

The Snowtown Windfarm is situated approximately 150 kilometres north of Adelaide, within the Mid-north region of South Australia (Figure 1). The project area is close to Yorke Peninsula and is less than 50 kilometres from both the Gulf of St Vincent and the Spencer Gulf. Stage 1 of the Snowtown Windfarm is currently operational along the main ridgeline of the Barunga Range. Stage 2 of the Snowtown Windfarm extends the current layout of turbines south along the Hummock Range main ridgeline through the Maro Creek area, and also extends east, adjacent Stage 1, along the smaller ridges and spurs which stem off of the main ridgeline in the Barunga Range (Figure 2).

Figure 1 Location of the Snowtown Windfarm and other existing and proposed windfarms in the area

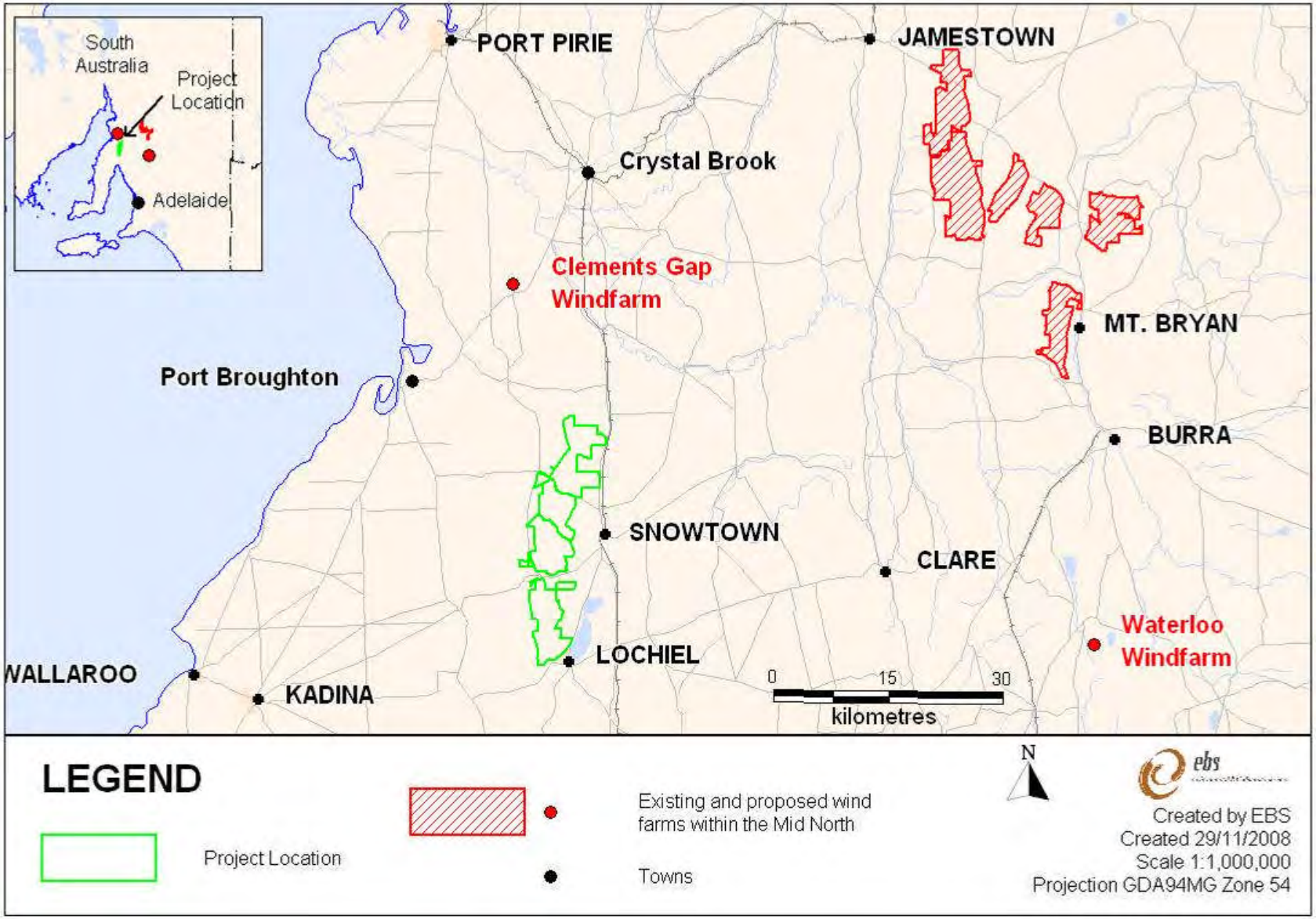
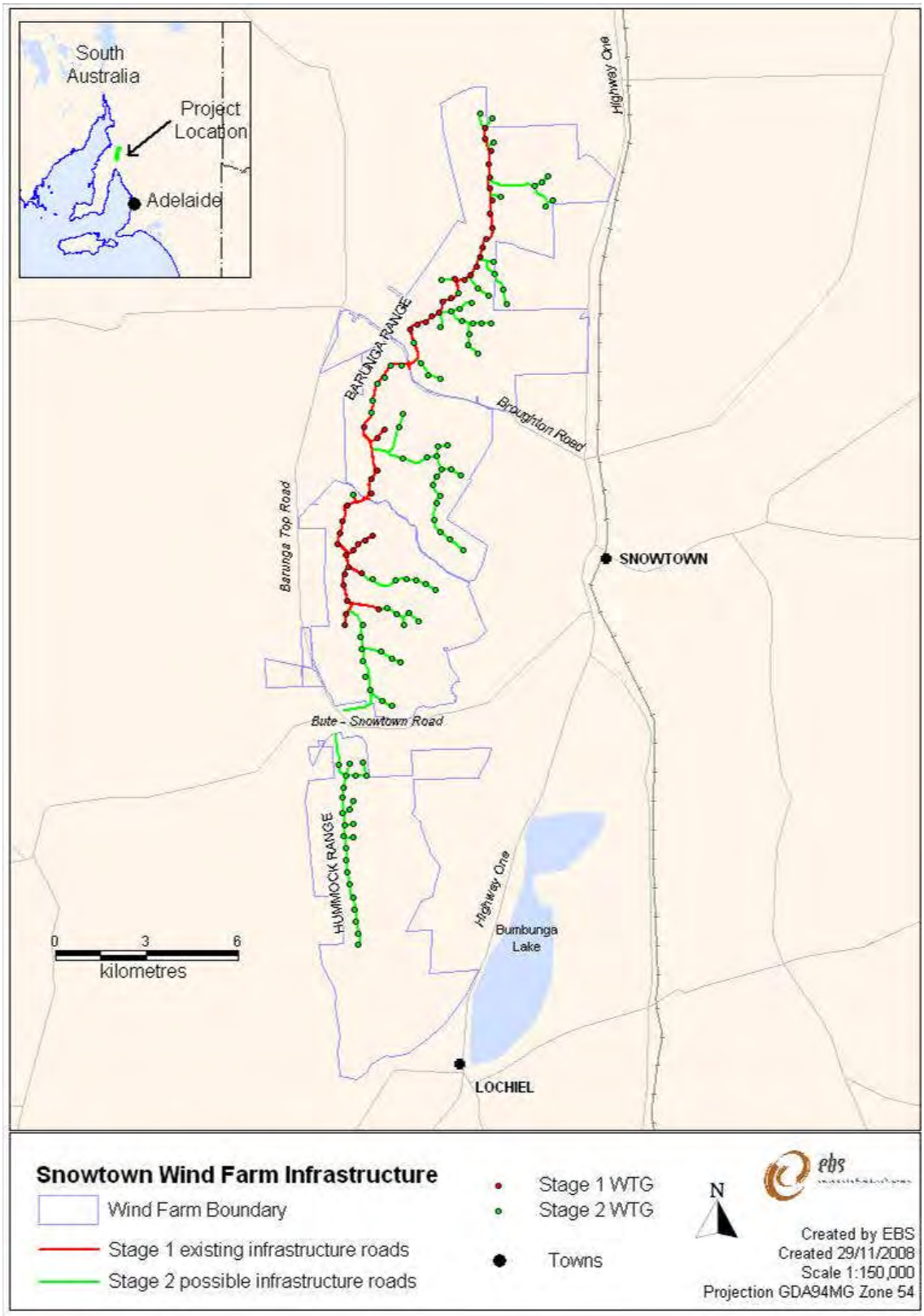


Figure 2 Site layout of the Snowtown Windfarm - Stage 1 (operational) and Stage 2 (proposed)



1.2.2 Regional context

The Stage 1 and Stage 2 areas of the Snowtown wind farm lie entirely within the Eyre and Yorke IBRA Bioregion (IBRA - Interim Biogeographic Regionalisation of Australia) and IBRA Subregion of St Vincent, in the Mid-north region of South Australia (Figure 3). The St Vincent Subregion contains approximately 8.4 % of its original native vegetation, which is considered to be low (the area has a completed assessment of remnancy).

The project boundary lies mostly within the IBRA Environmental Association of Barung, but also partly in the associations of Wokuna and Bumbunga (Figure 3). The Barung association contains approximately 3.7 % of its original native vegetation, which is considered to be extremely low. The association of Wokuna is also considered to be extremely low, with approximately 3.2 % or its original vegetation present. The association of Bumbunga contains approximately 16.7 % of its original native vegetation, which is considered to be low (DEH 2002).

The Mid-north region consists predominantly of cleared land utilised for either grazing (predominantly sheep) or cereal cropping. Seventy-eight percent of the region's land use is cropping and pastures (Graham et al 2001). There are several areas of remnant vegetation within the survey area, and many continuous areas of native vegetation exist amongst grazing land and cereal crops. Woodland areas exist mainly in gullies and slopes of the Barunga Range, separated by vast areas of grasslands (native and exotic) which dominate the tops of ridges as well as slopes of the range. The region has a mediterranean climate with warm to hot summers and mild to cool winters. The mid-north region receives an annual rainfall of between 300-700 mm.

In recent years, the Mid-north region of South Australia has been a focus for several windfarm proposals. Conditions in the area are well-suited to windfarm requirements and a number of projects have been planned. In 2007, the Australian Government decided to lift the nation's Clean Energy Target (CET) to 15 percent of all energy by 2020, promising 30,000 gigawatt hours of zero-emission and near-zero-emission electricity by 2020 (The Australian 2007). However, the current government (Rudd – Labour) has recently raised the target to 20 percent by 2020.

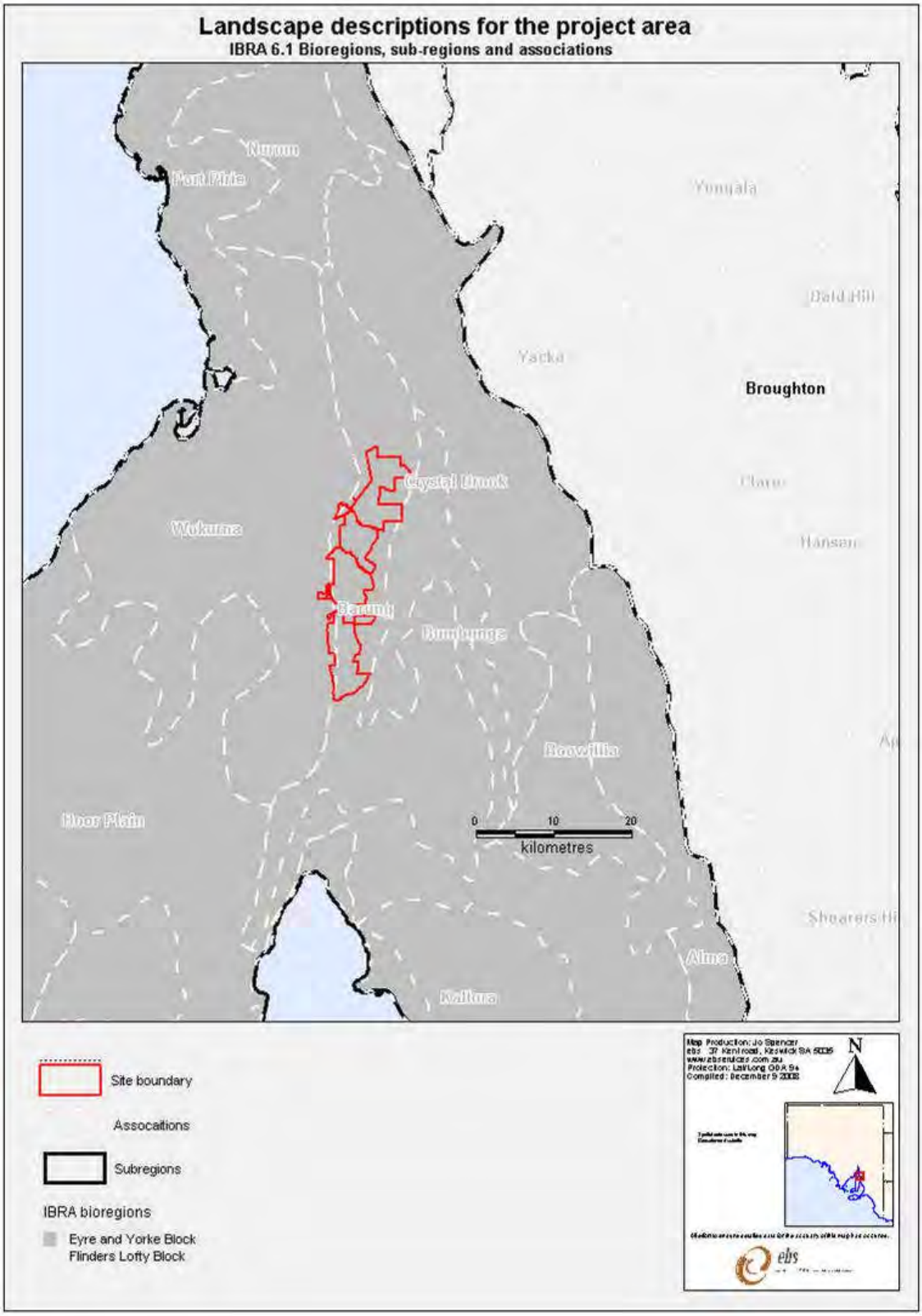


Figure 3 Regional context of the Snowtown windfarm in relation to IBRA

The proposed Stage 2 of the Snowtown Windfarm will be an extension of the currently operational Snowtown Windfarm (Stage 1). This project is one of many windfarms that are in varying stages of approval and development in the region (Figure 1). It is likely that additional windfarm sites are currently being assessed in the region, however, their locations and size are currently unknown. Windfarm projects within the mid-north region have been developed by Wind Prospect, and a variety of other companies, including:

- Brown Hill Range (45 turbines – approved in operation)
- North Brown Hill (63 turbines – application submitted to council)
- Willogoleche Hill (26 turbines - approved)
- The Bluff Range (25 turbines – approved)
- Hallett Hill (34 turbines - approved, in construction)
- Mt Bryan (30 turbines – planning in progress)
- Clements Gap, near Pt Pirie (27 turbines – approved, start work 2008)
- Waterloo, near Clare (39 turbines – approved, in construction)

1.3 Limitations

The survey aimed to capture the broad characteristics of the Stage 2 Snowtown Windfarm area. During the survey, an extensive amount of detail was captured in relation to flora and fauna and this report gives a good representation of the species that reside onsite. However, it would be unreasonable to assume that all species and locations of flora and fauna have been accounted for. Although the timing of the survey was appropriate (spring) to capture the majority of flora onsite, it is possible that some flora species were undetectable during the survey, such as some orchids, grasses and annual species. Selected flora species have a small timeframe in which they appear, however others are simply difficult to detect due to their size and distribution.

Due to the nature of the assessment, a limited amount of information is able to be presented regarding fauna at the site. Sightings and general observations of tracks, traces and habitat of native and exotic fauna were recorded onsite, in addition to specific bird and bat survey techniques. A Level One assessment (AusWind 2006) for birds and bats has been conducted onsite for this ecological assessment. In accordance with these guidelines, the depth of research and comment offered in this report reflect the requirements of Level One assessments for birds and bats.

2.0 Background research

2.1 General

A number of sources were consulted in order to investigate flora and fauna likely to be found on site, and to highlight species of conservation significance. Vegetation mapping of the area was investigated (DEH 2008) as well as topographical maps and aerial photography of the site. The Environment Protection and Biodiversity Conservation (EPBC) online databases were searched to identify any species of national conservation significance which may occur in the area. The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides legislative protection for the environment, and particularly matters of national environmental significance. The Act identifies seven matters of national environmental significance, including;

- World Heritage properties;
- National heritage properties;
- Wetlands of international importance (Ramsar wetlands);
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

The conservation status of fauna and flora species can be specified at three geographic scales: national, state or regional. For the purposes of this report, more attention and detail is given to national and state levels, than regional levels. Regional context gives a better understanding of the localised impact of the proposed development; however progression of the wind farm development will only be assessed at a national level.

Species of national conservation significance are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as either threatened, migratory or marine. Threatened species are further categorised as Extinct in the Wild, Critically Endangered, Endangered, or Vulnerable. Although not necessarily threatened, certain migratory and marine species, including species protected under international agreements to which Australia is a signatory (for example the Japan Australia Migratory Bird Agreement and the Bonn Convention on the Conservation of Migratory Wild Species of Wild Animals) are also listed and protected under the EPBC Act. Such species include those that are considered as migratory from the Anatidae (Swans, Geese and Ducks), Charadriidae (Plovers and Dotterals), Accipitridae (Hawks, Kites and Eagles), Falconidae (Falcons), and Recurvirostridae (Avocets and Stilts) families.

Species of state conservation significance are listed under the *National Parks and Wildlife Act 1972* (NPW Act) Schedule 7, 8 and 9 (revised February 2008) as Endangered, Vulnerable or Rare. Regional conservation ratings derive from a variety of sources, principally DEH Biodiversity Plans. The *Biodiversity Plan for the Northern Agricultural Districts* (Graham *et al.* 2000) covers the area of the Snowtown Windfarm.

Ecological communities of national conservation significance are listed under the EPBC Act as Critically Endangered, Endangered or Vulnerable. Ecological communities of state conservation significance are not currently recognised under state legislation, however DEH has listed a provisional list that is informally used until such time when legislation covers and allows for the protection of ecological communities (DEH in progress).

A search of the flora and fauna databases maintained by the Department of Environment and Heritage (DEH) and SA Museum were undertaken for an area within a 10 km radius of the project site (Appendix A and B). Other sources, such as the Biodiversity Plan for the Northern Agricultural Districts (Graham *et al* 2001) were also utilised. Documents relating to threatened species and communities within the region were reviewed such as the Recovery Plan for the Pygmy Blue-tongue (*Tiliqua adelaidensis*) (Milne et al 2000) and the EPBC Policy statement on the status of Peppermint Box (*Eucalyptus odorata*) Grassy Woodlands and Iron-grass Natural Temperate Grasslands (DEWR 2007). The background research results regarding threatened species and communities are presented within this section.

2.2 Flora

All native vegetation within the project area is covered by the *Native Vegetation Act 1991* and any proposed clearance will need to be assessed against native vegetation principles. A clearance application to the Native Vegetation Council may be required if the proposed infrastructure involves the clearance of native vegetation not covered by the exemptions in the principles. If proposed infrastructure may have an impact on nationally threatened flora or communities, an EPBC referral will be required.

2.2.1 Threatened flora species that may occur in the survey area

Four nationally threatened flora species that may reside within the survey area were highlighted by the EPBC search tool (Table 1). The DEH database search revealed that a number of threatened flora species have been recorded within 10 kms of the project area (Table 2).

Table 1 Nationally threatened flora highlighted as potentially present in the survey area (EPBC Search Tool)

Scientific name	Common name	Conservation rating		
		Aus	SA	NL
Caladenia macroclavia	Large-club Spider-orchid	EN	E	E
Caladenia tensa	Greencomb Spider-orchid, Rigid Spider-orchid	EN		
Olearia pannosa ssp. pannosa	Silver Daisy-bush	VU	V	V
Swainsona pyrophila	Yellow Swainson-pea	VU	R	

Table 2 Threatened flora species that have been recorded within 10 km of the survey area (DEH/SA Museum Database Search)

Number of records	Scientific Name	Common Name	Conservation Rating		
			AUS	SA	NL
2	*Austrostipa pilata*	Prickly Spear-grass		V	T
1	*Bothriochloa macra*	Red-leg Grass		R	K
1	*Caladenia macroclavia*	Large-club Spider-orchid	EN	E	E
1	*Dampiera lanceolata var. intermedia*	Aldinga Dampiera		E	
1	*Haegiela tatei*	Small Nut-heads		R	K
1	*Leptorhynchos elongatus*	Lanky Buttons		R	E
1	*Maireana decalvans*	Black Cotton-bush		E	E
3	*Maireana excavata*	Bottle Fissure-plant		V	E
5	*Maireana rohrlachii*	Rohrlach's Bluebush		R	V
5	*Olearia pannosa ssp. pannosa*	Silver Daisy-bush	VU	V	V
1	*Phebalium glandulosum ssp. glandulosum*	Glandular Phebalium		E	E
1	*Phlegmatospermum eremaeum*	Spreading Cress		R	V
1	*Podolepis jaceoides*	Showy Copper-wire Daisy		R	E
1	*Solanum eremophilum*	Rare Nightshade		R	
2	*Thysanotus tenellus*	Grassy Fringe-lily		R	R
2	*Wurmbea latifolia ssp. latifolia*	Broad-leaf Nancy		V	V

Conservation Ratings
AUS - Commonwealth conservation status codes (as listed under the *Environment Protection and Biodiversity Conservation Act* 1999)
EN Endangered
VU Vulnerable

SA - State conservation status codes (as listed under the *National Parks and Wildlife Act* 1972)
E Endangered
V Vulnerable
R Rare

NL - Regional conservation status codes for the Northern Lofty Botanical Region
E Endangered
V Vulnerable: rare and at risk from potential threats or long term threats that could cause the species to become endangered in the future.
K Uncertain: likely to be either Threatened or Rare but insufficient data available for a more precise assessment.

R Rare: has a low overall frequency of occurrence (may be locally common with a very restricted distribution or may be scattered sparsely over a wider area). Not currently exposed to significant or widespread threats, but warrants monitoring and protective measures to prevent reduction of population sizes.
U Uncommon: less common species of interest but not rare enough to warrant special protective measures.
Q Not yet assessed but flagged as being of possible significance.

The following sections briefly describe the nationally significant species highlighted in Table 1.

2.2.1.1 Large-club Spider-orchid *(Caladenia macroclavia)*

J Quarmby

The Large-club Spider-orchid is endemic to South Australia and occurs in mallee woodland areas in sandy loam over limestone. This species is known from only 5 populations in the state, with 2 locations within the Northern Agricultural Districts (Graham et al 2001), which encompasses the Mid-north region. This species has been recorded within 10 km of the project site (DEH 2008a). The orchid has a single, hairy, ovate-lanceolate shaped leaf (8 –14 cm long) which is usually produced in July/August from an underground tuber. However, it has been found that plants do not always produce a leaf or flowers every year, and can remain dormant for several years (Quarmby 2006). Yellow-green flowers with dark red/maroon tinges are produced late-August to mid-September. By the end of October the leaf has shrivelled and the seeds dry out, with only the underground tuber remaining over the summer.

2.2.1.2 Greencomb Spider-orchid *(Caladenia tensa)*

MH TIntinara (Bates 2008)

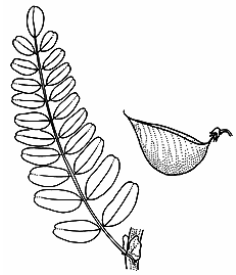
The Green-comb Spider-orchid has populations in Victoria and South Australia, occurring in Cypress-pine/Yellow Gum Woodlands, Heathy Woodlands and Mallee on sands and sandy loams derived from aeolian sand deposits (Todd 2000). *Caladenia tensa* is poorly understood due to taxonomic uncertainties and is not currently regarded as threatened in South Australia (J Quarmby *pers comm*.) despite its nationally ***Endangered*** rating. The species is considered widespread but uncommon in South Australia, and while the species does not have a state conservation rating, some forms that may be defined as distinct species in the future may prove to be vulnerable (Bates 2008). White-green flowers with dark red/maroon tinges are produced September - October. By the end of November the leaf has shrivelled and the seeds dry out, with only the underground tuber remaining over the summer.

2.2.1.3 Silver Daisy-bush *(Olearia pannosa ssp pannosa)*

www.environment.sa.gov.au

Silver Daisy-bush occurs in the understorey of mallee, woodland and forest communities as a medium-sized shrub with dark green leaves on the upper surface, silvery-white underneath and a large daisy flower. This species is distributed within a number of regions within South Australia, including the Flinders Ranges, Eyre Peninsula, Yorke Peninsula, the Northern and Southern Lofty Ranges, the Murray Mallee and the South East. This species has been recorded within 10 km of the project site (DEH 2008a). The robust bushy habit of this species and distinct leaves makes it easily identifiable.

2.2.1.4 Yellow Swainson-pea *(Swainsona pyrophila)*



Plant Net

The Yellow Swainson-pea is a small, short-lived, shrub-like herb that can grow to around 1 metre tall. Yellow pea flowers occur in July-October, on stalks in groups of 15-20, the flowers opening in succession along the stalk from the base to the tip. The current species distribution lies in SA, NSW and VIC, occurring on sandy or loamy soil in mallee scrublands. In South Australia, records occur on Eyre Peninsula (multiple records), Yorke Peninsula (Rogues Gully) and on the Murray (Mannum) (DEH 2007). Yellow Swainson-pea is usually found after fires, appearing only one to two years after the fire has occurred (Pobke 2007).

2.2.2 Threatened Flora communities that may occur in the survey area

Two nationally threatened vegetation communities that may be found within the project area were high-lighted by the EPBC search tool as ***Critically Endangered***. These are:

- Iron-grass (*Lomandra spp.*) Grassland of South Australia, and
- Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia.

These two vegetation communities were listed at the national level as ***Critically Endangered*** in 2007 due to a severe decline in distribution and an ongoing loss of integrity (DEWR 2007). The majority of remnants of these associations reside between Victor Harbour and Port Augusta, encompassing the Mid-North region, as well as the Adelaide region, Mount Lofty Ranges and part of York Peninsula (DEWR 2007). The key threats to both these communities are clearing, grazing and invasion by weeds (DEWR 2007).

2.2.2.1 Iron-grass (Lomandra spp.) Grassland

These Open Tussock Grasslands are dominated by *Lomandra* species and other perennial tussock grasses. Trees and shrubs are often sparse or absent from the structure whilst herbaceous species grow within inter-tussock spaces (DEWR 2007).

2.2.2.2 Peppermint Box (Eucalyptus odorata) Grassy Woodland

The canopy of this relatively low spreading Woodland community is dominated by Peppermint Box, however other species of Eucalypt are commonly found through out the extent of the association. A grassy understorey is most often present, although some shrubs may exist such as Sweet Bursaria (*Bursaria spinosa*) and Golden Wattle (*Acacia pycnantha*) (DEWR 2007).

2.3 Fauna and habitat

2.3.1 Threatened fauna species that may occur in the area

Four nationally threatened fauna species that may occur within the area were highlighted by the EPBC search tool (Table 3). Additionally, several migratory bird species were listed by the EPBC Act as possibly occurring in the area, including terrestrial, wetland and marine based species (Appendix C). It is considered that these species would be rare visitors to the survey area and hence they are not highlighted as species of concern within this report, however it will be recommended that they are included in an EPBC referral for the project.

Table 3 Threatened fauna species that may be present within the survey area (EPBC search)

Scientific name	Common name	Conservation rating	
		AUS	SA
Aprasia pseudopulchella	Flinders Worm-lizard	VU	
Pedionomus torquatus	Plains-wanderer	VU	E
Rostratula australis	Australian Painted Snipe	VU	R
Tiliqua adelaidensis	Pygmy Blue-tongue	EN	E

Conservation Ratings
AUS - Commonwealth conservation status codes (as listed under the *Environment Protection and Biodiversity Conservation Act* 1999)
EN Endangered
VU Vulnerable

SA - State conservation status codes (*National Parks and Wildlife Act* 1972)
E Endangered
V Vulnerable
R Rare

The DEH/SA Museum database search revealed a number of fauna species to have been recorded within 10 km of the survey area. This includes several threatened fauna species which have been highlighted in Table 4. Although the Australian Sea Lion (*Neophoca cinerea*) is listed in the database search as having been recorded within 10 km of the project area, it is not addressed within this report. It is considered that the project area is outside of its range (coastal

habitat) and no suitable habitat occurs within the general area of the project site, in addition to the fact that the records appear to be from 1939.

Table 4 Threatened fauna species that have been recorded within 10 km of the survey area (DEH/SA Museum Database Search)

Number of records	Class Name	Scientific name	Common Name	Conservation Rating	
				AUS	SA
1	AMPHIBIA	*Pseudophryne bibronii*	Brown Toadlet		R
1	AVES	*Burhinus grallarius*	Bush Stone-curlew		R
1	AVES	*Cladorhynchus leucocephalus*	Banded Stilt		V
1	AVES	*Coracina papuensis*	White-bellied Cuckoo-shrike		R
1	AVES	*Corcorax melanorhamphos*	White-winged Chough		R
7	AVES	*Falco peregrinus*	Peregrine Falcon		R
2	AVES	*Myiagra inquieta*	Restless Flycatcher		R
10	AVES	*Neophema elegans*	Elegant Parrot		R
3	AVES	*Pedionomus torquatus*	Plains-wanderer	VU	E
9	AVES	*Plectorhyncha lanceolata*	Striped Honeyeater		R
1	AVES	*Rostratula australis*	Australian Painted Snipe		V
4	AVES	*Turnix varia*	Painted Button-quail		R
2	MAMMALIA	*Neophoca cinerea*	Australian Sea-lion	VU	V
4	MAMMALIA	*Trichosurus vulpecula*	Common Brushtail Possum		R
32	REPTILIA	*Tiliqua adelaidensis*	Pygmy Bluetongue	EN	E

Conservation Ratings
AUS - Commonwealth conservation status codes (as listed under the *Environment Protection and Biodiversity Conservation Act* 1999)
EN Endangered
VU Vulnerable

SA - State conservation status codes (*National Parks and Wildlife Act* 1972)
E Endangered
V Vulnerable
R Rare

The following sections briefly describe the nationally significant species highlighted in Table 3.

2.3.1.1 Pygmy Blue-tongue (Tiliqua adelaidensis)

The Pygmy Blue-tongue is endemic to South Australia and occurs within the Mid North Region of the state. By 1990, the Pygmy Blue-tongue was thought to be extinct as there were no collection records of this species for 40 years; however, in 1992 it was rediscovered in the Burra region. Since this time other small isolated populations of this species have been found in the Mid North Region of South Australia. Milne (1999) conservatively estimated that the population size in 1999 was approximately 5800 individuals. However, since this time several new populations have been

found which would increase this estimate. An accurate population estimate has not been conducted recently for this species (T Milne, pers. comm.). A recovery plan has been developed for this species and is currently being implemented (Milne *et al* 2000).

EBS 2008

The Pygmy Blue-tongue relies on spider burrows, made by wolf spiders and trapdoor spiders, as refuge sites, and this can be used as an indicator of the species potential presence. Availability of suitable spider holes which are stable and not subject to winter flooding has proven to restrain the species distribution (Milne 1999; Milne *et al.* 2003; Souter *et al.* 2004). Suitable spider holes utilised as burrows are typically vertical and circular up to 20 mm in diameter (Milne *et al*. 2000) and 23 cm deep, although burrows as short as 12 cm have been utilised (Milne 1999). This species is known to occupy native grassland habitats (Milne 1999) and it is considered that suitable grasslands may occur within the proposed project site. Even highly degraded grasslands (dominated by exotic species) are potential habitat, providing that the area is unploughed and the soil structure remains intact (J Schofield pers comm. 2008).

2.3.1.2 Flinders Worm-lizard (Aprasia pseudopulchella)

The Flinders Worm-lizard is endemic to South Australia and although it has a national conservation rating, it does not have a state conservation rating. At the time (approximately 1993) when the national conservation rating was assigned to this species, little was known about its habits and abundance (M Hutchinson. pers. comm.). Since this time, it has been found that there are numerous sites where this species has been found. The state conservation ratings have been updated more recently than the national ratings, which have caused the difference between the two. It is likely that this species occurs across the project area in a number of vegetation associations with rocky habitats. Unploughed grassland areas are considered to be potential habitat for this species, particularly where flat surface rocks occur in the landscape. Therefore it is considered that suitable habitat occurs within the Snowtown Stage 2 site.

EBS 2004

2.3.1.3 Plains-wanderer (Pedionomus torquatus)

www.anwc.csiro.au

Plains-wanderers are rarely reported but widespread throughout the grassed areas of South Australia. Their decline has been related to the reduction of native grasslands following agricultural development (Baker-Gabb *et al*. 1990), although small numbers are still recorded in heavily cropped districts during periods when quails are abundant (Taylor 1988). The proposed area support areas of native grasslands that would provide habitat for this species, given that the species has been recorded in nearby districts and that some of the native grasslands on the subject land provide floristically and structurally suitable habitat. It is unlikely that the Plains-wanderer would be common within the Snowtown wind farm, as it is more likely they are a very rare seasonal visitor. Plains-wanderers could be at risk from the proposed development if they migrate at night with quails.

2.3.1.4 Australian Painted Snipe (Rostratula australis)

The Australian Painted Snipe has a scattered distribution throughout many parts of Australia. Their distribution within South Australia is limited according to available records and their occurrence is often unpredictable and hence they are recorded irregularly (Garnett and Crowley 2000). They are usually found in shallow inland wetlands, either freshwater or brackish, that are either permanently or temporarily filled. Small pockets of mudflats and wetlands in farmland surrounding the wind farm site may provide suitable habitat for this transient species, given that it has been recorded in nearby districts of the Mid-north. This species has been recorded in the Mid-north of South Australia within the Clare-Burra region, in addition to records in the Southern Lofty Ranges and South East.

www.pbase.com

The Australian Painted Snipe is cryptic, hard-to-see and often overlooked. Usually only single birds are seen, though larger groups of up to 30 have been recorded. It nests on the ground amongst tall reed-like vegetation near water, and feeds near the water's edge and on mudflats, taking invertebrates, such as insects and worms, and seeds. Its rarity and perceived decline is of concern and its conservation status is nationally vulnerable, though with a population estimate as low as 1,500 birds, a strong case can be made for upgrading the status to endangered. The species has suffered primarily from the drainage of wetlands and diversion of water for domestic and agricultural purposes (Garnett and Crowley 2000). Diversion of water means that many shallow wetlands never form. Nest predation by introduced mammals, and over-grazing of shallow swamps could also have played a role in the population decline.

3.0 Field survey methods

A field assessment was conducted across the survey area at the proposed Snowtown Windfarm Stage 2 site on September 24-26, 2008. Plant species and vegetation communities present were recorded, and the condition and significance of vegetation present was noted. All fauna species observed were recorded, including a Level One survey (AusWind 2006) for bats and birds. The presence of fauna habitat was recorded in the survey area, with a particular focus on threatened species. Survey methods that were used to survey flora and fauna are detailed in section 3.1 and 3.2.

The Stage 1 area of the Snowtown Windfarm (operational) was also briefly reviewed during the course of this survey, the details of which are in a separate report updating flora and fauna for the area (Stage 1 Ecological Report draft (EBS, in progress)).

3.1 Flora

3.1.1 Vegetation associations and species present

General observations of vegetation associations present within the site were recorded and mapped during the survey. Native flora species were added to the lists gathered during previous surveys of the site. Exotic flora species were identified and GPS locations were recorded for declared and environmental pest species.

3.1.2 Vegetation condition ratings

The vegetation condition ratings assigned across the project area were based on the quality of the understorey vegetation. The methodology used for the assigned condition was adapted from Stokes et al (1998) (see Table 5 below). This methodology was selected as it is considered to be a good indicator of condition across different vegetation communities. A map of vegetation condition was compiled during the survey at the proposed Snowtown Stage 2 site.

Table 5 A summary of the Condition Ratings used to rate vegetation communities across the project area

Condition Rating	Overview Condition	Description
1	Excellent	Very little or no sign of alien vegetation in the understorey*; resembles probable pre-European condition.
2	Good	High proportion of native species and native cover in the understorey*; reasonable representation of probable pre-European vegetation.
3	Moderate	Substantial invasion of aliens but native understorey* persists; for example, may be a low proportion of native species and a high native cover, or a high proportion of native species and low native cover.
4	Poor	The understorey* consists predominately of alien species, although a small number of natives persist.
5	Very Poor	The understorey* consists only of alien species. (however, isolated natives may occur)
*Or all strata if the upper and lower strata are difficult to distinguish		
(Adapted from 'Guide to Roadside Vegetation Survey Methodology for South Australia', Stokes et al 1998).		

3.2 Fauna

3.2.1 General

Sightings and general observations of tracks, traces and habitat of native and exotic fauna were recorded onsite. Particular attention was paid to identifying habitat for threatened species, and specific bird and bat surveys were conducted. Habitat such as woodlands, grasslands, tree hollows, loose rocky areas and creek lines were recorded across the site.

3.2.2 Bird survey

The bird assessment for the Stage 2 Wind Farm project was undertaken in line with AusWind Best Practice Guidelines and the Wind Farms and Birds: Interim Standard for Risk Assessment documents. A Level 1 bird study was undertaken to identify any significant bird issues, to determine the possible approval requirements under Commonwealth and State legislation, and to identify any constraints and/or the need for more detailed surveys of the site.

The field survey component of the project involved undertaking a general bird survey of the Stage 2 area, and surrounding locations of interest (i.e. accessible waterways, significant habitat areas) as per the Level 1 requirements of the AusWind Best Practice Guidelines. The bird survey involved recording information on the bird species (native and exotic) present within the project area as well as the available bird habitats within the project area.

The project area was surveyed for birds at several times of the day including early morning, during the middle of the day and late afternoon. Bird surveys were conducted in each of the different available habitat types at a total of 32 survey sites (Figure 3a and 3b). The survey methodology used was a combination of a slow walk and occasional stop for 5 - 20 minutes at a time, covering a maximum of 2 ha per survey. These 2 ha searches involved a combination of conventional point count and roaming methods. Binoculars were used to assist in the identifying birds to species level. Bird calls were only used to alert the observer to the presence of a bird and to assist to identify its location and identity. All species seen or heard during surveys were recorded. Details on raptor nests were recorded including location, dimensions, signs of activity and nearby bird sightings and behaviours. Additionally, all birds noted opportunistically during the course of moving around the site were identified and GPS coordinates of their location recorded.

Maps showing the location of surveys are included in this report, and were produced using MapInfo GIS software.

3.2.3 Bat survey

The bat assessment for the Snowtown Stage 2 project was undertaken in line with AusWind Best Practice Guidelines. A Level 1 bat study was undertaken to identify any significant bat issues, to determine the possible approval requirements under Commonwealth and State legislation, and to identify any constraints and/or the need for more detailed surveys of the site.

AnaBat detectors were set up at several locations across the site for each night of the field survey (Figure 3a and 3b). At each location, the AnaBat recorded bat calls from late afternoon until early the following morning to determine bat species present within the area. Due to the open nature of the majority of the project area, specific locations were selected for the AnaBats. For best results, the AnaBats were placed in areas thought to be of suitable habitat for bats or that bats may frequent when feeding. Woodland areas seen to contain small hollows for roosting and 'fly-way' tunnels through the canopy were targeted for bat call activity.

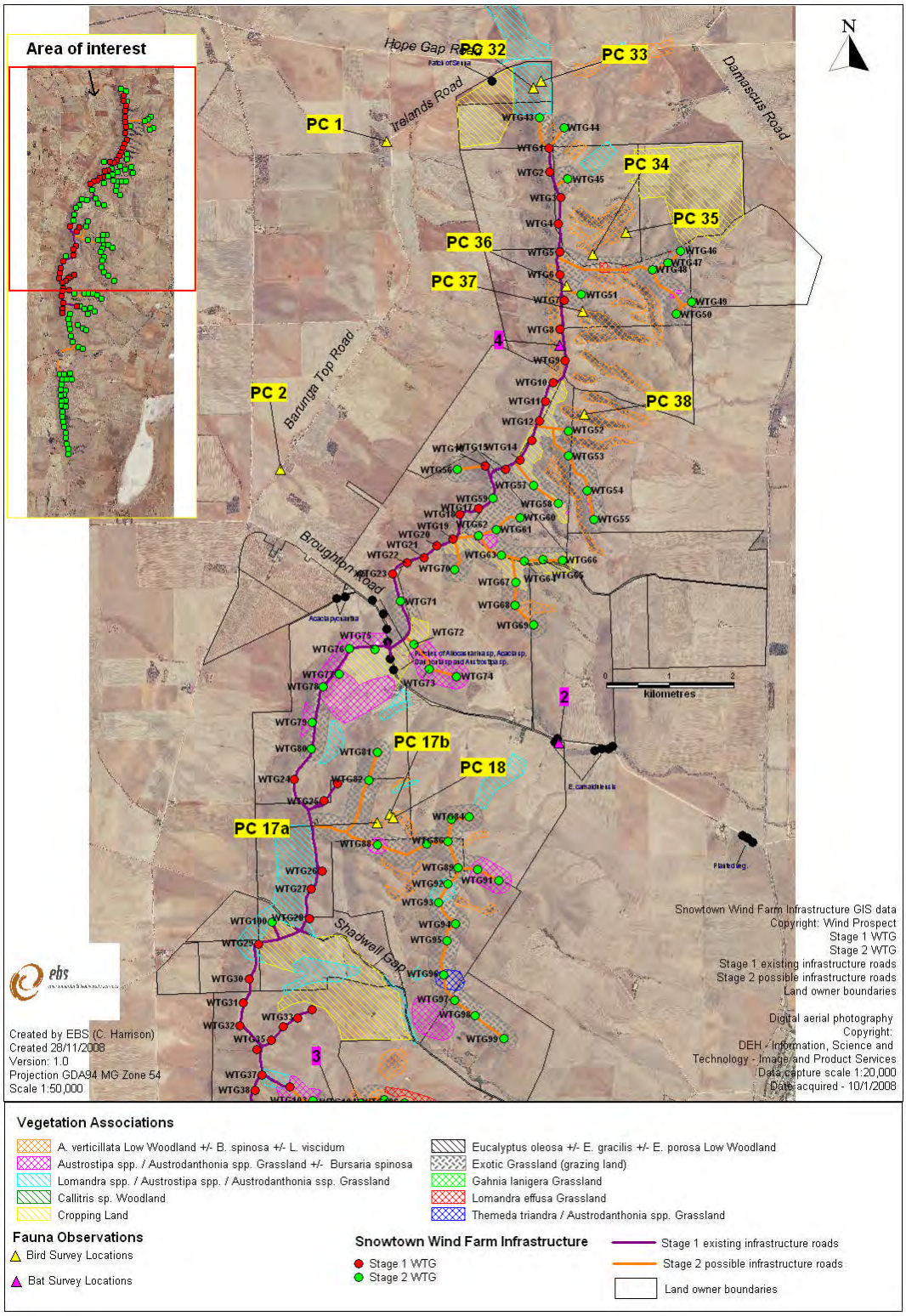


Figure 3a Location of survey points for bats and birds (northern area)

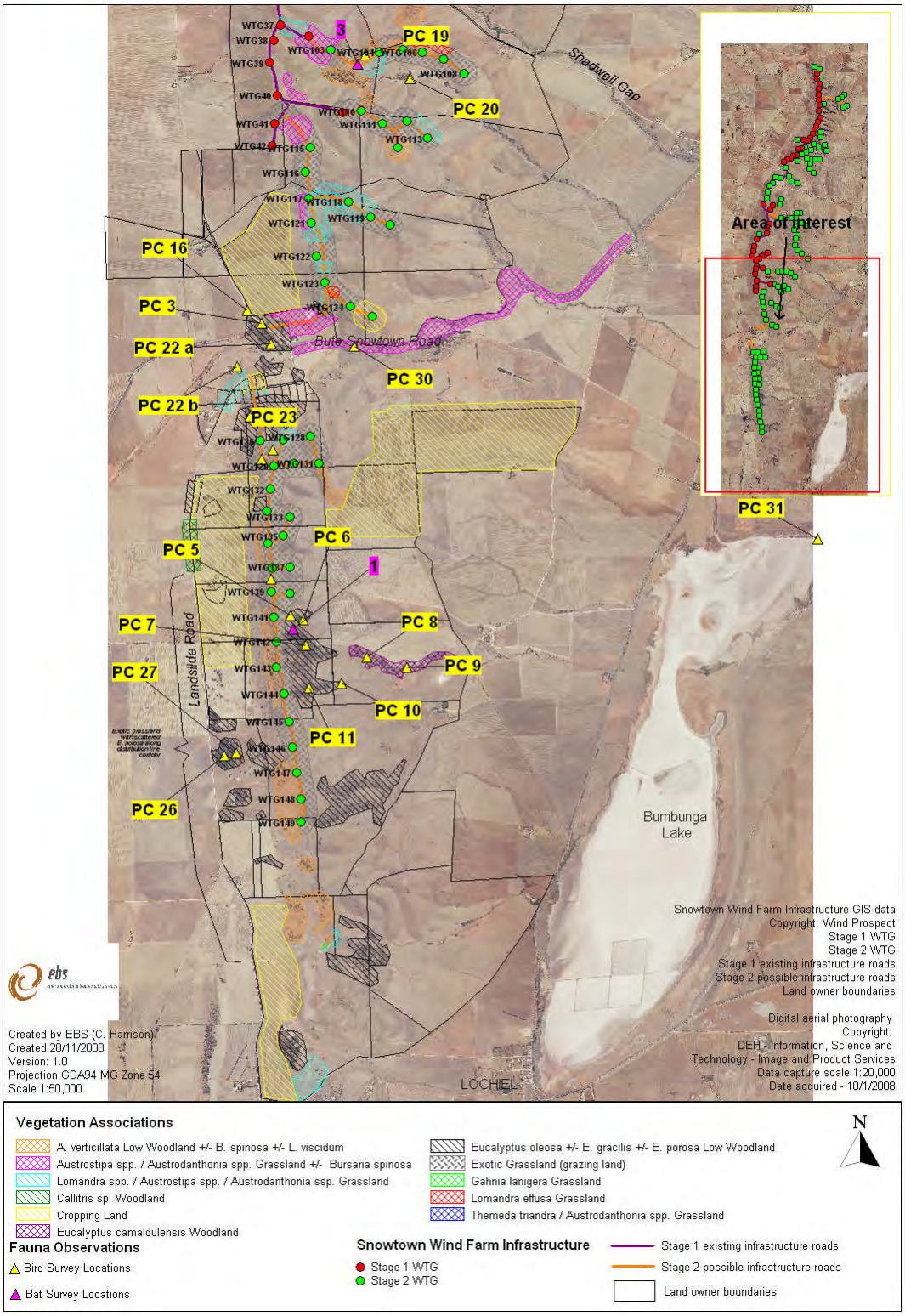


Figure 3b Locations of survey points for bats and birds (southern area)

4.0 Results

4.1 Flora results

4.1.1 Flora species and vegetation associations

A number of vegetation associations were found within the Snowtown Stage 2 survey area. The major associations found include:

- *Allocasuarina verticillata* Low Woodland +/- *Bursaria spinosa* +/- *Lepidosperma viscidum*
- *Austrostipa ssp./ Austrodanthonia spp*. Grassland +/- *Bursaria spinosa*
- *Lomandra spp. / Austrostipa ssp./ Austrodanthonia spp*. Grassland
- *Eucalyptus oleosa +/- Eucalyptus gracilis +/- Eucalyptus porosa* Low Woodland
- Exotic Grassland (grazing land)
- Cropping Land

Some of the more minor associations found during the survey (or that were present on the provided mapping) include:

- *Lomandra effusa* Grassland
- *Gahnia lanigera* Grassland
- *Themeda triandra / Austrodanthonia spp* Grassland
- *Eucalyptus camaldulensis* Woodland
- *Callitris spp.* Woodland

Many of these associations have been described and mapped in previous survey work in the area (EBS 2003 and mapping supplied by Wind Prospect). A number of flora species were added to the species list gathered during the initial survey in 2003, and an updated species list is provided in Appendix D.

The vegetation associations were mapped in the Stage 2 development areas (Figure 4a, 4b and 4c). As a project boundary was not defined, the vegetation mapping encompasses a buffer zone of a few hundred metres around proposed Stage 2 areas. Some mapping of Stage 1 vegetation appears on the maps, however this report focuses on the Stage 2, and these are mostly overlap areas. Some of the mapped areas were not visited during this survey however, as they were provided by Wind Prospects, they were included on the mapping. Most of the associations were encountered along the corridors surrounding the Stage 2 development areas; however some associations existed mostly between the corridors (such as the *Eucalyptus* Woodlands and *Allocasuarina* Woodlands).

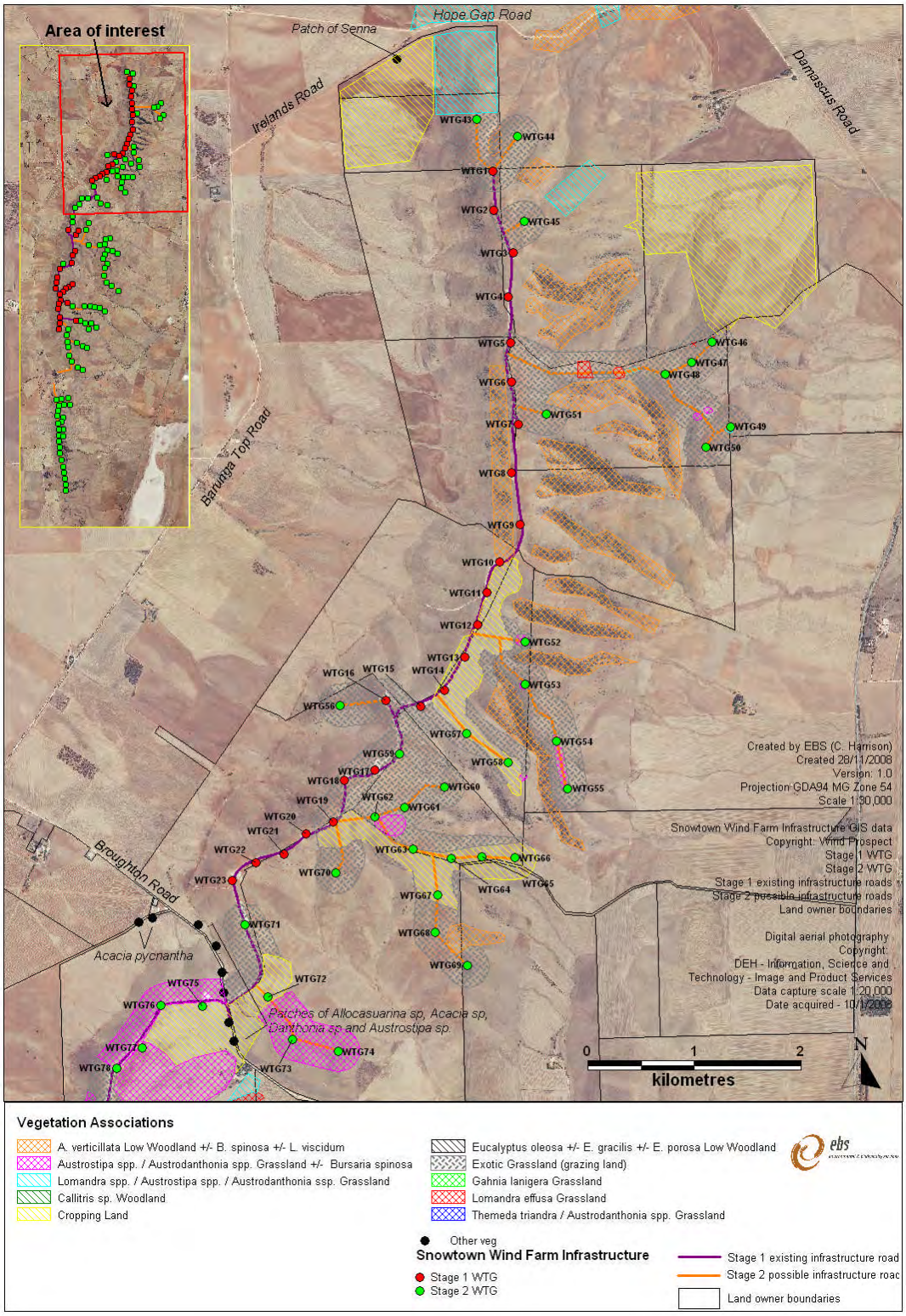


Figure 4a Vegetation associations identified within the survey area (northern area)

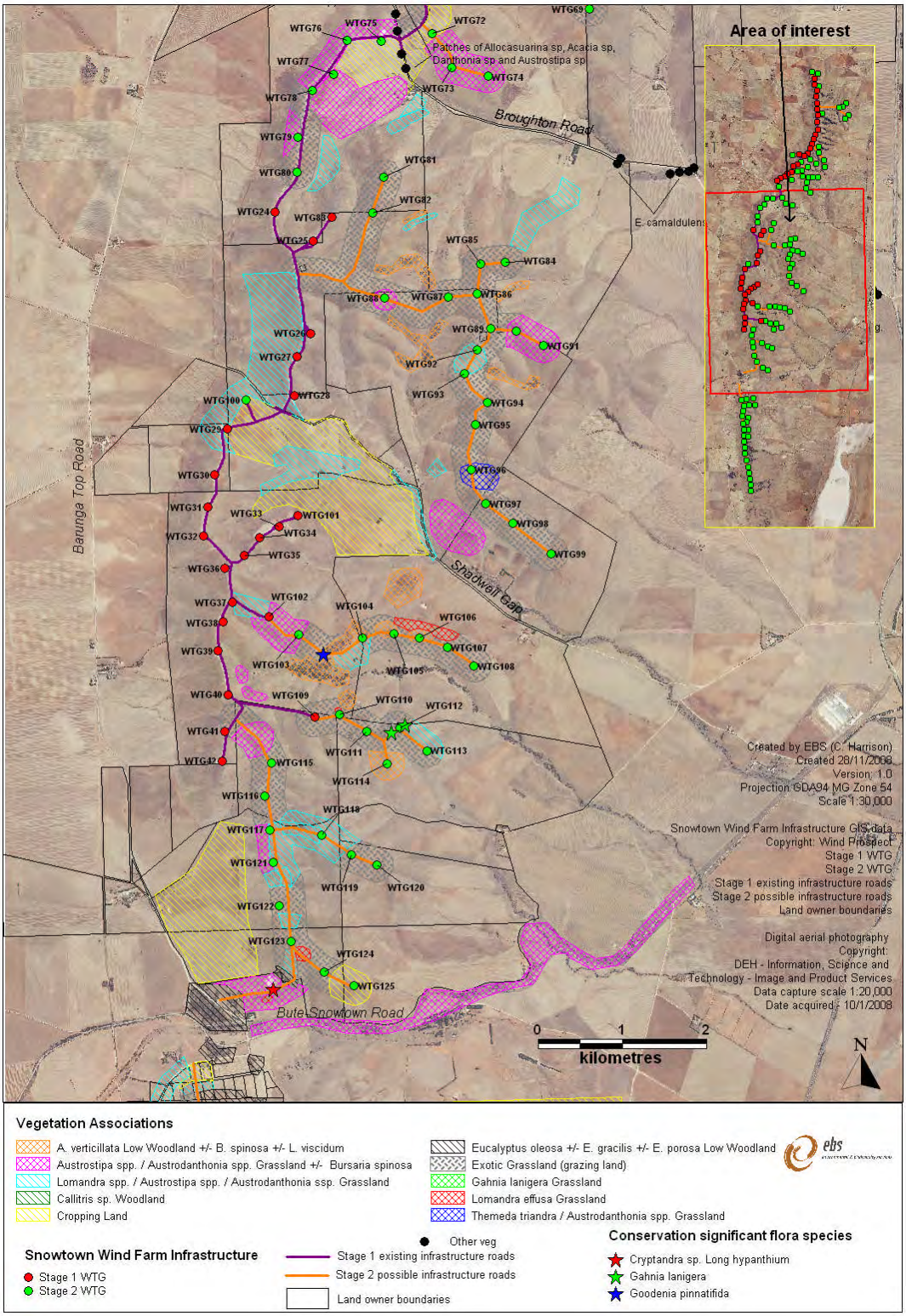


Figure 4b Vegetation associations identified within the survey area (middle area)

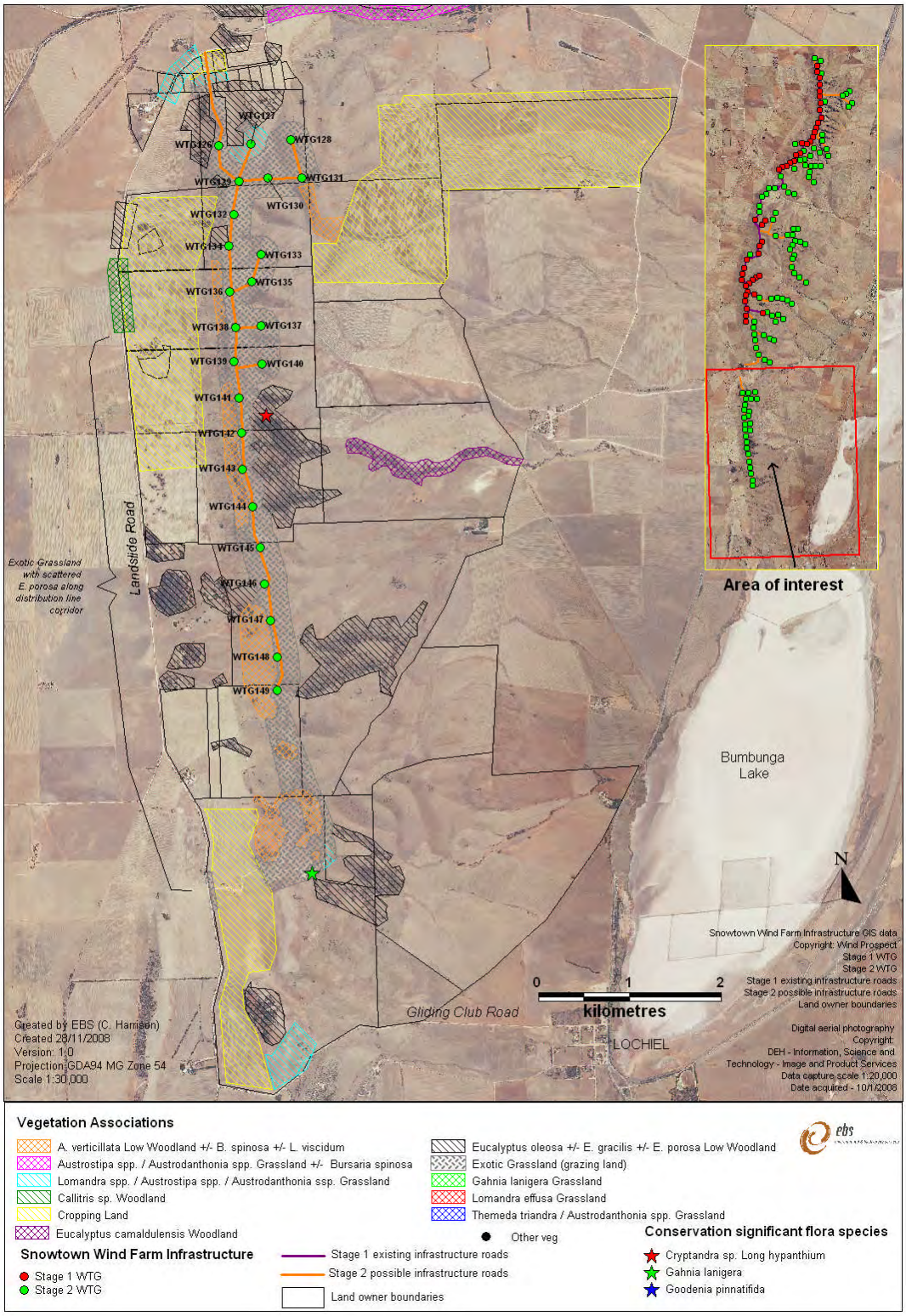


Figure 4c Vegetation associations identified within the survey area (southern area)

4.1.1.1 Allocasuarina verticillata Low Woodland +/- Bursaria spinosa +/- Lepidosperma viscidum

This association was found throughout the survey area, mainly in gullies which run from the main ridge out to the east and west. Drooping Sheoak (*Allocasuarina verticillata*) was the dominant species, however Sweet Bursaria (*Bursaria spinosa ssp. spinosa*) was commonly found in this association. The perennial understorey was limited, consisting mainly of exotic species, although a number of natives are known to persist in this association. One particular area was in good condition and had a thick understorey of Sticky Sword-sedge (*Lepidosperma viscidum*). These areas were good habitat for birds and bats due to the number and quality of hollows in the older trees.

Plate 1 *Allocasuarina verticillata* Low Woodland

Plate 2 *Allocasuarina verticillata* Low Woodland over *Lepidosperma viscidum*

4.1.1.2 Austrostipa ssp. / Austrodanthonia spp. Grassland +/- Bursaria spinosa

Spear grasses (*Austrostipa* ssp) and Wallaby grasses (*Austrodanthonia* ssp) were co-dominant in this association which was scattered throughout the survey area. Vast areas of this association remain and although many grasses were not able to be identified to species level during the current survey, a number of species have been listed from the previous survey work including *Austrostipa puberula* (state ***Rare***) and *Austrodanthonia linkii var. fulva* (regionally ***Uncertain***). Other native flora was present; however these grasslands were heavily infested with exotic species such as Wild Oats (*Avena barbata*) and Barley (*Hordeum vulgare*).

Plate 3 *Austrostipa spp. / Austrodanthonia spp* Grassland

4.1.1.3 Lomandra spp. / Austrostipa ssp. / Austrodanthonia spp. Grassland

This association has been separated out from the *Austrostipa ssp. / Austrodanthonia spp.* Grassland association, as previous studies have grouped them together. A number of patches were highlighted within the survey area (Figures 4a, 4b and 4c). Grasslands dominated by *Lomandra spp.* should be highlighted due to the upgrading of the status of this association to a nationally threatened ecosystem since the previous studies were completed. Up to 4 species of *Lomandra* were found within this association, in addition to a number of *Austrostipa* spp and *Austrodanthonia* spp.

These grasslands may provide important habitat for nationally threatened species such as the Pygmy Blue Tongue Lizard (*Tiliqua adelaidensis*) and the Plains Wanderer (*Pedionomus torquatus*). Any proposal within or adjacent to this area that has the potential to impact on this community would require detailed assessment and potentially a referral under the *Environment Protection and Biodiversity Act (1999).*

Plate 4 *Lomandra spp. / Austrostipa ssp. / Austrodanthonia spp.* Grassland

4.1.1.4 *Eucalyptus oleosa +/- Eucalyptus gracilis +/- Eucalyptus porosa Low Woodland*

These woodlands were found on a number of ridges and gullies throughout the survey area and in vast areas along the bottom of the main ridgeline (Figures 4a, 4b and 4c). A mixture of Eucalyptus species were found throughout this association, however Red Mallee (*Eucalyptus oleosa*) was often the dominant species. The understorey was usually limited, but at times contained a thick shrub layer of Sweet Bursaria (*Bursaria spinosa ssp. spinosa*). The state ***Rare*** *Cryptandra sp. Long hypanthium* (Long-flower Cryptandra) was found within this association. These areas were good habitat for birds and bats due to the number and quality of hollows in the older trees.

Plate 5 Eucalypt Low Woodland with limited understorey

Plate 6 Eucalypt Low Woodland with Sweet Bursaria understorey

4.1.1.5 Exotic Grassland (grazing land)

This association was commonly found across the site (Figures 4a, 4b and 4c), consisting of pastoral species and weeds such as Wild Oats (*Avena barbata*), Barley Grass (*Hordeum vulgare*), Wild Sage (*Salvia verbenacea*) and Capeweed (*Arctotheca calendula*). Few native plants were present in this association, however isolated patches of native species including Drooping Sheoak (*Allocasuarina verticillata*), Iron grasses (*Lomandra spp*.) and Sweet Bursaria (*Bursaria spinosa ssp. spinosa*). Several small herbaceous native species were found in these areas including Creamy Candles (*Stackhousia myonogyna*), Pussy Tails (*Ptilotus spathulatus forma spathulatus*), Chocolate Lilly (*Arthropodium sp*), Wooly New Holland Daisy (*Vittadinnia gracillis*), Giant New Holland Daisy (*Vittadinnia megacephala*) and Stinking Pennywort (*Hydrocotyle laxiflora*).

Plate 7 Exotic Grasslands

Plate 8 Isolated native species within the Exotic Grasslands

Plate 9 *Stackhousia monogyna* population near an old *Allocasuarina* within Exotic Grasslands

4.1.1.6 Cropping Land

A number of areas within the Stage 2 survey area consisted of cereal crops. These areas were purely exotic species where native vegetation would not be expected. Some native fauna may use these areas as habitat, including the nationally threatened Plains Wanderer (*Pedionomis torquatus*).

4.1.1.7 Lomandra effusa Grassland

A few small patches of this vegetation association were found within the survey area. Distinct from the main *Lomandra* association, these patches were dominated by Scented Mat-rush (*Lomandra effusa)*. Few other native species were found in this association, aside from exotic pasture grasses and a few *Austrostipa spp* and *Austrodanthonia spp*.

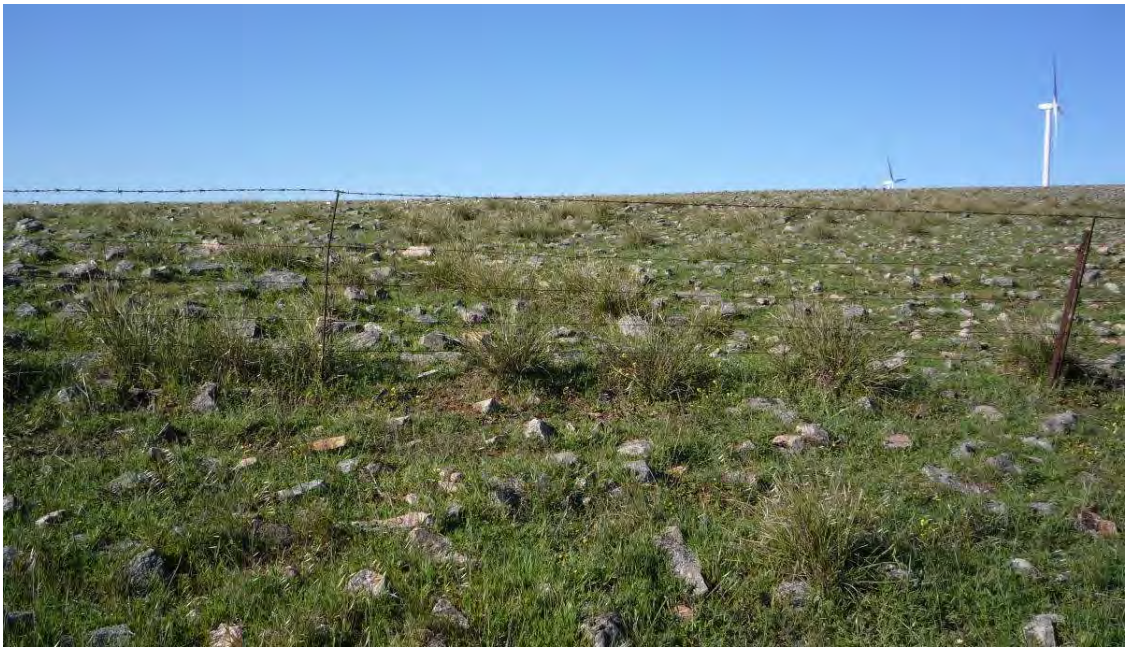


Plate 10 *Lomandra effusa* Grassland

4.1.1.8 Gahnia lanigera Grassland

This association was found in only a few places however was quite a distinct variation in vegetation cover. Black Grass Saw-sedge (*Gahnia lanigera*) is a species that has been flagged as being of possible conservation significance; however it is rated as ***Not Yet Assessed*** (rating Q). A number of native species occurred within this association including Glycine (*Glycine sp),* Creamy Candles (*Stackhousia monogyna*), Giant New Holland Daisy (*Vittadinnia megacephalus*) and Native Sorrel (*Oxalis perennans*).

Plate 11 *Gahnia lanigera* Grassland

4.1.1.9 Themeda triandra / Austrodanthonia spp Grassland

This association was also small but existed in a few patches within the Stage 2 survey area. Kangaroo Grass (*Themeda triandra*) dominated the area which made it stand out from the surrounding area, however without the tall heads of the grass it is an area that could be easily overlooked.

Plate 12 *Themeda triandra / Austrodanthonia spp Grassland* in mid-distance

4.1.1.10 Eucalyptus camaldulensis Woodland

This association was present within the vicinity of Stage 2 areas; however it was only briefly visited during the bird survey. The association was dominated by Red Gums (*Eucalyptus camaldulensis*) and followed creek lines running east and west of the main ridgeline. These areas were good habitat for birds and bats due to the number and quality of hollows in the older trees.

The confirmed vegetation mapping of this association is not complete as the brief survey visit did not allow for all of these areas to be investigated, and mostly they occurred outside of the immediate stage 2 development corridor. Some areas that were visited (primarily during the bird survey) are mapped in this report, as the mapping of these areas was provided by Wind Prospect.

4.1.1.11 Callitris spp. Woodland

These areas were included as the data was supplied by Wind Prospect. None of these areas occurred within the development corridor of the Stage 2 area.

4.1.2 Threatened flora species found within the survey area

Long-flower Cryptandra (*Cryptandra sp Long hypanthium*), a state ***Rare*** species, was detected during the survey in several areas of *Eucalyptus* Low Woodlands, however a few isolated plants were also found throughout the area (Figures 4b and 4c). Several species of regional conservation significance in the Northern Lofty botanical area have previously been detected within the survey area. The regionally conservation significant flora species detected during this survey include the Cut-leaf Goodenia *(Goodenia pinnaitifida)* ***(Uncommon)*** and the Black Grass Saw-sedge *(Gahnia lanigera)* (***Not yet assessed – possible conservation significance).*** No nationally threatened flora species were detected during the survey.

4.1.3 Threatened ecological communities found within the survey area

Several areas of Iron Grass (*Lomandra spp.)* Grasslands (including *Lomandra effusa* Grasslands) were found within the general survey area (Figures 4a, 4b and 4c and Plates 4, 10 and 13). This ecological community is now listed as threatened at the national level and is rated as ***Critically Endangered*** under the EPBC Act (1999). The upgrading of this ecological community was made in 2007 due to a severe decline in distribution and an ongoing loss of integrity in these communities, recognising that the long term survival of this community is under threat (DEWR 2007). These temperate native grasslands are considered one of the most threatened ecosystems in Australia (Graham et al 2001).

The patches found within the survey area were uncropped but most likely have been grazed. The grasslands were in good condition in terms of species diversity and density of plants; however they also contained many exotic grasses and herbs.

Plate 13 Iron Grass (*Lomandra spp.*) Grasslands in the northern part of Stage 2

4.1.4 Exotic flora species found within the survey area

Numerous exotic flora species were found within the survey area, as listed within Appendix D. A large proportion of the survey area was occupied by Exotic Grasslands, owing to extensive grazing and cropping of the area. Exotic species were found throughout all vegetation associations.

Declared and environmental exotic flora species (pest plants) were recorded in the survey area, in addition to the many other exotic flora species that have become widespread in the region. A **declared pest plant** is an invasive plant that is targeted for control under the South Australian Natural Resources Management Act 2004. Declared plants are known to have serious economic, social and environmental impacts and landholders are obliged to control these plants on their property. In taking measures to control declared plants, the landholder must take all reasonable

steps to ensure that native vegetation is not cleared except in accordance with guidelines set out by the Native Vegetation Council (Department of Water, Land and Biodiversity 2007). An **environmental pest plant** is an invasive plant that is not targeted for control under the South Australian Natural Resources Management Act 2004, but has the potential to have a significant economic, social and environmental impact.

Exotic flora species **declared** under the *Natural Resource Management Act* 2004 found within the survey area during this survey and previous studies include:

- Artichoke Thistle (*Cynara cardunculus ssp. flavescens*)
- Salvation Jane (*Echium plantagineum*)
- African Boxthorn (*Lycium ferocissimum*)
- Horehound (*Marrubium vulgare*)
- Slender Thistle (*Carduus tenuiflorus*)
- Aleppo Pine (*Pinus halepensis*)
- Pheasant's Eye (*Adonis microcarpa*)

Many of these declared species were found throughout the survey area (such as Horehound (*Marrubium vulgare*), Salvation Jane (*Echium plantagineum*) and Artichoke Thistle (*Cynara cardunculus ssp. flavescens*)), however others occurred in patches and as isolated plants, such as African Boxthorn (*Lycium ferocissimum*) and Pheasant's Eye (*Adonis microcarpa*) (see Appendix E for locations of isolated patches and plants). Exotic Grasslands were dominated by Wild Oats (*Avena spp*), Barley Grass (*Hordeum vulgare*), Salvation Jane (*Echium plantagineum*) and Capeweed (*Arctotheca calendula*).

4.1.6 Vegetation Association Condition

The project area ranged from Very Poor (condition 5) to Moderate (condition 3) condition, with reference to the vegetation associations present (Figures 5a, 5b and 5c). The invasion of exotic flora species throughout the site was obvious and the area has historically been utilised for agricultural and pastoral activities, resulting in a highly modified landscape.

Many of the Stage 2 proposed areas were assigned to the Very Poor (condition 5) category (Figures 5a, 5b and 5c). These areas most often consisted of Exotic Grasslands and cropping land, where native understorey species were largely non-existent. However, the occasional isolated native understorey species were present in this association, such as patches of Sweet Bursaria (*Bursaria spinosa*), Creamy candles (*Stackhousia monogyna*), Stinking Pennywort (*Hydrocotyle laxiflora*) and Pussy-tails (*Ptilotus spathulatus f. spathulatus*).

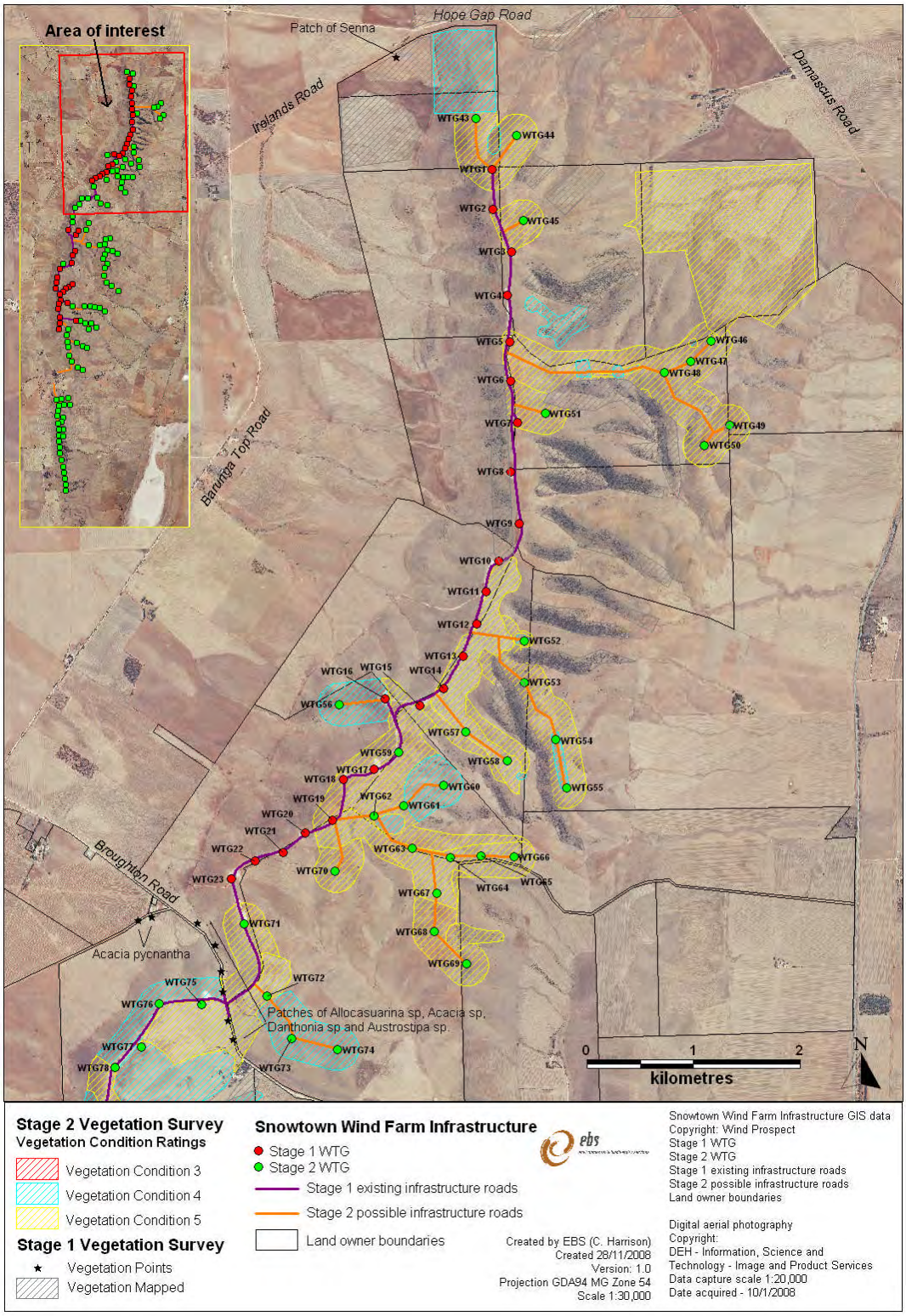


Figure 5 a Vegetation Condition mapping of the proposed Stage 2 areas (northern area)

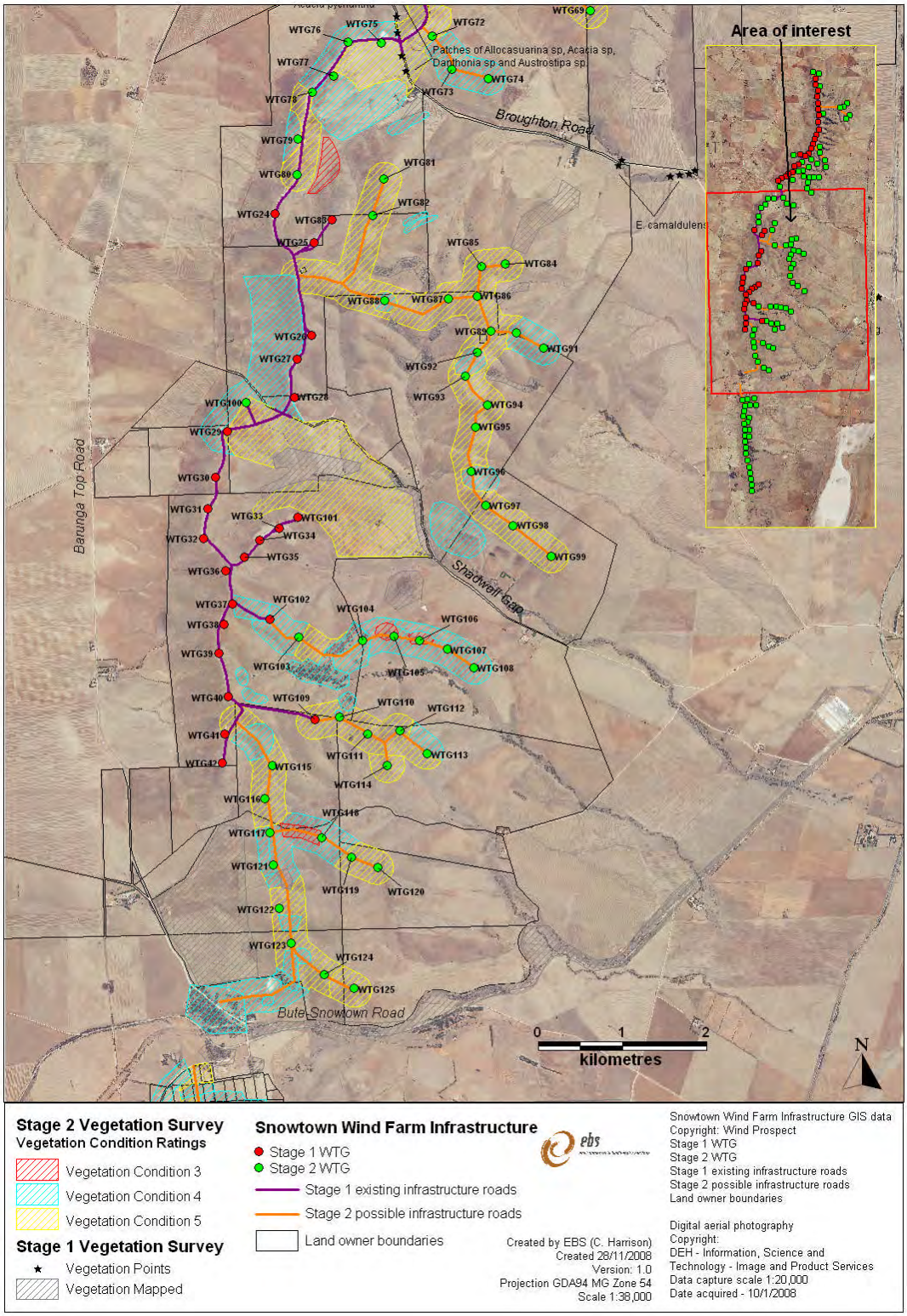


Figure 5b Vegetation Condition mapping of the proposed Stage 2 areas (middle area)

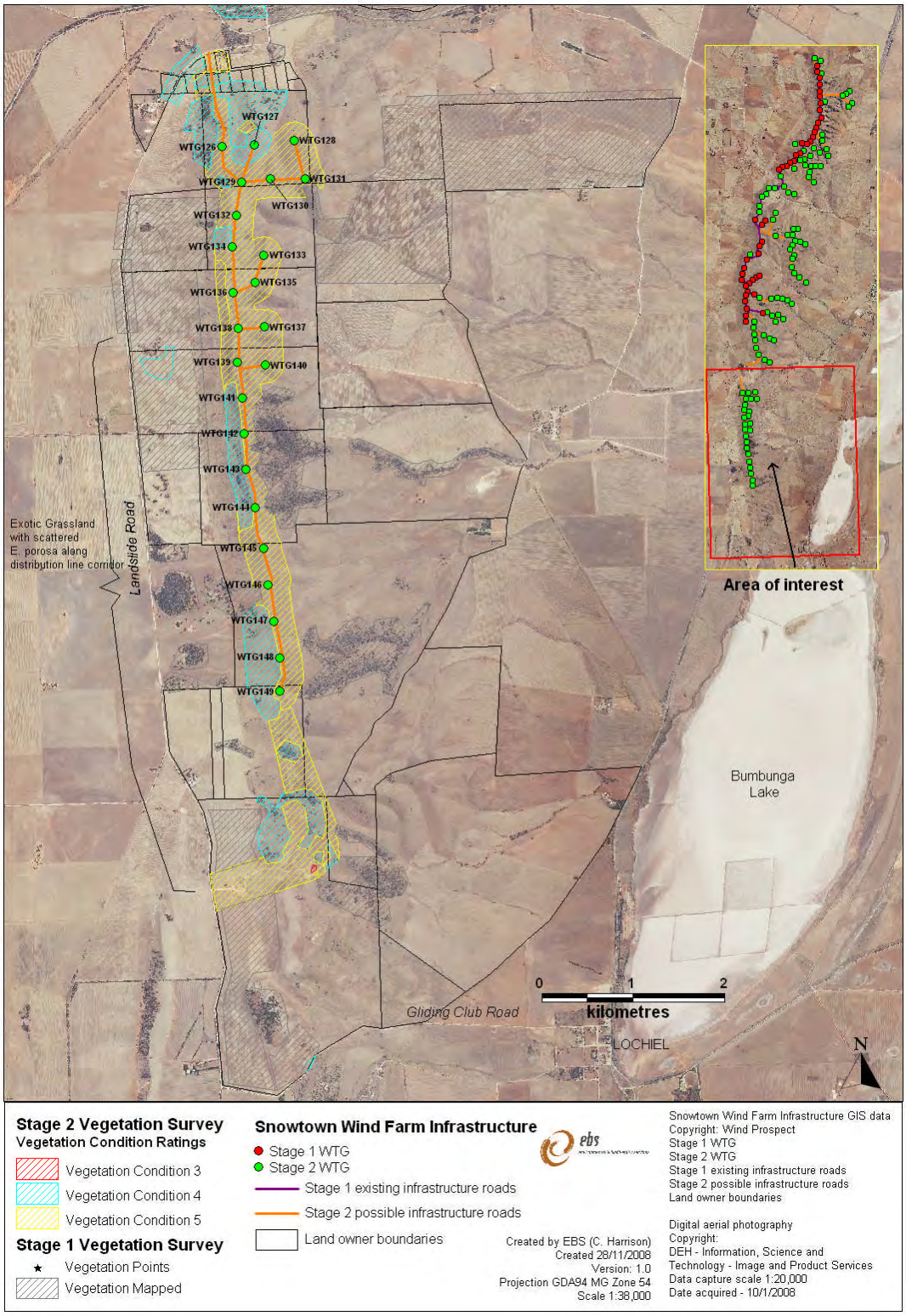


Figure 5 c Vegetation Condition mapping of the proposed Stage 2 areas (southern area)

These small pockets of native understorey (within the Condition 5 areas) would commonly exist in rock crevices, under logs or beneath isolated Drooping Sheoaks (*Allocasuarina verticillata)*. Hence, the pre-construction micro-sighting of turbine locations by a qualified ecologist will be essential to avoid the destruction of these precious pockets of native species within this highly modified landscape. Some woodland areas were also assigned the condition rating of Very Poor, due to the absence of native understorey species.

The condition rating of Poor (condition 4) was assigned to a number of areas, crossing several vegetation associations, owing to a small number of species persisting in the understorey layers (Figures 5a, 5b and 5c). The woodland associations mainly fell into this category as a small number of native understorey species were often present. Most of the native grassland associations came under this category as often there was a good density of native species, despite a low level of species diversity.

A few small areas were assigned a better condition rating of Moderate (condition 3) due to the increased density and diversity of native species in the understorey layer. One such area was an *Allocasuarina* Woodland that had a dense understorey of Sticky Sword-sedge (*Lepidosperma viscidum)* (Figure 5b, Plate 15). Other species found within this patch included Spine Bush (*Acacia nyssophylla*), Cut-leaf Goodenia (*Goodenia pinnaitifida*) and Dwarf Sunray (*Hyalosperma demissum*). This area encompasses the proposed turbines WTG105 and WTG106, which appear to fall within the patches of Moderate condition woodland. Another area of Moderate condition *Allocasuarina verticillata* Woodland was found near WTG 53. This patch of woodland does not appear to coincide with any turbine locations; however the proposed access track is aligned next to it. The alignment of this track should be altered if necessary to avoid the removal of any vegetation associated with this area.

The only recorded patch of *Gahnia lanigera* Grassland was in Moderate condition (Figure 5c). In addition to the high density of Black Grass Sword-sedge (*Gahnia lanigera*), a number of other native species were recorded in the patch. Unfortunately, a graded access track associated with a tower at Bumbunga Hill has already been created on the edge of this association. The road spoil has encroached on the patch, burying some plants, and it is expected that plants in the patch may be affected by dust from the unsealed track (Plate 15).

Plate 14 *Allocasuarina verticillata* Woodland in Moderate condition near WTG105 and WTG106

Plate 15 Spoil of access track to Bumbunga Hill on the edge of the only patch of *Gahnia lanigera* Grassland (in Moderate condition)

An area of *Lomandra spp*. Grassland was considered to be of Moderate condition during the survey. This occurred between proposed turbines WTG117 and WTG118 (Figure 5b). A good density of native grasses and understorey species was found to be present such as Iron grasses (*Lomandra spp*), Spear grasses (*Austrostipa spp*), Wallaby grasses (*Austrodanthonia spp*), Sticky Sword-sedge (*Lepidosperma viscidum*) and Sweet Bursaria (*Bursaria spinosa*) (See Plate 16). Currently an ungraded access track runs through part of this patch. Any access track or turbines proposed along this spur of turbines should aim to avoid this patch.

Plate 16 *Lomandra spp* Grassland in Moderate condition, between WTG117 and WTG118

4.2 Fauna results

The site was generally degraded in terms of habitat value for native fauna; however it contains pockets of suitable habitat within an agricultural and pastoral landscape. Woodland areas and remnant native vegetation associations generally offer the most habitat value for native fauna. Considering that the extent of fauna habitat in the region is relatively poor for many native species (Graham et al 2001), these small pockets of habitat may be of increased importance to the species that still reside in the area. A full fauna survey was not undertaken during the three visits; however a general assessment was conducted of the fauna at the site.

4.2.1 General fauna

Few native fauna were directly observed during the general assessment, in addition to tracks and traces that were recorded. Most fauna detected were exotic species such as Sheep (*Ovis aries*), European Rabbits (*Oryctolagus cuniculus*) and European Red Foxes (*Vulpes vulpes*). Native species observed or recorded during the surveys included the Western Grey Kangaroo (*Macropus fuliginosus*), the Euro (*Macropus robustus*), Bearded Dragon (*Pogona vitticeps*; Plate 17) and Sleepy Lizard (*Tiliqua rugosa*). Birds and bats were recorded in separate surveys, detailed in sections 4.2.2 and 4.2.3.

Plate 17 Bearded Dragon caught in the survey area within Exotic Grasslands

4.2.2 Birds

4.2.2.1 General description of the bird community

A total of 730 birds from 40 species were recorded during the three day survey of the Snowtown Stage 2 Wind Farm Site, and its surrounding area (Table 6). The five most abundant species accounted for 60% of all individuals recorded. These were the Galah, White-plumed Honeyeater, Crested Pigeon, and the introduced Common Starling and House Sparrow (Table 6). The Galah was the most abundant bird, with 148 individuals sighted (Table 6). These records were mostly of more than one individual, as flocks of 5-35 birds were often recorded. In contrast, most records of White-plumed Honeyeaters were of a single bird moving through the foliage of eucalypts foraging on nectar from flowers. Similarly, all records of Crested Pigeons were of one or two birds flying between trees. A wide range of bird types were recorded, including raptors (5 species), waterbirds (2), parrots (3) and honeyeaters (4), small passerines (10), and other forest birds (9), as well as grassland bird species (2), and introduced species (4). The diversity of birds recorded was largely due to the range of habitats that occur across the wind farm site.

Table 6. All bird sightings made during the current survey of the Stage 2 Snowtown wind farm, showing their conservation significance.

		Conservation significance		
Common name	**Total number of birds recorded**	**AUS**	**SA**	**MN**
Australian Magpie	22			
Australian Wood Duck	5			
Banded Lapwing	2			
Black-faced Cuckoo-shrike	10			
Brown Falcon	3			
Collared Sparrowhawk	1			
Common Starling	133			
Crested Pigeon	37			
Dusky Woodswallow	18			
Elegant Parrot	2		R	U
Eurasian Blackbird	2			
Eurasian Skylark	1			
Galah	148			
Grey Shrike-thrush	2			
Hooded Robin	4		R	U
House Sparrow	57			
Jacky Winter	1		R	U
Little Raven	5			
Magpie-lark	2			
Mulga Parrot	2			
Nankeen Kestrel	17			
Noisy Miner	18			
Peregrine Falcon	1		R	R
Rainbow Bee-eater	6			
Red-rumped Parrot	37			U
Richard's Pipit	18			
Rufous Fieldwren	2			
Rufous Whistler	1			
Singing Honeyeater	13			
Spiny-cheeked Honeyeater	3			
Striated Pardalote	23			
Varied Sittella	6			

Wedge-tailed Eagle	12		
White-faced Heron	1		
White-fronted Chat	4		
White-plumed Honeyeater	53		
White-winged Triller	1		
Willie Wagtail	23		
Yellow Thornbill	5		U
Yellow-rumped Thornbill	18		
Grand Total	717		

4.2.2.2 Bird use of different habitats

Bird surveys were performed in six different habitat types across the Snowtown wind farm site. This included the *Allocasuarina verticillata* Low Woodlands, and mixed Eucalypt Low Woodlands which occurred in the gullies that run off either side of the major ridge line, and on the lower slopes of the hills (Figures 3a and 3b). Native *Austrostipa spp. / Austrodanthonia spp* Grasslands, *Lomandra ssp*. Grasslands and Exotic Grasslands on the ridge tops and hills were also surveyed for birds. The *Eucalyptus camaldulensis* (Red Gum) dominated creek lines in the foothills and valleys to the east of the ridge line were also covered in the current study. In addition, a single survey was performed on the banks of nearby Bumbunga Lake to determine its use by waterbirds and waders.

The greatest number of birds and highest species diversity was recorded from mixed Eucalypt Woodland habitat. This included 458 individuals from 29 species (Table 7). Relatively high species diversity was also recorded in the *Allocasuarina verticillata* dominated gullies, with 23 species observed, however bird abundance was much reduced, with only 83 individuals sighted. Whilst a reduced amount of time was spent performing surveys in *Allocasuarina verticillata* Woodland compared to the mixed Eucalypt Woodland (30% vs 23%, see Table 7), this does not account for the reduced number of birds recorded. This indicates that the *Allocasuarina verticillata* Woodland surveyed supported a lower abundance of birds compared to mixed Eucalypt Woodlands. The reduction in bird numbers using the *Allocasuarina verticillata* Woodlands is likely due to the increased fragmentation of this habitat. In the Stage 2 area that joins Stage 1, *Allocasuarina verticillata* Woodlands predominantly occurred low in gullies, being separated by treeless hilltops. In many of these areas trees were widely spaced, and sheep grazing had prevented the growth of any understorey plants. However, in some patches trees formed more dense stands, and formed a closed canopy. These specific sites recorded an elevated abundance of birds (e.g. PC35 and 37, Figure 3a). *Allocasuarina verticillata* trees in these gullies were heavily used as breeding sites by Wedge-tailed Eagles, as five nest sites were located.

Survey effort in native grasslands represented only 18% of the total time involved in bird surveys, and the same amount of time was spent in exotic grasslands (see Table 7). Despite a reduced

survey effort in comparison to woodland habitats, bird diversity and abundance was heavily reduced in the grassland habitats across the wind farm site in comparison to woodland habitats. 35 individuals from 8 species were recorded in exotic grasslands (Table 7). Even fewer birds were recorded from native grasslands, with only 18 individuals from 5 species sighted (Table 7). This is largely due to the decreased number of niches available in this habitat type in comparison to woodland. Three species observed in both exotic and native grasslands were the Richards Pipit, Nankeen Kestrel, and White-fronted Chat (Table 7). Additional species recorded using exotic grasslands were the Red-rumped Parrot, Australian Magpie and Banded Lapwing, whilst the Elegant Parrot (*Rare SA*) and Mulga Parrot were sighted in native grasslands (Table 7).

The six bird species recorded using both woodland and grassland habitats were also those most commonly observed birds performing movements across the wind farm site. They included the Australian Magpie, Galah, Wedge-tailed Eagle, Nankeen Kestrel, Red-rumped Parrot, and Richard's Pipit. Australian Magpies and Galahs were commonly recorded feeding on the ground among the exotic grasses on the sides of the hills, and in the valley on the eastern and western side of the dominant ridgeline. They were also observed flying from tree to tree in the tree-lined creeks in the valley, and between the patches of eucalypt and Allocasuarina woodland associated with numerous gullies. The majority of Red-rumped Parrot sightings were from mixed Eucalypt Woodland (35/37) in the southern sector of the Stage 2 development; however two individuals were recorded feeding on the ground in exotic grassland in this same area. This species was also regularly recorded flying between remnant patches of woodland. This involved numerous movements over the dominant north - south running ridgeline, as well as over ridge lines lower on the hills. The two raptor species recorded in both grassland and woodland habitat were also the most commonly observed birds in flight across the wind farm site. The Wedge-tailed Eagle was observed a total of 12 times, and on most occasions they flew extensively over the crest of the dominant ridge, and also travelled widely over the ridges and hills to the west and east (Figures 6a and 6b). Nankeen Kestrels were recorded on 17 occasions, and their flights were predominantly confined to the tops and sides of the hills over both exotic and native grasslands (Figures 6a and 6b).

Table 7. Bird records from different habitat types across the Stage 2 Snowtown wind farm, showing the survey effort performed.

Common Name	Species Name	Eucalypt Low Woodlands	Allocasuarina Woodlands	Redgum Creeklines	Exotic Grasslands	Native Grasslands	Lake Bumbunga	Total
Australian Magpie	*Gymnorhina tibicen*	7	2	5	8			22
Australian Wood Duck	*Chenonetta jubata*			5				5
Banded Lapwing	*Vanellus tricolor*				2			2
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	5	3	2				10
Brown Falcon	*Falco berigora*	2		1				3
Collared Sparrowhawk	*Accipiter cirrhocephalus*		1					1
Common Starling	*Sturnus vulgaris*	102	10	21				133
Crested Pigeon	*Ocyphaps lophotes*	20	8	9				37
Dusky Woodswallow	*Artamus cyanopterus*	9	9					18
Elegant Parrot	*Neophema elegans*					2		2
Eurasian Blackbird	*Turdus merula*	2						2
Eurasian Skylark	*Alauda arvensis*		1					1
Galah	*Cacatua roseicapilla*	98	7	43	5			153
Grey Shrike-thrush	*Colluricincla harmonica*	2						2
Hooded Robin	*Melanodryas cucullata cucullata*	1	3					4
House Sparrow	*Passer domesticus*	40	12	5				57
Jacky Winter	*Microeca leucophaea leucophaea*	1						1
Little Raven	*Corvus mellori*	4	1					5
Magpie-lark	*Grallina cyanoleuca*	1	1					2
Mulga Parrot	*Psephotus varius*					2		2
Nankeen Kestrel	*Falco cenchroides*	3	3	4	2	4	1	17
Noisy Miner	*Manorina melanocephala*	11	2	5				18
Peregrine Falcon	*Falco peregrinus*		1					1
Rainbow Bee-eater	*Merops ornatus*	6						6
Red-rumped Parrot	*Psephotus haematonotus*	27		8	2			37
Richard's Pipit	*Anthus novaeseelandiae*	1	1		11	3	2	18
Rufous Fieldwren	*Calamanthus campestris campestris*						2	2
Rufous Whistler	*Pachycephala rufiventris*	1						1
Singing Honeyeater	*Lichenostomus virescens*	5	5				3	13
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	3						3
Striated Pardalote	*Pardalotus striatus*	19	1	3				23
Varied Sittella	*Daphoenositta chrysoptera*	6						6
Wedge-tailed Eagle	*Aquila audax*	5	2		5			12
White-faced Heron	*Egretta novaehollandiae*				1			1
White-fronted Chat	*Epthianura albifrons*				4	6		10
White-plumed Honeyeater	*Lichenostomus penicillatus*	39	2	12				53
White-winged Triller	*Lalage tricolor*		1					1
Willie Wagtail	*Rhipidura leucophrys*	17	3	3				23
Yellow Thornbill	*Acanthiza nana*	5						5
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	16	2					18
Bird Abundance (i.e. number of birds)		**458**	**81**	**126**	**40**	**17**	**8**	**730**
Species Diversity		**29**	**23**	**14**	**9**	**5**	**4**	**40**
Proportion of time spent in survey		**30**	**23**	**11**	**18**	**18**	**1**	**100**

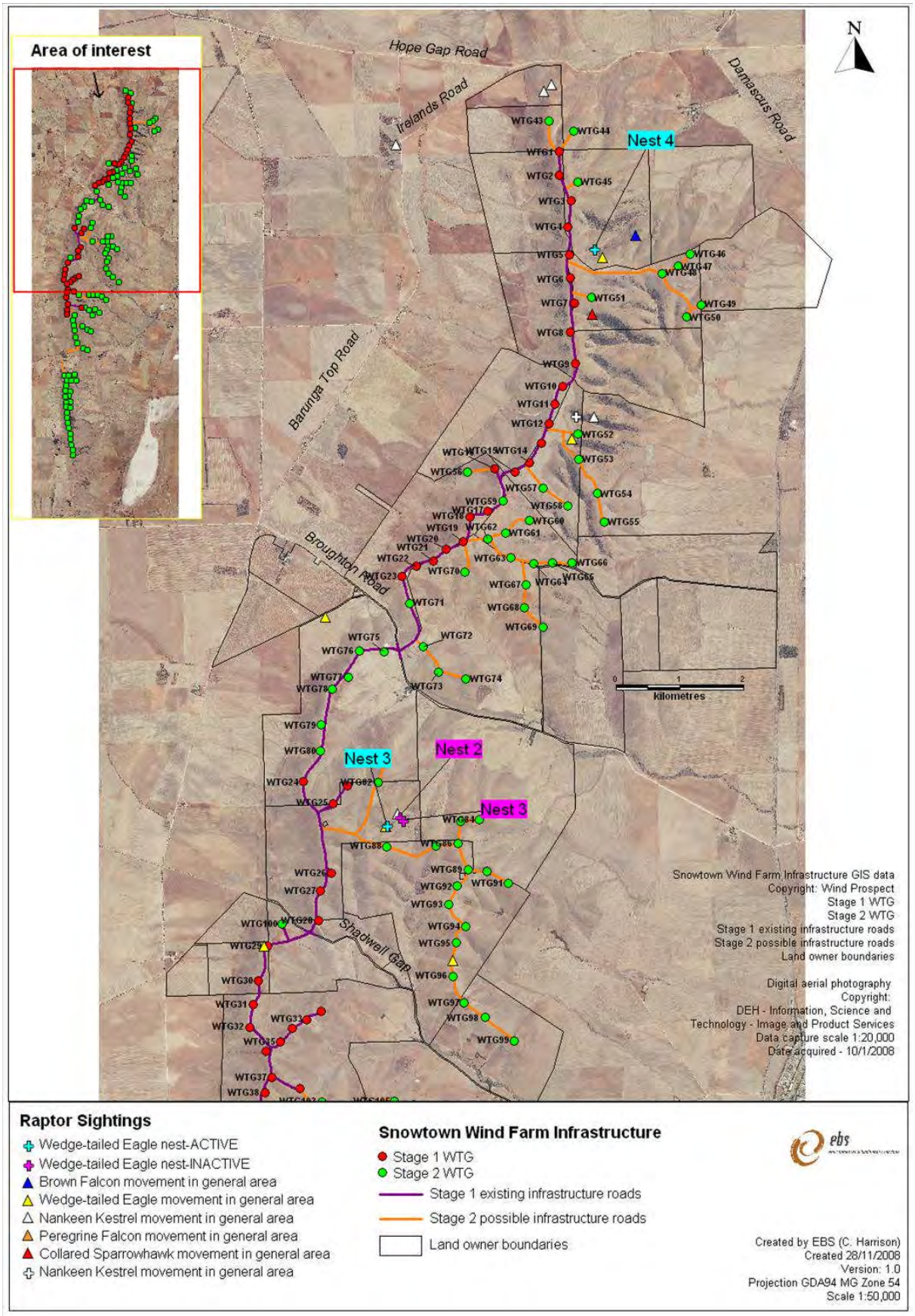


Figure 6a Raptor sightings and nests at Snowtown Windfarm (northern area)

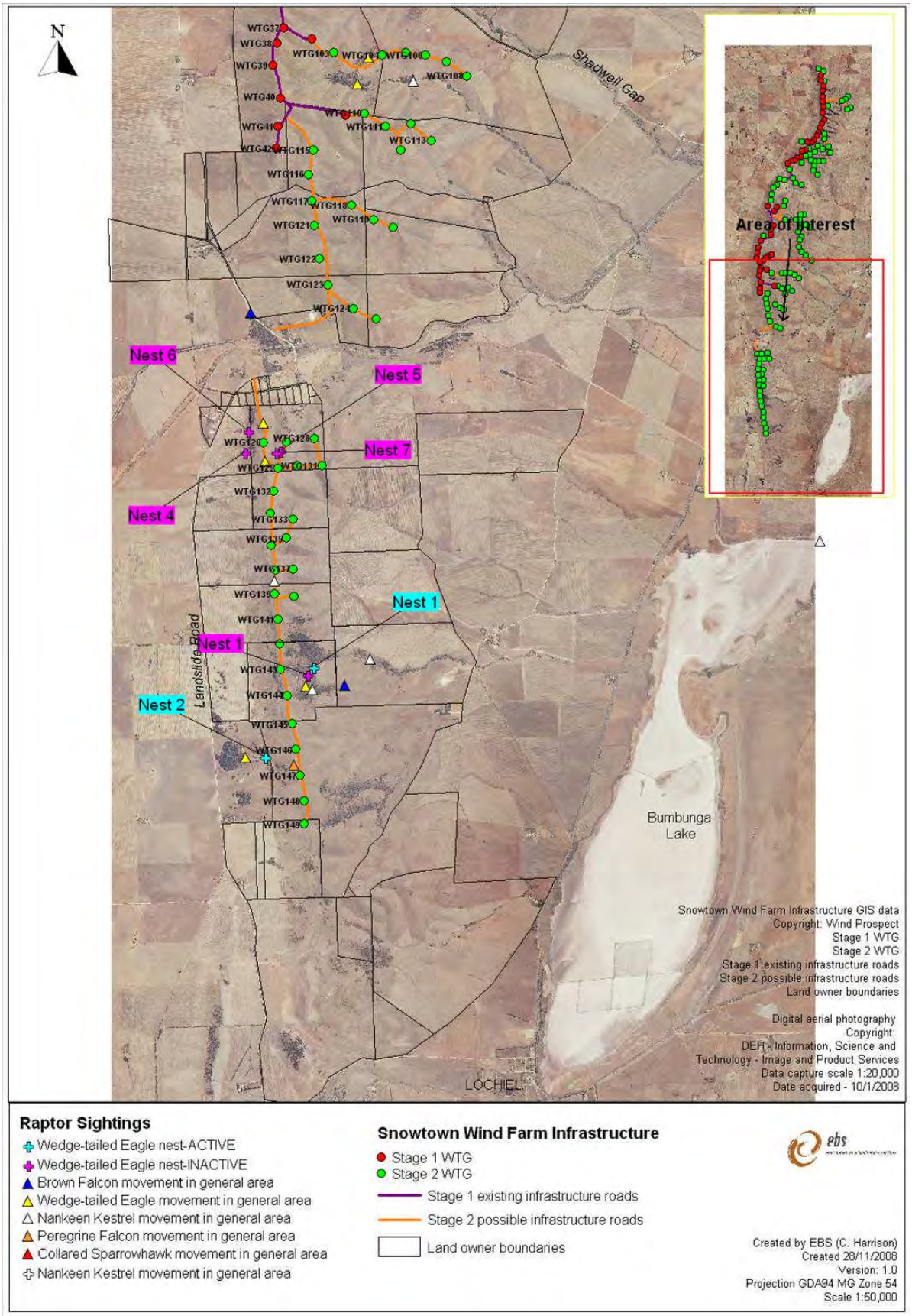


Figure 6b Raptor sightings and nests at Snowtown Windfarm (southern area)

4.2.2.3 Breeding habitat

Nest sites of a range of different bird species were sighted both within, and surrounding the Stage 2 site. The most commonly recorded nests sites were of the Wedge-tailed Eagle, with a total of 10 nests sighted. Four of these nests were active at the time of this survey, as they contained one or two chicks.

Wedge-tailed Eagle active nest site 1

The first active Wedge-tailed Eagle nest was located ~250m due north of PC11 (Figure 3b) in a large eucalypt (Figures 6a and 6b). The nest tree was located on a minor ridge about 400m down the hill to the east of the major ridge line. This location is ~520 m from the proposed turbines WTG 142 and 143 (Figures 6a and 6b). It was in a large patch of *Eucalyptus oleosa* dominated low woodland. At least one medium-sized, white coloured chick was sighted in the bowl of the nest. As the chick had a lot of its downy feathers, it had roughly 4-8 weeks to go before fledging from the nest. Two adult birds were observed in the area for ~10 minutes, and flew extensively over the ridgeline directly over PC 12, as well as over the major ridgeline itself. Both Wedge-tailed Eagles were then observed to fly down and perch on trees nearby the nest.

A second inactive Wedge-tailed Eagle nest (inactive nest 1) was sighted in another eucalypt ~120m from nest site 1.

Wedge-tailed Eagle active nest site 2

A second active Wedge-tailed Eagle nest was situated in a tall eucalypt tree that was located in a small patch of low woodland ~250m down the side of the hill on the western side of the major ridgeline (Figures 6a and 6b, Plate 18). The nest tree was situated approximately two thirds the way down the hill from the ridge top, and was ~430 – 600 m from the proposed turbines WTG 145, 146 and 147 (Figures 6a and 6b). At least two downy chicks were observed in the nest bowl from the view point on top of the ridge. No adults were recorded during the 10 minutes of initial observation, but one Wedge-tailed Eagle was recorded in the area the following day.

Plate 18 Active Wedge-tailed Eagle nest site 2.

Wedge-tailed Eagle active nest site 3

The third active Wedge-tailed Eagle nest was located in a thin and sparse patch of open *Allocasuarina verticillata* Woodland that lined a gully on the eastern side of the major ridge line. The nest was situated in a 7m tall *Allocasuarina verticillata* which was one of the dominant trees in a small fragmented woodland habitat. The nest bowl was ~60 vertical metres below the top of the minor ridgeline, and ~300m from the proposed turbine WTG 88 (Figures 6a and 6b). Observations of two chicks were made from approximately 20m further up the ridge (Plate 19). These two chicks were covered in down and appeared healthy. A single adult was sighted flying low over the area during the 2 minutes of observation at this site. This bird flew at a height of 5-50m over the ridge line where turbines are proposed, and then headed due south over and out of sight towards Shadwell Gap Rd.

A secondary Wedge-tailed Eagle nest was sighted ~150m further down the same gully, and was also situated in an *Allocasuarina verticillata*. This nest was inactive (inactive nest 2), but white wash directly under the nest indicates that eagles have used the nest in recent months, likely as a perching site. A third nest (inactive nest 3), was also sighted in a dead *Allocasuarina verticillata*, and was close by the inactive nest 2. No signs of recent activity were obvious at inactive nest 3. Due to the proximity of these nests to active nest site 3, these inactive nests most likely belong to the same breeding pair.

Plate 19 Active Wedge-tailed Eagle nest site 3.

Wedge-tailed Eagle active nest site 4

A fourth active Wedge-tailed Eagle nest was located on the southern side of a smaller ridgeline that stemmed to the east off the major ridge. This nest was situated in a dead *Allocasuarina verticillata* which was located high on the hill ~50m from the top of the nearby ridgeline. This nest is ~750 m from a proposed turbine location to the south (Figures 6a and 6b). At least one chick was visible in the nest bowl, and was covered in white downy feathers (Plate 20). Two adult Wedge-tailed Eagles were sighted at the same time, and flew to the east of the nest along the top of the ridgeline, and spent the remaining 5 minutes of observation time soaring high over the hilltops where turbines WTG 46-48 are proposed (Figures 6a and 6b).

Plate 20 Active Wedge-tailed Eagle nest site 4.

Other inactive Wedge-tailed Eagle nests

An inactive Wedge-tailed Eagle nest was sighted in a small patch of eucalypt woodland located roughly half the way down the side of the hill from the ridge top (i.e. ~200m) (inactive nest 4) (Figures 6a and 6b). This nest was on the western side of the major ridge line, and was situated in a small eucalypt.

An inactive Wedge-tailed Eagle nest was also sighted in a solitary eucalypt located approximately 80m from the ridge top (inactive nest 5) (Figures 6a and 6b). This nest faced north, and was located on the south eastern side of a wide gully. An adult Wedge-tailed Eagle was sighted at the same time, flying low over the ridge tops in an area where turbines are proposed approximately 100m to the south (Figures 6a and 6b). This bird was observed travelling further south at heights of 10-130m and then hung around for ~5 minutes soaring over the top of the major ridgeline where other turbines are planned. This bird may belong to inactive nest site 5 which was located close by, and may have bred earlier in the season and already fledged a chick from this nest.

Another inactive Wedge-tailed Eagle nest was recorded on the western side of the ridgeline (inactive nest 6) (Figures 6a and 6b). This nest was approximately one third the way down the side of the hill in an old Eucalypt tree.

A final inactive Wedge-tailed Eagle nest was situated in a solitary Eucalypt located ~60m from the crest of the ridge, and was facing in a northerly direction (inactive nest 7) (Figures 6a and 6b). The nest bowl was fairly well established, suggesting that it had been maintained during the current breeding season.

Nankeen Kestrel active nest site

A Nankeen Kestrel flew from its nest to a nearby high perch. The nest was located in a medium sized *Allocasuarina verticillata* (Figures 6a and 6b). The nest tree was on the edge of a large patch of *Allocasuarina verticillata* Woodland in a moderate sized wide gully. A second Kestrel was seen flying high over the ridge major ridgeline to the northwest. This bird flew overhead, and down towards the nest site giving off a loud chipping call, which was presumed to be an alarm call.

4.2.2.4 Birds deemed at high risk of collision with turbines

The most direct impact on birds from Stage 2 of the Snowtown wind farm is likely to involve bird mortalities or injuries from collisions with turbines. The birds most at risk of direct impacts are those that fly over the ridge tops in the areas associated with proposed turbine locations. Based on the observations made during this Level 1 survey these high risk movements are predominantly made by raptor species, as well as a number of parrots and woodland birds. Wedge-tailed Eagles, Nankeen Kestrels, Brown Falcons and Peregrine Falcons were all recorded performing flights over the dominant north-south ridge line in the Southern sector of the Stage 2 development (Figures 6a and 6b). Wedge-tailed Eagles and Nankeen Kestrels were also recorded flying over proposed turbine locations in the northern sector of the wind farm, where Stage 2 extends from the Stage 1 turbines (Figures 6a and 6b).

Raptors

Five raptor species were recorded at or near Stage 2 during the three day survey. Of these the Wedge-tailed Eagle performed the highest risk movements, as they regularly flew at the height associated with the rotor swept area of turbines (35 - 95 metres) (Brett Lane and Associates 2004). These areas are heavily used by eagles as the steep sided hills along prominent ridgelines create updrafts in the wind which enable them to increase the efficiency of their soaring flight. Wedge-tailed Eagle activity was further concentrated over the ridge lines around areas where active nests were located. The birds seen in these areas were most likely the breeding parents, and they were observed using the ridge directly behind each nest, as well as the sub-dominant ridges that run east - west off the dominant ridge.

Nankeen Kestrels also soared and hovered directly over the ridge tops. These birds were observed performing foraging behaviour, as they regularly dropped to the ground to catch invertebrate and reptilian prey. Kestrels most commonly flew below the rotor-swept height of turbines, but sometimes soared to heights >35 metres, putting them at risk of collision with

rotors. The single observation of a Peregrine Falcon was an individual flying rapidly from east to west over the dominant ridgeline at PC 13 (Figures 6a and 6b). This bird cleared the ridge at a height of ~10 metres, and descended into the *E. oleosa / E. gracilis / E. porosa* Woodland to the east of the ridge. This flight behaviour puts this species at risk of collision with the tower of a turbine. It is also highly likely that this species may fly over the crest of the ridge at heights within the rotor-swept area.

Three Brown Falcons were recorded during the current survey, and were observed flying over the valley floor on the eastern side of the ridge (PC 10), over the slopes of the hills (PC 35), as well as over the ridge top itself (PC 16) (Figures 6a and 6b). When flying over the ridge top the Brown Falcon cleared the crest at a height of 10-15 metres, and flew to the west. Brown Falcons, and a range of other raptor species, commonly fly within the rotor-swept area of turbines. These birds often forage by flying high over grassland habitats looking for small mammals, reptiles and amphibians to feed on. This flight behaviour puts them at risk of collision with turbines.

A single Collared Sparrowhawk was sighted in a remnant patch of *Allocasuarina verticillata* Woodland ~100m to the east of PC 37 (Figures 6a and 6b) (Plate 21). This bird was perching at the top of a large dead *Allocasuarina verticillata*, and after a number of minutes of observation it flew in a northerly direction over the nearby minor ridge, and down into the next gully. The bird cleared the ridge at 10m in a location, that is, ~150m from the proposed turbine WTG 51.

Plate 21 *Allocasuarina verticillata* Woodland where a Collared Sparrowhawk was recorded.

Parrots

Red-rumped Parrots are also considered to be at high risk of collision with turbines, as they were observed flying aver the crest of the ridge at PC 5, 14 and 24 (Figures 3a and 3b). Parrots and other nectar feeding birds (i.e. lorikeets, rosellas and honeyeaters) commonly travel widely across the landscape in search of flowering trees upon which they can feed. Whilst Red-rumped Parrots were recorded flying at 5-15 metres height during the current survey, they are quite capable of flying at greater heights. The potential risk of collision with turbines is likely to be increased where turbines are located near woodland habitat, or in between two areas of suitable habitat where these nectar feeding birds are likely to travel more frequently.

The state *Rare* Elegant Parrot was also recorded feeding in native *Lomandra spp.* Grassland +/- *Austrostipa spp. / Danthonia spp.* at the northern most end of Stage 1, in an area where Stage 2 is planned (PC 33) (Figures 3a and 3b). Elegant Parrots are a seed eating species who spend most of their time foraging among native and exotic grasses. Given the proximity of these sightings to the proposed turbine locations it is likely that they will come into direct contact with turbines. They fly at high speed when travelling between feeding sites, and have been recorded in small flocks at heights of 30-100m. This foraging and flight behaviour puts them at risk of collision with turbine rotors, or turbine towers.

4.2.2.5 Bird species of conservation significance recorded at the site or which may occur at the site

Two bird species listed as nationally *Vulnerable* (EPBS Act) were highlighted in the background search conducted before the site visit, and were therefore considered to possibly use the survey area (Table 8). Neither the Plains Wanderer nor Australian Painted Snipe were recorded during the current survey. Based on their habitat preferences the likelihood of them actually inhabiting the wind farm site is considered to be low.

A further five species identified in the background search are listed as state *Rare* under the NPW Act 1972. Of these the Peregrine Falcon, Hooded Robin and Elegant Parrot were recorded at the site during the current survey. The state *Rare* Jacky Winter was also recorded during the current survey (Table 8).

Four species that are *Uncommon* in the Mid North region were also identified in the background search (Table 8), but only the Red-rumped Parrot and Yellow Thornbill were observed during this survey.

Table 8 Bird species of conservation significance that are may possibly occur, or were recorded on or near the Stage 2 area of the Snowtown wind farm.

		Conservation rating			
Scientific name	**Common name**	**AUS**	**SA**	**MN**	**Source**
Pedionomus torquatus	Plains Wanderer	VU	E	E	EPBC search tool
Rostratula benghalensis australis	Australian Painted Snipe	VU	R	R	EPBC search tool
Neophema elegans	**Elegant Parrot**		**R**	**U**	**This survey / EBS**
Melanodryas cucullata cucullata	**Hooded Robin**		**R**	**U**	**This survey / EBS**
Falco peregrinus	**Peregrine Falcon**		**R**	**R**	**This survey / BDSA**
Plectorhyncha lanceolata	Striped Honeyeater		R	E	BDSA
Corcorax melanorhamphos	White-winged Chough		R	U	EBS
Ardea ibis	Cattle Egret		R	U	EPBC search tool
Microeca leucophaea leucophaea	**Jacky Winter**		**R**	**U**	**This survey**
Ardeotis australis	Australian Bustard		V	V	BDSA
Stagonopleura guttata	Diamond Firetail		V	V	BDSA
Turnix varia	Painted Button-quail		V	V	BDSA
Climacteris picumnus picumnus	Brown Treecreeper			U	EBS
Glossopsitta concinna	Musk Lorikeet			U	EBS
Psephotus haematonotus	**Red-rumped Parrot**			**U**	**This survey / EBS**
Acanthiza nana	**Yellow Thornbill**			**U**	**This survey**

Conservation Ratings
AUS - Commonwealth conservation status codes (as listed under the *Environment Protection and Biodiversity Conservation Act* 1999)
EN Endangered
VU Vulnerable

SA - State conservation status codes (as listed under the *National Parks and Wildlife Act* 1972)
E Endangered
V Vulnerable
R Rare

MN - Regional conservation status codes for the Mid North
E Endangered
V Vulnerable: rare and at risk from potential threats or long term threats that could cause the species to become endangered in the future.
K Uncertain: likely to be either Threatened or Rare but insufficient data available for a more precise assessment.
R Rare: has a low overall frequency of occurrence (may be locally common with a very restricted distribution or may be scattered sparsely over a wider area). Not currently exposed to significant or widespread threats, but warrants monitoring and protective measures to prevent reduction of population sizes.
U Uncommon: less common species of interest but not rare enough to warrant special protective measures.
Q Not yet assessed but flagged as being of possible significance.

4.2.2.6 Descriptions of bird species that were detected during the survey

Elegant Parrot

The Elegant Parrot is listed as *Rare* in South Australia, and Uncommon in the Mid North. However, current information on populations is considered inadequate to provide an accurate estimate of its conservation significance. The Elegant Parrot is most often encountered in flocks of 20-100 or more, except in the breeding season when tend to be found either in pairs or small parties. Like other *Neophemas* they are quiet and unobtrusive, and forage almost entirely on the ground. Its flight is high, swift and direct. Partly nomadic, the Elegant Parrot

may be encountered in the company of the similar looking Blue-winged Parrot. They prefer heathland and open country, open woodland, cropland and semiarid scrub, and feed on seeds of grasses and herbaceous plants. Two Juvenile birds were recorded from PC 33 at the very northern end of Stage 1, in an area where Stage 2 turbines are proposed (Figure 1). As these birds fly rapidly and at heights up to 150m across the landscape they may be at risk of collision with turbines.

Hooded Robin

Hooded Robins are found all over mainland Australia, except Cape York and eastern Gulf of Carpentaria or inland around the Simpson Desert, on the Nullarbor Plain or south of the Kimberley Ranges. They are more commonly found in south-eastern Australia from Adelaide to Brisbane, but the eastern sub species *Melanodryas cucullata cucullata* is distributed across south-eastern Australia, and is listed as Vulnerable in NSW and in SA, and is considered near threatened nationally (Garnett and Crowley 2000). Hooded Robins are found in lightly timbered woodland, mainly dominated by acacia and/or eucalypts. Hooded Robins construct a cup-shaped nest of leaves and bark, bound with spiders' web, placed in a crevice, hollow or hole in a tree or stump. Clearing of woodlands in south-eastern Australia has caused a decline in populations of the Hooded Robin. Much of the habitat of the south-eastern sub-species has been cleared, and a large part of their remaining habitat has been fragmented (Garnett and Crowley 2000). Even large fragments of their remaining habitat appear unable to sustain Hooded Robins over the long term (Traill and Duncan 2000). The survival of young birds is also jeopardized by predation from foxes. Recommended actions include protecting all habitats where they are resident from clearing (Garnett and Crowley 2000). Four Hooded Robins were recorded at the Snowtown wind farm in the current survey. Three records were from the Allocasuarina woodlands in the gullies at PCs 18 and 19, and one individual was recorded in low eucalypt woodland at PC 7 (Figure 1). These birds are unlikely to collide with turbines, meaning that habitat disturbance of loss is the greatest threat of disturbance to this species from the proposed wind farm development.

Peregrine Falcon

The Peregrine Falcon is listed as *Rare* under the NPW Act in South Australia, and is listed as *Rare* in the Mid North region where the proposed Snowtown wind farm is located. The Peregrine Falcon is found across Australia, but is not common anywhere. It is found in most habitats, from rainforests to the arid zone, and at most altitudes, from the coast to alpine areas. It requires abundant prey and secure nest sites, and prefers coastal and inland cliffs or open woodlands near water. Although these birds are not common, they have successfully spread worldwide, and will sometimes nest on artificial structures such as the window ledges of high buildings. Peregrine Falcons commonly occur at windy sites along ranges, and often nest in crevices of rocky cliff faces (Pizzey and Knight 1997). Given their flight behaviour they may be at risk of colliding with wind turbines.

Jacky Winter

Two sub species of the Jacky Winter live in South Australia. The sub species *Microeca fascinans fascinans* is listed as *Rare* under NPW Act, and *Uncommon* in the Mid North. They prefer open woodland with an open shrub layer and a lot of bare ground, and are often seen in farm paddocks with scattered trees. They catch insects from the air on the wing. Numbers have declined substantially in some areas, particularly in the south, from clearing of woodland habitat for farming or housing.

Red rumped Parrot

The Red-rumped Parrots has a state listing of Common, but is regionally Uncommon in the Mid North. They are a are medium-sized, slender parrots, found in south-eastern Australia, throughout most of New South Wales (less so on the coast) and Victoria, with an isolated population in north-eastern South Australia and south-western Queensland. The Red-rumped Parrot is found in open grasslands or lightly timbered plains, as well as along watercourses and in mallee farmlands with access to water. The Red-rumped Parrot feeds in pairs or small flocks on the ground, preferring seeds and leaves of grasses. It also will feed on seeds, fruits and flowers in trees. They avoid the coast and the wetter, more heavily timbered areas. Clearing of large tracts of forest and the provision of water for stock has probably extended their range. They are often seen in suburban parks and gardens. Like many parrots, red-rumps nest in tree hollows or similar places, including fenceposts and stumps. Breeding usually takes place in spring (August to January), however, in the dryer inland areas, breeding can occur at any time of year in response to rainfall.

Yellow Thornbill

The Yellow Thornbill is found throughout mainland eastern Australia, from Atherton Tableland, Queensland to eastern South Australia. Often seen in parks and gardens, preferring more established areas. They are listed as *Uncommon* in South Australia, and *Uncommon* in the Mid North. This small bird is strictly arboreal, rarely coming to ground. Single birds or small parties forage among the mid to upper storey foliage of a tree. The Yellow Thornbill feeds mainly on insects, but may sometimes eat seeds. They feed almost exclusively in the foliage of trees, most often acacias, paperbarks, casuarinas and native pines. They live in open forests, and woodlands of acacia, casuarina, and brigalow in preference to eucalypts. They are unlikely to directly collide with turbines, but the clearance of disturbance of woodland habitat may impact this bird.

4.2.3 Bats

In many areas of SA, not enough information is available on bat reference calls to make definitive identifications from AnaBat recordings. AnaBat data has a degree of uncertainty in that the recordings can often only be used as a guide, rather than a means of accurate identification. Some species will be readily identified, but many will be ambiguous, even to the experts. No reference calls exist for the Mid-North region, which includes Snowtown, as it is very poorly surveyed for bats. Reference calls from the Adelaide region were used to identify the call files recorded during the Stage 2 Snowtown Windfarm survey (T Reardon *pers comm.* 2008).

A number of calls were recorded during the survey, however many of the AnaBat call files recorded were of very poor quality and consisted of very few pulses, making it difficult for confident identifications to be made. Six bat species were able to be positively identified over 2 nights of AnaBat recordings during the field surveys (see Table 9). An additional species, Southern Forest Bat (*Vespadelus regulus*) was possibly detected, however this identification is uncertain as only one poor quality call was available. Examples of the calls recorded during the survey are presented in Appendix F.

Table 9 Bat species detected within the survey area

		Conservation rating		Number of call	
Scientific name	**Common Name**	**AUS**	**SA**	**files**	**Comments**
Chalinolobus gouldii	Gould's Wattled Bat			14	
Chalinolobus gouldii /Mormopterus sp	Gould's Wattled Bat / Southern Freetail-bats	?	?	73	Calls not able to be distinguished between *Chalinolobus gouldii* and *Mormopterus sp*
Chalinolobus morio	Chocolate Wattled Bat			3	One call file assigned to this species was a possible identification only.
Mormopterus sp	Southern Freetail-bats (several undefined species)	?	?	5	Taxonomic definition of these species is pending. It is also expected that several of these will be assigned a conservation rating in the near future.
Nyctophilus geoffroyi	Lesser Long-eared Bat			11	One call file assigned to this species was a possible identification only.
Tadarida australis	White-striped Freetail-bat			3	
Vespadelus regulus	Southern Forest Bat			1	One call file assigned to this species was a possible identification only.
TOTAL				**110**	

No species of conservation significance were able to be positively identified from the AnaBat calls recorded during the survey. However, several calls of the *Mormopterus* genus were recorded, some of which may be of conservation significance. *Mormopterus* species definitions are currently unclear, with up to 7 species awaiting scientific description and most have no published scientific name at present (Menkhorst and Knight 2004). Species to be described include (among others) the Inland Freetail-bat (short penis form), Eastern Freetail-bat (long penis form) & Hairy Rostrum Freetail-bat. The *Mormopterus* genus has previously

been listed as state *Rare*, however this is no longer current. It is likely that several species of this genus will be assigned a conservation status in the coming months (D Stemmer *pers comm*. 2008). The Hairy Rostrum Freetail-bat has previously been listed as state *Vulnerable* however this also awaits confirmation.

A number of calls were able to be assigned to Gould's Wattled Bat (14 call files) and the Lesser Long-eared Bat (11 call files). The largest number of call files (73) was assigned to Gould's Wattled Bat / Southern Freetail-bats, but the species identification was not able to be determined. These calls are not easily distinguished from AnaBat recordings alone.

Although undetected, it is expected that the Inland Broad-nosed Bat (*Scotorepens balstoni*) is likely to be in this region. Its calls are very similar to Gould's Wattled Bat; therefore good quality search-phase calls with many pulses in the file would be required before any positive identification would be possible from AnaBat data (T Reardon *pers comm*. 2008). It is possible that amongst the very poor quality calls assigned to Gould's Wattled Bat / Southern Freetail-bats that there could be calls from the Inland Broad-nosed Bat, however it is expected that the species is not abundant in the region.

The areas considered to be of most habitat value for roosting bats are the *Allocasuarina* Low Woodlands and *Eucalyptus* Woodlands. The Drooping Sheoak *(Allocasuarina verticillata)* found as isolated plants in Exotic Grasslands may also be of habitat value, since they are often the only tree in this association. All of these woodlands were found to have large and small hollows (see Plate 22) suitable for bat roosting.

Plate 22 Small hollows found in *Eucalyptus* Low Woodlands

4.2.4 Threatened reptile species

Habitat suitable for the nationally listed reptiles was investigated, in particular, for the Pygmy Blue-tongue *(Tiliqua adelaidensis)* and the Flinders Worm-lizard *(Aprasia pseudopulchella).*

4.2.4.1 Habitat for the Pygmy Blue-tongue (Tiliqua adelaidensis)

No Pygmy Blue-tongues were observed during the field surveys for the Snowtown Stage 2 Ecological Assessment, however a number of areas that may be suitable habitat for the species were noted. The areas that offer the greatest habitat value onsite were unploughed areas of native grasslands, especially Iron Grass (*Lomandra spp*) Grassland and Spear Grass *(Austrostipa sp)* / Wallaby grass *(Austrodanthonia sp.)* Grassland but also Exotic Grasslands. Although a targeted search for spider holes was not conducted during this survey, a number of spider holes were seen within these areas.

4.2.4.2 Habitat for the Flinders Worm-lizard (Aprasia pseudopulchella)

No Flinders Worm-lizards were observed during the field surveys for the Snowtown Stage 2 Ecological Assessment. However this species was detected during the 2004 surveys of the Stage 2 area. The entire survey area is considered to be potential habitat for this species. It is considered likely that the Flinders Worm-lizard exists in various habitats across the entire survey area due to the presence of loose rocky areas and leaf litter in the woodlands associations.

5.0 Discussion and possible impacts of the proposed windfarm

5.1 Flora species and vegetation communities

Limited remnant native vegetation is present within the survey area and clearance of these areas should be avoided when determining the locations of infrastructure for Stage 2 areas. All native vegetation within the project area is covered by the *Native Vegetation Act 1991* and any proposed clearance will need to be assessed against native vegetation principles. A clearance application to the Native Vegetation Council may be required if the proposed infrastructure involves the clearance of native vegetation not covered by the exemptions in the principles. If proposed infrastructure may have an impact on nationally threatened flora or communities, an EPBC referral will be required. The limited amount of remnant native vegetation present within the region of the mid-north highlights the need to protect these areas that remain. These areas provide vital refuge and resources for common and threatened native fauna in the area, regardless of their condition.

In particular, the areas of Iron Grass. (*Lomandra spp*) Grasslands in the survey area, which form part of the ***Critically Endangered*** vegetation community 'Iron-grass (*Lomandra spp*.) Grassland of South Australia' under Commonwealth legislation (EPBC Act 1999), should be avoided. An assessment of these areas should be undertaken and an EPBC referral may be required if there is any possibility that proposed infrastructure may impact on the Iron Grass (*Lomandra sp.*) Grassland. A number of threatened flora species exist in the proposed Stage 2 development areas, including the state ***Rare*** Long-flower Cryptandra (*Cryptandra sp. Long hypanthium*) and several regionally threatened species (Appendix E). Any further occurrences of these species should be recorded within proposed areas and adjacent habitat, so as to be avoided. Fine scale surveys during spring should be conducted as proposed areas become more defined. A number of conservation significant species, such as orchids and lilies, may occur within the area and were undetected at the time of the survey.

Proposed Stage 2 developments should be confined to the Exotic Grasslands or Cropping Land wherever possible, but avoid scattered trees (e.g. Drooping Sheoak (*Allocasuarina verticillata*)), native populations (e.g. Creamy Candles *(Stackhousia monogyna*)) and fauna habitat within that association. When working within Exotic Grasslands, the proliferation of exotic flora species should be avoided during all phases of Stage 2 development, particularly declared species found within the survey area. Mitigation measures will need to be put in place regrading vehicle movement and soil movement on the site to avoid the distribution of exotic flora species.

5.2 Fauna and habitat

5.2.1 General

The Exotic Grasslands and Cropping Lands are considered to have a low habitat value for native fauna species. Although the value is considered to be low, birds of prey, reptiles and large mammals would all utilise the survey area for foraging. At times these areas would have high mouse (*Mus musculus)* numbers and therefore provide food for a number of birds of prey species as well as brown snakes (*Pseudonaja textilis*).

Although native grasslands usually lack diversity in regard to fauna species, all native grasslands onsite are considered to have a moderate – high habitat value for several species of conservation significance. These include the nationally ***Endangered*** Pygmy Bluetongue Lizard and the nationally ***Vulnerable*** Plains-wanderer. These areas would also offer foraging habitat for large herbivorous mammals (macropods), reptiles (snakes, lizards, dragons) and birds (especially birds of prey). There are some large continuous areas of native grasslands that reside within the survey area (within Stage 1 and Stage 2). The integrity of these associations is ecologically very valuable, as such environments in the Mid-North are highly fragmented and few continuous remnants remain. Any further clearance or dissection of the grasslands recorded at the Snowtown site should be avoided.

The woodland associations are very important habitat within the survey area and thus are considered to have a high value for native mammals, reptiles and birds. These pockets of habitat provide shelter for a vast range of native fauna (and exotic fauna) either as permanent residents or transient visitors. The woodland trees provide vital hollows for bat roosting, bird shelter and nesting, shelter for larger mammals (kangaroos and euros) and cover/shelter for reptiles as mentioned above. Therefore clearance of woodlands or scattered trees should also be avoided.

5.2.2 Habitat for the Pygmy Blue Tongue Lizard (Tiliqua adelaidensis)

It is possible that this species occurs within native grasslands identified in the Stage 2 area, even though it was not observed during this ecological assessment. Pygmy Bluetongue Lizards are notoriously sensitive to both noise and movement, and consequently are difficult to observe. The density of Pygmy Blue-tongues at a site near Burra was estimated at over 100 lizards per hectare and approximately 45% of spider burrows were occupied by Pygmy Blue-tongues (Milne, 1999). Therefore, if this species was present within the survey area in similar densities it would be expected that a number of lizards would be observed with a more detailed survey. A number of recent records exist within the region and it is possible that the species is present within the survey area, possibly at a low density.

A targeted survey for Pygmy Blue-tongues should be undertaken in spring / early summer within the native grasslands onsite in an attempt to detect the presence of the species. Much of the potential habitat within Stage 2 proposed areas is along ridge tops, which is often considered to be unsuitable for this species due to a lack of soil profile. However, many of the grasslands within the proposed Stage 2 areas are along rolling hills which potentially contain a soil profile suitable for this species to persist. Pygmy Blue-tongues are also known to inhabit highly degraded grasslands and hence any spider holes in unploughed grasslands (including Exotic Grasslands) within the survey area should be considered an indication that this species may exist (J Schofield *pers comm*. 2008).

Even if no Pygmy Blue-tongues are observed during this type of survey, they cannot be ruled out from occurring within the survey area. If they do inhabit the proposed project area, it is possible to translocate the affected individuals from the construction zone. This has been undertaken previously with construction projects near Burra (Milne pers. com.), however the overall success rate was not measured (no follow up surveys were undertaken).

5.2.3 Habitat for the Flinders Worm-lizard (Aprasia pseudopulchella)

The entire survey area is potential habitat for the Flinders Worm-lizard (M Hutchinson *pers comm.).* Considering a prey specimen of this species was found during the survey, a targeted survey should be undertaken (possibly in conjunction with the Pygmy Blue-tongue survey) in the optimal season (spring) to determine the presence of the species on site. This species would inhabit varied habitats containing loose rocks or leaf litter, in scattered woodlands and grasslands, and all of varying condition.

The survey effort required to detect this species, if present onsite, may be considerable in that a number of rocks will need to be turned over in a variety of habitats to catch a glimpse of the species, unless a full fauna survey is undertaken (including pitfalls) within the survey area.

5.2.4 Birds

5.2.4.1 Possible impacts of the Snowtown wind farm on birds

A range of direct and indirect impacts of wind farms on birds have been recognised in recent years. The most obvious of these is mortality via the direct collision with turbines (summarised by Madders and Whitfield 2006). Other major effects include displacement due to habitat loss and various types of disturbance effects (Drewitt and Langston 2006). These are discussed below.

Habitat loss

Given the patchy structure of the existing woodlands, and the occurrence of exotic grasslands along many of the ridge tops across the site, it would be possible to construct turbines at already cleared sites. This would limit the need for the removal of any trees associated with the woodland habitat. Given the wide diversity of native grasslands that occur across the site impacts on this habitat is likely to be much greater. A number of birds sighted during the current survey or considered likely to inhabit the area rely heavily on the seeds of native grasses as food. These include the Elegant Parrot, White-fronted Chat, Diamond Firetail, Painted Button-quail, and Yellow-rumped Thornbill. The loss of this habitat through the construction of roads and turbines has the potential to influence the movement of these birds across the landscape. This may have the largest impact on the regionally *Rare* Elegant Parrot, and state *Vulnerable* Diamond Firetail and Painted Button-quail, as they are a seed eater that predominantly feed on the ground in sparsely wooded habitats. It is recommended that the building of roads and construction sites for turbines be guided by up to date GIS maps of the location of native and exotic grasslands, to avoid disturbance to significant areas of native grasslands.

Woodland habitat had the greatest species diversity and abundance of birds at the Snowtown wind farm site. Due to the scattered distribution of remnant patches of *Allocasuarina L*ow Woodland, and *Eucalypt olesa / E. gracilis / E. porosa* Low Woodland birds that use these habitats regularly cross open areas of grassland and pasture grasses. Bird activity in these areas will likely be further elevated when these eucalypts are in flower, as an increased abundance of honeyeaters, lorikeets, and parrots would be attracted to the area. Such events may attract numerous bird species of regional, state and national significance. These may include the regionally *Uncommon* Blue Bonnet, Musk Lorikeet, and Australian Ringneck, and state *Vulnerable* Black-chinned Honeyeater. As outlined in this report, these bird species have the potential to be impacted by a number of factors involved in the construction and development of wind farms. Further Level 2 surveys at the site that coincide with a flowering event are recommended, to more accurately gauge bird use in the area, and to identify the importance of the woodland habitat.

Disturbance effects

There is little available data on the disturbance effects of wind farm developments on birds in Australia. Much more information has been collected on the effects of wind farms on birds in the Northern Hemisphere, with the majority of this work involving raptors (summarised by Madders and Whitfield 2006). Some data on the avoidance behaviour of Australian raptors has been collected in Tasmania, but we still have a poor understanding of the impact of wind farms on raptors and other birds in South Australia.

One impact that has been proposed from studies in the Northern Hemisphere is that of a 'barrier effect'. This can arise when a row of closely spaced turbines creates an artificial barrier to bird movements. This may be an issue for local birds who regularly traverse a ridge line when moving between foraging, roosting and/or breeding sites. Birds commonly move across the landscape during inter-seasonal movements when traveling from spring breeding grounds to summer and winter feeding areas. Birds that are highly likely to move across the wind farm in the Stage 2 area are raptors, honeyeaters, parrots, and waterfowl. More specifically, Wedge-tailed Eagles, Brown Falcons, Peregrine Falcons, and Nankeen Kestrels were observed foraging over the bare hilltops associated with prominent ridgelines at the Snowtown site. Ravens, Tree Martins and Red-rumped Parrots were also recorded performing at risk movements. Most these species are also likely to nest in trees in the *Allocasuarina* and *Eucalyptus* woodlands on the hillsides either side of the prominent ridge line. The construction of a long row of turbines through this habitat may have the effect of splitting the home range of resident breeding birds. This could mean that the size of the area available for foraging by these birds is reduced. The pressures placed on breeding birds of prey are hard to gauge, but the artificial modification of their foraging area may have an impact on their foraging success, and resultant breeding success (Drewitt and Langston 2006).

Wedge-tailed Eagles are notoriously fussy nesters and abandon nests if disturbed too much. The presence of turbines overhead with noise and constant movement of shadows across the landscape may reduce bird numbers, reduce nesting attempts and cause death to young birds learning to fly. Scavenging young birds may be at risk of being struck by turbines if they try to pick up other dead birds that may have been struck by the turbine previously. Several species of nocturnal birds are expected to inhabit the area, so they may hunt in the area, and be at risk from being struck by turbines while hunting.

The most obvious approach to mitigate the risks posed by a wind farm on bird movements and behaviour would be to space turbines at a distance that allow birds to fly between them, and thereby avoid collision. However this approach may raise opposition from wind farm developers, owners and managers due to the imperative to optimise the efficiency of the instillation. At sites where there is an unacceptably high risk of disturbance to critical bird species a suitable compromise may be to arrange turbines into clusters of perhaps four or five. This may enable birds to use the suitable sized gaps between turbine clusters when traveling across the landscape.

The opportunity exists at this site to investigate the disturbance effects of wind farms on birds, due to the close proximity of the operational Stage 1 site to the proposed Stage 2 area. It would be feasible to perform simultaneous pre and post construction surveys of bird activity in both areas. This would enable a robust scientific comparison of the utilisation rates of the

ridge lines and other habitat in the area, to determine the existence of any avoidance behaviour. The impact of the wind farm developments on the breeding success and foraging behaviour of resident breeding Wedge-tailed Eagles could also be examined. The recommended Stage 2 surveys would enable such a comparison, and provide valuable information on this little known topic in South Australia.

Bird collisions with turbines

It is expected that the largest impact of the Snowtown wind farm on local bird populations will come from the direct collision of birds with turbines. This is particularly important for the raptors that inhabit the area, as their foraging behaviour means that they are at the highest risk of colliding with turbines. The impacts of the development can be further reduced by positioning turbines in areas of lowest bird activity. The probability of bird-strikes associated with windfarm projects has been studied and modelled (Drewitt and Langston 2006, Smales and Muir 2005, Fielding et al 2006) however it is difficult to accurately assess the impacts as bird utilisation is variable between sites. Further Level 2 surveys are required in the Stage 2 areas of the wind farm to assess bird utilisation across the area. This is an important requirement for any wind farm site where the risk of impact on birds is considered to be moderate to high, in line with the Aus Wind Best Practice Guidelines (AusWEA Report 2005).

Bird studies reviewed by Smales and Muir (2005) have shown that bird avoidance rates of windfarm infrastructure (involving the individual's successful avoidance of collision) are around 95%. Although the possible birds strike rate at a windfarm development may be expected to be low (Madders and Whitfield 2006, Smales and Muir 2005), the effect may be significant for long-lived species with lower reproduction rates (Drewitt and Langston 2006). With the collection of windfarm developments in the area and the cumulative effect of these strikes over time, particular species may decline in the region.

The occurrence of migratory bird flight paths through the study region also needs more investigation. At the time of the survey numerous small farm dams were dry, and Bumbunga Lake was also completely dry. In wetter years when these water bodies are holding water it is highly likely that a greater number of waterfowl and waders would visit the area. Many waterbirds and migratory birds move around at night and don't necessarily follow set fly ways season after season, but are nomadic in movement patterns. This means that irregular visiting birds who may not have previously encountered turbines may be at high risk. Future Level 2 surveys may coincide with wetter seasons and provide information on these bird species.

5.2.4.2 Reducing the risk of bird collisions of priority species via buffers around nest sites

Where the risk of impact of a wind farm on a bird species of concern is considered to be medium to high, mitigation actions can be required to reduce this risk to an acceptable level. This may include modifications to the wind farm layout, or alterations to the construction schedule. This issues arises at the Snowtown wind farm, due to the proximity of some proposed turbine locations to active Wedge-tailed Eagle nests. The interim standards for risk assessment, released by AusWEA (AusWEA Report 2005) makes no reference to the distances of buffers for this and other high risk bird species. We propose that a suitable buffer distance be considered in the planning process in order to reduce the likelihood of impacts on birds in the area. It is recommended that unused Wedge-tailed Eagle nest sites also be included in the decision making process to determine the best approach to protecting these site.

The absence of breeding activity at Wedge-tailed Eagle nest sites in a particular breeding season does not mean that these sites may not be used in future years. A change in nest site from one year to another by breeding pair is known to occur in Wedge-tailed Eagles, and is thought to follow breeding failure at one site. Breeding pairs often refurbish numerous nest sites within their territory early in the breeding season to provide a range of options where the female may lay the egg. Therefore an unused nest site may become an important breeding location in future years. It is recommended that both active and inactive Wedge-tailed Eagle nests be checked early in the breeding season of 2009 to identify their status (i.e. active or inactive). If it does become active it is recommended that construction activities cease during the breeding period to avoid disturbance effects. Wedge-tailed Eagles in the nearby region of the southern Mount Lofty Ranges breed from around mid-July to mid-December (Dennis 2006). Therefore it is recommneded that these dates be used as a stop-work period around active nest sites to allow the eagles to carry out their breeding operations undisturbed.

5.2.5 Bats

A number of bat species are known to inhabit the survey area from the AnaBat recordings and threatened species potentially use the area. Numerous areas of suitable roosting habitat are present in the woodland associations within the survey area, in addition to the habitat provided by isolated *Allocasuarina verticillata* within all grassland associations. AnaBat recordings alone may only represent a proportion of species that are actually present onsite or visiting the area. The recording of calls on any one night may be influenced by many factors including temperature, humidity, insect activity, wind and associated vegetation movement. The Mid-North region is very poorly known in terms of bats species' actual distributions and bat calls are not easily identifiable in the region. It is considered that trapping should be undertaken, particularly in this region (but also in other parts of South Australia), to confirm the identifications that can be inferred from the AnaBat recordings within the survey area (T Reardon *pers comm.*).

Little is known of the regional status of local bat populations in the region, species thought to be once common may now be regionally threatened. Thorough and ongoing monitoring of bat populations is required to determine the status of local bats in the Mid-North. The *Mormopterus* genus has been recorded at the Snowtown Windfarm in reasonable numbers over a relatively short period of recordings (2 nights). Considering that several species of the *Mormopterus* genus are awaiting definition and the possible assignment of a conservation status is pending, more detailed Level 2 bat surveys should be undertaken during summer months to better understand the species present and their use of the site.

Any clearance of woodland habitats within the survey area would result in direct removal of potential roosting habitat for bats, and possibly the destruction of roosting bats. Clearance of this roosting habitat should be avoided as the extent of native remnant vegetation within the region is very low (Graham et al 2001). If clearance of potential bat roosting habitat is to be undertaken within any part of the survey area, it is preferable to do this at night during warmer months when bats are more likely to be out searching for insects, thus minimising direct mortality of roosting bats (T Reardon *pers comm.*).

Bat-strike interactions are likely during the operation of proposed wind turbines in the survey area. Although it is not known which species may fly within the rotor-swept area, it is expected that several species may have interactions with turbines within the survey area. Little is known about the effect of operating turbines on bat behaviour, whether bats avoid turbines or not, and the actual number of bat-strikes that have been caused by operational wind farms in Australia (T Reardon *pers comm.*). Some recent windfarm studies overseas have suggested that bats may be impacted by a sudden change in localised air pressure created by turbines, after bats had been found with fatal injuries consistent with Barotrauma (Baerwald et al, 2008).

Without a more detailed knowledge of the bat species present, their distribution and their behaviours in the survey area (pre / post construction and during operation) it is difficult to accurately assess the impacts of the proposed Stage 2 area on bats. Detailed surveys should be undertaken to confirm the identification of bats onsite, indicate numbers and use of habitats. Trapping should be undertaken on warm summer evenings within the survey area, and, if possible, survey work to investigate bat utilisation of the survey site. Some investigations of hollow use can be undertaken in potential habitat. A methodology should be developed for detecting bat-strikes that may occur already in the operational Stage 1 areas, which will directly influence the risk assessment of Stage 2 areas. A procedure should be developed for reporting bat-strikes that occur onsite.

5.3 Cumulative impacts of the wind farms in the area

The development of a number of wind farms in the mid-north has raised the issue of the possible cumulative ecological impacts of the wind farms in operation or planned across the region. The main issues that need consideration are:

- the possible loss of remnant native vegetation and habitat in a region which has already been extensively cleared;
- the cumulative impact on birds in the region, with particular reference to raptor species that frequent the ridge tops and nest in the vicinity of the proposed developments; and
- the cumulative impact on bats in the region and the difficulty in studying these effects.

Remnant native vegetation in the region is considered to be low - extremely low (DEH 2002). Often, vegetation remnants in this region exist along rocky ridge tops where clearing for cropping and grazing has not historically occurred. The conflict exists with windfarm developments mainly during the construction phase, in that the ridge tops are the primary development area. The thorough planning that has occurred and micro-sighting of turbines and associated infrastructure has avoided much of the possible vegetation clearance. The displacement of native fauna (including bats birds, reptiles and mammals) via clearance of remnant vegetation is an issue due to the general paucity of existing suitable habitat in the region.

The cumulative impacts of the mid-north wind farms on birds in the region are difficult to quantify. Bird numbers and activity in the mid-north are considered to be comparatively low in regards to other regions. The occurrence of migratory bird flight paths through the study region needs more investigation. With the collection of windfarm developments in the mid-north and the cumulative effect of these strikes over time, particular species may decline in the region. Regional studies are needed to collect data and gain insight to the use of the

windfarm areas by priority species in a regional context, and accurately asses the cumulative impacts that wind farms may have.

The cumulative impact of wind farms in the mid-north on bat populations may also cause declines in certain species, however the regional distributions and behaviour of bats in the mid-north is poorly studied. The foraging behaviour and known flight path of bats needs more investigation, to determine their utilisation of the survey areas and hence estimate collision risk (or other potential risks such as Barotrauma) at wind farms in the mid-north. Similar to birds, bats can also have large flight ranges and data on bat fly-ways in the area should be collected to determine patterns (if any) and activity hotspots (i.e. Do bats fly along ridges in the region? Is bat activity concentrated in woodland habitat or open areas in the survey area?). The regional status of bat species is largely unknown within the mid-north (T Reardon pers comm. 2008) and it is considered that detailed studies need to be undertaken on a regional scale to provide the data required to assess the possible and actual cumulative impacts of wind farms in the area. Studies need to gather bat utilisation data at survey sites before and after construction as well as utilisation at similar sites that do not contain windfarm infrastructure.

6.0 Recommendations and mitigating measures

The following recommendations have been made to reduce the possible impacts of the development of the Snowtown Stage 2 Windfarm on native flora, fauna and ecological communities in the project area.

If there is a possibility that proposed infrastructure may impact on matters of national environmental significance under the EPBC Act 1999, the project proponent should:

- **Submit a referral under the *Environment Protection and Biodiversity Act (1999)* for proposals with potential impacts for nationally threatened species and communities identified in the survey area.**

A referral is recommended if areas of the nationally ***Critically Endangered*** vegetation community Iron Grass (*Lomandra spp.*) Grasslands in the Snowtown Stage 2 survey area are to be impacted upon in any way. The extent and importance of this matter in the region denotes that any proposals with potential impacts must be assessed under this legislation.

A number of migratory birds were highlighted in the EPBC search (Appendix C) may use or traverse the project area. These also need to be considered and included in an EPBC referral for the project, as even though they may be infrequent visitors to the site, it cannot be ruled out that they will be impacted by the development of the proposed Stage 2 project, even though it is unlikely.

Approval is required for actions that are likely to have a significant impact on a matter of national environmental significance. An action includes a project, development, undertaking an activity, or series of activities. Activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, or a member of a listed marine species will require approval under this legislation (DEH 2005).

If the proposed windfarm infrastructure requires the removal of any native vegetation within the survey area, the project proponent should:

- **Assess any clearance of native vegetation required in the survey area against native vegetation principles under the *Native Vegetation Act* (1991), and if required, submit a clearance application to the Native Vegetation Council for approval**.

All native vegetation within the project area is covered by the *Native Vegetation Act 1991* and any proposed clearance will need to be assessed against native vegetation principles. A clearance application to the Native Vegetation Council may be required if the proposed

infrastructure involves the clearance of native vegetation not covered by the exemptions in the principles.

➢ **Develop a suitable Significant Environmental Benefit (SEB) for the Stage 2 project**

If required, the Native Vegetation Council may request that a suitable SEB is calculated and implemented to offset any impacts or clearance of the native vegetation. The Significant Environmental Benefit could include:

- the protection of remnant habitat within the survey area (i.e. heritage agreements);
- the protection of remnant vegetation on suitable properties in the region (i.e. heritage agreements);
- the establishment of an exotic flora control program in the survey area focussed on the bush-regeneration of native vegetation remnants;
- the establishment of a rehabilitation program in degraded parts of the survey area;
- the establishment of a vertebrate pest control program in the survey area to reduce the effect of pest animals, such as foxes, on the native fauna in the region; or
- a payment to Native Vegetation Fund administered by the Native Vegetation Council.

Other general recommendations include:

➢ **Conduct targeted surveys for nationally threatened reptiles**

Although no nationally threatened species were recorded during the survey, there is potential habitat for both nationally threatened reptiles in the survey area. Targeted surveys should be undertaken for Pygmy Blue-tongues (in native and exotic grassland areas, during spring / summer) and Flinders Worm-lizards (throughout the survey area, during spring) to confirm their presence and the quality of their habitat within the survey area.

➢ **Avoid identified remnant native vegetation associations and isolated trees**

The woodland associations have been highlighted throughout this report as having high habitat value for common and threatened native fauna that may reside onsite. The native grassland associations are largely invaded by exotic species, however they are highly valuable due to their continuous nature in most of the Stage 1 and Stage 2 areas. Many of the native grasslands appeared to retain a density of tussocks that is absent from much of the Mid-north region. Other native vegetation associations found in the survey area have habitat value for native fauna, but also have intrinsic value as some of the few examples of these vegetation remnants in the region. These areas should be avoided when planning turbine locations and associated infrastructure. Any proposals for clearance of native vegetation within the survey area need to be assessed against native vegetation clearance principles

and/or referred to the Native Vegetation Council for approval under the *Native Vegetation Act* 1991.

- **Avoid known Wedge-tailed Eagle nests**

Avoid the known locations of the identified Wedge-tailed Eagle nests (active and inactive). It is suggested that any proposed turbine sites near remnant woodland vegetation, particularly within 300 m of a raptor nesting site, be moved to an alternate location to reduce impacts on birds using that habitat, especially in reference to young eagles just leaving their nest and attempting flight. Any construction near nest sites should avoid the species' breeding season (June-December).

- **Monitor the breeding activity at all known nest locations**

Assess the activity of all known Wedge-tailed Eagle nests at the beginning of the breeding season (June-July), to reduce disturbance to breeding activities during construction.

- **Conduct bird utilisation surveys to monitor birds within the survey area**

Further surveys are recommended to gather data on birds that inhabit, visit or traverse the survey area, with particular reference to threatened and priority species (e.g. raptors). Not enough information is available on bird species and their distributions in relation to the survey site and within the region to reliably infer the impacts for these species. Further bird surveys to determine the presence of State and Regionally rated birds that are considered to be in the vicinity but not detected during the current survey are needed to adequately assess the risks to these species. Ongoing bird utilisation surveys and monitoring programs should be conducted during pre-construction, construction and operation of the windfarm to monitor birds in the area in terms of usual behaviour, avoidance behaviour, survivorship, breeding success, distribution and numbers. A bird utilisation survey can be used to infer the likelihood of bird-strike interactions with proposed turbines in the survey area.

Ensure that monitoring visits are timed to coincide with a range of weather conditions, and across a number of seasons, to provide a better representation of both the resident and transient bird species so that the entire bird community is identified. Coordinate bird utilisation surveys with the Stage 1 wind farm to provide a comparison of pre and post construction bird activity in the region.

- **Position turbines in areas of lowest bird flight activity**

Turbine should be positioned in areas of lowest bird flight activity and consider seeking appropriate techniques to minimise and manage bird collisions with turbines.

- **Conduct detailed bat surveys within the survey area**

Further surveys are recommended to determine the presence of bats and their utilisation of roosting and foraging habitat in the survey area. Not enough information is available regarding bat species, numbers and distributions in the mid-north region and more data is needed through more intensive surveys of the area. Little is known about the regional status of local bat populations and this is thought to be of high importance (T Reardon pers comm., 2008). A combination of harp-trapping and mist-netting may be used to confirm the identification of bat species detected by calls recorded on AnaBats, and the quality and occupancy of roosting habitat identified may be further investigated. A methodology for investigating bat-strike likelihood should be developed. Bat-strike detection methodology and bat-strike reporting procedures should also be developed.

- **Conduct regional surveys of birds and bats**

Regional scale surveys for birds and bats are recommended to determine the possible and actual cumulative impact of the concentration of wind farms in the region. Collaborate with authorities and other windfarm projects in the mid-north to conduct regional surveys for bird and bat populations, distributions, utilisation of the windfarm-type landscape and collision rates. The development of a regional focus is needed to provide data on birds and bats since the smaller individual survey areas may be inappropriate, especially for birds and bats with larger flight ranges.

- **Conduct further detailed flora and fauna assessments once the location of windfarm turbines and associated infrastructure have been selected.**

Once more defined locations of turbines and infrastructure have been selected, a detailed flora and fauna assessment in these areas in recommended to assess the flora and fauna of the sites on a finer scale. If the removal of native vegetation is required, the clearance should be assessed against the native vegetation clearance principles, and if needed, a clearance application should be submitted to the Native Vegetation Council for approval. Undertake a detailed assessment of the level of impact on avifauna species and communities once the construction footprint has been determined.

- **Implement best practice environmental management measures during any construction**

Environmental management measures should include:

- Water roads regularly to reduce the dust level. Roads may also require regular maintenance (grading / rolling) to keep them as intact as possible.
- Water stockpiles to reduce the amount of dust.

- Regularly clean down vehicles and equipment, ensuring they are free of plant material and soil, to reduce the dispersal of exotic flora species into, out of and within the survey area.
- Control declared and environmental weeds found within the site.
- Minimise continual noise and vibration

➢ **Minimise construction footprint**

Environmental management measures should include:

- Keep disturbance of vegetation and soil to a minimum.
- Strip topsoil and stockpile during any construction and re-spread over the disturbed area after construction has been completed. This will aid the recovery of the plants within the disturbed areas.
- Avoid moving topsoil more than 500 m from where it was removed.
- After construction, return the disturbed area to the same level as it was previously.
- Use the access roads as stockpile areas in preference to any adjacent land.
- Establish designated truck turn-around areas to minimise extra tracks and turn around areas.

➢ **Provide staff training and awareness**

Environmental management measures should include:

- Ensure that all staff working in the project area are aware of the threatened flora and fauna species present and potentially present in the region. This awareness may be facilitated through training or workshops
- Provide staff training sessions to promote awareness of flora and fauna within the project area and outline activities that can affect their survival. These sessions should reinforce the need to minimise the potential impacts on these species from on-site works.

➢ **Implement an annual monitoring program**

Long-term ecological monitoring should be conducted to detect any future impacts (if any) of the development of the windfarm in the project area. The monitoring should focus on birds, bats and threatened flora and fauna species mentioned in this report (e.g. Pygmy Blue-tongue *(Tiliqua adelaidensis)* and the Flinders Worm-lizard *(Aprasia pseudopulchella)).* Monitoring programs should be implemented as soon as possible to establish as many pre-development datasets as possible. This data will be vital when attempting to detect environmental change (if any) due to the windfarm, as opposed to seasonal variation and pre-existing environmental trends in the region. An annual monitoring program is considered a minimum frequency required to detect environmental change in flora and fauna of concern at the site.

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8.0 Appendices

Appendix A Flora species records (DEH/SA Museum) within 10 km of survey site

Conservation Ratings
AUS - Commonwealth conservation status codes (as listed under the *Environment Protection and Biodiversity Conservation Act* 1999)
EN Endangered
VU Vulnerable

SA - State conservation status codes (as listed under the *National Parks and Wildlife Act* 1972)
E Endangered
V Vulnerable
R Rare

*indicates an introduced species

			Conservation Rating	
Scientific Name	**Common Name**	**Family Name**	**AUS**	**SA**
Acacia brachybotrya	Grey Mulga-bush	LEGUMINOSAE		
Acacia calamifolia (NC)	Wallowa	LEGUMINOSAE		
Acacia continua	Thorn Wattle	LEGUMINOSAE		
Acacia cupularis	Cup Wattle	LEGUMINOSAE		
Acacia cyclops	Western Coastal Wattle	LEGUMINOSAE		
Acacia hakeoides	Hakea Wattle	LEGUMINOSAE		
Acacia ligulata	Umbrella Bush	LEGUMINOSAE		
Acacia notabilis	Notable Wattle	LEGUMINOSAE		
Acacia nyssophylla	Spine Bush	LEGUMINOSAE		
Acacia oswaldii	Umbrella Wattle	LEGUMINOSAE		
Acacia pycnantha	Golden Wattle	LEGUMINOSAE		
Acacia rigens	Nealie	LEGUMINOSAE		
Acacia salicina	Willow Wattle	LEGUMINOSAE		
Acacia sclerophylla var. sclerophylla	Hard-leaf Wattle	LEGUMINOSAE		
Acacia spinescens	Spiny Wattle	LEGUMINOSAE		
Acacia victoriae ssp. victoriae	Elegant Wattle	LEGUMINOSAE		
Acaena echinata var. (NC)	Sheep's Burr	ROSACEAE		
Acianthus pusillus	Mosquito Orchid	ORCHIDACEAE		
Acrotriche patula	Prickly Ground-berry	EPACRIDACEAE		
Actinobole uliginosum	Flannel Cudweed	COMPOSITAE		
Alectryon oleifolius ssp. canescens	Bullock Bush	SAPINDACEAE		
Allocasuarina muelleriana ssp. muelleriana	Common Oak-bush	CASUARINACEAE		
Allocasuarina verticillata	Drooping Sheoak	CASUARINACEAE		
Alyogyne huegelii	Native Hibiscus	MALVACEAE		
Alyxia buxifolia	Sea Box	APOCYNACEAE		
Amaranthus grandiflorus	Large-flower Amaranth	AMARANTHACEAE		
Amphipogon caricinus var. caricinus	Long Grey-beard Grass	GRAMINEAE		
Amyema melaleucae	Tea-tree Mistletoe	LORANTHACEAE		
Amyema preissii	Wire-leaf Mistletoe	LORANTHACEAE		
Aristida behriana	Brush Wire-grass	GRAMINEAE		
Aristida contorta	Curly Wire-grass	GRAMINEAE		
Arthropodium fimbriatum	Nodding Vanilla-lily	LILIACEAE		
Arthropodium minus	Small Vanilla-lily	LILIACEAE		
Arthropodium strictum	Common Vanilla-lily	LILIACEAE		
Asperula conferta	Common Woodruff	RUBIACEAE		
Asteridea athrixioides f. athrixioides	Wirewort	COMPOSITAE		

Astroloma humifusum	Cranberry Heath	EPACRIDACEAE		
Atriplex acutibractea ssp. karoniensis	Pointed Saltbush	CHENOPODIACEAE		
Atriplex eardleyae	Eardley's Saltbush	CHENOPODIACEAE		
Atriplex paludosa ssp. cordata	Marsh Saltbush	CHENOPODIACEAE		
Atriplex semibaccata	Berry Saltbush	CHENOPODIACEAE		
Atriplex sp.	Saltbush	CHENOPODIACEAE		
Atriplex stipitata	Bitter Saltbush	CHENOPODIACEAE		
Atriplex suberecta	Lagoon Saltbush	CHENOPODIACEAE		
Atriplex vesicaria ssp.	Bladder Saltbush	CHENOPODIACEAE		
Austrodanthonia caespitosa	Common Wallaby-grass	GRAMINEAE		
Austrodanthonia setacea	Small-flower Wallaby-grass	GRAMINEAE		
Austrostipa acrociliata	Graceful Spear-grass	GRAMINEAE		
Austrostipa blackii	Crested Spear-grass	GRAMINEAE		
Austrostipa drummondii	Cottony Spear-grass	GRAMINEAE		
Austrostipa elegantissima	Feather Spear-grass	GRAMINEAE		
Austrostipa eremophila	Rusty Spear-grass	GRAMINEAE		
Austrostipa mollis	Soft Spear-grass	GRAMINEAE		
Austrostipa nitida	Balcarra Spear-grass	GRAMINEAE		
Austrostipa nodosa	Tall Spear-grass	GRAMINEAE		
Austrostipa pilata	Prickly Spear-grass	GRAMINEAE		V
Austrostipa platychaeta	Flat-awn Spear-grass	GRAMINEAE		
Austrostipa puberula	Fine-hairy Spear-grass	GRAMINEAE		
Austrostipa scabra group	Falcate-awn Spear-grass	GRAMINEAE		
Austrostipa scabra ssp.	Rough Spear-grass	GRAMINEAE		
Austrostipa scabra ssp. falcata	Slender Spear-grass	GRAMINEAE		
Austrostipa scabra ssp. scabra	Rough Spear-grass	GRAMINEAE		
Austrostipa sp.	Spear-grass	GRAMINEAE		
Beyeria lechenaultii	Pale Turpentine Bush	EUPHORBIACEAE		
Billardiera versicolor	Yellow-flower Apple-berry	PITTOSPORACEAE		
Boerhavia dominii	Tar-vine	NYCTAGINACEAE		
Boronia inornata ssp. leptophylla	Dryland Boronia	RUTACEAE		
Bothriochloa macra	Red-leg Grass	GRAMINEAE		R
Brachyscome ciliaris var. ciliaris	Variable Daisy	COMPOSITAE		
Brachyscome lineariloba	Hard-head Daisy	COMPOSITAE		
Bromus sp.	Brome	GRAMINEAE		
Bulbine bulbosa	Bulbine-lily	LILIACEAE		
Bulbine semibarbata	Small Leek-lily	LILIACEAE		
Bursaria spinosa ssp. spinosa	Sweet Bursaria	PITTOSPORACEAE		
Caladenia macroclavia	Large-club Spider-orchid	ORCHIDACEAE	EN	E
Calandrinia calyptrata	Pink Purslane	PORTULACACEAE		
Calandrinia eremaea	Dryland Purslane	PORTULACACEAE		
Callitris gracilis	Southern Cypress Pine	CUPRESSACEAE		
Callitris verrucosa	Scrub Cypress Pine	CUPRESSACEAE		
Calocephalus citreus	Lemon Beauty-heads	COMPOSITAE		
Calostemma purpureum	Pink Garland-lily	AMARYLLIDACEAE		
Calotis hispidula	Hairy Burr-daisy	COMPOSITAE		
Calytrix involucrata	Cup Fringe-myrtle	MYRTACEAE		
Calytrix tetragona	Common Fringe-myrtle	MYRTACEAE		
Cassinia arcuata	Drooping Cassinia	COMPOSITAE		
Cassytha melantha	Coarse Dodder-laurel	LAURACEAE		
Casuarina pauper	Black Oak	CASUARINACEAE		
Chamaesyce drummondii (NC)	Caustic Weed	EUPHORBIACEAE		

Cheilanthes austrotenuifolia	Annual Rock-fern	ADIANTACEAE		
Chenopodium desertorum ssp.	Desert Goosefoot	CHENOPODIACEAE		
Chenopodium desertorum ssp. desertorum	Frosted Goosefoot	CHENOPODIACEAE		
Chenopodium desertorum ssp. microphyllum	Small-leaf Goosefoot	CHENOPODIACEAE		
Chloris pectinata	Comb Windmill Grass	GRAMINEAE		
Chloris truncata	Windmill Grass	GRAMINEAE		
Chrysocephalum apiculatum	Common Everlasting	COMPOSITAE		
Chrysocephalum semipapposum	Clustered Everlasting	COMPOSITAE		
Clematis microphylla var. microphylla	Old Man's Beard	RANUNCULACEAE		
Comesperma volubile	Love Creeper	POLYGALACEAE		
Convolvulus erubescens (NC)	Australian Bindweed	CONVOLVULACEAE		
Convolvulus microsepalus	Small-flower Bindweed	CONVOLVULACEAE		
Convolvulus remotus	Grassy Bindweed	CONVOLVULACEAE		
Cotula australis	Common Cotula	COMPOSITAE		
Crassula colligata ssp. lamprosperma		CRASSULACEAE		
Crassula colorata var. acuminata	Dense Crassula	CRASSULACEAE		
Crassula decumbens var. decumbens	Spreading Crassula	CRASSULACEAE		
Crassula sieberiana ssp. tetramera (NC)	Australian Stonecrop	CRASSULACEAE		
Cressa australis	Rosinweed	CONVOLVULACEAE		
Cryptandra amara var. amara (NC)	Spiny Cryptandra	RHAMNACEAE		
Cullen australasicum	Tall Scurf-pea	LEGUMINOSAE		
Cyperus laevigatus	Bore-drain Sedge	CYPERACEAE		
Cyperus vaginatus	Stiff Flat-sedge	CYPERACEAE		
Dactyloctenium radulans	Button-grass	GRAMINEAE		
Dampiera lanceolata var. intermedia	Aldinga Dampiera	GOODENIACEAE		E
Dampiera lanceolata var. lanceolata	Grooved Dampiera	GOODENIACEAE		
Dampiera rosmarinifolia	Rosemary Dampiera	GOODENIACEAE		
Danthonia sp. (NC)	Wallaby-grass	GRAMINEAE		
Daucus glochidiatus	Native Carrot	UMBELLIFERAE		
Dianella revoluta var. revoluta	Black-anther Flax-lily	LILIACEAE		
Dichanthium sericeum ssp. sericeum	Silky Blue-grass	GRAMINEAE		
Didymodon torquatus		POTTIACEAE		
Dillwynia hispida	Red Parrot-pea	LEGUMINOSAE		
Disphyma crassifolium ssp. clavellatum	Round-leaf Pigface	AIZOACEAE		
Dodonaea baueri	Crinkled Hop-bush	SAPINDACEAE		
Dodonaea hexandra	Horned Hop-bush	SAPINDACEAE		
Dodonaea viscosa ssp. angustissima	Narrow-leaf Hop-bush	SAPINDACEAE		
Dodonaea viscosa ssp. spatulata	Sticky Hop-bush	SAPINDACEAE		
Drosera macrantha ssp. planchonii	Climbing Sundew	DROSERACEAE		
Dysphania pumilio	Clammy Goosefoot	CHENOPODIACEAE		
Einadia nutans ssp.	Climbing Saltbush	CHENOPODIACEAE		
Einadia nutans ssp. nutans	Climbing Saltbush	CHENOPODIACEAE		
Elachanthus pusillus	Elachanth	COMPOSITAE		
Enchylaena tomentosa var. tomentosa	Ruby Saltbush	CHENOPODIACEAE		
Enneapogon nigricans	Black-head Grass	GRAMINEAE		
Enteropogon acicularis	Umbrella Grass	GRAMINEAE		
Eremophila crassifolia	Thick-leaf Emubush	MYOPORACEAE		
Eremophila deserti	Turkey-bush	MYOPORACEAE		
Eremophila glabra ssp. glabra	Tar Bush	MYOPORACEAE		
Eremophila longifolia	Weeping Emubush	MYOPORACEAE		

Eriochloa pseudoacrotricha	Perennial Cupgrass	GRAMINEAE		
Erodium crinitum	Blue Heron's-bill	GERANIACEAE		
Eucalyptus brachycalyx	Gilja	MYRTACEAE		
Eucalyptus calycogona var. calycogona (NC)	Square-fruit Mallee	MYRTACEAE		
Eucalyptus dumosa	White Mallee	MYRTACEAE		
Eucalyptus gracilis	Yorrell	MYRTACEAE		
Eucalyptus incrassata	Ridge-fruited Mallee	MYRTACEAE		
Eucalyptus leptophylla	Narrow-leaf Red Mallee	MYRTACEAE		
Eucalyptus odorata	Peppermint Box	MYRTACEAE		
Eucalyptus oleosa (NC)	Red Mallee	MYRTACEAE		
Eucalyptus phenax (NC)	Sessile-fruit White Mallee	MYRTACEAE		
Eucalyptus phenax ssp. phenax	White Mallee	MYRTACEAE		
Eucalyptus porosa	Mallee Box	MYRTACEAE		
Eucalyptus rugosa	Coastal White Mallee	MYRTACEAE		
Eucalyptus socialis (NC)	Beaked Red Mallee	MYRTACEAE		
Euchiton sphaericus	Annual Cudweed	COMPOSITAE		
Eutaxia diffusa	Large-leaf Eutaxia	LEGUMINOSAE		
Eutaxia microphylla	Common Eutaxia	LEGUMINOSAE		
Exocarpos aphyllus	Leafless Cherry	SANTALACEAE		
Exocarpos sparteus	Slender Cherry	SANTALACEAE		
Frankenia sp.	Sea-heath	FRANKENIACEAE		
Gahnia lanigera	Black Grass Saw-sedge	CYPERACEAE		
Galium migrans	Loose Bedstraw	RUBIACEAE		
Geijera linearifolia	Sheep Bush	RUTACEAE		
Geococcus pusillus	Earth Cress	CRUCIFERAE		
Geranium retrorsum	Grassland Geranium	GERANIACEAE		
Geranium solanderi var. solanderi	Austral Geranium	GERANIACEAE		
Glycine rubiginosa	Twining Glycine	LEGUMINOSAE		
Gnaphalium indutum	Tiny Cudweed	COMPOSITAE		
Gonocarpus elatus	Hill Raspwort	HALORAGACEAE		
Goodenia albiflora	White Goodenia	GOODENIACEAE		
Goodenia pinnatifida	Cut-leaf Goodenia	GOODENIACEAE		
Goodenia pusilliflora	Small-flower Goodenia	GOODENIACEAE		
Goodenia varia	Sticky Goodenia	GOODENIACEAE		
Goodenia willisiana	Silver Goodenia	GOODENIACEAE		
Grammosolen dixonii		SOLANACEAE		
Grevillea huegelii	Comb Grevillea	PROTEACEAE		
Haegiela tatei	Small Nut-heads	COMPOSITAE		R
Hakea carinata	Erect Hakea	PROTEACEAE		
Hakea leucoptera ssp. leucoptera	Silver Needlewood	PROTEACEAE		
Hakea mitchellii	Heath Needlebush	PROTEACEAE		
Halgania andromedifolia	Scented Blue-flower	BORAGINACEAE		
Halgania cyanea	Rough Blue-flower	BORAGINACEAE		
Haloragis aspera	Rough Raspwort	HALORAGACEAE		
Halosarcia sp. (NC)	Samphire	CHENOPODIACEAE		
Hardenbergia violacea	Native Lilac	LEGUMINOSAE		
Helichrysum leucopsideum	Satin Everlasting	COMPOSITAE		
Heliotropium asperrimum	Rough Heliotrope	BORAGINACEAE		
Heliotropium europaeum	Common Heliotrope	BORAGINACEAE		
Hibbertia exutiacies	Prickly Guinea-flower	DILLENIACEAE		
Hyalosperma semisterile	Orange Sunray	COMPOSITAE		

Hybanthus floribundus ssp. floribundus	Shrub Violet	VIOLACEAE		
Hydrocotyle laxiflora	Stinking Pennywort	UMBELLIFERAE		
Hydrocotyle medicaginoides	Medic Pennywort	UMBELLIFERAE		
Hydrocotyle pilifera var. glabrata	Buttercup Pennywort	UMBELLIFERAE		
Hypoxis glabella var. glabella	Tiny Star	HYPOXIDACEAE		
Isoetopsis graminifolia	Grass Cushion	COMPOSITAE		
Kennedia prostrata	Scarlet Runner	LEGUMINOSAE		
Lagenophora huegelii	Coarse Bottle-daisy	COMPOSITAE		
Lasiopetalum baueri	Slender Velvet-bush	STERCULIACEAE		
Lawrencia squamata	Thorny Lawrencia	MALVACEAE		
Lepidium papillosum	Warty Peppercress	CRUCIFERAE		
Lepidosperma congestum (NC)	Clustered Sword-sedge	CYPERACEAE		
Lepidosperma sp. Narrow leaf (R.L.Taplin 709)		CYPERACEAE		
Lepidosperma viscidum	Sticky Sword-sedge	CYPERACEAE		
Leptorhynchos elongatus	Lanky Buttons	COMPOSITAE		R
Leptospermum coriaceum	Dune Tea-tree	MYRTACEAE		
Lichen sp.		Major Group only-Lichens		
Linum marginale	Native Flax	LINACEAE		
Lomandra collina	Sand Mat-rush	LILIACEAE		
Lomandra densiflora	Soft Tussock Mat-rush	LILIACEAE		
Lomandra effusa	Scented Mat-rush	LILIACEAE		
Lomandra leucocephala ssp. robusta	Woolly Mat-rush	LILIACEAE		
Lomandra multiflora ssp. dura	Hard Mat-rush	LILIACEAE		
Lotus australis	Austral Trefoil	LEGUMINOSAE		
Lysiana exocarpi ssp. exocarpi	Harlequin Mistletoe	LORANTHACEAE		
Maireana aphylla	Cotton-bush	CHENOPODIACEAE		
Maireana brevifolia	Short-leaf Bluebush	CHENOPODIACEAE		
Maireana decalvans	Black Cotton-bush	CHENOPODIACEAE		E
Maireana enchylaenoides	Wingless Fissure-plant	CHENOPODIACEAE		
Maireana erioclada	Rosy Bluebush	CHENOPODIACEAE		
Maireana excavata	Bottle Fissure-plant	CHENOPODIACEAE		V
Maireana oppositifolia	Salt Bluebush	CHENOPODIACEAE		
Maireana radiata	Radiate Bluebush	CHENOPODIACEAE		
Maireana rohrlachii	Rohrlach's Bluebush	CHENOPODIACEAE		R
Maireana sedifolia	Bluebush	CHENOPODIACEAE		
Maireana sp.	Bluebush/Fissure-plant	CHENOPODIACEAE		
Maireana trichoptera	Hairy-fruit Bluebush	CHENOPODIACEAE		
Marsilea hirsuta	Short-fruit Nardoo	MARSILEACEAE		
Melaleuca acuminata ssp. acuminata	Mallee Honey-myrtle	MYRTACEAE		
Melaleuca lanceolata	Dryland Tea-tree	MYRTACEAE		
Melaleuca lanceolata ssp. lanceolata (NC)	Dryland Tea-tree	MYRTACEAE		
Microseris lanceolata	Yam Daisy	COMPOSITAE		
Millotia muelleri	Common Bow-flower	COMPOSITAE		
Millotia myosotidifolia	Broad-leaf Millotia	COMPOSITAE		
Minuria leptophylla	Minnie Daisy	COMPOSITAE		
Moss sp.		Major Group only-Mosses		
Muehlenbeckia adpressa	Climbing Lignum	POLYGONACEAE		
Myoporum platycarpum ssp. perbellum	Mallee Sandalwood	MYOPORACEAE		
Myoporum platycarpum ssp. platycarpum	False Sandalwood	MYOPORACEAE		

Neurachne alopecuroidea	Fox-tail Mulga-grass	GRAMINEAE		
Nicotiana goodspeedii	Small-flower Tobacco	SOLANACEAE		
Nitraria billardierei	Nitre-bush	ZYGOPHYLLACEAE		
Olearia decurrens	Winged Daisy-bush	COMPOSITAE		
Olearia muelleri	Mueller's Daisy-bush	COMPOSITAE		
Olearia pannosa ssp. pannosa	Silver Daisy-bush	COMPOSITAE	VU	V
Omphalolappula concava	Burr Stickseed	BORAGINACEAE		
Oxalis perennans (NC)	Native Sorrel	OXALIDACEAE		
Ozothamnus retusus	Notched Bush-everlasting	COMPOSITAE		
Panicum effusum var. effusum	Hairy Panic	GRAMINEAE		
Parietaria debilis (NC)	Smooth-nettle	URTICACEAE		
Pelargonium littorale	Native Pelargonium	GERANIACEAE		
Phebalium glandulosum ssp. glandulosum	Glandular Phebalium	RUTACEAE		E
Phlegmatospermum eremaeum	Spreading Cress	CRUCIFERAE		R
Phyllanthus saxosus	Rock Spurge	EUPHORBIACEAE		
Pimelea curviflora var. gracilis	Curved Riceflower	THYMELAEACEAE		
Pimelea glauca	Smooth Riceflower	THYMELAEACEAE		
Pimelea micrantha	Silky Riceflower	THYMELAEACEAE		
Pimelea microcephala ssp. microcephala	Shrubby Riceflower	THYMELAEACEAE		
Pimelea serpyllifolia ssp. serpyllifolia	Thyme Riceflower	THYMELAEACEAE		
Pittosporum angustifolium	Native Apricot	PITTOSPORACEAE		
Plantago gaudichaudii	Narrow-leaf Plantain	PLANTAGINACEAE		
Plantago sp. B (R.Bates 44765)	Little Plantain	PLANTAGINACEAE		
Poa crassicaudex	Thick-stem Tussock-grass	GRAMINEAE		
Podolepis canescens	Grey Copper-wire Daisy	COMPOSITAE		
Podolepis capillaris	Wiry Podolepis	COMPOSITAE		
Podolepis jaceoides	Showy Copper-wire Daisy	COMPOSITAE		R
Podolepis tepperi	Delicate Copper-wire Daisy	COMPOSITAE		
Pogonolepis muelleriana	Stiff Cup-flower	COMPOSITAE		
Pomaderris paniculosa ssp. paniculosa	Mallee Pomaderris	RHAMNACEAE		
Prostanthera serpyllifolia ssp. microphylla	Small-leaf Mintbush	LABIATAE		
Pseudognaphalium luteoalbum	Jersey Cudweed	COMPOSITAE		
Pterostylis biseta (NC)	Two-bristle Greenhood	ORCHIDACEAE		
Pterostylis pusilla	Small Rusty-hood	ORCHIDACEAE		
Pterostylis robusta	Large Shell-orchid	ORCHIDACEAE		
Ptilotus nobilis var. nobilis	Yellow-tails	AMARANTHACEAE		
Ptilotus seminudus	Rabbit-tails	AMARANTHACEAE		
Ptilotus spathulatus f. spathulatus	Pussy-tails	AMARANTHACEAE		
Ranunculus hamatosetosus	Hill Buttercup	RANUNCULACEAE		
Ranunculus sessiliflorus var. sessiliflorus	Annual Buttercup	RANUNCULACEAE		
Rhagodia candolleana ssp. candolleana	Sea-berry Saltbush	CHENOPODIACEAE		
Rhagodia parabolica	Mealy Saltbush	CHENOPODIACEAE		
Rhagodia preissii ssp. preissii	Mallee Saltbush	CHENOPODIACEAE		
Rhodanthe corymbiflora	Paper Everlasting	COMPOSITAE		
Rhodanthe pygmaea	Pigmy Daisy	COMPOSITAE		
Rhodanthe stuartiana	Clay Everlasting	COMPOSITAE		
Salsola tragus	Buckbush	CHENOPODIACEAE		
Santalum acuminatum	Quandong	SANTALACEAE		
Santalum sp.		SANTALACEAE		

Scaevola humilis	Inland Fanflower	GOODENIACEAE		
Scaevola spinescens	Spiny Fanflower	GOODENIACEAE		
Scambopus curvipes		CRUCIFERAE		
Sclerolaena brachyptera	Short-wing Bindyi	CHENOPODIACEAE		
Sclerolaena diacantha	Grey Bindyi	CHENOPODIACEAE		
Sclerolaena obliquicuspis	Oblique-spined Bindyi	CHENOPODIACEAE		
Sclerolaena sp.	Bindyi	CHENOPODIACEAE		
Sclerolaena uniflora	Small-spine Bindyi	CHENOPODIACEAE		
Senecio glossanthus (NC)	Annual Groundsel	COMPOSITAE		
Senecio pinnatifolius	Variable Groundsel	COMPOSITAE		
Senecio tenuiflorus (NC)	Woodland Groundsel	COMPOSITAE		
Senna artemisioides ssp. filifolia	Fine-leaf Desert Senna	LEGUMINOSAE		
Senna artemisioides ssp. petiolaris (NC)	Flat-stalk Senna	LEGUMINOSAE		
Senna artemisioides ssp. X coriacea	Broad-leaf Desert Senna	LEGUMINOSAE		
Sida corrugata var.	Corrugated Sida	MALVACEAE		
Sida corrugata var. angustifolia	Grassland Sida	MALVACEAE		
Sida corrugata var. corrugata	Corrugated Sida	MALVACEAE		
Sida intricata	Twiggy Sida	MALVACEAE		
Solanum capsiciforme	Capsicum Kangaroo-apple	SOLANACEAE		
Solanum coactiliferum	Tomato-bush	SOLANACEAE		
Solanum eardleyae	Eardley's Nightshade	SOLANACEAE		
Solanum eremophilum	Rare Nightshade	SOLANACEAE		R
Solanum esuriale	Quena	SOLANACEAE		
Solanum simile	Kangaroo Apple	SOLANACEAE		
Stackhousia monogyna	Creamy Candles	STACKHOUSIACEAE		
Stenopetalum lineare (NC)	Narrow Thread-petal	CRUCIFERAE		
Swainsona stipularis	Orange Swainson-pea	LEGUMINOSAE		
Tecticornia halocnemoides ssp.	Grey Samphire	CHENOPODIACEAE		
Tecticornia indica ssp. bidens	Brown-head Samphire	CHENOPODIACEAE		
Tecticornia indica ssp. leiostachya	Brown-head Samphire	CHENOPODIACEAE		
Tecticornia pergranulata ssp.	Black-seed Samphire	CHENOPODIACEAE		
Tecticornia pergranulata ssp. pergranulata	Black-seed Samphire	CHENOPODIACEAE		
Templetonia sulcata	Flat Mallee-pea	LEGUMINOSAE		
Teucrium racemosum	Grey Germander	LABIATAE		
Teucrium sessiliflorum	Mallee Germander	LABIATAE		
Thelymitra nuda (NC)	Scented Sun-orchid	ORCHIDACEAE		
Themeda triandra	Kangaroo Grass	GRAMINEAE		
Thysanotus baueri	Mallee Fringe-lily	LILIACEAE		
Thysanotus patersonii	Twining Fringe-lily	LILIACEAE		
Thysanotus sp.	Fringe-lily	LILIACEAE		
Thysanotus tenellus	Grassy Fringe-lily	LILIACEAE		R
Tragus australianus	Small Burr-grass	GRAMINEAE		
Tricoryne elatior	Yellow Rush-lily	LILIACEAE		
Triraphis mollis	Purple Plume Grass	GRAMINEAE		
Trymalium wayi	Grey Trymalium	RHAMNACEAE		
Velleia arguta	Toothed Velleia	GOODENIACEAE		
Vittadinia australasica var. australasica	Sticky New Holland Daisy	COMPOSITAE		
Vittadinia blackii	Narrow-leaf New Holland Daisy	COMPOSITAE		
Vittadinia cervicularis var. cervicularis	Waisted New Holland Daisy	COMPOSITAE		
Vittadinia cuneata var.	Fuzzy New Holland Daisy	COMPOSITAE		

Vittadinia gracilis	Woolly New Holland Daisy	COMPOSITAE		
Vittadinia megacephala	Giant New Holland Daisy	COMPOSITAE		
Vulpia bromoides/myuros		GRAMINEAE		
Wahlenbergia communis	Tufted Bluebell	CAMPANULACEAE		
Wahlenbergia gracilenta	Annual Bluebell	CAMPANULACEAE		
Wahlenbergia sp.	Native Bluebell	CAMPANULACEAE		
Wahlenbergia stricta ssp. stricta	Tall Bluebell	CAMPANULACEAE		
Westringia rigida	Stiff Westringia	LABIATAE		
Wilsonia rotundifolia	Round-leaf Wilsonia	CONVOLVULACEAE		
Wurmbea dioica ssp. dioica (NC)	Early Nancy	LILIACEAE		
Wurmbea latifolia ssp. latifolia	Broad-leaf Nancy	LILIACEAE		V
Zygophyllum angustifolium	Scrambling Twinleaf	ZYGOPHYLLACEAE		
Zygophyllum apiculatum	Pointed Twinleaf	ZYGOPHYLLACEAE		
Zygophyllum aurantiacum ssp. aurantiacum (NC)	Shrubby Twinleaf	ZYGOPHYLLACEAE		
Zygophyllum aurantiacum ssp. simplicifolium		ZYGOPHYLLACEAE		
Zygophyllum confluens	Forked Twinleaf	ZYGOPHYLLACEAE		
Zygophyllum crenatum	Notched Twinleaf	ZYGOPHYLLACEAE		
Zygophyllum glaucum	Pale Twinleaf	ZYGOPHYLLACEAE		
Zygophyllum ovatum	Dwarf Twinleaf	ZYGOPHYLLACEAE		
* *Acacia baileyana*	Cootamundra Wattle	LEGUMINOSAE		
* *Achillea millefolium (NC)*	Yarrow	COMPOSITAE		
* *Adonis microcarpa*	Pheasant's Eye	RANUNCULACEAE		
* *Aira cupaniana*	Small Hair-grass	GRAMINEAE		
* *Allium neapolitanum*	Naples Onion	LILIACEAE		
* *Allium scorodoprasum ssp. rotundum*		LILIACEAE		
* *Amaranthus albus*	Stiff Tumbleweed	AMARANTHACEAE		
* *Amaranthus deflexus*	Spreading Amaranth	AMARANTHACEAE		
* *Amaranthus muricatus*	Rough-fruit Amaranth	AMARANTHACEAE		
* *Amaranthus retroflexus*	Red-root Amaranth	AMARANTHACEAE		
* *Amaranthus viridis*	Green Amaranth	AMARANTHACEAE		
* *Ammi majus*	False Bishop's Weed	UMBELLIFERAE		
* *Anagallis arvensis*	Pimpernel	PRIMULACEAE		
* *Arctotheca calendula*	Cape Weed	COMPOSITAE		
* *Arundo donax*	Giant Reed	GRAMINEAE		
* *Asparagus asparagoides (NC)*	Bridal Creeper	LILIACEAE		
* *Asphodelus fistulosus*	Onion Weed	LILIACEAE		
* *Asteriscus spinosus*	Golden Pallensis	COMPOSITAE		
* *Avena barbata*	Bearded Oat	GRAMINEAE		
* *Avena fatua*	Wild Oat	GRAMINEAE		
* *Avena sativa*	Cultivated Oat	GRAMINEAE		
* *Brachypodium distachyon*	False Brome	GRAMINEAE		
* *Brassica tournefortii*	Wild Turnip	CRUCIFERAE		
* *Briza minor*	Lesser Quaking-grass	GRAMINEAE		
* *Bromus catharticus*	Prairie Grass	GRAMINEAE		
* *Bromus diandrus*	Great Brome	GRAMINEAE		
* *Bromus hordeaceus ssp. hordeaceus*	Soft Brome	GRAMINEAE		
* *Bromus madritensis*	Compact Brome	GRAMINEAE		
* *Bromus rigidus*	Rigid Brome	GRAMINEAE		
* *Bromus rubens*	Red Brome	GRAMINEAE		
* *Buglossoides arvensis*	Sheepweed	BORAGINACEAE		
* *Bupleurum semicompositum*	Hare's Ear	UMBELLIFERAE		

* *Calendula arvensis*	Field Marigold	COMPOSITAE		
* *Capsella bursa-pastoris*	Shepherd's Purse	CRUCIFERAE		
* *Carduus tenuiflorus*	Slender Thistle	COMPOSITAE		
* *Carrichtera annua*	Ward's Weed	CRUCIFERAE		
* *Carthamus lanatus*	Saffron Thistle	COMPOSITAE		
* *Carthamus tinctorius*	Safflower	COMPOSITAE		
* *Cenchrus longispinus*	Spiny Burr-grass	GRAMINEAE		
* *Centaurea calcitrapa*	Star Thistle	COMPOSITAE		
* *Centaurea melitensis*	Malta Thistle	COMPOSITAE		
* *Centaurium tenuiflorum (NC)*	Branched Centaury	GENTIANACEAE		
* *Cerastium glomeratum*	Common Mouse-ear Chickweed	CARYOPHYLLACEAE		
* *Chasmanthe floribunda var. floribunda*	African Corn-flag	IRIDACEAE		
* *Chenopodium album*	Fat Hen	CHENOPODIACEAE		
* *Chenopodium murale*	Nettle-leaf Goosefoot	CHENOPODIACEAE		
* *Chondrilla juncea*	Skeleton Weed	COMPOSITAE		
* *Chrozophora tinctoria*	Dyer's Litmus Plant	EUPHORBIACEAE		
* *Convolvulus arvensis*	Field Bindweed	CONVOLVULACEAE		
* *Conyza bonariensis*	Flax-leaf Fleabane	COMPOSITAE		
* *Critesion murinum ssp. (NC)*	Barley-grass	GRAMINEAE		
* *Critesion sp. (NC)*	Barley-grass	GRAMINEAE		
* *Cynodon dactylon (NC)*	Couch	GRAMINEAE		
* *Dactylis glomerata*	Cocksfoot	GRAMINEAE		
* *Datura ferox*	Long-spine Thorn-apple	SOLANACEAE		
* *Datura inoxia*	Downy Thorn-apple	SOLANACEAE		
* *Digitaria sanguinalis*	Crab Grass	GRAMINEAE		
* *Dittrichia graveolens*	Stinkweed	COMPOSITAE		
* *Ecballium elaterium*	Squirting Cucumber	CUCURBITACEAE		
* *Echinochloa crus-galli*	Common Barnyard Grass	GRAMINEAE		
* *Echinochloa esculenta*	Japanese Millet	GRAMINEAE		
* *Echium plantagineum*	Salvation Jane	BORAGINACEAE		
* *Ehrharta longiflora*	Annual Veldt Grass	GRAMINEAE		
* *Emex australis*	Three-corner Jack	POLYGONACEAE		
* *Eragrostis cilianensis*	Stink Grass	GRAMINEAE		
* *Eragrostis minor*	Small Stink-grass	GRAMINEAE		
* *Erodium botrys*	Long Heron's-bill	GERANIACEAE		
* *Erodium cicutarium*	Cut-leaf Heron's-bill	GERANIACEAE		
* *Erodium moschatum*	Musky Herons-bill	GERANIACEAE		
* *Euphorbia peplus*	Petty Spurge	EUPHORBIACEAE		
* *Euphorbia terracina*	False Caper	EUPHORBIACEAE		
* *Filago pyramidata*	Filago	COMPOSITAE		
* *Fumaria bastardii*	Bastard Fumitory	FUMARIACEAE		
* *Fumaria capreolata*	White-flower Fumitory	FUMARIACEAE		
* *Galenia secunda*	Galenia	AIZOACEAE		
* *Galium murale*	Small Bedstraw	RUBIACEAE		
* *Galium spurium ssp. ibicinum*	Bedstraw	RUBIACEAE		
* *Genista monspessulana*	Montpellier Broom	LEGUMINOSAE		
* *Hainardia cylindrica*	Common Barb-grass	GRAMINEAE		
* *Hedypnois rhagadioloides (NC)*	Cretan Weed	COMPOSITAE		
* *Heliotropium curassavicum*	Smooth Heliotrope	BORAGINACEAE		
* *Herniaria cinerea*	Rupturewort	CARYOPHYLLACEAE		
* *Hordeum distichon*		GRAMINEAE		

* *Hordeum glaucum*	Blue Barley-grass	GRAMINEAE		
* *Hordeum leporinum*	Wall Barley-grass	GRAMINEAE		
* *Hordeum marinum*	Sea Barley-grass	GRAMINEAE		
* *Hornungia procumbens*	Oval Purse	CRUCIFERAE		
* *Hyparrhenia hirta*	Tambookie Grass	GRAMINEAE		
* *Hypochaeris glabra*	Smooth Cat's Ear	COMPOSITAE		
* *Hypochaeris radicata*	Rough Cat's Ear	COMPOSITAE		
* *Ipheion uniflorum*	Spring Star-flower	LILIACEAE		
* *Iris germanica (NC)*	Flag Iris	IRIDACEAE		
* *Kochia scoparia*		CHENOPODIACEAE		
* *Lactuca serriola (NC)*	Prickly Lettuce	COMPOSITAE		
* *Lamarckia aurea*	Toothbrush Grass	GRAMINEAE		
* *Lepidium africanum*	Common Peppercress	CRUCIFERAE		
* *Limonium lobatum*	Winged Sea-lavender	LIMONIACEAE		
* *Limonium sinuatum*	Notch-leaf Sea-lavender	LIMONIACEAE		
* *Lolium loliaceum*	Stiff Ryegrass	GRAMINEAE		
* *Lolium perenne*	Perennial Ryegrass	GRAMINEAE		
* *Lolium perenne X Lolium rigidum*	Hybrid Ryegrass	GRAMINEAE		
* *Lolium rigidum*	Wimmera Ryegrass	GRAMINEAE		
* *Lupinus cosentinii*	Blue Lupin	LEGUMINOSAE		
* *Lycium ferocissimum*	African Boxthorn	SOLANACEAE		
* *Malva parviflora*	Small-flower Marshmallow	MALVACEAE		
* *Marrubium vulgare*	Horehound	LABIATAE		
* *Medicago arabica*	Spotted Medic	LEGUMINOSAE		
* *Medicago minima var. minima*	Little Medic	LEGUMINOSAE		
* *Medicago polymorpha var. polymorpha*	Burr-medic	LEGUMINOSAE		
* *Medicago scutellata*	Snail Medic	LEGUMINOSAE		
* *Medicago truncatula*	Barrel Medic	LEGUMINOSAE		
* *Melilotus indicus*	King Island Melilot	LEGUMINOSAE		
* *Mesembryanthemum aitonis*	Angled Iceplant	AIZOACEAE		
* *Mesembryanthemum crystallinum*	Common Iceplant	AIZOACEAE		
* *Mesembryanthemum nodiflorum*	Slender Iceplant	AIZOACEAE		
* *Minuartia mediterranea*	Slender Sandwort	CARYOPHYLLACEAE		
* *Moraea setifolia*	Thread Iris	IRIDACEAE		
* *Myagrum perfoliatum*	Musk Weed	CRUCIFERAE		
* *Neatostema apulum*	Hairy Sheepweed	BORAGINACEAE		
* *Oenothera speciosa*	Rose Evening Primrose	ONAGRACEAE		
* *Oenothera stricta ssp. stricta*	Common Evening Primrose	ONAGRACEAE		
* *Oncosiphon suffruticosum*	Calomba Daisy	COMPOSITAE		
* *Ornithogalum umbellatum*	Star Of Bethlehem	LILIACEAE		
* *Oxalis pes-caprae*	Soursob	OXALIDACEAE		
* *Oxalis purpurea*	One-o'clock	OXALIDACEAE		
* *Panicum hillmanii*	Witch-grass	GRAMINEAE		
* *Panicum miliaceum ssp. miliaceum*	Broom Millet	GRAMINEAE		
* *Papaver hybridum*	Rough Poppy	PAPAVERACEAE		
* *Parapholis incurva*	Curly Ryegrass	GRAMINEAE		
* *Paspalum dilatatum*	Paspalum	GRAMINEAE		
* *Peganum harmala*	African Rue	ZYGOPHYLLACEAE		
* *Pennisetum purpureum*	Elephant Grass	GRAMINEAE		
* *Pennisetum setaceum*	Fountain Grass	GRAMINEAE		
* *Pennisetum villosum*	Feather-top	GRAMINEAE		

* *Pentaschistis airoides*	False Hair-grass	GRAMINEAE		
* *Periballia minuta*	Small Hair-grass	GRAMINEAE		
* *Phalaris aquatica*	Phalaris	GRAMINEAE		
* *Phalaris minor*	Lesser Canary-grass	GRAMINEAE		
* *Phalaris paradoxa*	Paradox Canary-grass	GRAMINEAE		
* *Phyla canescens*	Lippia	VERBENACEAE		
* *Picnomon acarna*	Soldier Thistle	COMPOSITAE		
* *Piptatherum miliaceum*	Rice Millet	GRAMINEAE		
* *Plantago arenaria*	Rough Plantain	PLANTAGINACEAE		
* *Plantago coronopus ssp. coronopus*	Bucks-horn Plantain	PLANTAGINACEAE		
* *Poa annua (NC)*	Winter Grass	GRAMINEAE		
* *Polygonum aviculare (NC)*	Wireweed	POLYGONACEAE		
* *Polypogon monspeliensis*	Annual Beard-grass	GRAMINEAE		
* *Raphanus raphanistrum*	Wild Radish	CRUCIFERAE		
* *Rapistrum rugosum ssp. rugosum*	Turnip Weed	CRUCIFERAE		
* *Reichardia tingitana*	False Sowthistle	COMPOSITAE		
* *Reseda luteola*	Wild Mignonette	RESEDACEAE		
* *Ricinus communis*	Castor Oil Plant	EUPHORBIACEAE		
* *Rostraria cristata*	Annual Cat's-tail	GRAMINEAE		
* *Rostraria pumila*	Tiny Bristle-grass	GRAMINEAE		
* *Rumex crispus*	Curled Dock	POLYGONACEAE		
* *Salvia verbenaca*	Wild Sage	LABIATAE		
* *Salvia verbenaca var. verbenaca*	Wild Sage	LABIATAE		
* *Schismus barbatus*	Arabian Grass	GRAMINEAE		
* *Sclerochloa dura*	Hard Meadow-grass	GRAMINEAE		
* *Secale cereale*	Rye	GRAMINEAE		
* *Setaria verticillata*	Whorled Pigeon-grass	GRAMINEAE		
* *Silene nocturna*	Mediterranean Catchfly	CARYOPHYLLACEAE		
* *Silene sp.*	Catchfly	CARYOPHYLLACEAE		
* *Sisymbrium erysimoides*	Smooth Mustard	CRUCIFERAE		
* *Sisymbrium irio*	London Mustard	CRUCIFERAE		
* *Sisymbrium orientale*	Indian Hedge Mustard	CRUCIFERAE		
* *Solanum cinereum*	Narrawa Burr	SOLANACEAE		
* *Solanum elaeagnifolium*	Silver-leaf Nightshade	SOLANACEAE		
* *Solanum nigrum*	Black Nightshade	SOLANACEAE		
* *Solanum retroflexum*		SOLANACEAE		
* *Solanum rostratum*	Buffalo Burr	SOLANACEAE		
* *Solidago canadensis*	Golden Rod	COMPOSITAE		
* *Sonchus oleraceus (NC)*	Common Sow-thistle	COMPOSITAE		
* *Sonchus tenerrimus (NC)*	Clammy Sow-thistle	COMPOSITAE		
* *Sorghum halepense*	Johnson Grass	GRAMINEAE		
* *Spergularia diandra (NC)*	Lesser Sand-spurrey	CARYOPHYLLACEAE		
* *Spergularia rubra (NC)*	Red Sand-spurrey	CARYOPHYLLACEAE		
* *Sphenopus divaricatus*	Wedge-foot Grass	GRAMINEAE		
* *Stellaria media*	Chickweed	CARYOPHYLLACEAE		
* *Stenotaphrum secundatum*	Buffalo Grass	GRAMINEAE		
* *Taraxacum officinale (NC)*	Dandelion	COMPOSITAE		
* *Tribolium acutiflorum (NC)*		GRAMINEAE		
* *Tribulus terrestris*	Caltrop	ZYGOPHYLLACEAE		
* *Trifolium angustifolium*	Narrow-leaf Clover	LEGUMINOSAE		
* *Trifolium campestre*	Hop Clover	LEGUMINOSAE		
* *Trifolium glomeratum*	Cluster Clover	LEGUMINOSAE		

* *Trifolium subterraneum*	Subterranean Clover	LEGUMINOSAE		
* *Trifolium tomentosum*	Woolly Clover	LEGUMINOSAE		
* *Triticum aestivum*	Wheat	GRAMINEAE		
* *Urospermum picroides*	False Hawkbit	COMPOSITAE		
* *Urtica urens*	Small Nettle	URTICACEAE		
* *Veronica arvensis*	Wall Speedwell	SCROPHULARIACEAE		
* *Veronica hederifolia*	Ivy-leaf Speedwell	SCROPHULARIACEAE		
* *Vicia monantha*	Spurred Vetch	LEGUMINOSAE		
* *Vicia monantha ssp. triflora*		LEGUMINOSAE		
* *Vicia sativa ssp. sativa*	Common Vetch	LEGUMINOSAE		
* *Vinca major*	Blue Periwinkle	APOCYNACEAE		
* *Vulpia bromoides*	Squirrel-tail Fescue	GRAMINEAE		
* *Vulpia muralis*	Wall Fescue	GRAMINEAE		
* *Vulpia myuros f. myuros*	Rat's-tail Fescue	GRAMINEAE		
* *Vulpia sp.*	Fescue	GRAMINEAE		
* *Xanthium spinosum*	Bathurst Burr	COMPOSITAE		

Appendix B Fauna species records (DEH/SA Museum) within 10 km of the survey site

Conservation Ratings
AUS - Commonwealth conservation status codes (as listed under the *Environment Protection and Biodiversity Conservation Act* 1999)
EN Endangered
VU Vulnerable

SA - State conservation status codes (as listed under the *National Parks and Wildlife Act* 1972)
E Endangered
V Vulnerable
R Rare

*indicates an introduced species

Class Name	Scientific name	Common Name	Conservation Rating	
			AUS	SA
AMPHIBIA	*Crinia signifera*	Common Froglet		
AMPHIBIA	*Limnodynastes tasmaniensis*	Spotted Marsh Frog		
AMPHIBIA	*Neobatrachus pictus*	Burrowing frog		
AMPHIBIA	*Pseudophryne bibronii*	Brown Toadlet		R
AVES	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater		
AVES	*Acanthiza apicalis*	Inland Thornbill		
AVES	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill		
AVES	*Acanthiza pusilla*	Brown Thornbill		
AVES	*Accipiter cirrhocephalus*	Collared Sparrowhawk		
AVES	*Accipiter fasciatus*	Brown Goshawk		
AVES	*Aegotheles cristatus*	Australian Owlet-nightjar		
AVES	*Anas gracilis*	Grey Teal		
AVES	*Anas superciliosa*	Pacific Black Duck		
AVES	*Anthochaera carunculata*	Red Wattlebird		
AVES	*Anthus novaeseelandiae*	Richard's Pipit		
AVES	*Apus pacificus*	Fork-tailed Swift		
AVES	*Aquila audax*	Wedge-tailed Eagle		
AVES	*Ardea pacifica*	White-necked Heron		
AVES	*Artamus cyanopterus*	Dusky Woodswallow		
AVES	*Artamus personatus*	Masked Woodswallow		
AVES	*Artamus superciliosus*	White-browed Woodswallow		
AVES	*Barnardius zonarius*	Australian Ringneck, (Ring-necked Parrot)		
AVES	*Burhinus grallarius*	Bush Stone-curlew		R
AVES	*Cacatua galerita*	Sulphur-crested Cockatoo		
AVES	*Cacatua roseicapilla*	Galah		
AVES	*Cacatua sanguinea*	Little Corella		
AVES	*Cacomantis flabelliformis*	Fan-tailed Cuckoo		
AVES	*Charadrius australis*	Inland Dotterel		
AVES	*Charadrius ruficapillus*	Red-capped Plover		
AVES	*Charadrius veredus*	Oriental Plover		
AVES	*Chenonetta jubata*	Australian Wood Duck, (Maned Duck)		
AVES	*Cheramoeca leucosternus*	White-backed Swallow		
AVES	*Chlidonias hybridus*	Whiskered Tern		
AVES	*Chrysococcyx basalis*	Horsfield's Bronze-cuckoo		
AVES	*Chrysococcyx osculans*	Black-eared Cuckoo		
AVES	*Cincloramphus cruralis*	Brown Songlark		
AVES	*Cincloramphus mathewsi*	Rufous Songlark		
AVES	*Circus approximans*	Swamp Harrier		
AVES	*Circus assimilis*	Spotted Harrier		
AVES	*Cladorhynchus leucocephalus*	Banded Stilt		V

AVES	*Climacteris picumnus*	Brown Treecreeper		
AVES	*Colluricincla harmonica*	Grey Shrike-thrush		
AVES	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike		
AVES	*Coracina papuensis*	White-bellied Cuckoo-shrike		R
AVES	*Corcorax melanorhamphos*	White-winged Chough		R
AVES	*Corvus coronoides*	Australian Raven		
AVES	*Corvus mellori*	Little Raven		
AVES	*Corvus sp.*			
AVES	*Coturnix pectoralis*	Stubble Quail		
AVES	*Cracticus torquatus*	Grey Butcherbird		
AVES	*Cuculus pallidus*	Pallid Cuckoo		
AVES	*Dacelo novaeguineae*	Laughing Kookaburra		
AVES	*Daphoenositta chrysoptera*	Varied Sittella		
AVES	*Dicaeum hirundinaceum*	Mistletoebird		
AVES	*Dromaius novaehollandiae*	Emu		
AVES	*Egretta novaehollandiae*	White-faced Heron		
AVES	*Elanus axillaris*	Black-shouldered Kite		
AVES	*Elseyornis melanops*	Black-fronted Dotterel		
AVES	*Epthianura albifrons*	White-fronted Chat		
AVES	*Epthianura tricolor*	Crimson Chat		
AVES	*Erythrogonys cinctus*	Red-kneed Dotterel		
AVES	*Eurostopodus argus*	Spotted Nightjar		
AVES	*Falco berigora*	Brown Falcon		
AVES	*Falco cenchroides*	Nankeen Kestrel		
AVES	*Falco longipennis*	Australian Hobby		
AVES	*Falco peregrinus*	Peregrine Falcon		R
AVES	*Falco subniger*	Black Falcon		
AVES	*Fulica atra*	Eurasian Coot		
AVES	*Gallinula tenebrosa*	Dusky Moorhen		
AVES	*Gallinula ventralis*	Black-tailed Native-hen		
AVES	*Geopelia placida*	Peaceful Dove		
AVES	*Gliciphila melanops*	Tawny-crowned Honeyeater		
AVES	*Glossopsitta concinna*	Musk Lorikeet		
AVES	*Glossopsitta porphyrocephala*	Purple-crowned Lorikeet		
AVES	*Grallina cyanoleuca*	Magpie-lark		
AVES	*Gymnorhina tibicen*	Australian Magpie		
AVES	*Haliastur sphenurus*	Whistling Kite		
AVES	*Hieraaetus morphnoides*	Little Eagle		
AVES	*Himantopus himantopus*	Black-winged Stilt		
AVES	*Hirundo neoxena*	Welcome Swallow		
AVES	*Lalage tricolor*	White-winged Triller		
AVES	*Larus novaehollandiae*	Silver Gull		
AVES	*Lichenostomus ornatus*	Yellow-plumed Honeyeater		
AVES	*Lichenostomus penicillatus*	White-plumed Honeyeater		
AVES	*Lichenostomus virescens*	Singing Honeyeater		
AVES	*Malurus lamberti*	Variegated Fairy-wren		
AVES	*Malurus leucopterus*	White-winged Fairy-wren		
AVES	*Manorina flavigula*	Yellow-throated Miner		
AVES	*Megalurus gramineus*	Little Grassbird		
AVES	*Melanodryas cucullata*	Hooded Robin		
AVES	*Melithreptus brevirostris*	Brown-headed Honeyeater		
AVES	*Melopsittacus undulatus*	Budgerigar		
AVES	*Merops ornatus*	Rainbow Bee-eater		
AVES	*Microeca fascinans*	Jacky Winter		
AVES	*Milvus migrans*	Black Kite		
AVES	*Mirafra javanica*	Horsfield's Bushlark		
AVES	*Myiagra inquieta*	Restless Flycatcher		R
AVES	*Neophema elegans*	Elegant Parrot		R

AVES	*Ninox novaeseelandiae*	Southern Boobook		
AVES	*Northiella haematogaster*	Blue Bonnet		
AVES	*Nymphicus hollandicus*	Cockatiel		
AVES	*Ocyphaps lophotes*	Crested Pigeon		
AVES	*Oriolus sagittatus*	Olive-backed Oriole		R
AVES	*Pachycephala pectoralis*	Golden Whistler		
AVES	*Pachycephala rufiventris*	Rufous Whistler		
AVES	*Pardalotus punctatus*	Spotted Pardalote		
AVES	*Pardalotus striatus*	Striated Pardalote		
AVES	*Pedionomus torquatus*	Plains-wanderer	VU	E
AVES	*Petrochelidon ariel*	Fairy Martin		
AVES	*Petrochelidon nigricans*	Tree Martin		
AVES	*Petroica goodenovii*	Red-capped Robin		
AVES	*Phalacrocorax carbo*	Great Cormorant		
AVES	*Phalacrocorax melanoleucos*	Little Pied Cormorant		
AVES	*Phalacrocorax varius*	Pied Cormorant		
AVES	*Phaps chalcoptera*	Common Bronzewing		
AVES	*Phaps elegans*	Brush Bronzewing		
AVES	*Phylidonyris albifrons*	White-fronted Honeyeater		
AVES	*Phylidonyris novaehollandiae*	New Holland Honeyeater		
AVES	*Platalea flavipes*	Yellow-billed Spoonbill		
AVES	*Plectorhyncha lanceolata*	Striped Honeyeater		R
AVES	*Podargus strigoides*	Tawny Frogmouth		
AVES	*Poliocephalus poliocephalus*	Hoary-headed Grebe		
AVES	*Pomatostomus superciliosus*	White-browed Babbler		
AVES	*Porphyrio porphyrio*	Purple Swamphen		
AVES	*Psephotus haematonotus*	Red-rumped Parrot		
AVES	*Psephotus varius*	Mulga Parrot		
AVES	*Recurvirostra novaehollandiae*	Red-necked Avocet		
AVES	*Rhipidura albiscapa*	Grey Fantail		
AVES	*Rhipidura leucophrys*	Willie Wagtail		
AVES	*Rostratula benghalensis*	Painted Snipe		V
AVES	*Smicrornis brevirostris*	Weebill		
AVES	*Stiltia isabella*	Australian Pratincole		
AVES	*Strepera versicolor*	Grey Currawong		
AVES	*Tachybaptus novaehollandiae*	Australasian Grebe, (Little Grebe)		
AVES	*Taeniopygia guttata*	Zebra Finch		
AVES	*Todiramphus pyrrhopygia*	Red-backed Kingfisher		
AVES	*Trichoglossus haematodus*	Rainbow Lorikeet		
AVES	*Turnix varia*	Painted Button-quail		R
AVES	*Turnix velox*	Little Button-quail		
AVES	*Tyto alba*	Barn Owl		
AVES	*Vanellus miles*	Masked Lapwing		
AVES	*Vanellus tricolor*	Banded Lapwing		
AVES	*Zosterops lateralis*	Silvereye		
AVES	* *Alauda arvensis*	Eurasian Skylark		
AVES	* *Columba livia*	Rock Dove		
AVES	* *Passer domesticus*	House Sparrow		
AVES	* *Streptopelia chinensis*	Spotted Turtle-dove		
AVES	* *Sturnus vulgaris*	Common Starling		
AVES	* *Turdus merula*	Eurasian Blackbird		
MAMMALIA	*Chalinolobus gouldii*	Gould's Wattled Bat		
MAMMALIA	*Chalinolobus morio*	Chocolate Wattled Bat		
MAMMALIA	*Macropus fuliginosus*	Western Grey Kangaroo		
MAMMALIA	*Macropus robustus*	Euro		
MAMMALIA	*Macropus sp.*			
MAMMALIA	*Mormopterus sp.*			

MAMMALIA	*Neophoca cinerea*	Australian Sea-lion	VU	V
MAMMALIA	*Nyctophilus geoffroyi*	Lesser Long-eared Bat		
MAMMALIA	*Tachyglossus aculeatus*	Short-beaked Echidna		
MAMMALIA	*Tadarida australis*	White-striped Freetail-bat		
MAMMALIA	*Trichosurus vulpecula*	Common Brushtail Possum		R
MAMMALIA	*Vespadelus regulus*	Southern Forest Bat		
MAMMALIA	* *Felis catus*	Cat (Feral Cat)		
MAMMALIA	* *Mus musculus*	House Mouse		
MAMMALIA	* *Oryctolagus cuniculus*	Rabbit (European Rabbit)		
MAMMALIA	* *Ovis aries*	Sheep (Feral Sheep)		
MAMMALIA	* *Vulpes vulpes*	Fox (Red Fox)		
REPTILIA	*Aprasia sp.*			
REPTILIA	*Christinus marmoratus*	Marbled Gecko		
REPTILIA	*Ctenotus robustus*	Eastern Striped Skink		
REPTILIA	*Delma molleri*	Adelaide Snake-lizard		
REPTILIA	*Eremiascincus richardsonii*	Broad-banded Sandswimmer		
REPTILIA	*Hemiergis decresiensis*	Three-toed Earless Skink		
REPTILIA	*Heteronotia binoei*	Bynoe's Gecko		
REPTILIA	*Lerista bougainvillii*	Bougainville's Skink		
REPTILIA	*Morethia adelaidensis*	Adelaide Snake-eye		
REPTILIA	*Morethia boulengeri*	Common Snake-eye		
REPTILIA	*Morethia obscura*	Mallee Snake-eye		
REPTILIA	*Pogona barbata*	Eastern Bearded Dragon		
REPTILIA	*Pseudonaja textilis*	Eastern Brown Snake		
REPTILIA	*Pygopus schraderi*	Hooded Scaly-foot		
REPTILIA	*Ramphotyphlops bicolor*	Southern Blind Snake		
REPTILIA	*Tiliqua adelaidensis*	Pygmy Bluetongue	EN	E
REPTILIA	*Tiliqua rugosa*	Sleepy Lizard		
REPTILIA	*Tiliqua scincoides*	Eastern Bluetongue		
REPTILIA	*Varanus gouldii*	Sand Goanna		

Appendix C Migratory bird species highlighted by the EPBC search

Scientific Name	Common Name	National rating	State rating	Habitat
Apus pacificus	Fork-tailed Swift	M	-	marine
Ardea alba	Great Egret, White Egret	M	-	wetland
Ardea ibis	Cattle Egret	M	-	wetland
Gallinago hardwickii	Latham's Snipe, Japanese Snipe	M	V	wetland
Haliaeetus leucogaster	White-bellied Sea-Eagle	M, Ma	V	terrestrial
Hirunapus caudacutus	White-throated Needletail	M	-	terrestrial
Merops ornatus	Rainbow Bee-eater	M, Ma	-	terrestrial
Rostratula australis	Australian Painted Snipe	V, M	-	wetland

Conservation Ratings
AUS - Commonwealth conservation status codes (as listed under the *Environment Protection and Biodiversity Conservation Act* 1999)
V Vulnerable
M Migratory
Ma Marine Overfly

SA - State conservation status codes (as listed under the *National Parks and Wildlife Act* 1972)
V Vulnerable

Appendix D Updated flora species list for the survey area (includes Stage 1 and Stage 2)

Plant Associations:

1 Exotic Grassland/Crop land
2 *Lomandra spp / Austrostipa spp. / Austrodanthonia spp*. Grassland
3 *Eucalyptus oleosa +/- E. gracilis +/- E. porosa* Low Woodland
4 *Allocasuarina verticillata* Low Woodland +/- *Bursaria spinosa +/- Lepidosperma viscidum*
5 *Eucalyptus camaldulensis* Woodland
6 *Austrostipa ssp./ Austrodanthonia spp*. Grassland +/- *Bursaria spinosa*
7 *Lomandra effusa* Grassland
8 *Gahnia lanigera* Grassland
9 *Themeda triandra / Austrodanthonia* spp Grassland
10 *Callitris* spp. Woodland

		Conservation Rating			Plant Associations									
Botanical Name	**Common Name**	**Aus**	**SA**	**NL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Acacia nyssophylla	Spine Bush				▪	▪	✓	✓	▪	▪	▪	▪	▪	▪
Acacia pycnantha	Golden Wattle				▪	▪	✓	✓	✓	▪	▪	▪	▪	▪
Acacia salicina	Willow Wattle				▪	▪	▪	▪	✓	▪	▪	▪	▪	▪
Acacia victoriae ssp. victoriae	Elegant Wattle				✓	▪	✓	▪	✓	▪	▪	▪	▪	▪
Acaena echinata	Sheep's Burr				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Alectryon oleifolius ssp. canescens	Bullock Bush			U	▪	▪	✓	▪	▪	▪	▪	▪	▪	▪
Allocasuarina verticillata	Drooping Sheoak				✓	▪	✓	✓	✓	✓	▪	▪	▪	▪
Amphipogon caricinus var. caricinus	Long Grey-beard Grass			R	▪	✓	▪	✓	▪	▪	▪	▪	▪	▪
Arabidella filifolia	Thread-leaf Cress			K	▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Aristida behriana	Brush Wire-grass				✓	✓	▪	✓	▪	✓	▪	▪	▪	▪
Aristida holathera var. holathera	Tall Kerosene Grass			R	▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Arthropodium sp.	Vanilla-lily				✓	▪	▪	✓	▪	▪	▪	▪	▪	▪
Asperula conferta	Common Woodruff				▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Asperula sp.	Woodruff				▪	✓	▪	▪	▪	▪	▪	▪	▪	▪

		Conservation Rating			Plant Associations									
Botanical Name	**Common Name**	**Aus**	**SA**	**NL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Austrodanthonia caespitosa	Common Wallaby-grass				✓	✓	✓	▪	▪	✓	▪	▪	✓	▪
Austrodanthonia linkii var. fulva	Leafy Wallaby-grass			K	▪	✓	▪	▪	▪	✓	▪	▪	▪	▪
Austrodanthonia setacea var. setacea	Small-flower Wallaby-grass				✓	✓	▪	▪	▪	✓	▪	▪	▪	▪
Austrodanthonia sp.	Wallaby-grass				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Austrostipa blackii	Crested Spear-grass				✓	✓	✓	✓	▪	✓	▪	▪	▪	▪
Austrostipa elegantissima	Feather Spear-grass				▪	✓	✓	✓	▪	✓	▪	▪	▪	▪
Austrostipa eremophila	Rusty Spear-grass				▪	✓	▪	▪	▪	✓	▪	▪	▪	▪
Austrostipa nodosa	Tall Spear-grass				▪	✓	✓	▪	▪	✓	▪	▪	▪	▪
Austrostipa puberula	Fine-hairy Spear-grass		R	T	▪	✓	✓	▪	▪	▪	▪	▪	▪	▪
Austrostipa scabra ssp. falcata	Slender Spear-grass				✓	▪	▪	✓	✓	✓	✓	✓	✓	▪
Bulbine bulbosa	Bulbine-lily				▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Bursaria spinosa	Sweet Bursaria				✓	✓	✓	✓	✓	✓	✓	▪	▪	▪
Callitris gracilis	Southern Cypress Pine				▪	▪	✓	✓	▪	▪	▪	▪	▪	✓
Calytrix tetragona	Common Fringe-myrtle				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Cheilanthes austrotenuifolia	Annual Rock-fern				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Chenopodium desertorum	Desert Goosefoot				▪	▪	✓	▪	▪	▪	▪	▪	▪	▪
Chrysocephalum apiculatum	Common Everlasting				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Convolvulus erubescens	Australian Bindweed				✓	✓	▪	✓	▪	✓	✓	▪	▪	▪
Convolvulus remotus	Grassy Bindweed				▪	✓	▪	▪	▪	▪	▪	✓	▪	▪
Cryptandra sp. Long hypanthium (C.R. Alcock 10626)	Long-flower Cryptandra		R	R	▪	✓	✓	✓	▪	▪	▪	▪	▪	▪
Cullen australasicum	Tall Scurf-pea				▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Cynoglossum sp	Hound's-tongue				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Dianella revoluta var. revoluta	Black-anther Flax-lily				▪	▪	✓	✓	✓	▪	▪	▪	▪	▪
Dichanthium sericeum ssp. Sericeum	Silky Blue-grass			R	▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Dodonaea viscosa	Sticky Hop-bush				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Enchylaena tomentosa var. tomentosa	Ruby Saltbush				▪	✓	✓	▪	✓	▪	▪	▪	▪	▪

		Conservation Rating			Plant Associations									
Botanical Name	**Common Name**	**Aus**	**SA**	**NL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Enneapogon nigricans	Black-head Grass				✓	✓	▪	✓	✓	✓	▪	▪	▪	▪
Enteropogon acicularis	Umbrella Grass			Q	▪	▪	▪	▪	✓	▪	▪	▪	▪	▪
Eucalyptus brachycalyx	Gilja				▪	▪	✓	▪	▪	▪	▪	▪	▪	▪
Eucalyptus camaldulensis var. camaldulensis	River Red Gum				▪	▪	▪	▪	✓	▪	▪	▪	▪	▪
Eucalyptus gracilis	Yorrell				▪	▪	✓	▪	▪	▪	▪	▪	▪	▪
Eucalyptus odorata	Peppermint Box				▪	▪	✓	▪	▪	▪	▪	▪	▪	▪
Eucalyptus oleosa	Red Mallee				▪	▪	✓	▪	▪	▪	▪	▪	▪	▪
Eucalyptus porosa	Mallee Box				✓	▪	✓	▪	✓	▪	▪	▪	▪	▪
Gahnia lanigera	Black Grass Saw-sedge			Q	▪	✓	▪	✓	▪	▪	▪	✓	▪	▪
Galium gaudichaudii	Rough Bedstraw				✓	▪	▪	✓	▪	▪	▪	▪	▪	▪
Geranium retrorsum	Grassland Geranium				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Glycine clandestina var. sericea	Twining Glycine				▪	✓	▪	✓	▪	▪	✓	✓	▪	▪
Gonocarpus elatus	Hill Raspwort				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Goodenia pinnatifida	Cut-leaf Goodenia			U	▪	✓	▪	✓	▪	▪	▪	▪	▪	▪
Goodenia sp.	Goodenia				▪	▪	✓	▪	▪	▪	▪	▪	▪	▪
Hakea leucoptera ssp. leucoptera	Silver Needlewood				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Hyalosperma demissum	Dwarf Sunray				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Hydrocotyle laxiflora	Stinking Pennywort				✓	▪	▪	✓	▪	✓	▪	▪	▪	▪
Isotoma petraea	Rock Isotome			R	▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Juncus sp.(at Nyowee HS)	Rush				▪	▪	▪	▪	▪	✓	▪	▪	▪	▪
Lepidosperma viscidum	Sticky Sword-sedge				▪	✓	✓	✓	▪	▪	▪	▪	▪	▪
Leptorhynchos squamatus	Scaly Buttons				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Lomandra collina	Sand Mat-rush				▪	✓	▪	✓	▪	▪	▪	▪	▪	▪
Lomandra densiflora	Soft Tussock Mat-rush				▪	✓	▪	✓	▪	▪	▪	▪	▪	▪
Lomandra effusa	Scented Mat-rush				✓	✓	▪	✓	✓	✓	✓	▪	▪	▪
Lomandra multiflora ssp. dura	Hard Mat-rush				✓	✓	✓	✓	▪	✓	▪	✓	▪	▪
Maireana aphylla	Cotton-bush			V	✓	▪	▪	▪	▪	▪	▪	▪	▪	▪

		Conservation Rating			Plant Associations									
Botanical Name	**Common Name**	**Aus**	**SA**	**NL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Maireana enchylaenoides	Wingless Fissure-plant				✓	✓	✓	✓	▪	▪	▪	▪	▪	▪
Maireana rohrlachii	Rohrlach's Bluebush		R	V	▪	✓	✓	▪	▪	▪	▪	▪	▪	▪
Maireana sp.	Bluebush/Fissure-plant				▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Melaleuca lanceolata ssp. lanceolata	Dryland Tea-tree				▪	▪	✓	▪	▪	▪	▪	▪	▪	▪
Olearia lanuginosa	Woolly Daisy-bush			K	▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Oxalis perennans	Native Sorrel				✓	✓	▪	✓	▪	▪	✓	✓	▪	▪
Pimelea micrantha	Silky Riceflower				▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Pittosporum phylliraeoides var. microcarpa	Native Apricot				▪	▪	✓	✓	▪	▪	▪	▪	▪	▪
Poa labillardieri var. labillardieri	Common Tussock-grass				▪	✓	▪	✓	▪	▪	▪	▪	▪	▪
Ptilotus erubescens	Hairy-tails		R	T	▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Ptilotus nobilis var. nobilis	Yellow-tails			E	▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Ptilotus spathulatus forma spathulatus	Pussy-tails				✓	✓	▪	✓	▪	✓	▪	▪	▪	▪
Rhagodia parabolica	Mealy Saltbush				▪	▪	✓	✓	▪	▪	▪	▪	▪	▪
Salsola kali	Buckbush				✓	▪	✓	▪	▪	▪	▪	▪	▪	▪
Scaevola humilis	Inland Fanflower				▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Sclerolaena diacantha	Grey Bindyi				✓	▪	▪	▪	▪	▪	▪	▪	▪	▪
Senna artemisioides nothossp. coriacea	Broad-leaf Desert Senna				▪	▪	✓	▪	▪	▪	▪	▪	▪	▪
Sida sp. aff. corrugata var. angustifolia	Grassland Sida				▪	✓	▪	✓	▪	▪	▪	▪	▪	▪
Stackhousia monogyna	Creamy Candles				✓	✓	✓	▪	▪	✓	▪	✓	▪	▪
Stackhousia sp.	Candles				▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Themeda triandra	Kangaroo Grass				✓	✓	✓	✓	✓	✓	▪	▪	✓	▪
Velleia sp. aff arguta	Toothed Velleia				▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Vittadinia blackii	Narrow-leaf New Holland Daisy				▪	✓	▪	▪	▪	▪	▪	▪	▪	▪
Vittadinia gracilis	Woolly New Holland Daisy				✓	✓	✓	✓	✓	✓	▪	✓	▪	▪
Vittadinia megacephala	Giant New Holland Daisy				▪	▪	▪	▪	▪	▪	✓	▪	▪	▪
Wahlenbergia luteola	Yellow-wash Bluebell				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
Whalleya proluta	Rigid Panic				▪	▪	▪	▪	✓	▪	▪	▪	▪	▪

		Conservation Rating			Plant Associations									
Botanical Name	**Common Name**	**Aus**	**SA**	**NL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Wurmbea sp.	Nancy				▪	▪	▪	▪	▪	✓	▪	▪	▪	▪
+**Adonis microcarpa*	Pheasant's Eye				✓	✓	▪	▪	▪	▪	▪	▪	▪	▪
**Aira sp.*	Hair-grass				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
**Anagallis arvensis*	Pimpernel				▪	▪	▪	▪	▪	▪	✓	✓	▪	▪
**Arctotheca calendula*	Cape Weed				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
**Avena barbata/fatua*	Wild Oat				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
**Briza maxima*	Large Quaking-grass				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
**Bromus hordeaceus ssp. hordeaceus*	Soft Brome				✓	✓	✓	▪	▪	▪	▪	▪	▪	▪
**Bromus rubens*	Red Brome				✓	✓	✓	✓	▪	▪	▪	▪	▪	▪
**Bromus sp.*	Brome				▪	▪	✓	▪	▪	✓	▪	▪	▪	▪
+**Carduus tenuiflorus*	Slender Thistle				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
**Critesion murinum ssp. glaucum*	Blue Barley-grass				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
+**Cynara cardunculus*	Artichoke Thistle				✓	✓	✓	▪	▪	✓	▪	▪	▪	▪
+**Echium plantagineum*	Salvation Jane				✓	✓	✓	✓	▪	✓	✓	✓	✓	▪
**Hedypnois rhagadioloides*	Cretan Weed				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
**Helminthotheca echioides*	Ox-tongue				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
**Hordeum vulgare*	Barley				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
**Lagurus ovatus*	Hare's Tail Grass				▪	▪	▪	▪	✓	▪	▪	▪	▪	▪
**Limonium sp.*	Sea-lavender				✓	▪	▪	▪	▪	▪	▪	▪	▪	▪
**Lolium rigidum*	Wimmera Ryegrass				▪	▪	▪	▪	✓	▪	▪	▪	▪	▪
+**Lycium ferocissimum*	African Boxthorn				✓	▪	✓	✓	✓	✓	▪	▪	▪	▪
+**Marrubium vulgare*	Horehound				✓	✓	▪	✓	✓	▪	✓	▪	▪	▪
**Medicago sp.*	Medic				✓	✓	▪	▪	▪	▪	▪	▪	▪	▪
**Onopordum acaulon*	Horse Thistle				✓	▪	▪	▪	▪	✓	▪	▪	▪	▪
**Oxalis pes-caprae*	Soursob				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
**Pallenis spinosa*	Golden Pallensis				✓	✓	▪	▪	▪	▪	▪	▪	▪	▪
**Phalaris aquatica*	Phalaris				▪	▪	▪	▪	✓	▪	▪	▪	▪	▪

		Conservation Rating			Plant Associations									
Botanical Name	**Common Name**	**Aus**	**SA**	**NL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
+**Pinus halepensis*	Aleppo Pine				▪	▪	▪	▪	✓	▪	▪	▪	▪	▪
**Piptatherum miliaceum*	Rice Millet				▪	▪	▪	▪	✓	▪	▪	▪	▪	▪
**Romulea rosea*	Common Onion-grass				✓	▪	▪	✓	▪	▪	▪	▪	▪	▪
**Salvia verbenaca form*	Wild Sage				✓	✓	▪	▪	✓	▪	✓	▪	▪	▪
**Schinus areira*	Pepper-tree				▪	▪	▪	▪	✓	▪	▪	▪	▪	▪
**Sisymbrium sp.*	Wild Mustard				✓	▪	✓	▪	▪	▪	▪	▪	▪	▪
**Solanum nigrum*	Black Nightshade				▪	▪	▪	✓	▪	▪	▪	▪	▪	▪
**Solanum sp.*	Potato-bush				✓	▪	▪	▪	▪	▪	▪	▪	▪	▪
**Taraxacum officinale*	Dandelion				✓	✓	▪	▪	▪	▪	▪	▪	▪	▪
**Trifolium sp.*	Clover				✓	✓	▪	✓	▪	▪	▪	▪	▪	▪
**Verbena supina*	Trailing Verbena				✓	▪	▪	▪	▪	▪	▪	▪	▪	▪
	Total native species				26	50	35	48	17	23	8	9	4	2
	Total exotic species				21	14	10	17	12	8	7	5	4	3
	TOTAL species				**47**	**64**	**45**	**65**	**29**	**31**	**15**	**14**	**8**	**5**

* denotes an exotic flora species
+ denotes an exotic species declared under the *Natural Resource Management Act 2004*

Conservation Ratings

AUS - Commonwealth conservation status codes (as listed under the *Environment Protection and Biodiversity Conservation Act* 1999)

EN Endangered
VU Vulnerable

SA - State conservation status codes (as listed under the *National Parks and Wildlife Act* 1972)

E Endangered
V Vulnerable
R Rare

NL - Regional conservation status codes for the Northern Lofty Botanical Region

E Endangered
V Vulnerable: rare and at risk from potential threats or long term threats that could cause the species to become endangered in the future.
K Uncertain: likely to be either Threatened or Rare but insufficient data available for a more precise assessment.
R Rare: has a low overall frequency of occurrence (may be locally common with a very restricted distribution or may be scattered sparsely over a wider area). Not currently exposed to significant or widespread threats, but warrants monitoring and protective measures to prevent reduction of population sizes.
U Uncommon: less common species of interest but not rare enough to warrant special protective measures.
Q Not yet assessed but flagged as being of possible significance.

Appendix E Locations of isolated (or patches of) exotic flora species

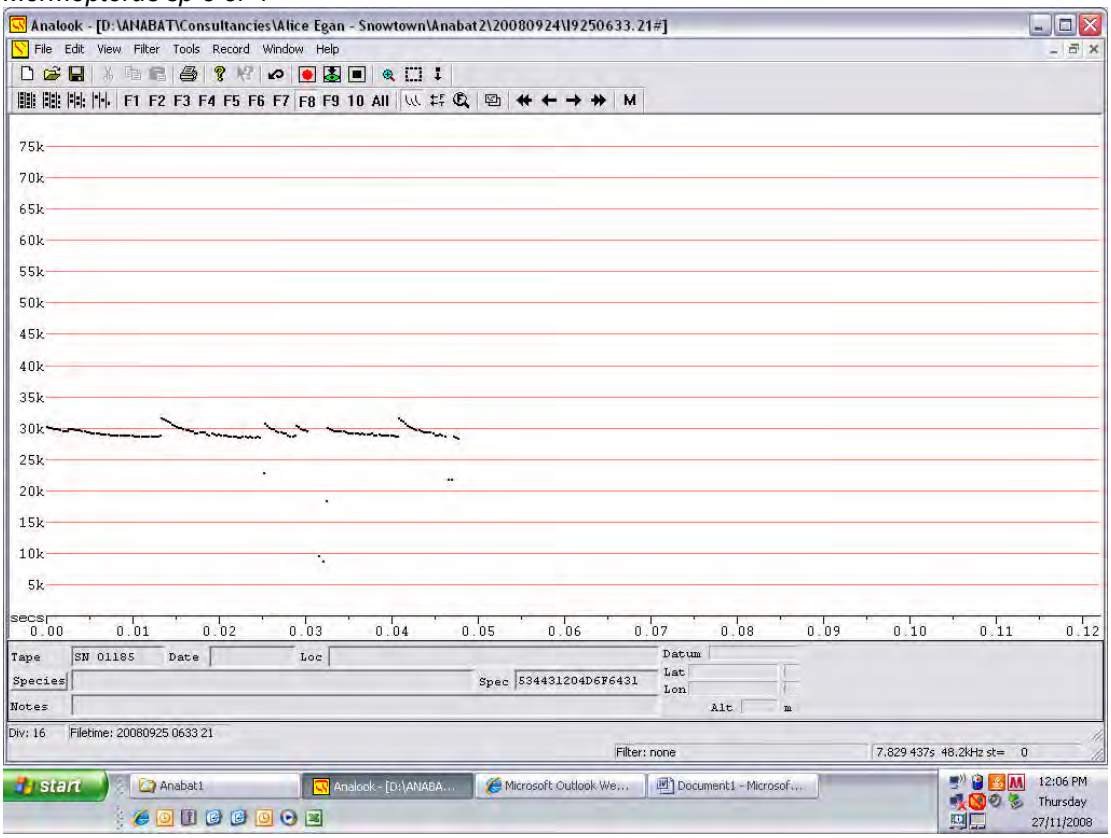
Location	Exotic flora found
54 H 233653 6248948	scattered *Marrubium vulgare*
54 H 234376 6244913	*Lycium ferocissimum*
54 H 234415 6244864	*Lycium ferocissimum*
54 H 234414 6243922	scattered *Marrubium vulgare*
54 H 234428 6243912	scattered *Marrubium vulgare*
54 H 234414 6243897	scattered *Marrubium vulgare*
54 H 234380 6243885	scattered *Marrubium vulgare*
54 H 234396 6243913	scattered *Marrubium vulgare*
54 H 234303 6241735	scattered *Marrubium vulgare*
54 H 235222 6265029	*Onopordum acaulon*
54 H 237692 6261219	*Lycium ferocissimum*
54 H 236521 6261223	*Lycium ferocissimum*
54 H 237983 6273005	*Lycium ferocissimum* patch
54 H 238330 6271822	*Lycium ferocissimum*
54 H 238943 6271098	*Lycium ferocissimum*
54 H 240035 6271173	*Cynara cardunculus* patch
54 H 240125 6271204	*Adonis microcarpa* patch
54 H 238472 6270392	*Lycium ferocissimum /Cynara cardunculus*
54 H 234423 6253854	*Lycium ferocissimum*
54 H 233520 6253591	*Lycium ferocissimum*

Datum WGS 84

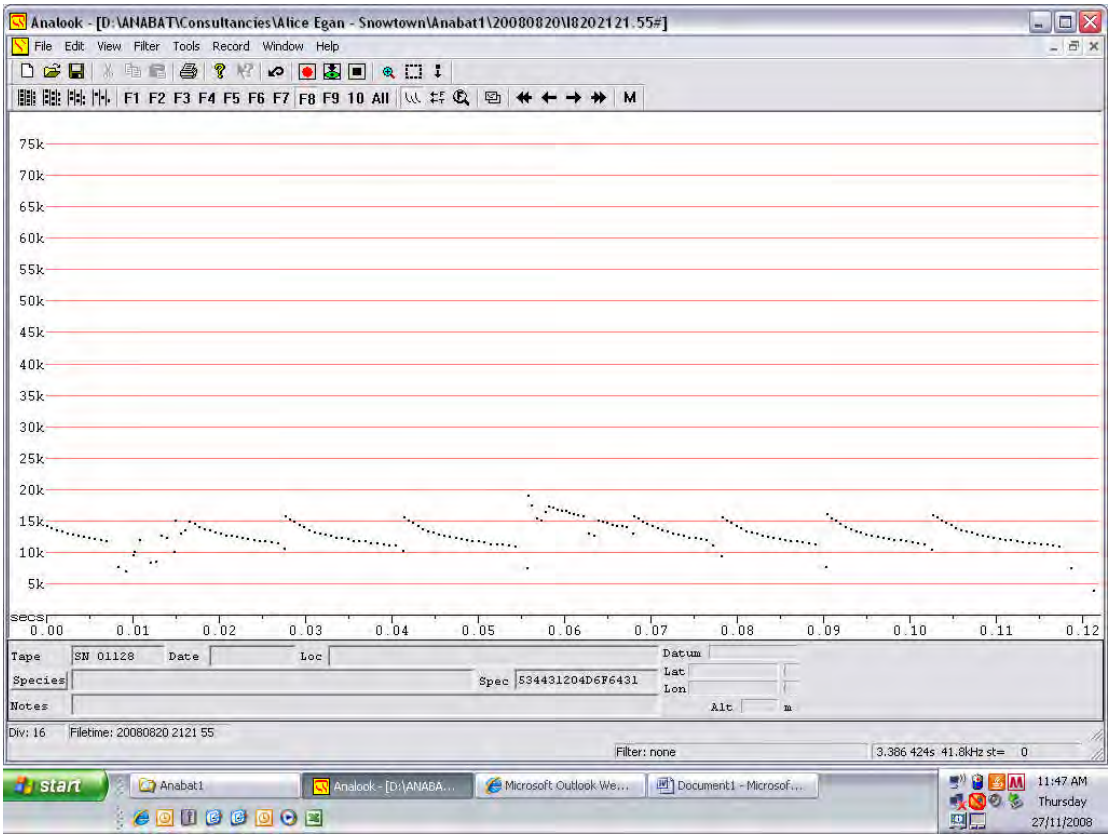
Appendix F Example ANABAT graphs from the Snowtown Stage 2 survey

(AnaBat call analysis completed by Terry Reardon, SA Museum)

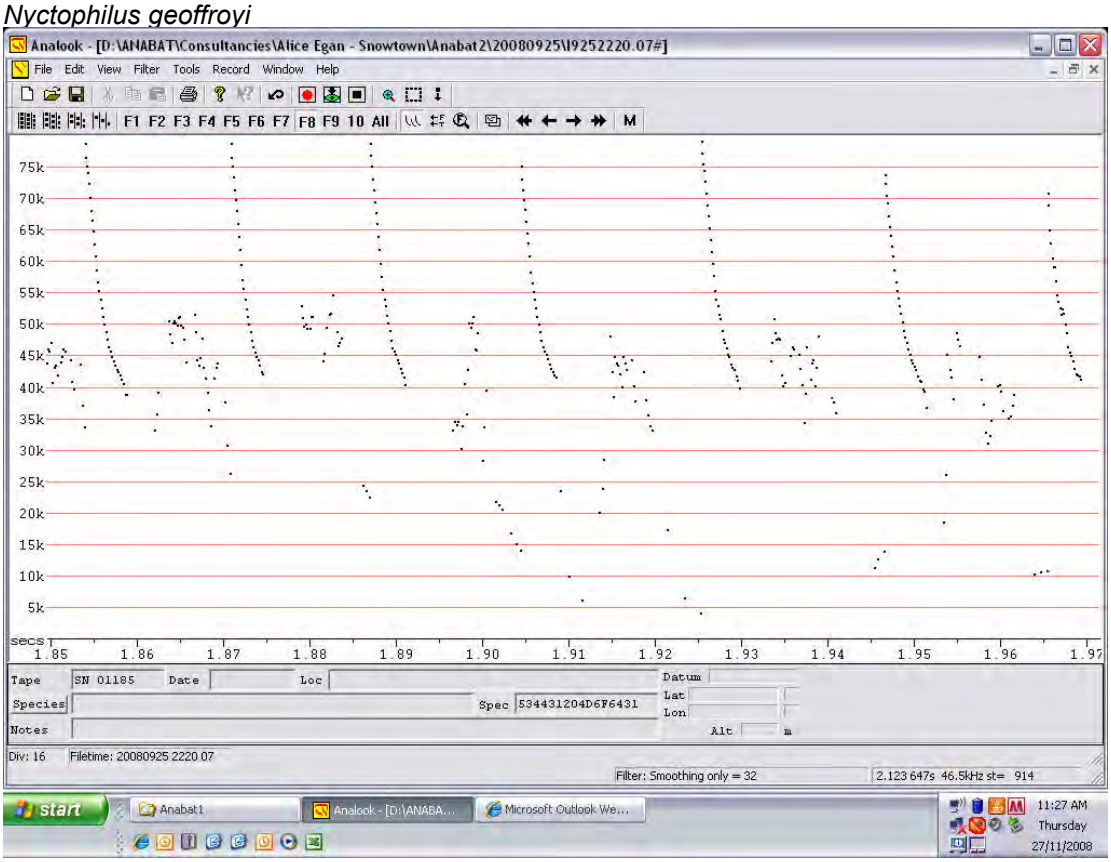
Mormopterus sp 3 or 4



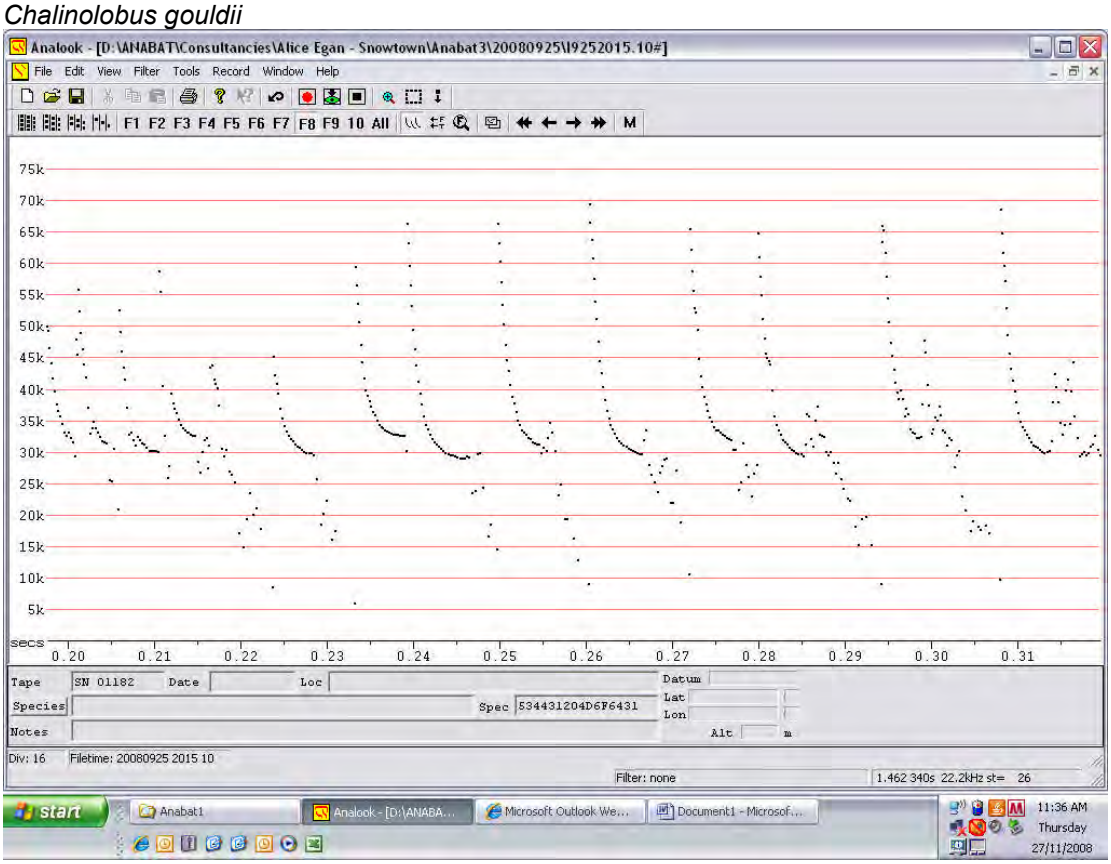
Tadarida australis



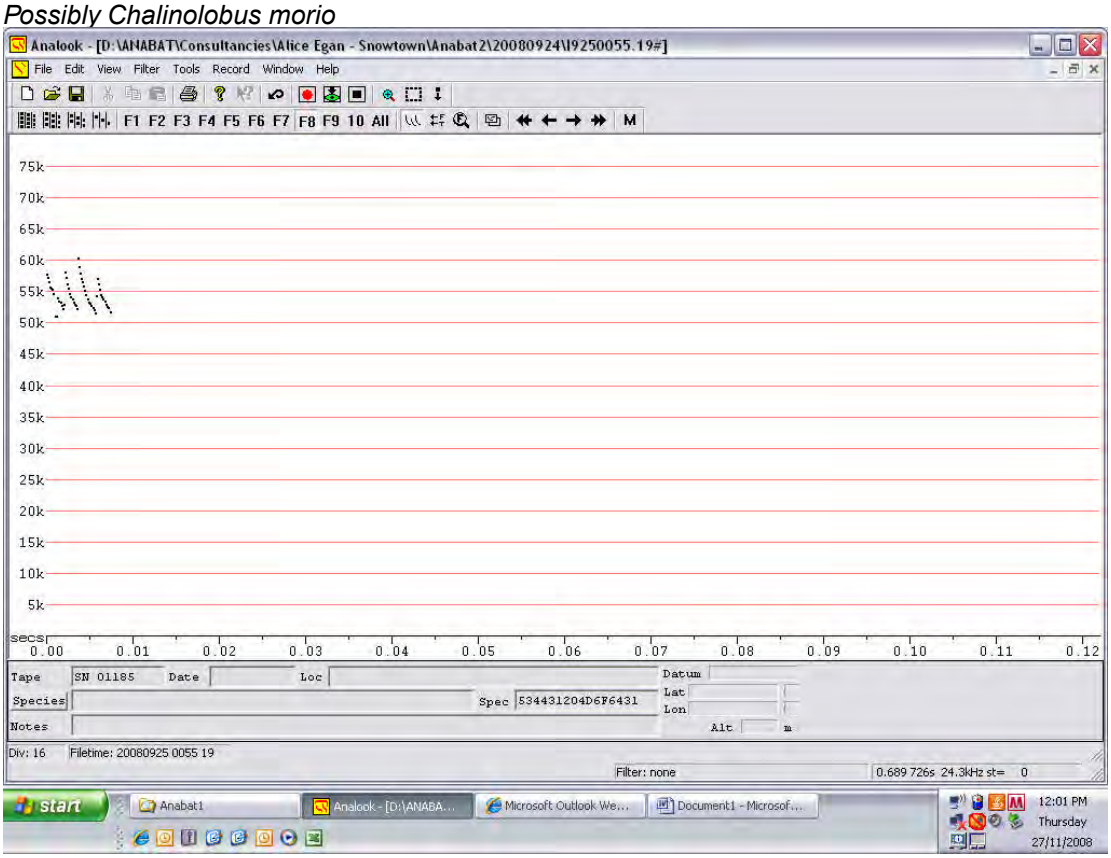
Nyctophilus geoffroyi



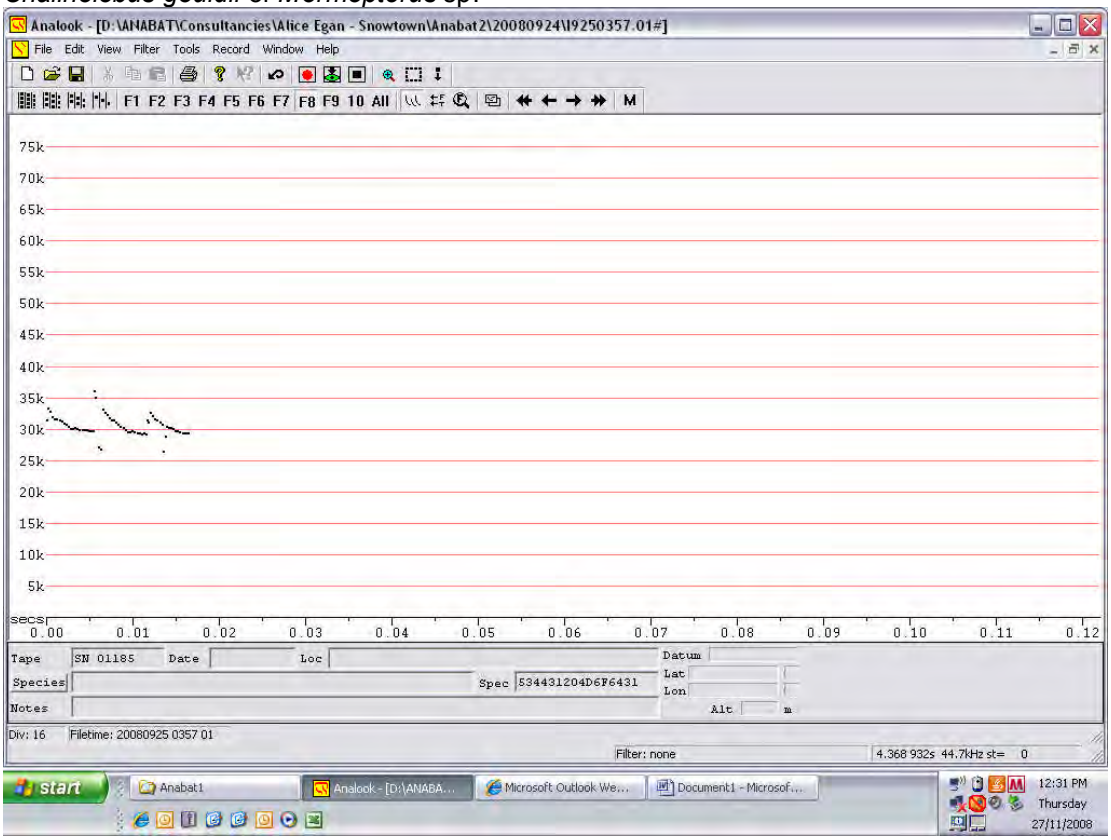
Chalinolobus gouldii



Possibly Chalinolobus morio



Chalinolobus gouldii or *Mormopterus* sp.



ebs ecology

Snowtown Windfarm Stage 2

Pygmy Blue-tongue Presence / Absence Survey

Snowtown Windfarm Stage 2 – Pygmy Blue-tongue Presence / Absence Survey

13 January 2010

Version 1.1

Prepared by Environmental and Biodiversity Services for Wind Prospect Pty Ltd, on behalf of Snowtown Wind Farm Pty Ltd

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Front cover photo: Grassland habitat within the Snowtown Windfarm Stage 2 project area.

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1 INTRODUCTION

EBS Ecology was contracted by Wind Prospect Pty Ltd to undertake a Pygmy Blue-tongue Lizard (*Tiliqua adelaidensis*) presence / absence survey of the Snowtown Stage 2 Windfarm site (Infrastructure corridor and turbine locations). The Pygmy Blue-tongue Lizard (PBT) has an **endangered** rating under the *Environment Protection and Biodiversity Conservation Act 1999*. This survey follows an ecological assessment of the Snowtown Stage 2 Windfarm site in September 2008 and a flora and fauna targeted assessment in July 2009. A recommendation from the initial ecological assessments was to conduct a PBT presence / absence survey within identified potential PBT habitat.

For detailed information on site and regional descriptions, PBT species profile, background research, prior results, discussion and recommendations refer to '*Snowtown Windfarm Stage 2 Ecological Assessment'* (EBS 2008) and '*Snowtown Windfarm Stage 2 – Flora and Fauna Targeted Assessment and Transmission Line Assessment* ' (EBS 2009).

1.1 Objectives

The objectives of this survey were to:

- Identify potential PBT habitat areas within the Snowtown Windfarm Stage 2 site (Infrastructure corridor and turbine locations)
- Determine if PBT's were present within identified potential habitat
- If PBT's were detected; to provide recommendations on avoidance or mitigation of potential impacts associated with the proposed windfarm development.

2 BACKGROUND

Ten areas containing potential PBT habitat were identified, based on PBT habitat attributes (see Table 1) during the initial ecological assessments of the Snowtown Windfarm Stage 2 in September 2008 and July 2009 (see Figure 1). Potential PBT habitat was identified within Exotic Grasslands, *Austrostipa ssp./ Austrodanthonia spp*. Grasslands and a large open Grassland area within an *Allocasuarina verticillata* Low Woodland.

3 METHODS

A field survey was conducted by two people on the 16th and 17th of November 2009 in the areas previously identified as potential PBT habitat. The survey involved the following steps:

- A corridor of approximately 50 metres within the potential PBT habitat area was searched for spider burrows (potential PBT burrows)

- All potential PBT burrows located whilst walking the survey area were checked for PBT occupancy by using an optic fibre 'Burrowscope'. Spider burrows that were not checked with the 'Burrowscope' included any burrows that were inhabited by large ants or that had an opening diameter of less than 5 millimetres (considered too small for juvenile PBT's).

3.1 Survey Limitations

A considerable amount of time was taken searching for spider burrows within the identified potential PBT habitat. It is likely that some spider burrows would have been missed as they are difficult to detect and could have been covered by vegetation at the time of the survey. However, it is probable that if a population of PBT's was present within the search area that they would have been detected as the majority of the spider burrows within the search area were checked for PBT occupancy.

Table 1. Known suitable Pygmy Blue-tongue habitat attributes versus unsuitable habitat attributes.

Attributes considered suitable habitat	Spider burrows within native or exotic grasslands; PBT's have also been detected in highly modified treeless grasslands.
	Soil of heavy sandy loam (red-brown earth).
	Footslopes of hills.
	Sheltered areas of footslopes.
Attributes considered unsuitable habitat	Areas that have been previously cropped.
	Areas lacking spider burrows.
	Areas containing dense ground cover vegetation.
	Steep terrain and exposed ridgelines.
	Overly rocky areas.

Figure 1. Potential PBT habitat and survey areas within Snowtown Windfarm Stage 2 (Infrastructure corridor and turbine locations).

4 RESULTS AND DISCUSSION

A total of 60 spider burrows were inspected in survey areas 'A' to 'J' (see Table 2). No PBT's were detected within the wind farm infrastructure corridor or turbine locations during the survey. Survey areas 'A', 'B' and 'H' contained a combined total of only 8 spider burrows. The ground within these areas contained high densities of surface rock (see Figure 2). Survey areas 'C', 'D', 'E', 'F', 'G' and 'I' contained no spider burrows. This is likely due to a combination of high densities of surface rock and large areas of dense ground cover vegetation (see Figure 3). A total of 52 spider burrows were inspected within survey area 'J', of which 46 contained spiders.

Survey areas 'A' to 'I' contained a very low density of spider burrows. Survey area 'J' supported a high number of spider burrows, the majority contained spiders. It is possible that PBT's could occur in suitable habitat adjacent to the current infrastructure corridors and turbine locations.

Figure 2. Surface rock within survey area 'B'.

Figure 3. Dense ground cover vegetation within survey area 'D'.

Table 2. Spider hole counts for infrastructure corridor and turbine location survey areas.

	Survey area										Total
	A	B	C	D	E	F	G	H	I	J	
Number of spider burrows detected and inspected	1	3	0	0	0	0	0	4	0	52	**60**
Number of spiders detected	1	1	0	0	0	0	0	2	0	46	**50**
Number of empty spider burrows	0	1	0	0	0	0	0	2	0	6	**9**
Number of PBT's detected	0	0	0	0	0	0	0	0	0	0	**0**

5 RECOMMENDATIONS

No PBT's were detected within the infrastructure corridor or turbine location areas. It is possible that PBT's could occur in habitat adjacent to the current infrastructure corridors and turbine locations. If any of the current infrastructure corridors or turbine locations are altered within potential PBT habitat, it is recommended that a presence / absence survey is conducted.

6 REFERENCES

EBS (2008). *Snowtown Windfarm Stage 2 Ecological Assessment.* Report to Wind Prospect Pty Ltd on behalf of AGL. Environmental and Biodiversity Services, Adelaide.

EBS (2009). *Snowtown Windfarm Stage 2 – Flora and Fauna Targeted Assessment and Transmission Line Assessment*. Report to Wind Prospect Pty Ltd on behalf of AGL. Environmental and Biodiversity Services, Adelaide.

Environmental & Biodiversity Services
2/48 Barwell Avenue
Kurralta Park, SA 5037
www.ebservices.com.au
t. 08 7127 5607
f. 08 8297 3768

APPENDIX F

ECOLOGICAL ASSESSMENT REPORT – TRANSMISSION CORRIDOR (ENVIRONMENT AND BIODIVERSITY SERVICES PTY LTD)

ebs
environmental & biodiversity services

Snowtown Wind Farm Stage 2 - Flora & Fauna Targeted Assessment & Transmission Line Assessment

2/48 Barwell Ave
Kurralta Park
SA 5037

Ph: 7127 5607
info@ebservices.com.au
www.ebservices.com.au

Snowtown Wind Farm Stage 2 - Flora & Fauna Targeted Assessment & Transmission Line Assessment

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Front cover photo: Wind turbine over exotic grassland

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- Catherine Lynch, *Wind Prospect Pty. Ltd.*
- Nathan Godfrey, *Wind Prospect Pty. Ltd.*
- Mark Telfer, *Suzlon Energy*, (site inductions and access)

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1 INTRODUCTION

An initial ecological assessment was conducted at the Snowtown Wind Farm in the Mid-north of South Australia (approximately 150 km north of Adelaide) by Environmental and Biodiversity Services (EBS) on behalf of Wind Prospect Pty Ltd in September 2008. Within this September 2008 survey, flora and fauna were assessed across the survey area and the surrounding landscape. The assessment focussed on determining vegetation associations and fauna habitat present within the Stage 2 project area, detailing their condition and significance, particularly in relation to threatened species and communities that may reside onsite. As an outcome of the September 2008 field survey efforts, several recommendations were made and were the catalyst for a second targeted survey conducted in July 2009.

The targeted survey conducted in July 2009 was undertaken to determine the likelihood of:

1. The nationally ***Endangered*** Pygmy Bluetongue Lizard (*Tiliqua adelaidensis*) listed under the *Environmental Biodiversity and Protection Conservation Act, 1999* (EPBC Act) inhabit the Stage 2 project area,
2. Potential disturbance from the proposed wind turbines to Wedge-tailed Eagles activity by determining the location and use of nest sites, and
3. Determine if the recorded *Lomandra effusa* (Iron Grass) Grasslands identified within the initial September 2008 survey qualify as the nationally ***Critically Endangered*** vegetation community, Iron-Grass Natural Temperate Grassland of South Australia, listed under the EPBC Act.

Additionally, a vegetation survey of the proposed transmission line options (option 1 & 2) was assessed this survey. An inventory of the vegetation associations present along the proposed routes were detailed, with particular reference to their condition and biodiversity value to the area. The results were used to determine the preferred option for the location of the transmission alignment from a biodiversity value.

This report is supplementary to the September 2008 report. For detailed information on site and regional descriptions, background research, prior results, discussion and recommendations refer to '*Snowtown Wind Farm Stage 2 Ecological Assessment - November 2008'* (EBS 2008).

1.1 Objectives

The objectives of this ecological assessment were to:

- Identify 'potential' Pygmy Bluetongue habitat within the Stage 2 proposed access tracks and turbine locations for a further detailed assessment in Spring 2009;
- Revisit the Wedge-tailed Eagle nest sites identified within the September 2008 survey and determine the use of these nests by breeding pairs;
- Complete a ground-search of woodland habitat within the southern section of Stage 2 project area for Wedge-tailed Eagle nest sites to supplement September 2008 survey results;
- Assess *Lomandra effusa* (Iron Grass) Grassland areas identified within the September 2008 survey against attributes listed in the '*Iron-grass Natural Temperate Grassland of South Australia EPBC Act Policy Statement 3.7*' to determine if they qualify as the ***Critically Endangered*** listed community (DEWR 2007); and
- Document vegetation associations along the two proposed transmission line options (option 1 & 2) recording flora species present, condition of vegetation, and any other noteworthy issues, so as to recommend the preferred option that will generate less impact on the biodiversity value of the area.

2 METHODOLOGY

A field assessment was conducted across the survey area at the proposed Snowtown Wind Farm Stage 2 project area on July 6 -10th, 2009. The proposed stage 2 access tracks and turbine locations were assessed for their potential impact on Pygmy Bluetongue habitat and *Lomandra effusa* (Iron Grass) Grassland locations. Targeted surveys of known Wedge-tailed Eagle nest-sites were conducted and an additional area within the southern section of the project site was traversed to survey for new nest site locations. See Figure 1 for the survey site locations.

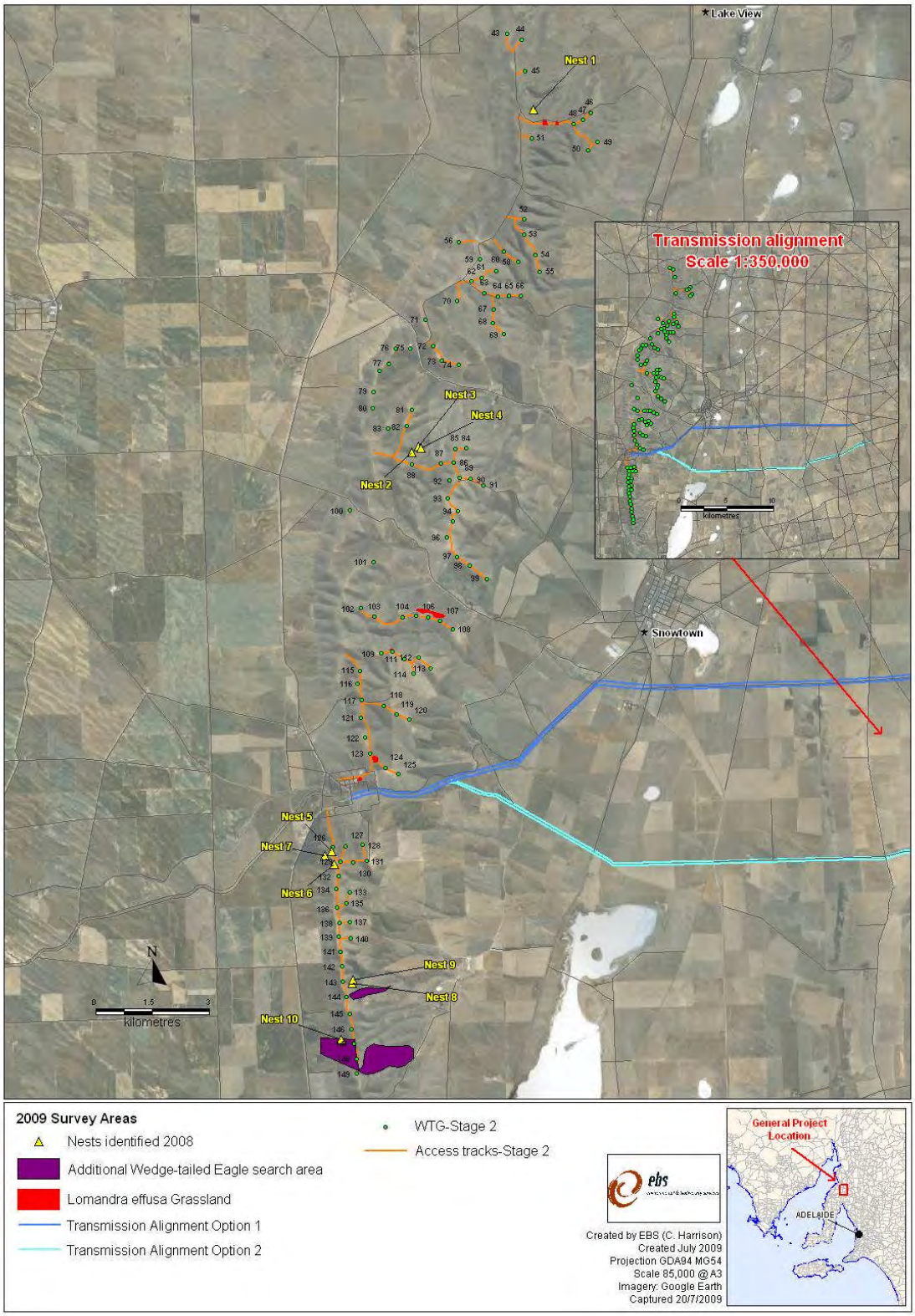

Figure 1. Survey locations for Pygmy Bluetongue Lizards, Wedge-tailed Eagle nest sites, and *Lomandra effusa* Grasslands

2.1 Pygmy Bluetongue (*Tiliqua adelaidensis*) Assessment

The survey techniques used for the Pygmy Bluetongue assessment involved the following steps:

- Visiting all Stage 2 proposed turbine locations and their associated access tracks by car or foot to assess the existing ground substrate and habitat attributes against preferred Pygmy Bluetongue habitat. Table 1 details attributes considered suitable and unsuitable for Pygmy Bluetongue habitat.

Table 1. Known suitable Pygmy Bluetongue habitat attributes versus unsuitable habitat attributes

Attributes considered suitable habitat	Attributes considered unsuitable habitat
Spider holes within native or exotic grasslands; lizards have been found in highly modified treeless grasslands	Spider holes containing *mygalomorph* and *lycosid* species
Soil of heavy sandy loam (red-brown earth)	Exposed ridgelines
Footslopes of hills	Overly rocky areas
Potentially sheltered areas of footslopes	Cropped land

- Any areas considered to support attributes contributing to suitable habitat for the lizard were marked on aerial photography and were mapped as areas to re-visit and survey in Spring 2009.
- General photos and site descriptions were recorded in areas of 'potential habitat'. Global Positioning System (GPS) waypoints were taken, if necessary.

2.2 Targeted Wedge-tailed Eagle (*Aquila audax*) Nest Search Assessment

The survey techniques used for the Wedge-tailed Eagle nest site assessment involved the following steps:

- All eleven Wedge-tailed Eagle nest sites identified in September 2008 were re-visited to determine their breeding status and if the nests were being utilised. A handheld GPS was used to find previously identified nests.
- The remaining un-surveyed woodland habitat within the southern section of the Stage 2 project area was searched on foot to locate any additional nests. This woodland habitat was traversed on-foot to search for medium to large sized trees where nest sites would be located. Binoculars were used to view distant trees before walking the area.

2.3 *Lomandra effusa* (Iron Grass) Grassland Assessment

The survey techniques for the *Lomandra effusa* Grassland involved the following steps:

- All *Lomandra effusa* (Iron Grass) Grassland locations identified within the September 2008 where re-visited and were surveyed to assess the community against attributes listed in the '*Iron-grass Natural Temperate Grassland of South Australia EPBC Act Policy Statement 3.7*' to determine if they qualify as the ***Critically Endangered*** listed community (DEWR 2007).
- The attributes used to assess the *Lomandra effusa* Grassland are identified through a flowchart within the Policy Statement. This flow chart was utilised in the field to determine the likelihood of the Grasslands resulting in the EPBC Act listed ecological community. The Policy statement and associated flowchart can be obtained from the following link:
  http://www.environment.gov.au/epbc/publications/peppermint-box-iron-grass-policy.html

2.4 Transmission Line Assessment

The survey techniques for the transmission line assessment involved the following steps:

- Both transmission alignment routes were first driven to confirm the exact alignment. Areas traversing public land were not accessed and public roads were followed. The actual route driven and non-accessible areas were delineated on aerial photography.
- Vegetation within both transmission lines was assessed starting from the eastern end and terminated at Barunga Gap (western end).
- For each transmission line, vegetation within the road verge on both sides of the road was assessed. Notes on the environmental landscape bordering the road verge were also recorded.
- The vegetation assessment included recording:
  - Changes in vegetation associations along the alignment which were documented by taking GPS waypoints. A vegetation association is defined by recording the dominant species and its structure. For example *Eucalyptus oleosa* Open Mallee was defined in the survey area, whereby *Eucalyptus oleosa* is the dominant

species and Open Mallee is the structural description of the dominant species. A change in vegetation association is recorded when a change in the dominant species is noted.

- Condition ratings were applied to each vegetation association recorded. Condition rating definitions applied in the field are detailed in Table 2.
- Species lists (native and exotic flora) were compiled for each vegetation association.
- Areas considered to contribute moderate-high biodiversity value to the local environment were recorded as areas best avoided.
- Representative photos were taken of each vegetation association, or of any areas of particular interest for reporting purposes.

Table 2. Ratios used to rate condition of vegetation communities within the transmission alignments

Vegetation Condition	Ratio
Clearance consists of lopping of limbs, not affecting the health of the tree/shrub	0
Weed-dominated with only scattered areas or patches of native vegetation Indicated by: Vegetation structure no longer intact (eg. Removal of one or more vegetation strata) Scope for regeneration , but not to a state approaching good condition without intensive management Dominated by very aggressive weeds Partial or extensive clearing (> 50% of area) Evidence of heavy grazing (tracks, browse limes, species changes, no evidence of soil surface crust)	2:1 (area)
Native vegetation with considerable disturbance Indicated by: Vegetation structure substantially altered (e.g. One or more vegetation strata depleted) Retains basic vegetation structure or the ability to regenerate it Very obvious signs of long-term or severe disturbance Weed dominated with some very aggressive weeds Partial clearing (10 – 50% of area) Evidence of moderate grazing (tracks, browse lines, soil surface crust extensively broken)	4:1 (area)
Native vegetation with some disturbance Indicated by: Vegetation structure altered (e.g. One or more vegetation strata depleted) Most seed sources available to regenerate original structure Obvious signs of disturbance (e.g. tracks, bare ground) Minor clearing (<10% of area) Considerable weed infestation with some aggressive weeds Evidence of some grazing (tracks, soil surface crust patchy)	6:1 (area)
Native vegetation with little disturbance	8:1 (area)

Indicated by: Vegetation structure intact (e.g. all strata intact) Disturbance minor, only affecting individual species Only non-aggressive weeds present Some litter build-up	
Intact vegetation Indicated by: All strata intact and botanical composition close to original Little or no signs of disturbance Little or no weed infestation Soil surface crust intact Substantial litter cover	10:1 (area)
Adapted from '*Guidelines for a Native Vegetation Significant Environmental Benefit Policy (*DWLBC, 2005).	

3 RESULTS

3.1 Pygmy Bluetongue (*Tiliqua adelaidensis*) Assessment

Generally, the majority of habitat available within the project area was considered unsuitable for Pygmy Bluetongues; these areas do not require further assessment. These 'unsuitable' areas are generally located on exposed ridge tops or footslopes where the soil surface is too rocky (Figure 2), or on lower ground that has been cropped. The substrate becomes progressively rockier in the southern sections of the project area compared to the northern areas; therefore, most of the areas requiring additional survey are focused in the northern and mid-sections of the project area. Ten areas were identified as potential Pygmy Bluetongue habitat and need further assessment within Spring 2009 These areas were generally degraded, but supported some native grass tussocks, were on footslopes or flatter ground, and contained few to nil rocks (Figure 3). Figure 16 details the areas for further survey in Spring 2009.

Figure 2. Example of unsuitable Pygmy Bluetongue habitat due to rocky ground

Figure 3. Potential Pygmy Bluetongue habitat on a gentle slope (presence of native grass and less rocky)

3.2 Targeted Wedge-tailed Eagle (*Aquila audax*) Nest Search Assessment

None of the eleven nest sites revisited this survey contained eggs or adult birds, indicating that eggs had not yet been laid. However, there were signs of activity in several nests, and Wedge-tailed Eagles were often sighted either perching in trees within close proximity to nests, or were seen in flight within the general vicinity. Overall, there appears to be five breeding pairs utilising nest sites across the entire wind farm site. The following section details each breeding pair and identifies their likely nest sites.

3.2.1 Breeding Pair 1

Wedge-tailed Eagle Nest 1

Nest 1, located at the northern end of the existing Stage 1 instillation, is situated high in a gully close to the major ridge line (Figure 16). This nest is situated in a dead *Allocasuarina verticillata* which is approximately 50 m from the top of the nearby ridgeline (Figure 4). Nest 1 is 400 m from the existing turbine WTG 5, and 780 m from the proposed turbine WTG 51 to the south (Figure 16). This nest was active last year, as a single chick and a pair of Wedge-tailed Eagles were observed flying overhead (EBS 2008).

No adult Wedge-tailed Eagles were recorded in the vicinity of the nest in the current survey, indicating that the pair had not yet laid eggs or begun incubation.

Nest 1, is located approximately 780m from the proposed turbine WTG51, which is outside the recommended 300m buffer, so there are no issues with turbine location. Visual and noise disturbance through the breeding season is the issue at this nest. It is located less than 300m from the proposed road that will provide access the turbine string WTG46 – 50 to the east. Nest 1 has clear views across a gully to the ridge where the road will be located, so we recommend a ‘quiet-period’ be considered for this road during construction. See detailed section below, concerning the duration and implications of a ‘quiet-period’.

Figure 4. Wedge-tailed Eagle Nest 1, showing the proximity to WTG5

3.2.2 Breeding Pair 2

Wedge-tailed Eagle Nest 2

Nest 2 is located in a thin and sparse patch of open *Allocasuarina verticillata* Woodland on the northern side of a deep gully on the eastern side of the major ridge line (Figure 16). The nest is situated in a 7 m tall *Allocasuarina verticillata,* which is one of the dominant trees in the small fragment of woodland habitat (Figure 5). The nest bowl is approximately 120 m below the top of the minor ridgeline, and approximately 320 m from the proposed turbine WTG 88 (Figure 16). This nest was active last year, as two chicks were observed, and a pair of Wedge-tailed Eagles were located nearby (EBS 2008).

Wedge-tailed Eagle Nest 3

A secondary Wedge-tailed Eagle nest is located approximately 150 m to the east, further down the same gully. This nest is also situated in an *Allocasuarina verticillata*, but is much smaller than Nest 2. Nest 3 was inactive the previous breeding season (EBS 2008), and is unlikely to be used in the coming breeding season, as it is a small and old looking nest with no signs of recent nest building activity. This nest is approximately 520 m from WTG 88.

Wedge-tailed Eagle Nest 4

The third nest site of Wedge-tailed Eagle breeding pair 2 is located approximately 20 m down the gully from Nest 3 (Figure 16), and is also situated in a dead *Allocasuarina verticillata* (Figure 6). This nest is much larger than both Nest 2 and Nest 3, but was not used in the previous breeding season (EBS 2008). There were signs of recent nest building activity, and relatively fresh whitewash (bird excrement) under the nest is further evidence it has been visited recently. This nest is approximately 490 m from WTG 88.

Two Wedge-tailed Eagles were sighted in the area, and are likely to be the resident breeding pair. Upon arrival one bird was flushed from a perch in trees near the nest sites, and the second bird was flushed from a solitary *Allocasuarina verticillata* high on the ridge above the nest sites. Both birds flew together overhead, and over the ridge to the north and south of the nest sites, then perched together on the solitary *Allocasuarina verticillata* on the ridgeline. Their breeding status was confirmed as they were observed copulating. This suggests that the pair will lay eggs in one of their three nest sites in the coming few weeks.

A cluster of 3 nests (Nest 2,3 and 4) all belonging to a single breeding pair occur just over 300m from turbine WTG88. More specifically, Nest 2 is approximately 320m from WTG88, Nest 4-490m, and Nest 3-520m. Given the solitary location of turbine WTG 88 along the ridge to the south of these nests we recommend that this turbine be micro-sited to maximize the distance from all 3 nests. It should be reiterated that the recommended buffer of 300m represents a minimum distance. See detailed section below, concerning the recommendations on a buffer distance.

Also, the breeding pair at these nest sites commonly perch on a solitary tree (*Allocasuarina*) up hill and behind their nests. From this point they have good views due south across the gully to the opposite ridge where WTG88 is proposed, as well as a road that will access the turbine string WTG84 -99. We recommend a ‘quiet-period’ be considered for this road. See detailed section below concerning the duration and implications of a ‘quiet-period’.

Figure 5. Wedge-tailed Eagle Nest 2

Figure 6. Wedge-tailed Eagle Nest 4

3.2.3 Breeding Pair 3

Wedge-tailed Eagle Nest 5

Nest 5 is located on the south eastern side of a wide gully, high on the ridge to the south of Barunga Gap Road (Figure 16). The nest is situated in a small patch of *Eucalypts* approximately 80 m from the ridge top below a weather station (Figure 7). This small sized nest was inactive last year (EBS 2008), and there were no signs of activity this year. Nest 5 is within close proximity to four proposed turbine locations, being 100 m from WTG 126, 390 m from WTG 128, and 360 m from WTG 129 (Figure 16).

Wedge-tailed Eagle Nest 6

Nest 6 is located on the western side of the major ridgeline, approximately 60 m from the ridgetop (Figure 16), in a moderate sized patch of *Eucalypts* (Figure 8). The nest is a secondary nest for breeding pair 3. It is relatively small, and was inactive the previous breeding season (EBS 2008). There were no signs of recent activity, suggesting that it is unlikely to be used for nesting in the coming season. This nest is approximately 170 m from WTG 129, and 330 m from WTG 132.

Wedge-tailed Eagle Nest 7

Nest 7 is the third nest that has been located for breeding pair 3 (Figure 9). This nest is approximately 330 m from Nest 6, and 210 m from Nest 5, and is the larger of the three. There were recent signs of nesting activity, as new sticks had been placed around the nest bowl, and whitewash was present on the ground beneath the nest. This nest is approximately 290 m from WTG 126, and 440 m from WTG 129 (Figure 16).

A pair of Wedge-tailed Eagles assumed to be the pair occupying Nests 5, 6 and 7, were observed 500 m to the south of the nest cluster. The birds were flushed from a perch atop a solitary dead *Allocasuarina verticillata* located on the top of the prominent ridgeline. The pair flew extensively over the ridge top behind the nest for 5 minutes, then again perched in the dead *Allocasuarina verticillata* on the ridge top, and began copulating. This observation confirms that the breeding pair are attempting breeding this year, and will likely lay eggs in Nest 7.

Nests 5, 6 and 7 belonging to another single breeding pair, and occur within close proximity to WTG 126 and 129. More specifically, the proposed location of WTG126 is approximately 100m from Nest 5, 340m from Nest 6, and 290m Nest 7. Turbine WTG129 is 360m from Nest 5, 170m from Nest 6, and 440m from Nest 7. Due to the close proximity of these two turbines to nests it is recommended that they are both relocated to provide a 300m buffer around all nests. Again, increasing the buffer distance is highly likely to lessen the potential for collision, and reduce the chances of disturbance to breeding. Relocating the two turbines to the tops of hills 200-500m further north may be an option. Where relocation of both turbines is not possible, it is highly recommended that their position be micro-sited to maximise the distance from nests. This is especially necessary for turbine WTG126, due to the close proximity with Nest 5.

Also, the proposed access road is within close proximity to these nest sites. As this is the only means of accessing the entire turbine string to the south implementing a 'quiet-period' during construction may not be feasible. It is recommended that an alternate route for the road be considered on either of the two hills to the east. Each hill provides access to the same ridge top, and would increase the distance between the road and nests. It is recommended that access and construction activities within the visible zone from the nest sites be limited throughout the breeding season. A series of activities that are deemed acceptable and non acceptable are outlined in the detailed section below, and should be employed as a means of minimising disturbance to this breeding pair.

Figure 7. Wedge-tailed Eagle Nest 5, indicated by red arrow, showing the proximity to the ridge top, and weather station

Figure 8. Wedge-tailed Eagle Nest 6

Figure 9. Wedge-tailed Eagle Nest 7

3.2.4 Breeding Pair 4

Wedge-tailed Eagle Nest 8

Nest 8 is located in a large patch of *Eucalyptus oleosa* Low Woodland high on the eastern side of the prominent ridge line (Figure 16). The nest is situated in a sizeable *Eucalypt* (Figure 10) on the hill side, and is very large. Last year this nest was used for breeding, which was confirmed by the presence of a chick and adult birds at the nest (EBS 2008). This nest is approximately 270 m from the proposed turbines WTG 143, and 402 m from WTG 144 (Fig 1). Nest 8 is likely to be active this year, as a freshly killed rabbit was seen in the nest bowl, indicating that Wedge-tailed Eagles had visited the site recently.

Wedge-tailed Eagle Nest 9

Nest 9 is a secondary nest of Breeding Pair 4, as it is located only 120 m from Nest 8. It is also situated low on the hill within a large patch of *Eucalyptus oleosa* Low Woodland. The nest is the largest on site, as it stands over 2.5 m high, and 1 m wide (Figure 11). It was not used for breeding last year (EBS 2008), and will unlikely be used this breeding season, due to the activity at Nest 8. Nest 9 is approximately 280 m from the proposed turbine WTG 143 (Figure 16).

Nests 8 and 9 belong to another breeding pair, and are located 270m, and 280m from the proposed location of turbine WTG143. While this is close to the recommended minimum buffer of 300m, the layout of this site raises real concerns for the safety of this breeding pair compared to other pairs across the wind farm. In general, Wedge-tailed Eagles concentrate their flight activity over the top of the ridge directly behind their nest site. Where nests are located on the hills off a prominent ridge the resident eagles will mainly fly over the prominent ridge. In contrast, where a nest site is located on the hill off a side ridge then the resident eagles will concentrate flight over the side ridge. Because nests 8 and 9 are located on the easterly slope of the prominent ridgeline where turbines are proposed, the birds are highly likely to concentrate their flight activity over this ridge. In other areas across the site nests are located off a side ridge which is free of turbines. The breeding pair at Nest site 8 and 9 were recorded flying heavily over the ridge top where turbines WTG142-144 are proposed. This case provides an example of how each nest site may need to be dealt with in an individual manner, because collision risk is likely to vary between based upon the lay of the land around each nest.

Figure 10. Wedge-tailed Eagle Nest 8

Figure 11. Wedge-tailed Eagle Nest 9

3.2.5 Breeding Pair 5

Wedge-tailed Eagle Nest 10

Nest 10 is situated in a small patch of low woodland approximately 250 m down the side of the hill on the western side of the major ridgeline (Figure 16). This nest is situated in a tall *Eucalypt* with prominent views over the woodland below, and grassy paddocks in the area (Figure 12). This nest was used for breeding last year, as a downy chick, and a pair of Wedge-tailed Eagles were observed in the vicinity (EBS 2008). This nest is likely to be used for breeding this season as the nest bowl contained green *Eucalypt* leaves. Breeding eagles line the nest bowl with leaves prior to egg laying. Also, a single Wedge-tailed Eagle was flushed from a perch in a nearby *Eucalypt*. The bird flew overhead numerous times during a 5 minute period, and soared high over the prominent ridge line to the east. This eagle then perched on a dead tree trunk on the ridge top directly behind the nest where turbine WTG146 is proposed, and also flew south to perch on another fallen tree in the vicinity of proposed turbine WTG 147. Nest 10 is

approximately 350 m from the proposed turbine WTG147, and 390 m from WTG 146 (Figure 16).

Wedge-tailed Eagle Nest 11

This nest is situated in a patch of woodland that was not searched the previous year (EBS 2008). It is located deep in a vegetated gully to the east of the prominent ridgeline (Figure 16). The nest itself is relatively small in size, and is partially falling out of the moderate sized *Eucalypt* in which it sits (Figure 13). This suggests that the nest was not used the previous breeding season, and is unlikely to be used in the coming season. Also, no Wedge-tailed Eagles were sighted in the area during this survey, so it is unlikely to be used this season. This nest may belong to breeding pair 5 to the east, or breeding pair 4 to the north. Nest 11 is located approximately 560 m from turbine WTG148.

Wedge-tailed Eagle Nest 12

Another Wedge-tailed Eagle nest was located further down the gully from Nest 11. It was situated in a large *Eucalypt* at the edge of a gully, and on the margin of the woodland patch. As for Nest 11, it is unclear if it belongs to breeding pair 5 to the east, or breeding pair 4 to the north.

Figure 12. Wedge-tailed Eagle Nest 10

Figure 13. Wedge-tailed Eagle Nest 11

3.3 *Lomandra effusa* (Iron Grass) Grassland Assessment

The *Lomandra effusa* Grassland areas do not qualify as the ***Critically Endangered*** listed community under the EPBC Act. While these patches of *L. effusa* Grassland do not qualify as a threatened community, native grasslands are very poorly conserved within South Australia and therefore, any degraded grassland offers biodiversity value to the local area. A large patch of *L. effusa* Grassland as well as the state ***Vulnerable*** threatened community, *Allocasuarina verticillata* Woodland, are present near the access track of WTG102 – WTG108 (Figure 14 & 15). Refer to section 3.5.1 for more detail on *Allocasuarina verticillata* Woodland and its status as a state threatened ecological community. Figure 16 shows the location of these areas.

Figure 14. Large patch of *Lomandra effusa* Grassland near access track of WTG102 – WTG108

Figure 15. *Allocasuarina verticillata* Woodland near access track of WTG102 – WTG108

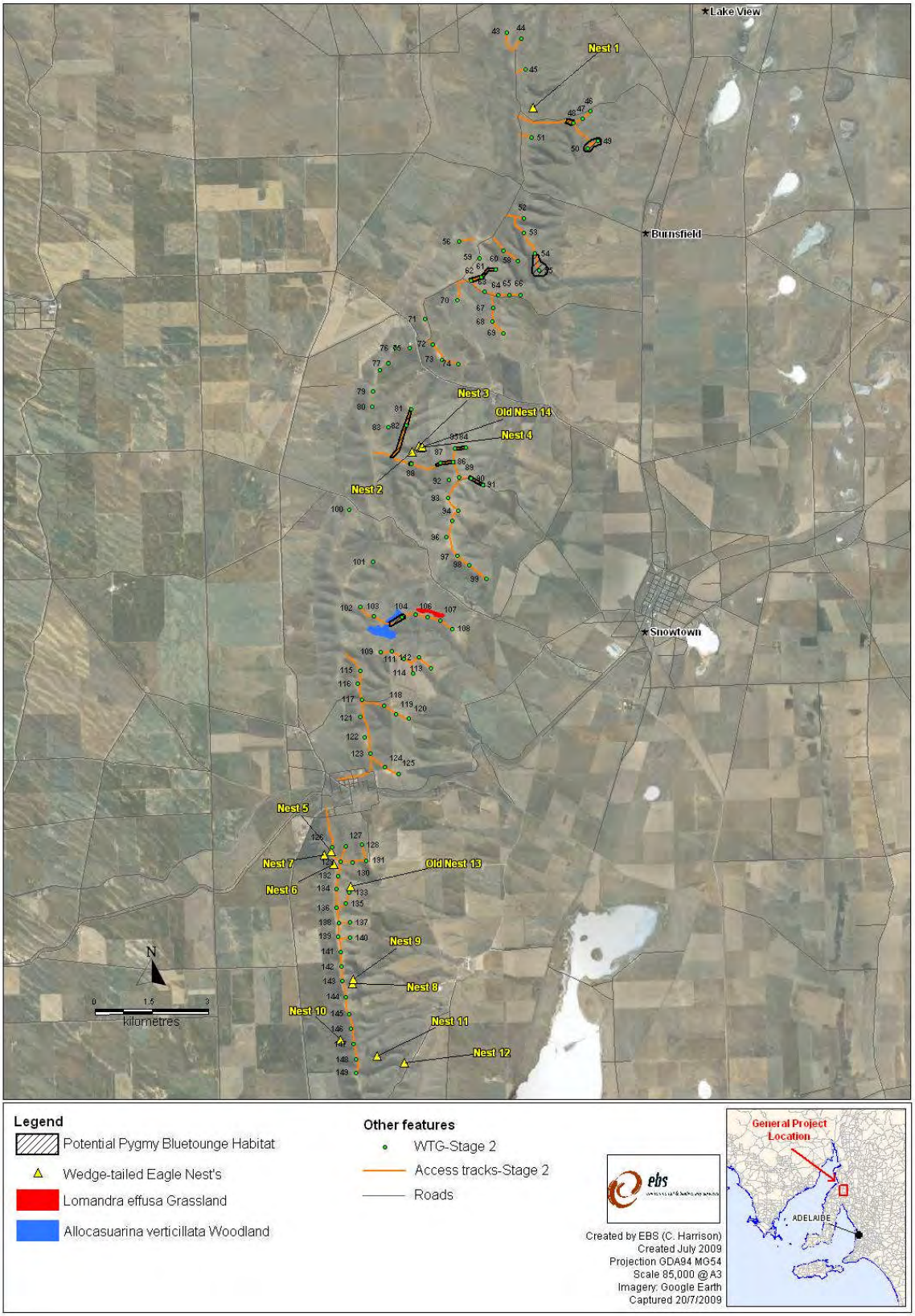

Figure 16. Locations of potential Pygmy Bluetongue habitat, Wedge-tailed Eagle nest site locations, and large patch of *Lomandra effusa* Grassland and *Allocasuarina verticillata* Woodland

3.4 Transmission Line Assessment

A total of 12 vegetation associations were defined across both transmission alignments. Each vegetation association is described below, with representative photos. See section 3.4 for more detailed descriptions of vegetation associations within each transmission line option and their locations. Appendix 1 details individual flora species detected within each vegetation association, as determined through the field survey.

3.4.1 Vegetation Association Descriptions

Vegetation association 1

Name: *Eucalyptus socialis* (Red Mallee) +/- *Eucalyptus oleosa* ssp. *oleosa* (Red Mallee) +/- *Eucalyptus porosa* (Mallee Box) Open Mallee

Overstory / midstory species: The dominant overstorey species detected was *Eucalyptus socialis*. This species was usually accompanied with two other Mallee species, *Eucalyptus oleosa* ssp. *oleosa*, and *Eucalyptus porosa* throughout the majority of the association. Common midstory species included *Acacia ligulata* (Umbrella Wattle), *Acacia sclerophylla var. sclerophylla* (Hard-leaf Wattle), *Eremophila longifolia* (Weeping Emubush), *Geijera linearifolia* (Sheep Bush) and *Senna artemisioides ssp. coriacea* (Broad-leaf Desert Senna).

Understory species: Common native understory species throughout the association included *Enchylaena tomentosa var. tomentosa* (Ruby Saltbush), *Maireana brevifolia* (Short-leaf Bluebush), *Rhagodia parabolica* (Mealy Saltbush) and *Rhagodia preisii* ssp. *preissii* (Mallee Saltbush). Sections of the understorey were dominated with introduced species; common species included *Carrichtera annua* (Wards Weed), *Echium plantagineum* (Salvation Jane) and *Oxalis pes-capra*e (Soursob).

Emergent species: *Callitris gracilis* (Southern Cypress Pine), *Eucalyptus gracilis* (Yorrell), *Exocarpus aphyllus* (Leafless Cherry) and *Myoporum platycarpum* (False Sandalwood).

Conservation significant flora species: No national or state conservation rated flora species were detected during the current survey. *Santalum acuminatum* (Quandong) which has a conservation rating of ***Uncommon*** within the Northern Lofty botanical region was recorded as a scattered species within the association.

Condition: The average condition rating of the association was considered to be 2:1 - 3:1, however, two sections of the association assessed were given a rating of 4:1 and 5:1.

Comments: *Lycium ferocissimum* (African Boxthorn), which is a declared weed under the *Natural Resources Management Act, 2004* was recorded as a scattered species throughout the association.

Figure 17. *Eucalyptus socialis* (Red Mallee) +/- *Eucalyptus oleosa* ssp. *oleosa* (Red Mallee) +/- *Eucalyptus porosa* (Mallee Box) Open Mallee

<u>Vegetation association 2</u>

Name: *Senna artemisioides* ssp. *coriacea* (Broad-leaf Desert Senna) +/- *Acacia* mix species Open Shrubland

Overstory / midstory species: Common species included *Acacia ligulata*, *Acacia hakeoides* (Hakea Wattle), *Acacia sclerophylla var. sclerophylla* and *Senna artemisioides ssp. coriacea*.

Understory species: Common native understory species throughout the association included *Enchylaena tomentosa var. tomentosa*, *Maireana brevifolia* and *Rhagodia parabolica*. Sections

of the understorey were dominated with introduced species such as *Carrichtera annua* and *Oxalis pes-caprae* (Soursob).

Emergent species: *Eucalyptus socialis* and *Eucalyptus oleosa* ssp. *oleosa.*

Conservation significant flora species: No national or state conservation rated flora species were detected during the current survey.

Condition: All areas identified as Association 2 were considered to have a condition rating of 2:1.

Comments: Some of the areas within the association contain revegetation plantings using locally common species. The revegetation is estimated to have been planted between 5-8 years ago.

Figure 18. *Senna artemisioides* ssp. *coriacea* (Broad-leaf Desert Senna) +/- *Acacia* mix species Open Shrubland

Vegetation association 3

Name: Exotic Grassland

Overstory / midstory species: None recorded

Understory species: The understorey / ground cover layer of vegetation is dominated by introduced species with only a low percentage of native species persisting. Common weed species included *Avena barbata* (Wild Oats), *Carrichtera annua*, *Echium plantagineum*, *Oxalis pes-capra*e, *Piptatherum miliaceum* (Rice Millet) and *Sonchus oleraceus* (Common Sow-thistle). Native species include *Austrodanthonia* sp. (Wallaby Grass), *Austrostipa* sp. (Spear Grass), *Maireana brevifolia* and *Themeda triandra* (Kangaroo Grass).

Emergent species: *Acacia* sp., *Eremophila longifolia* and *Senna artemisioides ssp. coriacea*.

Conservation significant flora species: No national or state conservation rated flora species were detected during the current survey.

Condition: All areas identified as Association 3 were considered to have a condition rating of 1:1.

Comments: Some of the areas within the association contain revegetation plantings using locally common species. The revegetation is estimated to have been planted between 5-8 years ago. Sections of the Exotic Grassland intersects *Eucalyptus Camaldulensis* (Red Gum) Creeklines (See Figure 16 for locations)

Figure 19. Exotic Grassland

Vegetation association 4

Name: *Nitraria billardierei* (Nitre Bush) Open Shrubland.

Overstory / midstory species: *Nitraria billardierei.*

Understory species: The understorey / ground cover layer of vegetation is dominated by introduced species with only a low percentage of native species persisting. Common weed species included *Avena barbata*, *Carrichtera annua*, *Echium plantagineum*, *Oxalis pes-caprae* and *Piptatherum miliaceum*. Native species include *Austrodanthonia* sp., *Austrostipa* sp., *Maireana brevifolia* and *Themeda triandra*.

Emergent species: *Eucalyptus* sp. and *Acacia* sp.

Conservation significant flora species: No national or state conservation rated flora species were detected during the current survey. *Maireana aphylla* (Cotton-bush) which has a conservation rating of ***Vulnerable*** within the Northern Lofty botanical region was recorded as a scattered species within the association.

Condition: The condition of the association ranged from 1:1 – 2:1.

Comments: Some of the areas within the association contain revegetation plantings using locally common species. The revegetation is estimated to have been planted between 5-8 years ago.

Figure 20. ***Nitraria billardierei*** **(Nitre Bush) Open Shrubland**

Vegetation association 5

Name: *Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Samphire Low Shrubland.

Overstory / midstory species: None recorded.

Understory species: Common native species include *Tecticornia pergranulata* ssp. *pergranulata* and *Maireana brevifolia*.

Emergent species: *Nitraria billardierei*.

Conservation significant flora species: No national or state conservation rated flora species were detected during the current survey.

Condition: The condition of this association was considered to be 3:1.

Comments: The association is located within a low-lying saltpan. Flora species diversity is low due to the high saline conditions within the saltpan area.

Figure 21. *Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Samphire Low Shrubland

Vegetation association 6

Name: *Acacia ligulata* (Umbrella Bush) Open Shrubland

Overstory / midstory species: *Acacia ligulata*, *Acacia hakeoides*, *Melaleuca lanceolata* (Dryland Tea-tree) and *Senna artemisioides ssp. coriacea*.

Understory species: Common native understory species throughout the association included *Enchylaena tomentosa var. tomentosa*, *Maireana brevifolia* and *Rhagodia parabolica*. Sections of the understorey were dominated with introduced species such as *Carrichtera annua* and *Oxalis pes-caprae*.

Emergent species: *Eremophila longifolia*.

Conservation significant flora species: No national or state conservation rated flora species were detected during the current survey.

Condition: The condition of the association ranged from 1:1 – 3:1.

Comments: *Lycium ferocissimum* is a declared weed under the *Natural Resources Management Act, 2004* and was recorded as a scattered species throughout the association.

Figure 22. *Acacia ligulata* (Umbrella Bush) Open Shrubland

Vegetation association 7

Name: *Eremophila longifolia* (Weeping Emu-bush) Shrubland

Overstory / midstory species: *Eremophila longifolia*, *Acacia ligulata*, *Acacia hakeoides*, and *Senna artemisioides ssp. coriacea*.

Understory species: The understorey / ground cover layer of vegetation is dominated by introduced species with only a low percentage of native species persisting. Common weed species included *Avena barbata* (Wild Oats), *Carrichtera annua*, *Echium plantagineum*, *Oxalis pes-capra*e, *Piptatherum miliaceum* (Rice Millet) and *Sonchus oleraceus* (Common Sow-thistle). Native species include *Austrodanthonia* sp. (Wallaby Grass), *Austrostipa* sp. (Spear Grass) and *Maireana brevifolia*.

Emergent species: None recorded

Conservation significant flora species: No national or state conservation rated flora species were detected during the current survey.

Condition: The condition of this association was considered to be 3:1.

Figure 23. ***Eremophila longifolia*** **(Weeping Emu-bush) Shrubland**

Vegetation association 8

Name: *Eremophila longifolia* (Weeping Emu-bush) / *Acacia* mix species / *Allocasuarina verticillata* (Drooping Sheoak) Shrubland.

Overstory / midstory species: Common overstory species included *Eremophila longifolia*, *Acacia* mix species and *Allocasuarina verticillata*.

Understory species: The understory is dominated by a mix of native grass species including *Austrodanthonia* sp., *Austrostipa* sp., *Enneapogon nigricans* and *Themeda triandra*. Small areas containing *Calostemma purpureum* (Pink Garland-lily) were also detected. Sections of the understorey were dominated with introduced species such as *Carrichtera annua*, *Oxalis pes-caprae* and a range of introduced grass species.

Emergent species: *Acacia victoriae* (Elegant Wattle).

Conservation significant flora species: No national or state conservation rated flora species were detected during the current survey.

Condition: The condition of the association ranged from 4:1 - 6:1.

Figure 24. *Eremophila longifolia* (Weeping Emu-bush) / *Acacia* mix species / *Allocasuarina verticillata* (Drooping Sheoak) Shrubland

Vegetation association 9

Name: *Allocasuarina verticillata* (Drooping Sheoak) Grassy Low Woodland

Overstory / midstory species: *Allocasuarina verticillata*, *Acacia* mix species, *Bursaria spinosa ssp. spinosa* (Sweet Bursaria) and *Eremophila longifolia*.

Understory species: The understory is dominated by a mix of native grass species including *Austrodanthonia* sp., *Austrostipa* sp., *Enneapogon nigricans* and *Themeda triandra*. Common native broadleaf species throughout the association included *Enchylaena tomentosa var. tomentosa*, *Maireana brevifolia* and *Rhagodia parabolica*. Small areas containing *Calostemma purpureum* (Pink Garland-lily) were also detected. Sections of the understorey were dominated with introduced species such as *Carrichtera annua* and *Oxalis pes-caprae*.

Emergent species: *Pittosporum angustifolium* (Native Apricot)

Conservation significant flora species: No national or state conservation rated flora species were detected during the current survey.

Condition: The condition of the association ranged from 4:1 to 6:1.

Comments: Some of the areas within the association contain revegetation plantings using locally common species. The revegetation is estimated to have been planted between 3-4 years ago and is in good condition.

Figure 25. *Allocasuarina verticillata* (Drooping Sheoak) Grassy Low Woodland

Vegetation association 10

Name: Exotic / Native Grassland.

Overstory / midstory species: None recorded.

Understory species: The understorey / ground cover layer of vegetation is dominated by introduced species, however there a large patches of native grasses persisting within the association. Common weed species included *Avena barbata*, *Carrichtera annua*, *Echium plantagineum*, *Oxalis pes-capr*ae, *Piptatherum miliaceum* and *Sonchus oleraceus*. Native grass species include *Austrodanthonia* sp., *Austrostipa* sp., *Enneapogon nigricans* (Black-head Grass) and *Themeda triandra*.

Emergent species: Exotic species of *Pinus radiata* (Radiata Pine) and *Prunus sp.*

Conservation significant flora species: No national or state conservation rated flora species were detected during the current survey.

Condition: The condition of this association was considered to be 2:1.

Figure 26. Exotic / Native Grassland.

Vegetation association 11

Name: *Acacia victoriae* (Elegant Wattle) Open Shrubland

Overstory / midstory species: *Acacia victoriae*

Understory species: The understorey / ground cover layer of vegetation is dominated by introduced species with only a low percentage of native species persisting. Common weed species included *Avena barbata*, *Carrichtera annua*, *Echium plantagineum*, *Oxalis pes-capra*e, *Piptatherum miliaceum* and *Sonchus oleraceus*. Native species include *Austrodanthonia* sp. and *Austrostipa* sp.

Emergent species: Exotic species of *Pinus radiata* (Radiata Pine)

Conservation significant flora species: No national or state conservation rated flora species were detected during the current survey.

Condition: The condition of this association was considered to be 1:1.

Figure 27. *Acacia victoriae* (Elegant Wattle) Open Shrubland

Vegetation association 12 and 13

Name: Cropping Land and Revegetation

These vegetation associations are not described as they are modified environments. The cropping land is heavily degraded and is comprised of uniform 'cropping' flora species. An individual species list could therefore not be developed for this association. The revegetation area comprises replanted species.

Figure 28. Cropping land bordering roadside verge

3.4.2 Exotic species

A total of 22 weed species were detected within the transmission line alignments during the survey period (refer to Appendix 1 for full species list). Weed species declared under the *Natural Resources Management Act, 2004* included *Cynara cardunculus ssp. flavescens* (Artichoke Thistle), *Echium plantagineum* (Salvation Jane), *Euphorbia terracina* (False Capper), *Lycium ferocissimum* (African Boxthorn), *Marrubium vulgare* (Horehound), *Olea europaea ssp. europaea* (Olive), *Oxalis pes-caprae* (Soursob) and *Solanum elaeagnifolium* (Silver-leaf Nightshade). Three species classified as environmental weeds, *Cynodon dactylon var. dactylon* (Couch), *Pinus radiata* (Radiata Pine), and *Carrichtera annua* (Wards Weed) were also detected within the transmission line alignments.

3.4.3 Flora Species of Conservation Significance

No national or state conservation rated flora species were detected within the transmission line alignments during the current survey. Two species which have a conservation rating within the Northern Lofty botanical region were detected, including the ***Vulnerable*** *Maireana aphylla* (Cotton Bush) and the ***Uncommon*** *Santalum acuminatum* (Quandong).

3.5 Individual Flora Results for the Transmission Alignments

3.5.1 Transmission Alignment Option 1

Eleven of the 12 vegetation associations were recorded in Transmission Alignment Option 1 (Table 3). Within the alignment, pockets of vegetation of good condition were specifically located within *Eucalyptus socialis* (Red Mallee) +/- *Eucalyptus oleosa* ssp. *oleosa* (Red Mallee) +/- *Eucalyptus porosa* (Mallee Box) Open Mallee found at the eastern end (Figure 29), and within *Allocasuarina verticillata* (Drooping Sheoak) Grassy Low Woodland at the western end. The western end of the alignment alternated between *Allocasuarina verticillata* (Drooping Sheoak) Grassy Low Woodland and Exotic / Native Grassland. Additionally, revegetation of the roadside was evident in the western end. Within a heavily degraded environment where most of the landscape is dominated by pasture or cropping lands, remnant native roadside vegetation becomes increasingly important as in the case of the remaining Mallee within this area of the alignment.

The *Allocasuarina verticillata* (Drooping Sheoak) Grassy Low Woodland is listed as a threatened ecosystem of South Australia (DEH Provisional list 2005). This community was located in two areas on both sides of the road along the western end of Transmission Option 1. The revegetation increases the biodiversity value within this area, and also acts to promote conservation of this state threatened woodland. Table 4 provides more detail about this vegetation community.

Three *Eucalyptus camaldulensis* var. *camaldulensis* (River Red Gum) Creeklines intersect the road verge at the western end of this alignment, with large Red Gums existing within the actual roadside vegetation (Figure 30). One of the Red Gum Creeklines traverses private property, as does the proposed alignment of Option 1 (Figure 31). Additionally, railway infrastructure is also present on the right side of the road in this area.

Two sections of this proposed alignment were not accessed as the alignment passed through private land (Figure 33). However, these sections were identified as cropping land and do not provide any conservation value to the biodiversity of the area.

Figure 33 and 34 reveal the locations and spread of the vegetation associations and their conditions.

Table 3. Vegetation associations present and length covered along Transmission Alignment Option 1

Veg. Assoc.	Vegetation Association	Length (km)	
		Left	Right
1	*Eucalyptus socialis* (Red Mallee) +/- *Eucalyptus oleosa* ssp. *oleosa* (Red Mallee) +/- *Eucalyptus porosa* (Mallee Box) Open Mallee	5.29	4.54
2	*Senna artemisioides* ssp. *coriacea* (Broad-leaf Desert Senna) +/- *Acacia* mix species Open Shrubland	0.82	1.56
3	Exotic Grassland	4.85	4.85
4	*Nitraria billardierei* (Nitre Bush) Open Shrubland	3.34	3.34
5	*Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Samphire Low Shrubland	0.47	0.47
6	*Acacia ligulata* (Umbrella Bush) Open Shrubland	2.56	2.56
7	*Eremophila longifolia* (Weeping Emu-bush) Shrubland	0.99	0.98
8	*Eremophila longifolia* (Weeping Emu-bush) / *Acacia* mix species / *Allocasuarina verticillata* (Drooping Sheoak) Shrubland	1.25	1.23
9	*Allocasuarina verticillata* (Drooping Sheoak) Grassy Low Woodland	1.46	1.46
10	Exotic / Native Grassland	1.70	1.70
12	Cropping Land	2.28	2.30
	Total Length	25.00	25.00

Figure 29. *Eucalyptus socialis* (Red Mallee) +/- *Eucalyptus oleosa* ssp. *oleosa* (Red Mallee) +/- *Eucalyptus porosa* (Mallee Box) Open Mallee showing good quality vegetation

Table 4. State threatened vegetation communities

***Allocasuarina verticillata* Grassy Low Woodland recorded during the field survey**

Listed as 'Vulnerable' – *Allocasuarina verticillata* Grassy Low Woodland on clay loams of low hills

This vegetation association was once formerly extensive but much has been lost through clearance. The association is poorly conserved within the state, but some patches with good understorey remain. This association has been highly modified by clearance, grazing and invasion of exotic flora species.

Figure 30. *Eucalyptus camaldulensis* var. *camaldulensis* (River Red Gum) creekline intersecting the road verge

Figure 31. *Eucalyptus camaldulensis* var. *camaldulensis* (River Red Gum) traversing private property

3.5.2 Transmission Alignment Option 2

Eight of the 12 vegetation associations were recorded in Transmission Alignment Option 2 (Table 5). Overall, Transmission Alignment Option 2 was more degraded than Option 1, with more Exotic Grassland and Cropping Land recorded. *Eucalyptus socialis* (Red Mallee) +/- *Eucalyptus oleosa* ssp. *oleosa* (Red Mallee) +/- *Eucalyptus porosa* (Mallee Box) Open Mallee was also recorded within the western end of the alignment but overall condition was poor, unlike Transmission Alignment Option 1.

Two sections of the Option 2 alignment were not assessed in detail due to access issues as the alignment was directed through private property, and access was only gained on public roads. One of these sections was cropping land, however, the other area supported a large expanse of *Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Samphire Low Shrubland near the mid-section of the alignment (Figure 32). The vegetation assessment for this association was completed on the species present on the bordering roadside verge; however, it is important to note that the Shrubland within the neighbouring paddock appeared in good condition.

Figure 33 and 34 reveal the locations and spread of the vegetation associations and their conditions.

Table 5. Vegetation associations present and length covered along Transmission Alignment Option 2

Veg. Assocn.	Vegetation Association	Length (km)	
		Left	Right
1	*Eucalyptus socialis* (Red Mallee) +/- *Eucalyptus oleosa* ssp. *oleosa* (Red Mallee) +/- *Eucalyptus porosa* (Mallee Box) Open Mallee	5.50	5.36
2	*Senna artemisioides* ssp. *coriacea* (Broad-leaf Desert Senna) +/- *Acacia* mix species Open Shrubland	1.57	2.97
3	Exotic Grassland	5.74	5.70
4	*Nitraria billardierei* (Nitre Bush) Open Shrubland	8.00	6.88
5	*Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Samphire Low Shrubland	4.63	4.63
6	*Acacia ligulata* (Umbrella Bush) Open Shrubland	0.86	0.47
11	*Acacia victoriae* (Elegant Wattle) Open Shrubland	0.45	0.47
12	Cropping Land	2.63	2.63
13	Revegetation	n/a	0.29
	Total Length	29.40	29.40

Figure 32. *Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Samphire Low Shrubland within private land

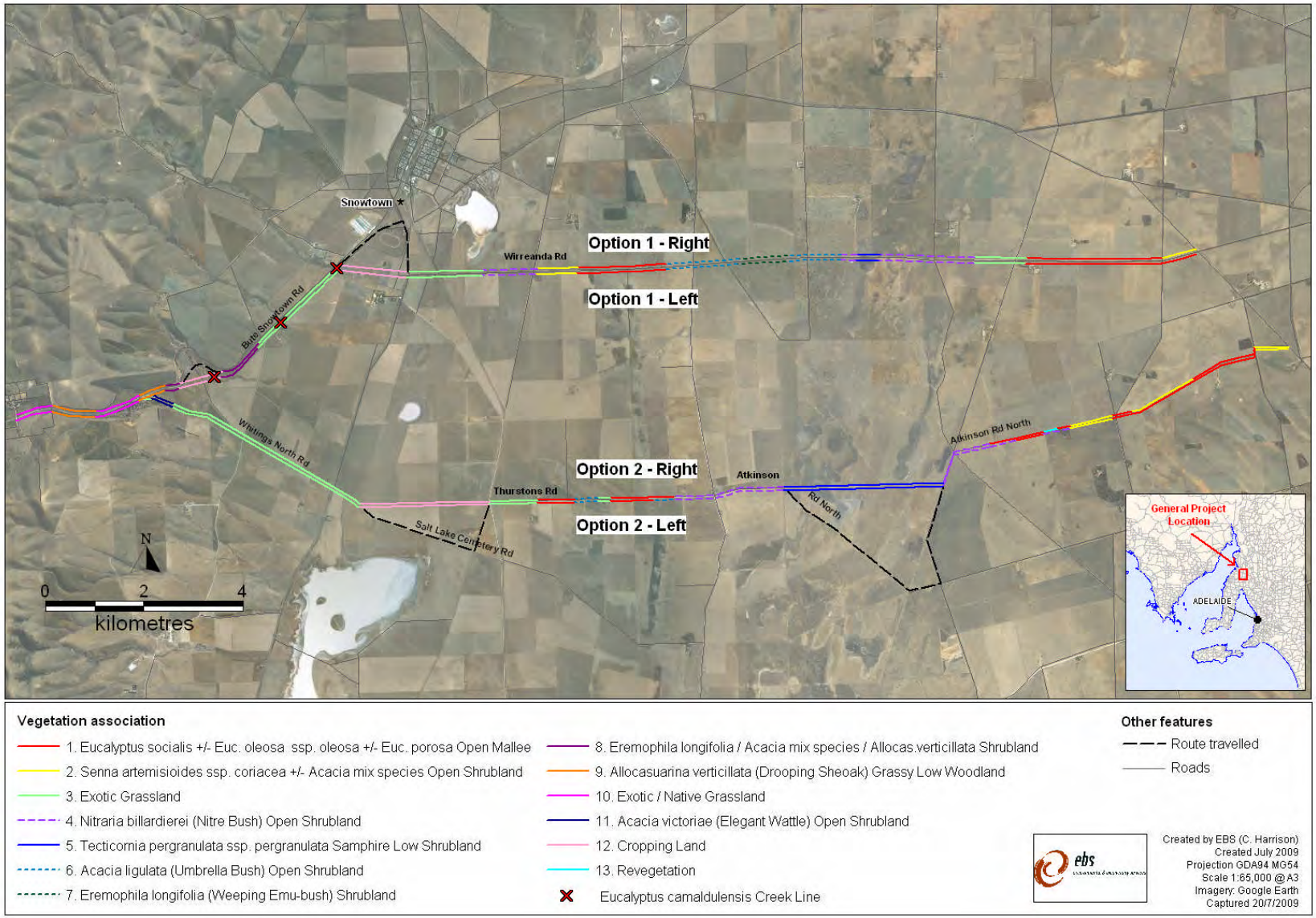

Figure 33. Vegetation associations recorded within Transmission Alignment Option 1 and 2 (black dashed lines denote public roads travelled in areas not accessed)

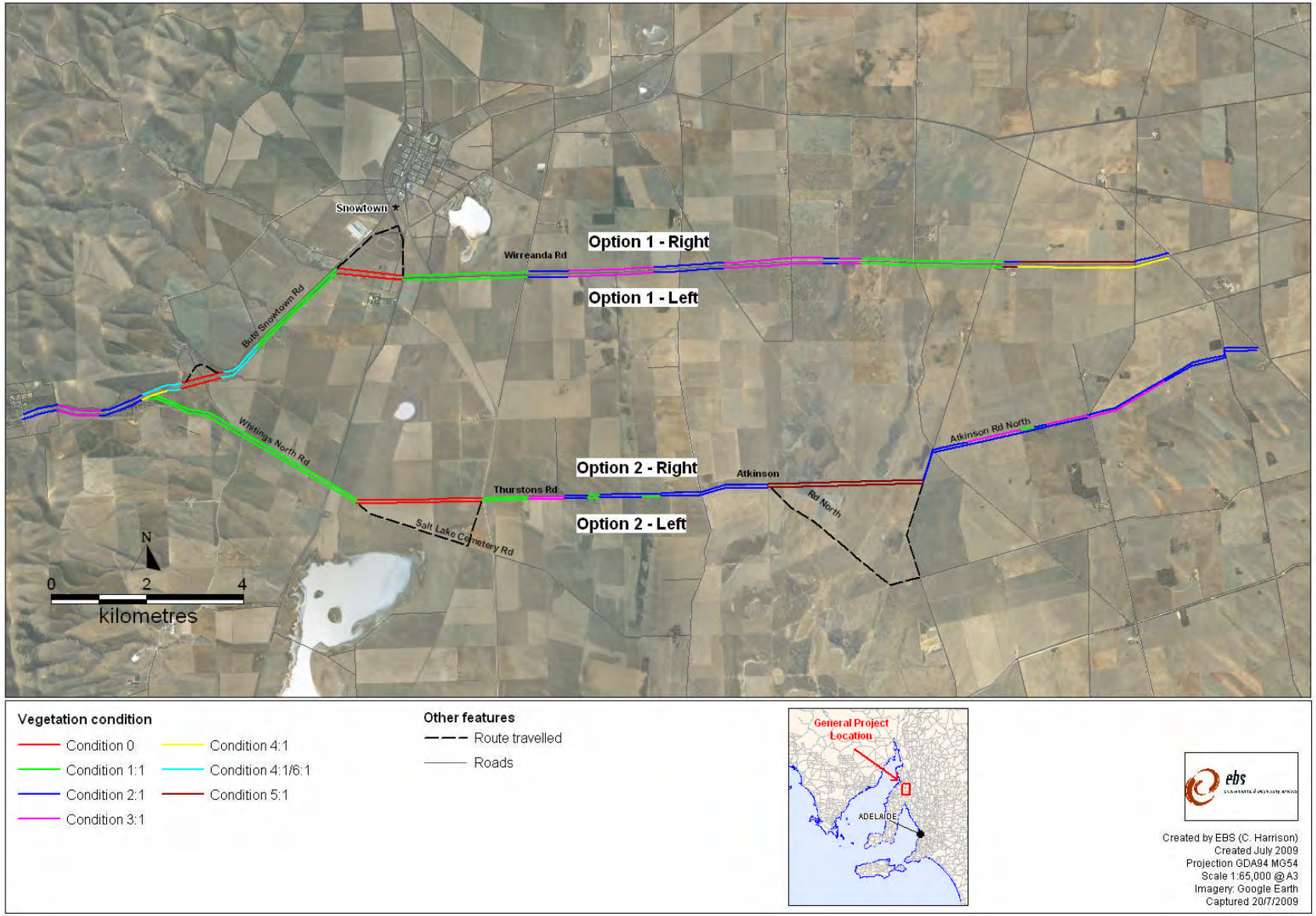

Figure 34. Condition of vegetation associations recorded within Transmission Alignment Option 1 and 2

4 DISCUSSION

4.1 Pygmy Bluetongue Assessment

Much of the area within the Wind Farm was confirmed as marginal, fragmented habitat where the soil profile was not adequate for suitably-sized spider holes to exist. Areas not considered 'potential' Pygmy Bluetongue habitat were land that was thought to have been previously ploughed and cropped, areas that lacked spider burrows, or lacked suitable spider burrows (poor soil structure and shallow depth), areas containing shallow soils with exposed rock / surface rock, and land that contained steep slopes. The potential habitat at the Snowtown Wind Farm is not considered ideal, however the Pygmy Bluetongue is known to inhabit highly degraded grasslands (Milne *et al.* 2000) and therefore the areas identified for further survey, while marginal, require further assessment.

Previous surveys conducted in the Mid-north for Wind Prospect (North Brown Hill Wind Farm) have located Pygmy Bluetongues in areas of low slopes supporting an Exotic Grassland +/- *Austrostipa* sp. (Spear Grass) +/- *Austrodanthonia* sp. (Wallaby Grass). The soils were generally red clay and were of solid structure (EBS, 2009). The North Brown Hill Wind Farm is further north and inland than Snowtown Wind Farm; however, similar attributes are present at the Snowtown Wind Farm. Thirty-three Pygmy Bluetongue records have been identified in the Hummock Ranges (between 2004-2007), as determined by Department for Environment and Heritage Biological Database records. These records are approximately 15 km south of the most southern proposed wind turbine (WTG149) (DEH 2008; Aaron Fenner pers. comm. 6th July 2009). The GPS locations of the 33 records are provided in Appendix 2.

4.2 Wedge-tailed Eagle Assessment

4.2.1 Suitability of the site for Wedge-tailed Eagles

The five Wedge-tailed Eagle breeding pairs that inhabit Snowtown Wind Farm represent a very high breeding density for this species. Factors that contribute to the suitability of this site for Wedge-tailed Eagle nest sites include its topography, the occurrence of remnant patches of native vegetation, and the high density of prey species (rabbits and macropods). Remnant

patches of native woodland on steep hills and in deep gullies provide suitable nesting locations for eagles, as these areas are well sheltered from the prevailing winds. A nest that is positioned high on the slopes of the prominent north-south ridgeline provides views over the surrounding landscape allowing eagles to scan their foraging territory from their nest tree, or other perches high on the ridge. Nest sites positioned close to bare hilltops is also an advantage for Wedge-tailed Eagles as they regularly forage over open areas of prominent ridgelines. Ridges are utilised regularly by eagles as the updrafts from wind patterns created by the topography of the surrounding hills can increase their flight efficiency. The agricultural district in which the wind farm is located is also likely to contain a high density of rabbits and kangaroos which are common prey of Wedge-tailed Eagles. The presence of these combined factors indicate that prominent ridge lines supporting scattered woodland vegetation provide vital breeding sites for eagles in the region.

4.2.2 Possible impacts of the proposed wind farm on Wedge-tailed Eagles

The major impacts of wind farms on eagles are reduced breeding success due to disturbance, and mortality through collision with turbines.

4.2.3 Disturbance Impacts

Wedge-tailed Eagles are notoriously fussy nesters and abandon nests if disturbed too much. The presence of turbines overhead with noise and constant movement of shadows across the landscape may distract breeding birds, or deter them from foraging in certain areas. Modifying the foraging areas of eagles, and disturbing them may reduce their ability to capture prey and feed their chicks. This can lead to nesting failure, or may cause eagles to abandon nesting attempts, or leave their breeding area altogether.

4.2.4 Collisions and Mortality

Due to the high density of Wedge-tailed Eagles across the Snowtown Wind Farm it is highly likely that interactions with turbine infrastructure will occur, some of which may lead to bird mortalities through direct collision. Of the entire bird community inhabiting the site, Wedge-tailed Eagles are at the highest risk of collision due to their flight behavior. They often concentrate their flight activities above ridges, and they regularly fly within the rotor-swept area of turbines (35 – 135 m) (Figure 35). Bird studies reviewed by Smales and Muir (2005) have shown that bird avoidance rates of wind farm infrastructure (involving the individual's successful avoidance

of collision) are around 95 %. Although the possible bird's strike rate at a wind farm development may be expected to be low (Madders and Whitfield 2006, Smales and Muir 2005), the effect may be significant for long-lived species with lower reproduction rates (Drewitt and Langston 2006). With the collection of wind farm developments in the area and the cumulative effect of these strikes over time, it is possible particular species may decline in the region.

Figure 35. A breeding pair of Wedge-tailed Eagles flying at rotor-swept height and in close proximity to a turbine at the Snowtown wind farm

4.2.5 Mitigation of Impacts to Wedge-tailed Eagles

While information exists on wind farm eagle interactions from the Northern Hemisphere (Drewitt and Langston 2006, Madders and Whitfield 2006), little information exists on the disturbance effects of wind farms on Wedge-tailed Eagles in Australia. At Snowtown Wind Farm the opportunity exists to investigate this, and provide much needed information on this issue. Due to the close proximity of the operational Stage 1 site to the proposed Stage 2 area it would be feasible to perform simultaneous pre- and post-construction surveys of Wedge-tailed Eagle activity in both areas. This would enable a robust scientific comparison of the utilisation rates of the ridge lines and other habitat in the area by breeding pairs, to determine the existence of any avoidance behaviour. The impact of the wind farm developments on the breeding success and

foraging behaviour of eagles could also be examined. Targeted Wedge-tailed Eagle habitat utilisation surveys are recommended at Snowtown Wind Farm to identify how each breeding pair utilises their habitat, especially their use of the ridge lines where turbines are positioned, or proposed. Collisions could be minimised at Snowtown Wind Farm by modifying the layout of turbines with consideration for how eagles utilise the site. Targeted Wedge-tailed Eagle habitat utilisation surveys are recommended at Snowtown Wind Farm to identify hot spots of flight activity. While activity may be concentrated across many areas of the ridge line and surrounding hills within an eagles foraging territory, it is certain that ridges within close proximity to nest sites will be heavily used.

Recommendations for a 270 - 300m buffer at all nest sites

There are numerous areas at the Snowtown Wind Farm where proposed turbine locations are within close proximity to Wedge-tailed Eagle nests. It is suggested that a buffer is applied to every Wedge-tailed Eagle nest site to reduce the likelihood of eagle collisions. The standards for risk assessment released by AusWEA (AusWEA Report 2005) makes no reference to the distances of buffers for Eagles or other high risk bird species. Ultimately how eagles utilise the air-space around their nests, and their entire territory will differ between sites, and between individuals. We propose that an interim buffer distance of 300 m be employed at the Snowtown Wind Farm, and recommend that post-construction surveys be employed at the Snowtown Wind Farm to assess the effectiveness of this buffer distance. This creates potential issues for the location of WTG126, WTG129, and WTG143.

It should be noted that the recommended buffer of 300m represents a minimum distance. Ultimately we do not know the impacts of positioning turbines close to nest sites, so all efforts should be taken to maximise the distance between nests and turbines, in an effort to reduce the disturbance on the eagles, and thereby reduce the chances of collisions, breeding failure, or nest abandonment. Reducing the buffer distance to 270m will be fine in cases where Wedge-tailed Eagle Habitat Utilisation Monitoring is planned for pre and post-construction. This will provide a means of validating the effectiveness/usefulness of these buffers. As expressed earlier, one or two sites with reduced buffers will provide for good comparisons. It is evident that locating all nests very early on in the planning process at all current and future wind farms will provide the beat outcomes, as a 300m buffer can be more easily incorporated in the positioning of turbines.

It is recommended that unused Wedge-tailed Eagle nest sites also be included in this approach, as breeding pairs often switch between multiple nest sites within their territory from one year to the next. A change in nest site by a breeding pair is well known, and is thought to follow breeding failure at one site. Breeding pairs often refurbish numerous nest sites within their territory early in the breeding season to provide a range of options where the female may lay the egg. Therefore an unused nest site may become an important breeding location in future years. It is recommended that both active and inactive Wedge-tailed Eagle nests be checked in spring of the 2009 breeding season to identify their status (i.e. active or inactive).

Wedge-tailed Eagles in the nearby region of the southern Mount Lofty Ranges breed from around mid-July to mid-December (Dennis 2006). Therefore, a possible recommendation is that work periods of infrastructure installation are planned around these dates in areas of active nest sites to allow the eagles to carry out their breeding operations undisturbed.

Recommendations for a 'Quiet Period' at some sites during construction

Due to the number of turbines planned for the wind farm it may be feasible to stager the construction schedule by timing access and construction activities across the site based on the occurrence of nests. We appreciate that the time constraints of the wind farm construction may deem it impossible to avoid some disturbance of eagles, but have provided a framework of activities to reflect what are deemed high risk and low risk activities.

Pre-planning activities for some areas so they occur outside the Wedge-tailed Eagle breeding season would reduce the chances of disturbing the birds. The areas of concern across a wind farm site are those ridge lines and gullies within the visible zone around 'active' nest sites (i.e. those used for breeding in a single year). Breeding eagles would benefit from reduced activity within the visible zone around their nests during their entire breeding season. This is a six month period from egg-laying in early-July to early-August to chick fledging in early to mid December (Dennis 2006). In instances where the visible zone around a nest cannot be avoided for 6 months, disturbance can likely be reduced by limiting access and construction activities through key periods. The period 6th July – 16th August is when eagles are most sensitive to disturbance, as they are laying eggs and beginning incubation. The most critical 8-9 week period of the entire breeding season would be from July 1st to Aug 31st. So avoiding construction and access through the visible zone during this period is essential. But it must be noted that if

activities performed after this period should also be restricted to a degree, as birds who lay eggs early (i.e. early July) will be rearing 1 wk old chicks when construction begins again, and those who layed late (early-mid August) would still be incubating eggs. A reduced construction period, or 'quiet period' of 8 to 9 weeks would be acceptable only if we can place some limitations on the kind of activities performed within the visible zone around each nest during this critical part of the breeding season. Again, remember that these restrictions are proposed to apply only to three relatively small sites across Snowtown WF, i.e. where roads or turbines are planned for areas highly visible from WTE nests.

If employing a quiet period shorter than 6 months it is valuable to outline some terms, which more clearly define activities which are suggested to be acceptable and non-acceptable during each period. This will more clearly define what we considered for the 'quiet period', and reveal that it is not intended to be a blanket 'stop-work' period.

Proposed activities within the visible zone around WTE nests:

1-Between June 1st to July 1st (copulation and nest building period)

-Regular vehicular access along road Is Acceptable

-Pegging out sites Is Acceptable (i.e. people walking along road and around areas of proposed turbines is OK, where these areas are outside a buffer of 270-300m))

-Construction of roads or turbines Not Acceptable

-Loud shock noises associated with drilling and other construction Not Acceptable

2-Between July 1st to Aug 31st (incubation and early chick rearing period)

-Regular vehicular access along road Not Acceptable

-Irregular vehicular access along road Is Acceptable (i.e. a few vehicles per day transiting through visible zone)

-Pegging out sites Not Acceptable

-Construction of roads or turbines Not Acceptable

-Loud shock noises associated with drilling and other construction Not Acceptable

3-Between Aug 31st to October 15th (early – mid chick rearing period)

-Regular vehicular access along road Is Acceptable

-Pegging out sites Not Acceptable

-Construction of roads or turbines Not Acceptable

-Loud shock noises associated with drilling and other construction Not Acceptable

4-Between October 15th to December 1st (late chick rearing and chick fledging period)

-Regular vehicular access along road Is Acceptable

-Pegging out sites Is Acceptable (i.e. people walking along road and around areas of proposed turbines is OK, these areas are outside a buffer of 270-300m)

-Construction of roads or turbines Is Acceptable, where these areas are outside a buffer of 270-300m. Loud shock noises associated with drilling, and other loud banging, tooting, or beeping noises are Not Acceptable.

Wedge-tailed Eagle habitat utilisation study

Survey work should also be considered which aims to assess the effectiveness of 'quiet-periods' and buffers. The most effective and comprehensive approach would be to conduct targeted Wedge-tailed Eagles habitat utilisation studies across the site, a minimum of two times. The first survey should be conducted for a minimum 5 days during early to mid chick rearing before turbine construction. A secondary survey replicating methods at the same eagle nests should be performed during the operation of the wind farm post-construction. These two surveys would provide a highly valuable means of assessing changes in flight behaviour (i.e. disturbance), and activity by the resident breeding pairs.

Further detail on the recommended survey methods, and the value of these surveys can be provided if required.

Monitoring of Wedge-tailed Eagle breeding success

It is recommended that the breeding success of all breeding pairs be monitored during construction, and in the first few years of operation. This involves a single day visit to the site during three periods each season: incubation, early chick rearing, and late chick rearing/fledging. More regular nest checks at the outset of the season would be advantageous, in providing an indication of the start of incubation, and the overall timing of breeding per nest. From this start date, the timing of visits and survey work through the remainder of the breeding season can be determined. This should be initially performed by well trained staff (EBS), with the aim of training on-ground staff (Trust-Power or Wind Prospect personnel). Survey locations, or vantage points that overlook each nest will be established by EBS for each nest, a GPS taken, and survey peg installed. This will enable each survey point to be easily re-visited by the surveyor to assess the status of each nest. The provision of a data sheet to be filled out will provide a fool-proof means of checking and re-checking each nest site. Establishing fixed survey points limits the potential for disturbance by un-trained persons, and will provide the route of least impact on the nest site.

4.3 *Lomandra effusa* (Iron Grass) Grassland Assessment

The *Lomandra effusa* Grassland areas do not qualify as the ***Critically Endangered*** listed community under the EPBC Act. It is considered very unlikely the grasslands would ever support the appropriate attributes necessary to qualify for protection under the EPBC Act as they exist within heavily degraded and modified environments. However, a large pocket of degraded *L. effusa* Grassland is present as understorey, or adjacent the state ***Vulnerable*** threatened community, *Allocasuarina verticillata* Woodland near the access track for wind turbines WTG102 – WTG108 and should be considered ecologically significant to the area.

4.4 Transmission Alignment Assessments

The native vegetation supported within the road verge of the proposed Transmission Alignments is some of the only remaining remnant vegetation within the broader landscape. Much of the

land has been disturbed and is now used for pastoral or horticultural use. Most of the surrounding land bordering the roadside verge is cropping land. As a recommendation, Wind Prospect could investigate the feasibility of utilising private land as use of the cropping land will have a minimal environmental impact on local biodiversity. Alternatively, selection of the Transmission Alignment Option 2 will have less impact on local biodiversity values.

4.4.1 Transmission Alignment Option 1

Overall, Transmission Alignment Option 1 provides more biodiversity value to the area than Option 2. Of particular note is the western end of the alignment which supports good quality vegetation, especially native grasses and pockets of the State Vulnerable *Allocasuarina verticillata* Grassy Low Woodland. Three Red Gum Creeklines are also located on this alignment at the western end, and if this option is chosen it is suggested disturbance to these creeklines should be avoided. The eastern end of the alignment supported mixed *Eucalyptus* Mallee and was also considered to be in reasonable condition.

Two sections of this proposed alignment were not accessed as the alignment passed through private land. However, these sections were identified as cropping land and do not provide any value to the biodiversity of the area.

4.4.2 Transmission Alignment Option 2

This alignment does not support any threatened ecosystems and should be the most direct option. The western end of this line consists of disturbed land and is more degraded than Option 2. While mixed *Eucalyptus* Mallee was also present within this Alignment, it was more degraded and therefore in poorer condition compared to the Mallee recorded in Option 2.

Two sections of the Option 2 alignment were not assessed in detail due to access issues as the alignment was directed through private property, and access was only gained on public roads. The first area not accessed supports cropping land and the other section supports *Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Samphire Low Shrubland. The Samphire Low Shrubland should be assessed in more detail if this option is chosen; however, it is not anticipated this Shrubland will pose a problem.

5 RECOMMENDATIONS

5.1 Pygmy Bluetongue Assessment

- *Conduct detailed Pygmy Bluetongue surveys*

Survey limitations encountered this survey relating to Pygmy Bluetongue assessments necessitate the need for further spring surveys. The limitations included timing, cold weather conditions, and inability to accurately identify spider holes due to dense vegetative cover. The identified areas of 'potential' habitat detailed on Figure 16 require further surveys in early September 2009. This will entail a 3-day survey effort; however, the field survey length is dependent on the number of spider holes located; if few are identified the survey effort will be reduced.

- *Meet with an engineer to determine if wind turbines will be problematic for Pygmy Bluetongue surveys, is so determine if turbines can be re-located*

It would be beneficial to conduct a half-day site-visit with an engineer within the same week of further Pygmy Bluetongue surveys to confirm that the locations of the turbines will not affect potential habitat.

5.2 Wedge-tailed Eagle Assessment

- *Implement a buffer around Wedge-tailed Eagle nests*

Avoid constructing turbines next to Wedge-tailed Eagle nests. It is suggested that any proposed turbine sites within 270 - 300 m of both active and inactive Wedge-tailed Eagle nests be moved to an alternate location to reduce disturbance impacts, and reduce the likelihood of collisions.

- *Targeted Wedge-tailed Eagle habitat utilisation surveys*

Pre-construction targeted Wedge-tailed Eagle surveys should be employed in locations where nests are within close proximity to proposed turbines. This should involve three survey periods, during copulation (June-July), nesting (Aug-Oct), and chick fledging (Nov-Dec), to cover times when activity around the nest will be highest. This will reveal how breeding pairs utilise the areas around their nests. Repeating these methods post-construction will provide a means of assessing changes in flight behavior (i.e. disturbance impacts), and enable an assessment of

the effectiveness of buffers. This will be very useful in directing future wind farm developments, and to ensure eagle collisions are effectively minimised.

- *Conduct seasonal nest checks during construction and implement stop-work periods to minimise disturbance of breeding Wedge-tailed Eagles*

Where construction is planned within close proximity of known Wedge-tailed Eagle nests during the breeding season (July – December) nest checks should be employed to determine their breeding status. If nest sites are active than construction works (within 300 m) within these areas could be planned to avoid the breeding season and therefore avoid disturbance. This may be conducted by on-site personnel after initial training from EBS staff. A data sheet should be established providing the GPS locations of vantage points to be visited for the survey of each nest, and survey pegs will be installed, so sites can be easily located. On-site staff should check nests from these locations regularly (e.g. once weekly) at the start of the breeding season (July – August) to determine the initiation of egg laying and incubation. The timing of this event should then be used to plan the timing of the remainder of the seasons field work.

- *Monitor long-term breeding success at Wedge-tailed Eagle nest sites*

The breeding status and success of all five breeding pairs could be monitored over a 5 to 10 year time period to assess the disturbance impacts of the wind farm. This could be conducted by on-ground staff who have received training from a suitably experienced ecologist.

- *Regular long-term monitoring of bird mortality*

Due to the very high density of Wedge-tailed Eagles at the Snowtown Wind Farm it is critical that dead-bird search methods be adopted, and searches conducted on a regular basis to identify bird mortalities. Dead-bird search can be conducted by suitably trained on-ground staff, however a formal reporting procedure to an external environmental agency is recommended, as this information is highly informative and valuable.

5.3 *Lomandra effusa* (Iron Grass) Grassland Assessment

- *Where possible, avoid existing Lomandra effusa* Grassland

No additional follow-up surveys are required as the existing grasslands do not qualify as the listed community under the EPBC Act. However, it is best to avoid disturbance to the grasslands, if possible, as these communities are poorly represented and are important for

biodiversity within an already heavily degraded environment. Specifically, the large patch of *Lomandra effusa,* and the nearby *Allocasuarina verticiallata* Woodland, located along the access track for turbines WTG102-WTG108 should be avoided.

5.4 Transmission Alignment Assessments

- *Transmission Alignment Option 2 is the preferred option*

This is the *preferred* option because the alignment does not support any state threatened ecosystems (unlike Option 1). Option 2 appears to be the most direct route and will impact less on native vegetation. The western end of this line consists of disturbed land and is much more degraded than the western end of Option 2.

- *Assess Samphire Shrubland not assessed this survey*

If Transmission Alignment Option 2 is chosen as the preferred option, a half-day assessment of *Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Samphire Low Shrubland should be conducted within the same survey week of the Pygmy Bluetongue survey to confirm that disturbance to this area does not significantly impact any matters of national significance as defined under the EPBC Act.

6 REFERENCES

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7 APPENDICES

7.1 Appendix 1 – Vegetation associations and associated species lists

Species Name	Common Name	Conservation Status			Vegetation Association											
		AUS	SA	NL	1	2	3	4	5	6	7	8	9	10	11	12
Acacia hakeoides	Hakea Wattle				✓					✓	✓					
Acacia ligulata	Umbrella Bush				✓	✓				✓	✓	✓	✓			
Acacia notabilis	Notable Wattle				✓											
Acacia oswaldii	Umbrella Wattle				✓	✓					✓					
Acacia pycnantha	Golden Wattle											✓	✓			
Acacia salicina	Willow Wattle						✓									
Acacia sclerophylla var. sclerophylla	Hard-leaf Wattle				✓							✓				
Acacia victoriae ssp. victoriae	Elegant Wattle											✓	✓			
Allocasuarina verticillata	Drooping Sheoak											✓	✓			
**Asteriscus spinosus*	Golden Pallensis											✓	✓	✓		
Atriplex vesicaria	Bladder Saltbush				✓	✓										
Austrodanthonia caespitosa	Common Wallaby-grass				✓	✓	✓				✓	✓	✓	✓		
Austrodanthonia setacea	Small-flower Wallaby-grass				✓	✓					✓	✓	✓	✓		
Austrostipa elegantissima	Feather Spear-grass				✓	✓		✓			✓	✓	✓			
Austrostipa sp.	Spear-grass				✓	✓					✓	✓	✓	✓		
**Avena barbata*	Bearded Oat				✓	✓		✓		✓	✓	✓	✓	✓	✓	
Bromus sp.	Brome						✓							✓		
Bursaria spinosa ssp. spinosa	Sweet Bursaria				✓							✓	✓			
Callitris gracilis	Southern Cypress Pine				✓							✓	✓			
Calostemma purpureum	Pink Garland-lily											✓	✓			
**Carrichtera annua*	Ward's Weed				✓	✓	✓				✓			✓	✓	
Chloris truncata	Windmill Grass				✓	✓										
**Citrullus lanatus*	Bitter Melon													✓		
Convolvulus erubescens complex					✓							✓	✓			

Species Name	Common Name	Conservation Status			Vegetation Association											
		AUS	SA	NL	1	2	3	4	5	6	7	8	9	10	11	12
Convolvulus remotus	Grassy Bindweed				✓	✓					✓					
**Cynara cardunculus ssp. flavescens*	Artichoke Thistle						✓									
**Cynodon dactylon var. dactylon*	Couch						✓							✓		
**Datura stramonium*	Common Thorn-apple													✓		
Dianella revoluta var. revoluta	Black-anther Flax-lily				✓	✓				✓	✓	✓	✓			
**Echium plantagineum*	Salvation Jane				✓	✓	✓			✓	✓	✓	✓	✓		
Enchylaena tomentosa var. tomentosa	Ruby Saltbush				✓	✓		✓		✓	✓					
Enneapogon nigricans	Black-head Grass				✓	✓	✓			✓		✓	✓	✓		
Eremophila longifolia	Weeping Emubush				✓					✓	✓	✓	✓			
Eucalyptus camaldulensis var. camaldulensis	River Red Gum						✓						✓			
Eucalyptus gracilis	Yorrell				✓											
Eucalyptus oleosa ssp. ampliata	Red Mallee				✓											
Eucalyptus porosa	Mallee Box				✓											
Eucalyptus socialis					✓											
Eucalyptus sp. (reveg)					✓											
**Euphorbia terracina*	False Caper						✓									
Exocarpos aphyllus	Leafless Cherry				✓						✓					
Geijera linearifolia	Sheep Bush				✓											
Grevillea huegelii	Comb Grevillea				✓											
Lomandra effusa	Scented Mat-rush				✓							✓	✓	✓		
Lomandra multiflora ssp. dura	Hard Mat-rush				✓							✓	✓	✓		
**Lycium ferocissimum*	African Boxthorn				✓			✓		✓						
Maireana aphylla	Cotton-bush			V				✓								
Maireana brevifolia	Short-leaf Bluebush				✓	✓		✓	✓	✓	✓					
**Malva nicaeensis*	Mallow Of Nice				✓	✓	✓							✓		
**Marrubium vulgare*	Horehound				✓	✓	✓	✓						✓		
Melaleuca lanceolata	Dryland Tea-tree				✓					✓						

Species Name	Common Name	Conservation Status			Vegetation Association											
		AUS	SA	NL	1	2	3	4	5	6	7	8	9	10	11	12
Myoporum platycarpum	False Sandalwood									✓	✓					
Nitraria billardierei	Nitre-bush				✓	✓		✓	✓	✓	✓					
**Olea europaea ssp. europaea*	Olive						✓									
**Oxalis pes-caprae*	Soursob				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Panicum decompositum var. decompositum	Native Millet				✓	✓		✓						✓		
Pimelea micrantha	Silky Riceflower											✓	✓			
**Pinus radiata*	Radiata Pine												✓	✓		
**Piptatherum miliaceum*	Rice Millet				✓	✓	✓			✓	✓	✓	✓	✓	✓	
Pittosporum angustifolium	Native Apricot				✓							✓	✓			
**Prunus sp.*	Plum						✓						✓	✓		
Rhagodia parabolica	Mealy Saltbush				✓	✓										
Rhagodia preissii ssp. preissii	Mallee Saltbush				✓	✓										
Salsola kali	Buckbush				✓	✓	✓	✓						✓	✓	
**Salvia verbenaca var. verbenaca*	Wild Sage				✓	✓	✓				✓			✓		
Santalum acuminatum	Quandong			U	✓											
**Scabiosa atropurpurea*	Pincushion				✓	✓	✓			✓	✓			✓		
**Schinus molle*	Pepper-tree				✓	✓					✓			✓		
Sclerolaena diacantha	Grey Bindyi				✓	✓					✓					
Senna artemisioides ssp. coriacea	Broad-leaf Desert Senna				✓	✓				✓	✓	✓				
**Solanum elaeagnifolium*	Silver-leaf Nightshade				✓	✓										
**Sonchus oleraceus*	Common Sow-thistle						✓							✓		
Tecticornia pergranulata ssp. pergranulata	Black-seed Samphire							✓	✓							
Themeda triandra	Kangaroo Grass											✓	✓			
Vittadinia blackii	Narrow-leaf New Holland Daisy				✓							✓	✓			
Vittadinia cuneata	Fuzzy New Holland Daisy											✓	✓			
Vittadinia gracilis	Woolly New Holland Daisy				✓	✓					✓		✓	✓		

Species Name	Common Name	Conservation Status			Vegetation Association											
		AUS	SA	NL	1	2	3	4	5	6	7	8	9	10	11	12
Westringia rigida	Stiff Westringia				✓											
Zygophyllum apiculatum	Pointed Twinleaf				✓											
Zygophyllum aurantiacum					✓						✓					

Regions:
AUS: Australia (*Environment Protection and Biodiversity Conservation Act, 1999*)
SA: South Australia (*National Parks and Wildlife Act, 1972*)
NL: Northern Lofty (local regional ratings)

Conservation Status Codes:
U: Uncommon
V: Vulnerable

7.2 Appendix 2 – Locations of Pygmy Bluetongue Records (DEH Biological Database)

Pygmy Bluetongue Records			
Zone	**Easting**	**Northing**	**Data Found**
54	229150	6230348	11/11/2006
54	229113	6230275	24/11/2006
54	229107	6230269	11/11/2006
54	229223	6230261	11/11/2006
54	229081	6230200	24/11/2006
54	229081	6230199	11/11/2006
54	229066	6230188	11/11/2006
54	228995	6230146	11/11/2006
54	229032	6230142	11/11/2006
54	229181	6230150	11/11/2006
54	228995	6230139	24/11/2006
54	228989	6230082	11/11/2006
54	229199	6230070	11/11/2006
54	229215	6230063	11/11/2006
54	229674	6230087	17/06/2004
54	229023	6230042	17/06/2004
54	229020	6230010	17/06/2004
54	228943	6229994	24/11/2006
54	228951	6229980	11/11/2006
54	228954	6229955	11/11/2006
54	228950	6229944	24/11/2006
54	229116	6229950	11/11/2006
54	229115	6229949	24/11/2006
54	229083	6229944	11/11/2006
54	229117	6229945	11/11/2006
54	229168	6229887	11/11/2006
54	229545	6229889	25/11/2007
54	229667	6229864	17/06/2004
54	229578	6229853	25/11/2007
54	229584	6229852	25/11/2007
54	229585	6229851	25/11/2007
54	228743	6229395	18/06/2004
54	228743	6229395	?

Snowtown Windfarm Stage 2 Transmission Line Survey – Option 3

Snowtown Windfarm Stage 2, Transmission Line Survey – Option 3

5 January 2010

Version 1.0

Prepared by Environmental and Biodiversity Services for Wind Prospect Pty Ltd

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Front cover photo: *Eucalyptus porosa* (Mallee Box) Very Open Mallee.

ebs ecology

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1 INTRODUCTION

EBS Ecology were contracted by Wind Prospect Pty Ltd to undertake a vegetation survey and a Pygmy Bluetongue (PBT) Lizard (*Tiliqua adelaidensis*) presence / absence survey of a proposed transmission line associated with the Snowtown Stage 2 Windfarm. This survey follows an ecological assessment of Snowtown Windfarm Stage 2 in September 2008 and two transmission line assessments during October 2009.

This report is supplementary to the September 2008 and October 2009 reports. For detailed information on site and regional descriptions, background research, prior results, discussion and recommendations refer to '*Snowtown Wind Farm Stage 2 Ecological Assessment - November 2008'* (EBS 2008). For details of proposed transmission line options 1 and 2 refer to '*Snowtown Wind Farm Stage 2 -Flora and Fauna Targeted Assessment and Transmission Line Assessment*' (EBS 2009).

1.1 Objectives

The objectives of this survey were to:

- Document vegetation associations along the proposed transmission line alignment. Recording flora species present, condition of vegetation, and any other noteworthy issues, so as to recommend the preferred option (in comparison with previously surveyed options 1 and 2) that will generate less impact on the biodiversity value of the area.
- Identify potential Pygmy Bluetongue habitat within the proposed transmission line alignment and conduct presence / absence surveys.

2 METHODS

2.1 Vegetation Survey

A field survey was conducted on the 2nd of December 2009. The proposed transmission line option was driven, where possible, prior to the commencement of the assessment. This was undertaken to confirm the exact alignment as well as determine the most appropriate way of recording the data. The survey commenced at the eastern end of the alignment and terminated at the Barrunga Gap homestead (Western end). An area 100 metres wide was surveyed except where the alignment followed a road, where both sides of the roadside were assessed. The vegetation survey included recording:

- Changes in vegetation associations along the alignment which were documented by taking GPS waypoints.
- Condition ratings were applied to each vegetation association recorded. Condition rating definitions applied in the field are detailed in Table 2.
- Species lists (native and introduced flora) were compiled for each vegetation association.

- Representative photos were taken of each vegetation association, or of any areas of particular interest for reporting purposes.

2.2 Pygmy Bluetongue Habitat and Presence / Absence Survey

The Pygmy Bluetongue habitat assessment was conducted within the proposed transmission line alignment at the same time as the vegetation survey (see Table 1 for PBT habitat attributes). A PBT presence / absence survey was conducted in areas identified as potential PBT habitat. The survey techniques for the PBT presence / absence survey involved the following steps:

- Conducting 'ramble' spider hole surveys within the alignment.
- All spider holes located were checked for PBT presence using an optic fibre 'Burrowscope'.

2.3 Survey Limitations

At the time the survey was undertaken not all flora species may have been visibly present. Species, such as some native grasses, had developed their seeds, at the time of the survey, are unidentifiable to species level without seed and seed heads due to a lack of distinguishing features. Therefore, some species which may occur on site may not have been observed or recorded and others were only identified to the genus level.

Table 1. Known suitable Pygmy Bluetongue habitat attributes versus unsuitable habitat attributes.

Attributes considered suitable habitat	Spider holes within native or exotic grasslands; PBT's have also been detected in highly modified treeless grasslands.
	Soil of heavy sandy loam (red-brown earth).
	Footslopes of hills.
	Potentially sheltered areas of footslopes.
Attributes considered unsuitable habitat	Areas that have been previously cropped.
	Exposed ridgelines.
	Overly rocky areas

Table 2. Ratios used to rate condition of vegetation associations.

Ratios used to rate condition of vegetation associations	
Vegetation Condition	**Ratio**
Clearance consists of lopping of limbs, not affecting the health of the tree/shrub	0
Weed-dominated with only scattered areas or patches of native vegetation Indicated by: • vegetation structure no longer intact (eg. Removal of one or more vegetation strata) • scope for regeneration, but not to a state approaching good condition without intensive management • dominated by very aggressive weeds • partial or extensive clearing (> 50% of area) • evidence of heavy grazing (tracks, browse limes, species changes, no evidence of soil surface crust)	2:1 (area)
Native vegetation with considerable disturbance Indicated by: • vegetation structure substantially altered (e.g. One or more vegetation strata depleted) • retains basic vegetation structure or the ability to regenerate it • very obvious signs of long-term or severe disturbance • weed dominated with some very aggressive weeds • partial clearing (10 – 50% of area) • evidence of moderate grazing (tracks, browse lines, soil surface crust extensively broken)	4:1 (area)
Native vegetation with some disturbance Indicated by: • vegetation structure altered (e.g. One or more vegetation strata depleted) • most seed sources available to regenerate original structure • obvious signs of disturbance (e.g. tracks, bare ground) • minor clearing (<10% of area) • considerable weed infestation with some aggressive weeds • evidence of some grazing (tracks, soil surface crust patchy)	6:1 (area)
Native vegetation with little disturbance Indicated by: • vegetation structure intact (e.g. all strata intact) • disturbance minor, only affecting individual species • only non-aggressive weeds present • some litter build-up	8:1 (area)
Intact vegetation Indicated by: • all strata intact and botanical composition close to original • little or no signs of disturbance • little or no weed infestation • substantial litter cover	10:1 (area)

Adapted from '*Guidelines for a Native Vegetation Significant Environmental Benefit Policy (*DWLBC, 2005).

3 RESULTS

3.1 Vegetation Survey

A total of ten vegetation associations and large areas of cropping land were defined within the proposed transmission line alignment. Each vegetation association is described below (refer to section 3.1.1) and representative photos of each association are provided. Figure 1 shows the location of each of the vegetation associations whilst Figure 2 shows the vegetation condition across the surveyed areas. Appendix 1 details individual flora species recorded within each vegetation association during the survey.

The dominant vegetation across the areas surveyed was the cropped paddocks. Remnant vegetation was confined to the following areas of the proposed alignment:

- Several sections of roadside reserves which contained Mallee, Shrubland and Grassland associations.
- A low-lying area which supports a *Nitraria billardierei* (Nitre Bush) Open Shrubland and *Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Low Shrubland.
- A section of *Eucalyptus porosa* (Mallee Box) Very Open Mallee.

Figure 1. Location of vegetation associations within the surveyed area.

Figure 2. Condition of the vegetation within the surveyed area.

3.1.1 Vegetation Association Descriptions

Vegetation Association 1 - Eucalyptus gracilis (Yorrell) Very Open Mallee over Exotic Grassland

Figure 3. General photo of *Eucalyptus gracilis* (Yorrell) Very Open Mallee over Exotic Grassland (in background) and a previously cropped area in the foreground.

Table 3. Features of the *Eucalyptus gracilis* (Yorrell) Very Open Mallee over Exotic Grassland.

Overstorey and midstorey species	The overstorey consisted of sparse *Eucalyptus gracilis* (Yorrell). A small patch of *Eremophila longifolia* (Weeping Emubush) was also recorded.
Understory species	The understorey / ground cover layer of vegetation was dominated by introduced species, however scattered patches of native grasses were located within the association.
	Common weed species included: • *Avena barbata* (Wild Oats) • *Carrichtera annua* (Wards Weed) • *Echium plantagineum* (Salvation Jane)
	Native species included: • *Austrostipa nodosa* (Spear Grass) • *Enchylaena tomentosa* var. *tomentosa* (Ruby Saltbush) • *Teucrium sessiliflorum* (Mallee Germander) • *Vittadinia gracilis* (Woolly New Holland Daisy)
Emergent species	None recorded
Conservation significant flora species	No national or state conservation rated flora species were detected during the current survey.
Condition	Association 1 was considered to have a condition rating of 4:1 (refer to Figure 2 for vegetation condition rating location). The association was bordered by cropping land on all sides.

Vegetation Association 2 - Exotic Grassland

Figure 4. General photo of an Exotic Grassland.

Table 4. Features of the Exotic Grassland.

Overstorey and midstorey species	None recorded
Understory species	The understorey / ground cover layer of vegetation was dominated by introduced species with only a small percentage of native species persisting.
	Common weed species included: • *Avena barbata* (Wild Oats) • *Carrichtera annua* (Wards Weed) • *Echium plantagineum* (Salvation Jane) • *Heliotropium europaeum* (Common Heliotrope)
	Native species included: • *Austrodanthonia caespitosa* (Common Wallaby Grass) • *Austrostipa nodosa* (Spear Grass) • *Enchylaena tomentosa* var. *tomentosa* (Ruby Saltbush)
Emergent species	*Acacia ligulata* (Umbrella Bush) and *Nitraria billardierei* (Nitre-bush)
Conservation significant flora species	No national or state conservation rated flora species were detected during the current survey.
Condition	All areas identified as Association 2 were considered to have a condition rating of 2:1 (refer to Figure 2 for vegetation condition rating locations).

Vegetation Association 3 - Nitraria billardierei (Nitre Bush) Open Shrubland

Figure 5. General photo of the *Nitraria billardierei* (Nitre Bush) Open Shrubland.

Table 5. Features of the *Nitraria billardierei* (Nitre Bush) Open Shrubland.

Overstorey and midstorey species	*Nitraria billardierei* (Nitre-bush)
Understory species	Small areas within the association were dominated by introduced ground cover species.
	Common weed species included: • *Avena barbata* (Wild Oats) • *Carrichtera annua* (Wards Weed) • *Echium plantagineum* (Salvation Jane) • *Heliotropium europaeum* (Common Heliotrope) • *Lycium ferocissimum* (African Boxthorn) • *Mesembryanthemum nodiflorum* (Slender Iceplant)
	Native species included: • *Atriplex stipitata* (Bitter Saltbush) • *Austrodanthonia caespitosa*. (Common Wallaby Grass) • *Austrostipa nodosa*. (Spear Grass) • *Enchylaena tomentosa* var. *tomentosa* (Ruby Saltbush) • *Maireana brevifolia* (Short-leaf Bluebush)
Emergent species	None recorded
Conservation significant flora species	No national or state conservation rated flora species were detected during the current survey.
Condition	Association 3 were considered to have a condition rating of 6:1 (refer to Figure 2 for vegetation condition location).

Vegetation Association 4 - Tecticornia pergranulata ssp. pergranulata (Black-seed Samphire) Low Shrubland

Figure 6. General photo of the *Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Low Shrubland.

Table 6. Features of the *Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Low Shrubland.

Overstorey and midstorey species	*Nitraria billardierei* (Nitre-bush)
Understory species	Small areas within the association were dominated by introduced ground cover species.
	Common weed species included: • *Avena barbata* (Wild Oats) • *Carrichtera annua* (Wards Weed) • *Echium plantagineum* (Salvation Jane) • *Mesembryanthemum nodiflorum* (Slender Iceplant)
	Native species included: • *Austrodanthonia caespitosa*. (Common Wallaby Grass) • *Austrostipa nodosa*. (Spear Grass) • *Enchylaena tomentosa* var. *tomentosa* (Ruby Saltbush) • *Maireana brevifolia* (Short-leaf Bluebush) • *Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire)
Emergent species	*Lawrencia squamata* (Thorny Lawrencia)
Conservation significant flora species	No national or state conservation rated flora species were detected during the current survey.
Condition	Association 4 was considered to have a condition rating of 6:1 (refer to Figure 2 for vegetation condition location).

Vegetation Association 5 Eucalyptus dumosa (White Mallee) / Eucalyptus Gracilis (Yorrell) Open Mallee

Figure 7. General photo of the *Eucalyptus dumosa* (White Mallee) / *Eucalyptus gracilis* (Yorrell) Open Mallee.

Table 7. Features of the *Eucalyptus dumosa* (White Mallee) / *Eucalyptus gracilis* (Yorrell) Open Mallee.

Overstorey and midstorey species	*Eucalyptus dumosa* (White Mallee) and *Eucalyptus gracilis* (Yorrell) were the dominant overstorey species. Common midstorey species included a mix of *Acacia* sp. and *Geijera linearifolia* (Sheep Bush).
Understory species	The understorey was dominated by native shrub species, introduced species are either contained in small pockets or sparsely located.
	Common weed species included: • *Avena barbata* (Wild Oats) • *Carrichtera annua* (Wards Weed) • *Lycium ferocissimum* (African Boxthorn) • *Salvia verbenaca* var. *verbenaca* (Wild Sage)
	Native species included: • *Atriplex stipitata* (Bitter Saltbush) • *Austrodanthonia caespitosa*. (Common Wallaby Grass) • *Austrostipa nodosa*. (Spear Grass) • *Enchylaena tomentosa* var. *tomentosa* (Ruby Saltbush) • *Maireana brevifolia* (Short-leaf Bluebush)
Emergent species	*Acacia oswaldii* (Umbrella Wattle)
Conservation significant flora species	No national or state conservation rated flora species were detected during the current survey.
Condition	Association 5 was considered to have a condition rating of 6:1 (refer to Figure 2 for vegetation condition location). The association is confined to a roadside reserve.

Vegetation Association 6 - Eremophila longifolia (Weeping Emu-bush) Shrubland

Figure 8. General photo of the *Eremophila longifolia* (Weeping Emu-bush) Shrubland.

Table 8. Features of the *Eremophila longifolia* (Weeping Emu-bush) Shrubland.

Overstorey and midstorey species	*Eremophila longifolia* (Weeping Emu-bush) and *Acacia ligulata* (Umbrella Wattle)
Understory species	The understorey / ground cover layer of vegetation was dominated by introduced species, however scattered patches of native grasses were found within the association.
	Common weed species included: • *Asphodelus fistulosus* (Onion Weed) • *Avena barbata* (Wild Oats) • *Carrichtera annua* (Wards Weed) • *Heliotropium europaeum* (Common Heliotrope) • *Marrubium vulgare* (Horehound)
	Native species included: • *Austrodanthonia caespitosa*. (Common Wallaby Grass) • *Austrostipa nodosa*. (Spear Grass) • *Enchylaena tomentosa* var. *tomentosa* (Ruby Saltbush))
Emergent species	*Acacia oswaldii* (Umbrella Wattle) and *Exocarpos aphylla* (Leafless Cherry)
Conservation significant flora species	No national or state conservation rated flora species were detected during the current survey.
Condition	Association 6 was considered to have a condition rating of 6:1 (Refer to Figure 2 for vegetation condition location). The association is confined to a roadside reserve.

Vegetation Association 7 - Eucalyptus camaldulensis (Red Gum) / E. leucoxylon ssp. pruinosa (Inland South Australian Blue Gum) / E. porosa (Mallee Box) Woodland

Figure 9. General photo of the *Eucalyptus camaldulensis* (Red Gum) / *E. leucoxylon* ssp. *pruinosa* (Inland South Australian Blue Gum) / *E. porosa* (Mallee Box) Woodland.

Table 9. Features of the *Eucalyptus camaldulensis* (Red Gum) / *E. leucoxylon* ssp. *pruinosa* (Inland South Australian Blue Gum) / *E. porosa* (Mallee Box) Woodland.

Overstorey and midstorey species	The majority of the mature trees in close proximity to the 'Barrunga Gap Homestead' have been planted. Planted species include *Eucalyptus camaldulensis* (Red Gum) and *E. leucoxylon* ssp. *pruinosa* (Inland South Australian Blue Gum). All *Eucalyptus porosa* (Mallee Box) are remnant vegetation.
Understory species	The understorey / ground cover layer of vegetation was dominated by introduced species with only a few scattered native grasses persisting.
	Common weed species included: • *Avena barbata* (Wild Oats) • *Carrichtera annua* (Wards Weed) • *Lycium ferocissimum* (African Boxthorn)
	Native species included: • *Aristida behriana* (Brush Wire-grass) • *Austrodanthonia caespitosa* (Common Wallaby Grass) • *Austrostipa nodosa* (Spear Grass)
Emergent species	None recorded
Conservation significant flora species	No national or state conservation rated flora species were detected during the current survey.
Condition	Association 7 was considered to have a condition rating of 2:1 (Refer to Figure 2 for vegetation condition location).

Vegetation Association 8 - Exotic / Native Grassland

Figure 10. General photo of the Exotic / Native Grassland.

Table 10. Features of the Exotic / Native Grassland.

Overstorey and midstorey species	None recorded
Understory species	The understorey contained a mix of native and weed grass species.
	Common weed species included: • *Avena barbata* (Wild Oats) • *Carrichtera annua* (Wards Weed) • *Salvia verbenaca* var. *verbenaca* (Wild Sage)
	Native species included: • *Austrodanthonia caespitosa* (Common Wallaby Grass) • *Austrostipa nodosa* (Spear Grass) • *Enchylaena tomentosa* var. *tomentosa* (Ruby Saltbush) • *Lomandra effusa* (Scented Mat-rush) • *Maireana brevifolia* (Short-leaf Bluebush)
Emergent species	*Nitraria billardierei* (Nitre-bush) and *Scaevola spinescens* (Spiny Fanflower)
Conservation significant flora species	No national or state conservation rated flora species were detected during the current survey.
Condition	All areas identified as Association 8 were considered to have a condition rating of 2:1 (refer to Figure 2 for vegetation condition locations). The association is confined to roadside reserves, other than one section located in a grazed paddock near Barrunga Top Road.

Vegetation Association 9 - Eucalyptus porosa (Mallee Box) Very Open Mallee

Figure 11. General photo of the *Eucalyptus porosa* (Mallee Box) Very Open Mallee.

Table 11. Features of the *Eucalyptus porosa* (Mallee Box) Very Open Mallee.

Overstorey and midstorey species	The overstorey consists of very sparse or small clusters of *Eucalyptus porosa* (Mallee Box).
Understory species	The understorey is dominated by native and introduced grass species. A small gully within the association contains a high density of *Rosa canina* (Dog Rose) and *Lycium ferocissimum* (African Boxthorn).
	Common weed species included: • *Avena barbata* (Wild Oats) • *Trifolium arvense* var. *arvense* (Hare's-foot Clover)
	Native species included: • *Aristida behriana* (Brush Wire-grass) • *Austrodanthonia caespitosa* (Common Wallaby Grass) • *Austrostipa blackii* (Crested Spear Grass) • *Austrostipa nodosa* (Spear Grass) • *Lomandra effusa* (Scented Mat-rush) • *Lomandra multiflora* ssp. *dura* (Hard Mat-rush) • *Themeda triandra* (Kangaroo Grass)
Emergent species	None recorded
Conservation significant flora species	No national or state conservation rated flora species were detected during the current survey.
Condition	Association 9 was considered to have a condition rating of 6:1 (refer to Figure 2 for vegetation condition location).

Vegetation Association 10 - Nitraria billardierei (Nitre Bush) / Atriplex stipitata (Bitter Saltbush) Shrubland

Figure 12. General photo of the *Nitraria billardierei* (Nitre Bush) / *Atriplex stipitata* (Bitter Saltbush) Shrubland.

Table 12. Features of the *Nitraria billardierei* (Nitre Bush) / *Atriplex stipitata* (Bitter Saltbush) Shrubland.

Overstorey and midstorey species	*Nitraria billardierei* (Nitre Bush)
Understory species	Small areas within the association were dominated by introduced ground cover species.
	Common weed species included: • *Avena barbata* (Wild Oats) • *Lycium ferocissimum* (African Boxthorn) • *Mesembryanthemum nodiflorum* (Slender Iceplant)
	Native species included: • *Atriplex stipitata* (Bitter Saltbush) • *Austrodanthonia caespitosa*. (Common Wallaby Grass) • *Austrostipa nodosa*. (Spear Grass) • *Enchylaena tomentosa* var. *tomentosa* (Ruby Saltbush) • *Maireana brevifolia* (Short-leaf Bluebush)
Emergent species	*Scaevola spinescens* (Spiny Fanflower)
Conservation significant flora species	No national or state conservation rated flora species were detected during the current survey.
Condition	Association 10 was considered to have a condition rating of 2:1(refer to Figure 3 for vegetation condition locations).

3.2 Weed species

A total of 27 weed species were detected within the proposed transmission line alignment during the current survey (refer to Appendix 1 for full species list). Weed species detected which are declared under the *Natural Resources Management Act, 2004* included *Asphodelus fistulosus* (Onion Weed), *Cynara cardunculus* ssp. *flavescens* (Artichoke Thistle), *Echium plantagineum* (Salvation Jane), *Lycium ferocissimum* (African Boxthorn), *Marrubium vulgare* (Horehound), *Rosa canina* (Dog Rose) and *Solanum elaeagnifolium* (Silver-leaf Nightshade).

A further seven species, regarded as environmental weed species, were also detected within the proposed transmission line alignment (Table 13).

Table 13. Declared and environmental weed species.

Species name	Common name	Declared species	Environ species	Vegetation association									
				1	2	3	4	5	6	7	8	9	10
Agave americana	Century Plant		✓							✓			
Asphodelus fistulosus	Onion Weed	✓							✓				
Asteriscus spinosus	Golden Pallensis		✓								✓		
Carrichtera annua	Ward's Weed		✓	✓				✓			✓		
Carthamus lanatus	Saffron Thistle		✓									✓	
Centaurea calcitrapa	Star Thistle		✓		✓								
Cynara cardunculus ssp. *flavescens*	Artichoke Thistle	✓										✓	
Cynodon dactylon var. *dactylon*	Couch		✓		✓								
Echium plantagineum	Salvation Jane	✓		✓		✓							
Lycium ferocissimum	African Boxthorn	✓				✓		✓		✓		✓	✓
Marrubium vulgare	Horehound	✓		✓	✓				✓	✓		✓	
Mesembryanthemum nodiflorum	Slender Iceplant		✓			✓	✓						
Rosa canina	Dog Rose	✓										✓	
Solanum elaeagnifolium	Silver-leaf Nightshade	✓		✓					✓			✓	

3.3 Flora Species of Conservation Significance

No national or state conservation rated flora species were detected within the proposed transmission line alignment during the current survey.

3.4 Pygmy Bluetongue Habitat and Presence / Absence Survey

Generally, the majority of habitat available within the proposed transmission line alignment area was considered unsuitable for Pygmy Bluetongue Lizards. These 'unsuitable' areas include cropping land, low-lying saltpans and footslopes containing dense surface rock. One area within the *Eucalyptus porosa* (Mallee Box) Very Open Mallee was identified as marginal Pygmy Bluetongue habitat. A presence /absence survey was conducted, however, no Pygmy Bluetongues were detected within the area. The area contained a low density of spider holes and all spider holes located contained spiders.

4 DISCUSSION AND RECOMMENDATIONS

The native vegetation supported within the proposed transmission line alignment is generally moderate to poor quality but does represent some of the only remaining remnant vegetation within the broader landscape. Much of the land has been disturbed and is now used for sheep grazing and cereal cropping. Overall, transmission line alignment option 3 provides a lower biodiversity value compared to transmission line alignment options 1 and 2 as the majority of the alignment is located within cropping land.

It is recommended that transmission line 3 is selected as the preferred alignment due to its lower biodiversity value (when compared to options 1 and 2).

The following actions are recommended if transmission line option 3 is constructed:

- Minimise the area of native vegetation impacted upon by the transmission line;
- Locate transmission line towers in areas clear of mature trees, such as cropping land and exotic grasslands. All mature trees are either contained in roadside reserves or sparsely located within grazing paddocks with large open areas and therefore removal of mature trees should not be required;
- If native vegetation is to be cleared, undertake discussions with the Native Vegetation Council to determine the reporting and approval requirements under the *Native Vegetation Act 1991*;
- Ensure vegetation clearance is restricted to the project area;
- Where possible utilise areas for storage of excavated materials, which have been previously disturbed and contain no native vegetation;
- Ensure that construction machinery is clean and free from soil pathogens, such as Phytophthora and any weed seed materials. This includes performing appropriate hygiene when leaving the project area to avoid potential spread;
- Weed management strategies should be implemented to ensure that weed species are not introduced.

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6 APPENDICES

Appendix 1. Vegetation associations and associated species lists.

Species name	Common name	Conservation rating		Vegetation association									
		Aus	SA	1	2	3	4	5	6	7	8	9	10
Native species													
Acacia ligulata	Umbrella Bush				✓			✓	✓				
Acacia notabilis	Notable Wattle							✓					
Acacia oswaldii	Umbrella Wattle							✓	✓				
Aristida behriana	Brush Wire-grass									✓		✓	
Atriplex stipitata	Bitter Saltbush					✓		✓					✓
Austrodanthonia caespitosa	Common Wallaby-grass			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Austrostipa blackii	Crested Spear-grass											✓	
Austrostipa nodosa	Spear-grass			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Boerhavia sp.	Tar-vine									✓		✓	
Chamaesyce drummondii				✓		✓			✓				✓
Convolvulus remotus	Grassy Bindweed			✓									
Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush			✓	✓	✓		✓	✓		✓		✓
Eremophila longifolia	Weeping Emubush			✓					✓				
Eucalyptus camaldulensis var. *camaldulensis*	River Red Gum									✓			
Eucalyptus dumosa	White Mallee							✓					
Eucalyptus gracilis	Yorrell			✓				✓					
Eucalyptus leucoxylon ssp. *pruinosa*	Inland South Australian Blue Gum									✓			
Eucalyptus porosa	Mallee Box									✓		✓	

Species name	Common name	Conservation rating		Vegetation association									
		Aus	SA	1	2	3	4	5	6	7	8	9	10
Exocarpos aphyllus	Leafless Cherry								✓				
Geijera linearifolia	Sheep Bush							✓					
Grevillea huegelii	Comb Grevillea							✓					
Halosarcia pergranulata ssp. *pergranulata*	Black-seed Samphire						✓						
Lawrencia squamata	Thorny Lawrencia				✓		✓						
Lomandra effusa	Scented Mat-rush										✓	✓	
Lomandra multiflora ssp. *dura*	Hard Mat-rush											✓	
Maireana aphylla	Cotton-bush				✓								
Maireana brevifolia	Short-leaf Bluebush				✓	✓	✓	✓			✓		✓
Nitraria billardierei	Nitre-bush				✓	✓	✓				✓		✓
Oxalis perennans	Native Sorrel							✓	✓			✓	
Rhagodia preissii ssp. *preissii*	Mallee Saltbush							✓					
Salsola kali	Buckbush				✓		✓	✓		✓		✓	
Scaevola spinescens	Spiny Fanflower					✓					✓		✓
Sclerolaena diacantha	Grey Bindyi						✓		✓				✓
Senna artemisioides ssp. *coriacea*	Broad-leaf Desert Senna								✓				
Senna artemisioides ssp. *petiolaris*								✓					
Sida corrugata	Corrugated Sida											✓	
Teucrium racemosum	Grey Germander											✓	
Teucrium sessiliflorum	Mallee Germander			✓									
Themeda triandra	Kangaroo Grass											✓	
Vittadinia cuneata	Fuzzy New Holland Daisy								✓		✓		
Vittadinia gracilis	Woolly New Holland Daisy			✓									

Species name	Common name	Conservation rating		Vegetation association									
		Aus	SA	1	2	3	4	5	6	7	8	9	10
Zygophyllum aurantiacum						✓					✓		✓
Zygophyllum glaucum	Pale Twinleaf										✓		
Introduced species													
**Agave americana*	Century Plant									✓			
**Asphodelus fistulosus*	Onion Weed								✓				
**Asteriscus spinosus*	Golden Pallensis										✓		
**Avena barbata*	Bearded Oat			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
**Bromus* sp.	Brome				✓	✓		✓	✓	✓	✓	✓	✓
**Carrichtera annua*	Ward's Weed			✓	✓			✓			✓		
**Carthamus lanatus*	Saffron Thistle											✓	
**Centaurea calcitrapa*	Star Thistle				✓								
**Cynara cardunculus* ssp. *flavescens*	Artichoke Thistle											✓	
**Cynodon dactylon* var. *dactylon*	Couch				✓								
**Echium plantagineum*	Salvation Jane			✓	✓	✓							
**Heliotropium europaeum*	Common Heliotrope				✓				✓				
**Hordeum leporinum*	Wall Barley-grass				✓	✓	✓						✓
**Lepidium* sp.	Peppercress											✓	
**Lolium* sp.	Ryegrass				✓		✓						
**Lycium ferocissimum*	African Boxthorn					✓		✓		✓		✓	✓
**Malva nicaeensis*	Mallow Of Nice								✓				
**Marrubium vulgare*	Horehound			✓	✓				✓	✓		✓	
**Mesembryanthemum nodiflorum*	Slender Iceplant					✓	✓						✓

Species name	Common name	Conservation rating		Vegetation association									
		Aus	SA	1	2	3	4	5	6	7	8	9	10
**Rosa canina*	Dog Rose											✓	
**Salvia verbenaca* var. *verbenaca*	Wild Sage			✓	✓			✓	✓		✓		
**Schinus molle*	Pepper-tree									✓			
**Sisymbrium erysimoides*	Smooth Mustard			✓	✓			✓	✓				
**Solanum elaeagnifolium*	Silver-leaf Nightshade			✓					✓			✓	
**Solanum nigrum*	Black Nightshade								✓				
**Sonchus oleraceus*	Common Sow-thistle			✓	✓				✓				
**Trifolium arvense* var. *arvense*	Hare's-foot Clover									✓		✓	

Conservation rating
Aus = Australia
SA = South Australia

Association 1: *Eucalyptus gracilis* (Yorrell) Very Open Mallee over Exotic Grassland
Association 2: Exotic Grassland
Association 3: *Nitraria billardierei* (Nitre Bush) Open Shrubland
Association 4: *Tecticornia pergranulata* ssp. *pergranulata* (Black-seed Samphire) Low Shrubland
Association 5: *Eucalyptus dumosa* (White Mallee) / *Eucalyptus gracilis* (Yorrell) Open Mallee
Association 6: *Eremophila longifolia* (Weeping Emu-bush) Shrubland
Association 7: *Eucalyptus camaldulensis* (Red Gum) / *E. leucoxylon* ssp. *pruinosa* (Inland South Australian Blue Gum) / *E. porosa* (Mallee Box) Woodland
Association 8: Exotic / Native Grassland
Association 9: *Eucalyptus porosa* (Mallee Box) Very Open Mallee
Association 10: *Nitraria billardierei* (Nitre Bush) / *Atriplex stipitata* (Bitter Saltbush) Shrubland

Environmental & Biodiversity Services
2/48 Barwell Avenue
Kurralta Park, SA 5037
www.ebservices.com.au
t. 08 7127 5607
f. 08 8297 3768

APPENDIX G

EPBC DETERMINATION

Australian Government

Department of the Environment, Water, Heritage and the Arts

Mr Rodney Ahern
Business Development Manager
TrustPower Australia Holdings Pty Ltd
GPO Box 1512
ADELAIDE SA 5001

Date: 29 January 2009
EPBC Ref: 2009/5073
EPBC contact: Amanda Slade
02 6275 9134
amanda.slade@environment.gov.au

Dear Mr Ahern

Decision on referral

Snowtown Wind Farm, near Snowtown, SA (EPBC 2009/5073)

This is to advise you of my decision, under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) about the proposed action to develop stage two of the Snowtown Wind Farm and associated transmission line, near Snowtown, South Australia.

I have decided that the proposed action is not a controlled action. This means that the proposed action does not require further assessment and approval under the EPBC Act before it can proceed. A copy of the document recording this decision is enclosed. This document will be notified publicly on the Department's website.

Please note that this decision relates only to the specific matters protected under Chapter 4 of the EPBC Act.

This decision does not affect any requirement for separate state or local government environment assessment and approvals of the proposed action.

The Department has an active audit program for proposals that have been referred under the EPBC Act. The audit program aims to ensure that proposals are implemented as planned. You should be aware that your project may be selected for audit by the Department at any time and all related records and documents may be subject to scrutiny. Information about the Department's audit strategy is enclosed.

I have written separately to the referring party, Mr Nathan Godfrey from Windprospect Pty Ltd, advising him of this decision.

If you have any questions about the referral process or this decision, please contact the EPBC project manager and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely

Vicki Middleton

Ms Vicki Middleton
Assistant Secretary
Environment Assessment Branch

Australian Government

Department of the Environment, Water, Heritage and the Arts

Notification of
REFERRAL DECISION – not controlled action

Development of Snowtown Wind farm, near Snowtown, SA (EPBC 2009/5073)

This decision is made under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Proposed action

person named in the referral	Trustpower Pty Ltd
proposed action	To develop and build stage two of the Snowtown Wind Farm, including the construction of up to 102 wind turbines and associated infrastructure, on land along the Hummock and Barunga Ranges, 6km west of Snowtown, South Australia (see EPBC Act referral number 2009/5073).

Referral decision: Not a controlled action

status of proposed action	The proposed action is not a controlled action.

Person authorised to make decision

Name and position	Ms Vicki Middleton Assistant Secretary Environment Assessment Branch
signature	Vicki Middleton
date of decision	29 **January 2010**

APPENDIX H

NOISE STUDY REPORT
(SONUS PTY LTD)

Sonus Pty Ltd
280 Melbourne St
NORTH ADELAIDE SA 507
Phone: 8361 7844
Facsimile: 8361 7879
www.sonus.com.au
ABN: 67 882 843 130
ct@sonus.com.au

SNOWTOWN WIND FARM

ENVIRONMENTAL NOISE ASSESSMENT

FOR

TRUSTPOWER LTD
GPO Box 1512
Adelaide
South Australia 5001

And

WIND PROSPECT PTY LTD
PO Box 389
Christies Beach
South Australia 5165

December 2009

INTRODUCTION

TrustPower, in conjunction with Wind Prospect are proposing to develop "stage 2" of the wind farm along the Barunga and Hummock Ranges, west of Snowtown and north-west of Lochiel, in South Australia.

An assessment of the environmental noise from the wind farm has been made. The assessment has been based on comparing predicted noise levels at the surrounding dwellings from all three wind farm stages with the applicable environmental noise criteria determined using the relevant South Australian Environmental Protection Authority (EPA) "Wind farms, environmental noise guidelines"[1] (2009 Guidelines).

The noise from the proposed turbine layout was predicted to the residences in the vicinity based on the CONCAWE[2] noise propagation model and the sound power level data provided by the manufacturer of the turbines. A comparison between the calculated noise levels and the determined environmental noise criteria was then made in order to ensure the proposed wind farm design complies with the Guidelines.

This report includes the following appendices:

Appendix A:	Nomenclature used in this report;
Appendix B:	Graphs of background noise data correlated with wind speed;
Appendix C:	Photographs of logger locations;
Appendix D:	Coordinates of the nearest residences to the proposed development, and;
Appendix E:	Turbine coordinates for the 2 stages.

[1] Environmental Protection Authority of South Australia, "Wind farms, environmental noise guidelines", July 2009.
[2] CONCAWE - The oil companies' international study group for conservation of clean air and water – Europe, "The propagation of noise from petrochemical complexes to neighbouring communities", May 1981.

DEVELOPMENT PLAN

The subject land is located within a "Primary Production" Zone of the Wakefield Regional Council Development Plan.

Council Wide Objectives include:

Wakefield Regional Council Objective 2 (Renewable Energy Facilities):

Location, siting, design and operation of renewable energy facilities to avoid or minimise adverse impacts and maximise positive impacts on the environment, the local community and the State.

Council Wide Principles of Development Control include:

Wakefield Regional Council PDC 2 (Renewable Energy Facilities):

2. Wind farms and ancillary development such as substations, maintenance sheds, access roads and connecting power-lines, should be sited, designed and operated in a manner that:

(a) avoids or minimises negative impacts on the character, .. or amenity of the area;
…

(e) avoids or minimizes nuisance or hazard to nearby property owners and/or occupiers, road users and wildlife by not:
…

(ii) creating excessive noise;
…

All of the considered residences are located within a "Primary Production" Zone of the Development Plan

GUIDELINES

2009 Guidelines

The South Australian EPA has developed environmental noise guidelines for noise from wind farms. The 2009 Guidelines state:

> *The predicted equivalent noise level ($L_{Aeq,10}$) adjusted for tonality in accordance with these guidelines should not exceed:*
>
> - *35 dB(A) at relevant receivers in localities which are primarily intended for rural living, or*
> - *40 dB(A) at relevant receivers in localities in other zones, or*
> - *the background noise ($L_{A90,10}$) by more than 5 dB(A)*
>
> *whichever is greater, at all relevant receivers for wind speed from cut-in to rated power of the WTG and each integer wind speed in between.*

In addition, the 2009 Guidelines note that:

> *The criteria have been developed to minimise the impact on the amenity of premises that do not have an agreement with the wind farm developers.*

The landowners of a number of residences in the vicinity of the wind farm have a commercial agreement with TrustPower. These residences are Davidson, Price, Turner, Michael, Ross Na Ree, Wilson, Percyton, Ebsary Section 97, Atkinsons, Gum Park, Cummins, Seafield Farm, Ebsary Section 771, Jamiesons, Burnsfield, and Slattery.

As each of these landowners has an agreement with the wind farm developer, suitable noise criteria for each residence will be agreed between the developer and the landowner. However, to protect landholders with an agreement in this project from unreasonable interference to amenity, reference is made to the WHO Guidelines[3]. The WHO Guidelines recommend an indoor level of 30 dB(A) is achieved to protect the landholders against sleep disturbance. The indoor limit of 30 dB(A) equates to an outdoor noise level of 45 dB(A) with windows open or 52 dB(A) with windows closed.

It is proposed that the noise at residences of landholders with an agreement will achieve either the requirements of the 2009 Guidelines (used for landholders without an agreement) or the recommendations of the WHO to protect against sleep disturbance.

[3] "WHO Guidelines for Community Noise" World Health Organisation, 1999

Guideline Evolution

Background noise measurements were carried out for "stage 1" in 2003 and 2005. At this time the South Australian EPA had in place the document, "Wind farms, Environmental Noise Guidelines- February 2003"[4] (2003 Guidelines), which provided guidance to measuring background noise.

The release of the 2009 Guidelines has resulted in an evolved method of measuring background noise and determining the noise criteria.

The 2009 Guidelines methodology for measuring background noise now specifically includes having a localised meteorological logger at microphone height to discard data during high wind or rain periods at the microphone position and the use of noise measurement instruments with a low noise floor.

In addition, when determining the noise criteria, the 2009 Guidelines suggest that the wind speed measured on the wind farm site should be at the turbine hub height, rather than the 10m height specified by the 2003 Guidelines.

BACKGROUND NOISE MEASURMENTS

To determine the background noise level at various wind speeds, the background noise levels were measured at seven locations within the proposed site between the 18th of November and the 19th of December, 2003, and at a further three locations between the 20th of April and the 17th of May, 2005. During both periods, the procedure of the 2003 Guidelines was used.

The ten measurement locations were chosen to represent the background noise at the measurement location, and in some cases, a number of residences within the vicinity.

The background noise level was measured in 10-minute intervals at each of the ten locations. During the background noise measurement periods, Wind Prospect measured the wind speed (at 10m above ground) at locations within the proposed wind turbine site.

The background noise levels were compared against rain data, and all periods that the microphone was exposed to rain were discarded. The resultant background noise data was correlated with the wind speed measured at 10m above ground at locations within the proposed wind turbine site, and a least squares regression analysis of the data was undertaken to determine the line of best fit. The data and the regression curve are shown in Appendix B. Based on this regression analysis, the background noise level ($L_{A90,10}$) at a range of wind speeds within the operating range of the turbines is shown in the table below:

[4] Environmental Protection Authority of South Australia, "Wind farms, environmental noise guidelines", February 2003.

Wind Speed (m/s)	Price	Turner	Wilson	Percyton	Ross Na Ree
	$L_{A90,10}$	$L_{A90,10}$	$L_{A90,10}$	$L_{A90,10}$	$L_{A90,10}$
3	26	32	28	34	27
4	28	34	30	37	30
5	30	36	33	39	33
6	32	38	35	41	35
7	34	41	37	43	38
8	36	43	39	45	40
9	38	45	41	47	42
10	40	47	42	48	43

Wind Speed (m/s)	Hayes	Kooliatta	Adalisa	E Stringer	G Stringer
	$L_{A90,10}$	$L_{A90,10}$	$L_{A90,10}$	$L_{A90,10}$	$L_{A90,10}$
3	29	30	24	22	24
4	32	30	28	25	25
5	35	31	31	27	26
6	37	32	34	30	27
7	39	33	37	32	29
8	41	33	39	34	31
9	43	35	40	36	33
10	45	36	41	38	36

The following table details the site number and grid references (in WGS84 map datum) of the wind measurement masts used for correlation with the measured background noise levels:

Wind Mast			
Site Number	**Easting**	**Northing**	**Represented Residences**
9223	236792	6267076	Adalisa, E Stringer, G Stringer
9224	238268	6267250	Turner, Hayes
9225	234045	6256156	Ross Na Ree, Percyton, Wilson, Price, Kooliatta

The background noise was measured at the locations of Percyton, Turner, Wilson, Hayes, and Adalisa using Rion NL21 sound level meters, at the location of G Stringer using a Rion NL31 sound level meter, and at the location of E Stringer using a Svan 947 sound level meter. At the locations of Ross Na Ree and Kooliatta, Acoustic Research Laboratories (ARL) noise loggers were used, whilst a Renzo Tonin & Associates (RTA) noise logger was used to measure background noise levels at the location of Price. All equipment was fitted with standard wind shields, with microphones approximately 1500mm above ground level. Photographs of the noise monitoring equipment in the measurement positions are shown in Appendix C.

Each of the ten measurement locations was chosen to represent a number of residences in the vicinity. The following table details the residences represented by each measurement location:

Measurement Location	Represented Residences
Price	Price
Turner	Turner, Michael
Wilson	Wilson, Pine Lodge
Percyton	Ebsary Section 97, Percyton, Venning Allotment 1, Venning Section 104, Gum Park
Ross Na Ree	Ross Na Ree, Davidson
Hayes	Hayes, Fountains, Cummins, Burnsfield
Kooliatta	Kooliatta, Whitings, House 39, Ebsary Section 771, Snowyview
E Stringer	E Stringer, Taloumbi, Irelands, Sharps Well, A Stringer
Adalisa	Adalisa, Seafield Farm, Jamiesons, Barunga Pastoral
G Stringer	G Stringer, Atkinsons, Slattery, Kilkee

It is noted that the residences of Nicholls Lot 53, Nicholls Section 296, House 34, House 35, House 36, House 37, Maro Creek and Chelsea are not represented by any of the ten background noise measurement locations.

BACKGROUND NOISE CONFIRMATION

An assessment of the background noise levels at one residence was made in July 2009. The aim of the assessment was to confirm that the background noise levels have not significantly changed since the noise measurements were carried out for “stage 1” in 2003 and 2005.

To make the comparison, background noise levels were measured in July 2009 at the Wilson residence and correlated with wind speed data collected from a meteorological mast on the wind farm site. The correlations have then been made in accordance with the 2009 Guidelines. However, to allow a direct comparison to previous noise measurements taken in 2003 at the same location, 10m high wind speed measurements on the wind farm site have been used.

It was found that the background noise levels measured in July 2009 did not greatly vary from the initial background noise measurements, with higher noise levels recorded at some wind speeds, and lower noise levels at other wind speeds. The variance in background noise correlation was no greater than 2 dB(A) at any wind speed.

It was concluded that the variation in background noise level measured between 2003 and 2009 is not considered to represent a trend but rather natural variation. Therefore, the background noise measurements used for “stage 1” of the wind farm development have been used for the predictions of “stage 2”.

PREDICTED NOISE FROM WIND FARM

This environmental noise assessment has been prepared based on the easting and northing coordinates of wind turbines for the two stages comprising a total of 149 Suzlon S88 turbines as shown in Appendix E.

The predictions of noise from the 149 Suzlon S88 turbines have been based sound power levels that correspond to wind speed at a height of 10m. These sound power levels have been used as background noise was correlated (prior to the 2009 Guidelines) against 10m high wind speed on the wind farm site, and these must be the same to accurately predict the noise from the wind farm.

In the prediction model, different sound power levels were applied to the 47 turbines of "stage 1" and the 102 turbines of "stage 2", based on data provided by the manufacturer. The sound power levels used are given below.

Stage 1 - 47 Suzlon S88 turbines

Octave Band Data - A-Weighted Sound Power Level (dB(A))								
Freq (Hz) Bin	10m AGL Wind Speed (m/s)							
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
62.5	82.8	82.8	83.5	84.6	86.7	89.0	90.1	90.2
125	93.1	93.1	93.8	94.9	96.8	98.4	98.8	98.4
250	97.6	97.6	98.3	99.4	101.2	101.9	102.7	102.0
500	98.3	98.3	99.0	100.1	100.4	101.1	101.6	101.5
1000	94.7	94.7	95.4	96.5	97.0	98.5	99.0	99.3
2000	91.2	91.2	91.9	93.0	95.3	96.7	97.8	97.6
4000	85.2	85.2	85.9	87.0	90.7	92.1	93.3	92.8
8000	74.8	74.8	75.5	76.6	80.7	82.1	82.3	83.0
Total	102.9	102.9	103.6	104.7	106.0	107.0	107.7	107.4

Stage 2 - 102 Suzlon S88 turbines

Octave Band Data - A-Weighted Sound Power Level (dB(A))								
Freq (Hz) Bin	10m AGL Wind Speed (m/s)							
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
62.5	76.5	77.6	78.5	79.1	79.8	82.6	81.8	81.2
125	88.5	89.6	90.5	91.1	92.2	94.3	92.4	91.8
250	94.9	96.0	97.0	97.5	98.6	99.8	98.0	97.4
500	95.3	96.4	97.4	97.9	98.7	99.0	99.0	98.3
1000	93.6	94.7	95.7	96.2	96.8	95.7	96.6	96.0
2000	90.9	92.0	93.0	93.5	92.6	93.5	92.7	92.0
4000	82.2	83.2	84.2	84.7	85.5	87.5	85.3	84.7
8000	68.6	69.7	70.6	71.2	71.2	75.0	71.2	70.6
Total	100.4	101.5	102.4	103.0	103.7	104.3	103.6	103.0

It is understood that these sound power levels will be included as warranted levels in guarantees entered into between the wind farm developers and Suzlon. It is further understood that the developers will require Suzlon to measure and confirm the absence of tonal characteristics and show compliance with the warranted sound power levels during commissioning of the wind farm.

The CONCAWE noise propagation model was used to model the noise from the generators with the topography and worst case wind directions input to the model. The CONCAWE model is used around the world and is widely accepted as an appropriate noise propagation model. The assessment is based on the following meteorological conditions:

- Night
- No cloud
- 10°C air temperature
- 80% relative humidity

The 2009 Guidelines provide a default prediction method which incorporates hard ground in the noise propagation model unless justification is provided for using another input. The CONCAWE propagation model separates ground attenuation into the categories of hard ground and ground with finite acoustic impedance. CONCAWE states that hard ground should be used for surfaces such as concrete or water and all other surfaces including grass or soil should be considered as finite acoustic impedance. Considering the ground between the turbines and residences is mostly covered with grass or rough pasture, CONCAWE is clear that the ground should not be modelled as hard ground. Therefore, the ground was modelled as having finite acoustic impedance.

The predicted noise levels (dB(A)) at residences of landholders without a commercial agreement with TrustPower are summarised in the tables below for worst case wind directions at each residence along with the relevant criteria.

Residences represented by background noise measurement location Percyton

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*34*	*37*	*39*	*41*	*43*	*45*	*47*	*48*
Criterion	40	42	44	46	48	50	52	53
Residence								
Percyton	38	38	39	40	41	42	42	43
Venning Allotment 1	37	37	38	39	40	41	42	42
Venning Section 104	36	37	37	38	40	41	41	42

Residences represented by background noise measurement location Wilson

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*28*	*30*	*33*	*35*	*37*	*39*	*41*	*42*
Criterion	40	40	40	40	42	44	46	47
Residence								
Pine Lodge	34	35	36	36	37	38	37	41

Residences represented by background noise measurement location Hayes

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*29*	*32*	*35*	*37*	*39*	*41*	*43*	*45*
Criterion	40	40	40	42	44	46	48	50
Residence								
Hayes	31	32	33	34	35	36	36	37
Fountains	27	28	29	30	31	32	32	33

Residences represented by background noise measurement location Kooliatta

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*30*	*30*	*31*	*32*	*33*	*33*	*35*	*36*
Criterion	40	40	40	40	40	40	40	41
Residence								
Kooliatta	35	35	36	37	38	39	38	41
Whitings	32	33	34	35	36	37	36	39
House 39	26	27	28	28	29	30	29	33
Snowyview	28	29	30	31	32	33	32	35

Residences represented by background noise measurement location E Stringer

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*22*	*25*	*27*	*30*	*32*	*34*	*36*	*38*
Criterion	40	40	40	40	40	40	41	43
Residence								
E Stringer	32	33	34	35	36	37	37	38
Taloumbi	31	32	32	33	34	35	36	37
Irelands	32	32	33	34	35	36	37	37
Sharps Well	32	32	33	34	35	36	36	37
A Stringer	26	27	27	28	30	31	31	32

Residences represented by background noise measurement location Adalisa

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*24*	*28*	*31*	*34*	*37*	*39*	*40*	*41*
Criterion	40	40	40	40	42	44	45	46
Residence								
Adalisa	31	32	33	34	35	36	36	38
Barunga Pastoral	32	32	33	34	35	36	37	38

Residences represented by background noise measurement location G Stringer

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*24*	*25*	*26*	*27*	*29*	*31*	*33*	*36*
Criterion	40	40	40	40	40	40	40	41
Residence								
G Stringer	34	35	36	37	38	38	38	41
Kilkee	<25	25	26	27	28	29	29	31

It has been assumed that background noise levels at the following residences are below 35 dB(A) for all wind speeds. Therefore, the most stringent 2009 Guidelines criterion of 40 dB(A) has been applied for all wind speeds at these residences.

Residences represented by a background noise measurement location

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Criterion	*40*	*40*	*40*	*40*	*40*	*40*	*40*	*40*
Residence								
Nicholls Lot 53	<25	<25	<25	<25	<25	<25	<25	<25
Nicholls Section 296	<25	<25	<25	<25	<25	<25	<25	<25
House 34	<25	<25	<25	<25	<25	<25	<25	<25
House 35	<25	<25	<25	<25	<25	<25	<25	<25
House 36	<25	<25	<25	<25	<25	<25	<25	<25
House 37	<25	<25	<25	<25	<25	<25	<25	<25
Maro Creek	25	26	27	28	29	30	29	32
Chelsea	<25	<25	<25	<25	<25	<25	<25	26

The predicted noise levels (dB(A)) at residences of landholders with a commercial agreement with TrustPower are summarised in the tables below for worst case wind directions at each residence along with the relevant criteria.

Residences represented by background noise measurement location Price

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*26*	*28*	*30*	*32*	*34*	*36*	*38*	*40*
Criterion	45	45	45	45	45	45	45	45
Residence								
Price	39	40	41	42	43	43	43	45

Residences represented by background noise measurement location Turner

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*32*	*34*	*36*	*38*	*41*	*43*	*45*	*47*
Criterion	45	45	45	45	46	48	50	52
Residence								
*Turner	42	43	44	44	45	46	45	48
*Michael	40	41	41	42	43	44	44	46

Residences represented by background noise measurement location Wilson

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*28*	*30*	*33*	*35*	*37*	*39*	*41*	*42*
Criterion	45	45	45	45	45	45	46	47
Residence								
Wilson	30	31	32	33	34	34	34	37

Residences represented by background noise measurement location Percyton

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*34*	*37*	*39*	*41*	*43*	*45*	*47*	*48*
Criterion	45	45	45	46	48	50	52	53
Residence								
Ebsary Section 97	36	37	37	38	40	41	41	41
Gum Park	34	34	35	36	37	38	38	40

Residences represented by background noise measurement location Ross Na Ree

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*27*	*30*	*33*	*35*	*38*	*40*	*42*	*43*
Criterion	45	45	45	45	45	45	47	48
Residence								
Ross Na Ree	37	38	39	39	40	41	40	44
Davidson	37	38	39	40	41	41	40	44

Residences represented by background noise measurement location Hayes

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*29*	*32*	*35*	*37*	*39*	*41*	*43*	*45*
Criterion	45	45	45	45	45	46	48	50
Residence								
Cummins	29	30	31	32	33	34	33	36
Burnsfield	29	29	30	31	32	33	33	35

Residences represented by background noise measurement location Adalisa

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*24*	*28*	*31*	*34*	*37*	*39*	*40*	*41*
Criterion	45	45	45	45	45	45	45	46
Residence								
Seafield Farm	32	33	34	35	36	37	37	38
Jamiesons	33	34	35	36	37	38	38	39

Residences represented by background noise measurement location Kooliatta

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*30*	*30*	*31*	*32*	*33*	*33*	*35*	*36*
Criterion	45	45	45	45	45	45	45	45
Residence								
Ebsary Section 771	39	40	41	41	42	43	42	45

Residences represented by background noise measurement location G Stringer

Wind speed (m/s)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Background ($L_{A90,10}$)	*24*	*25*	*26*	*27*	*29*	*31*	*33*	*36*
Criterion	45	45	45	45	45	45	45	45
Residence								
Atkinsons	36	37	37	38	39	40	39	42
Slattery	28	29	30	31	32	33	32	35

The above tables indicate that the predicted noise levels from the proposed wind farm achieve the relevant criteria at all residences.

CONCLUSION

An environmental noise assessment of the proposed wind farm has been made.

The assessment indicates that for the proposed arrangement of 149 Suzlon S88 turbines, the predicted noise level at:

- residences of landholders without an agreement with TrustPower in the vicinity of the development will achieve the requirements of the EPA 2009 Guidelines, and;

- residences of landholders with an agreement with TrustPower in the vicinity of development will achieve the requirements of the EPA 2009 Guidelines or the recommendations of the WHO Guidelines.

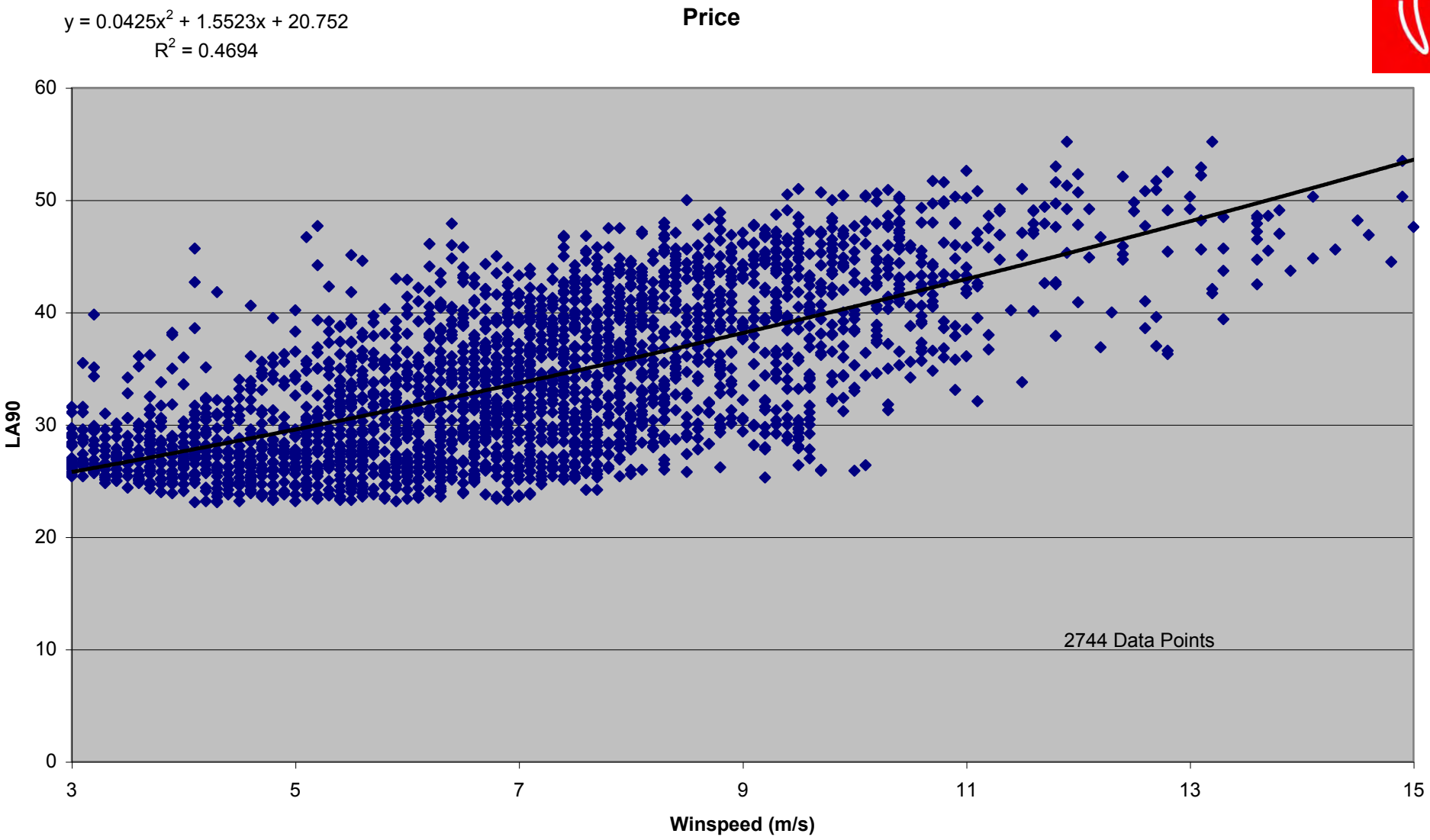
Given the above, it is considered that the proposed wind farm has been located, sited and designed to avoid adverse noise impacts and to avoid nuisance or hazard to nearby property owners/ occupiers by way of noise. Therefore, it is considered that Council Wide Objective 2 and Council Wide Principle of Development Control 2 are achieved with respect to noise.

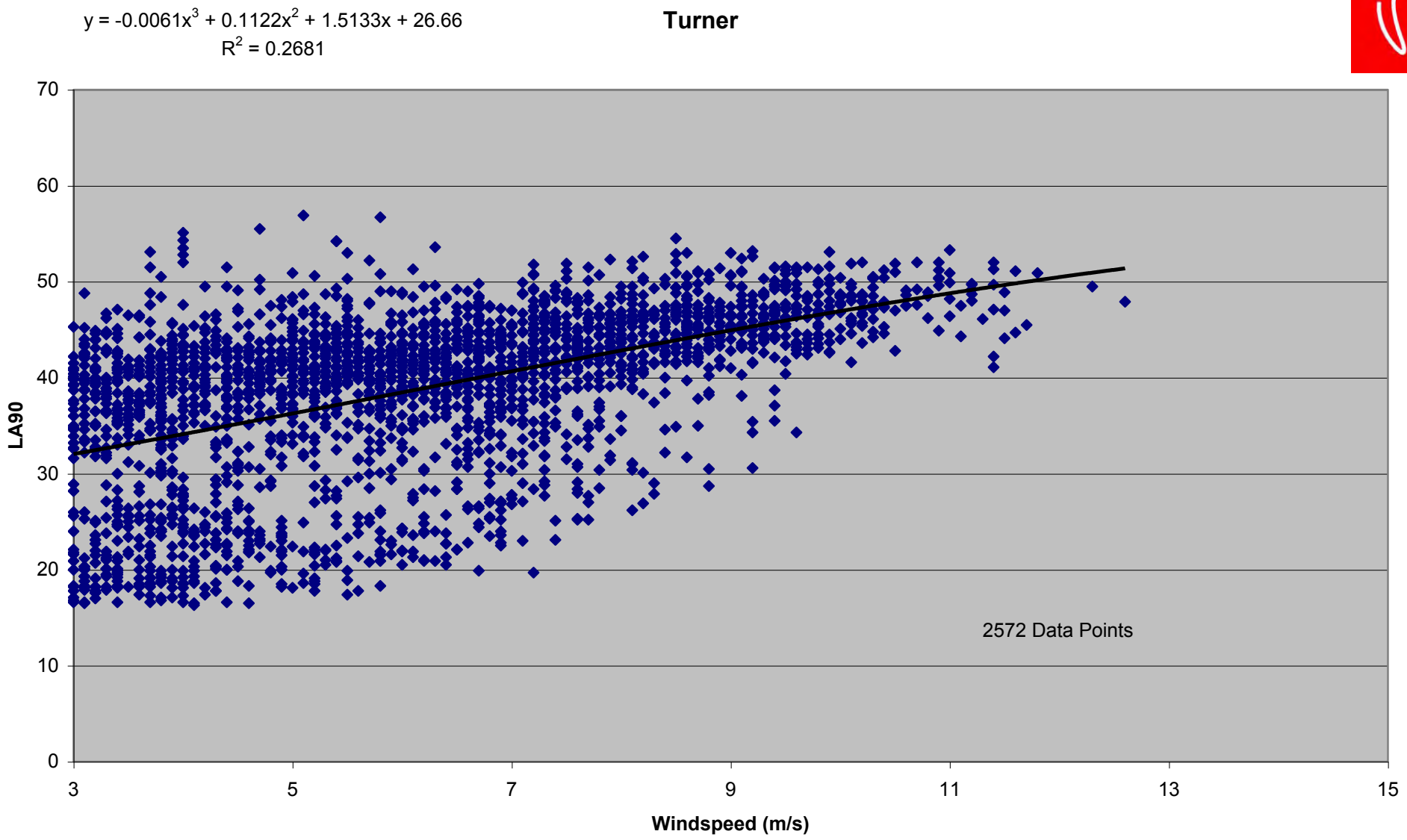
Appendix A: Nomenclature

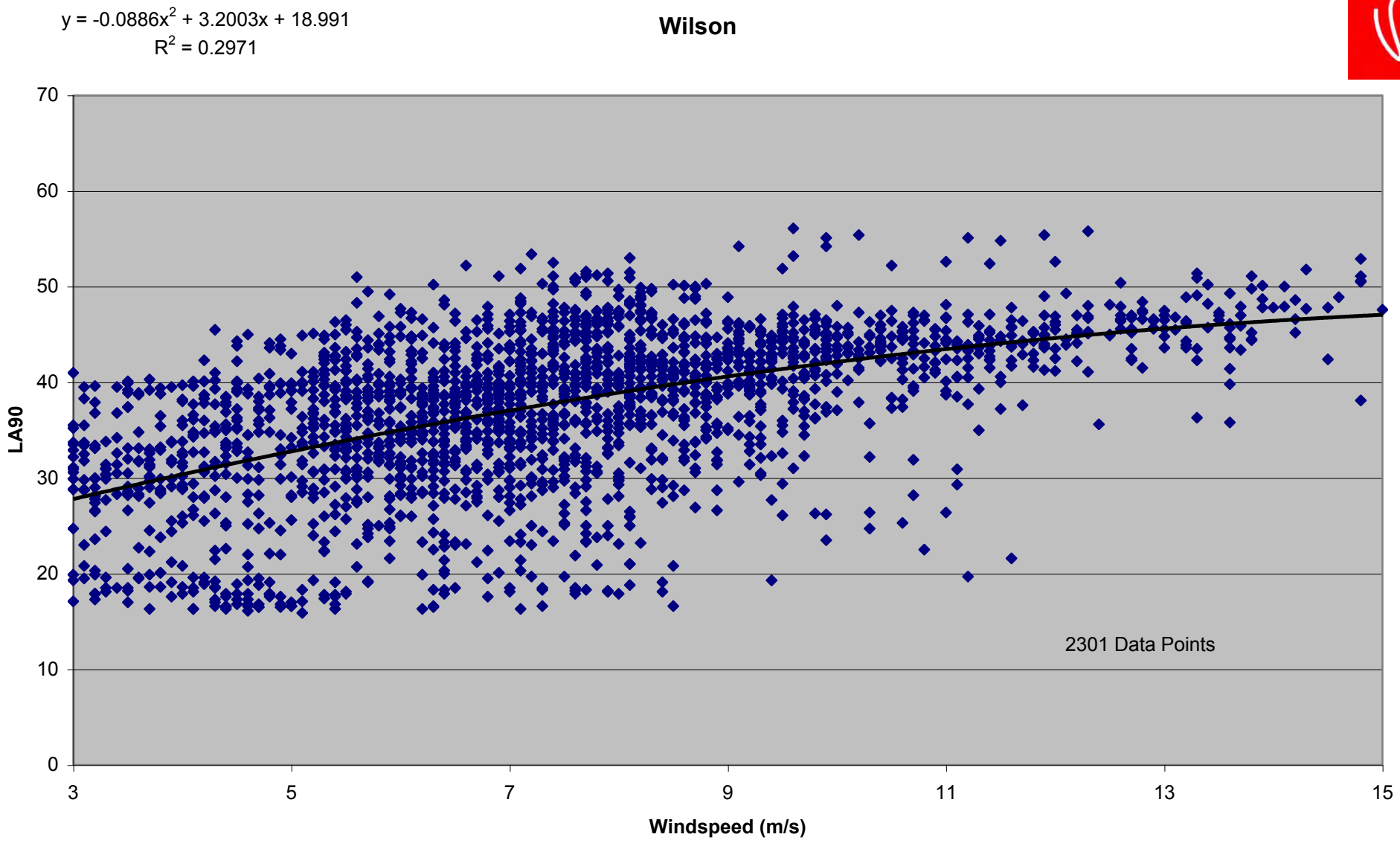
The noise level terminology used is summarised below:

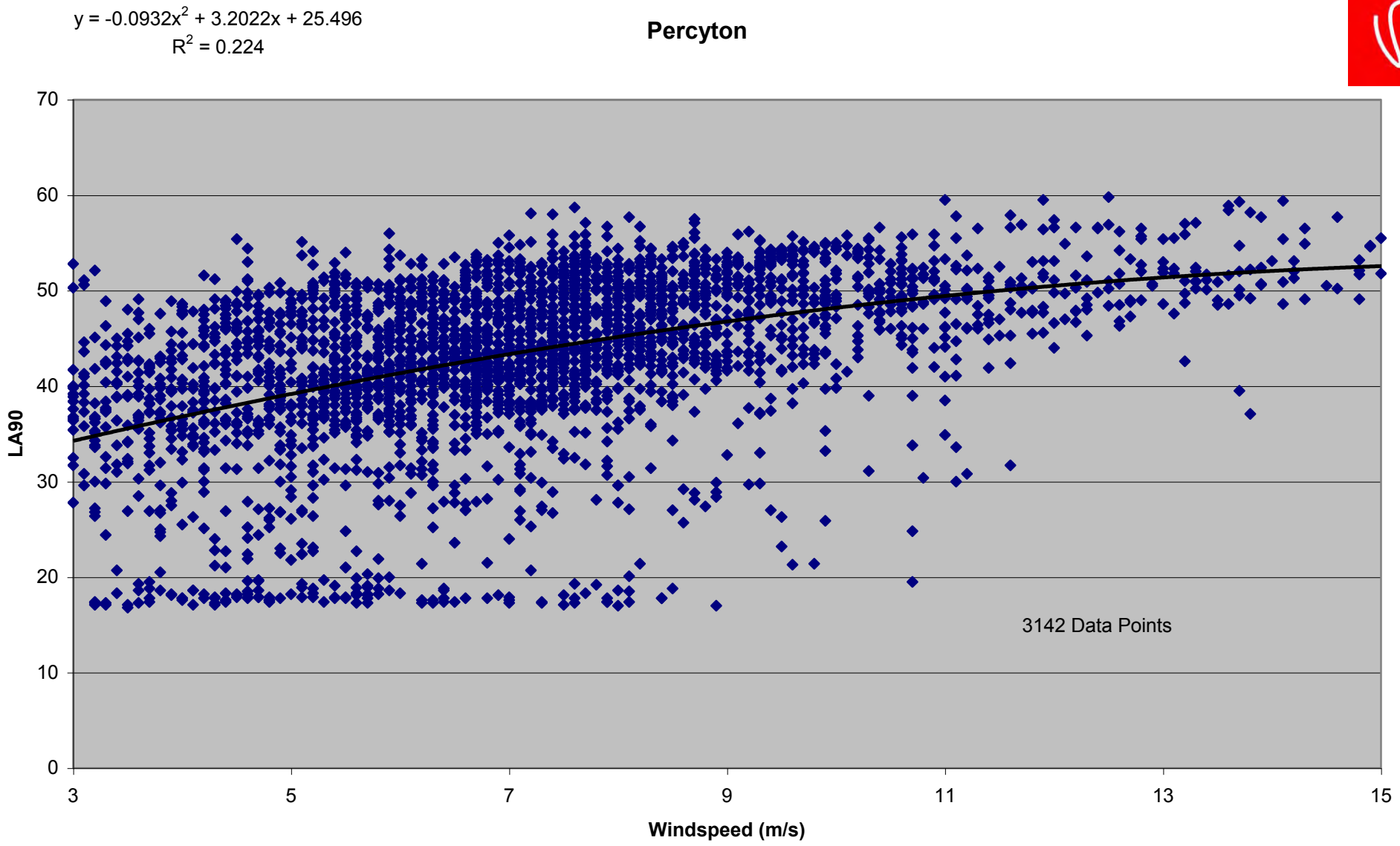
‚A' Weighted	Frequency filter applied to measured noise levels to replicate the frequency response of the human ear.
dB(A)	‚A' Weighted overall sound pressure level.
$L_{A90,10}$	The ‚A' Weighted noise level exceeded 90% of a 10 minute measurement period. This descriptor is used to represent the background noise level.
$L_{Aeq,10}$	‚A' weighted time based equivalent (or average) noise level measured over a 10 minute period.

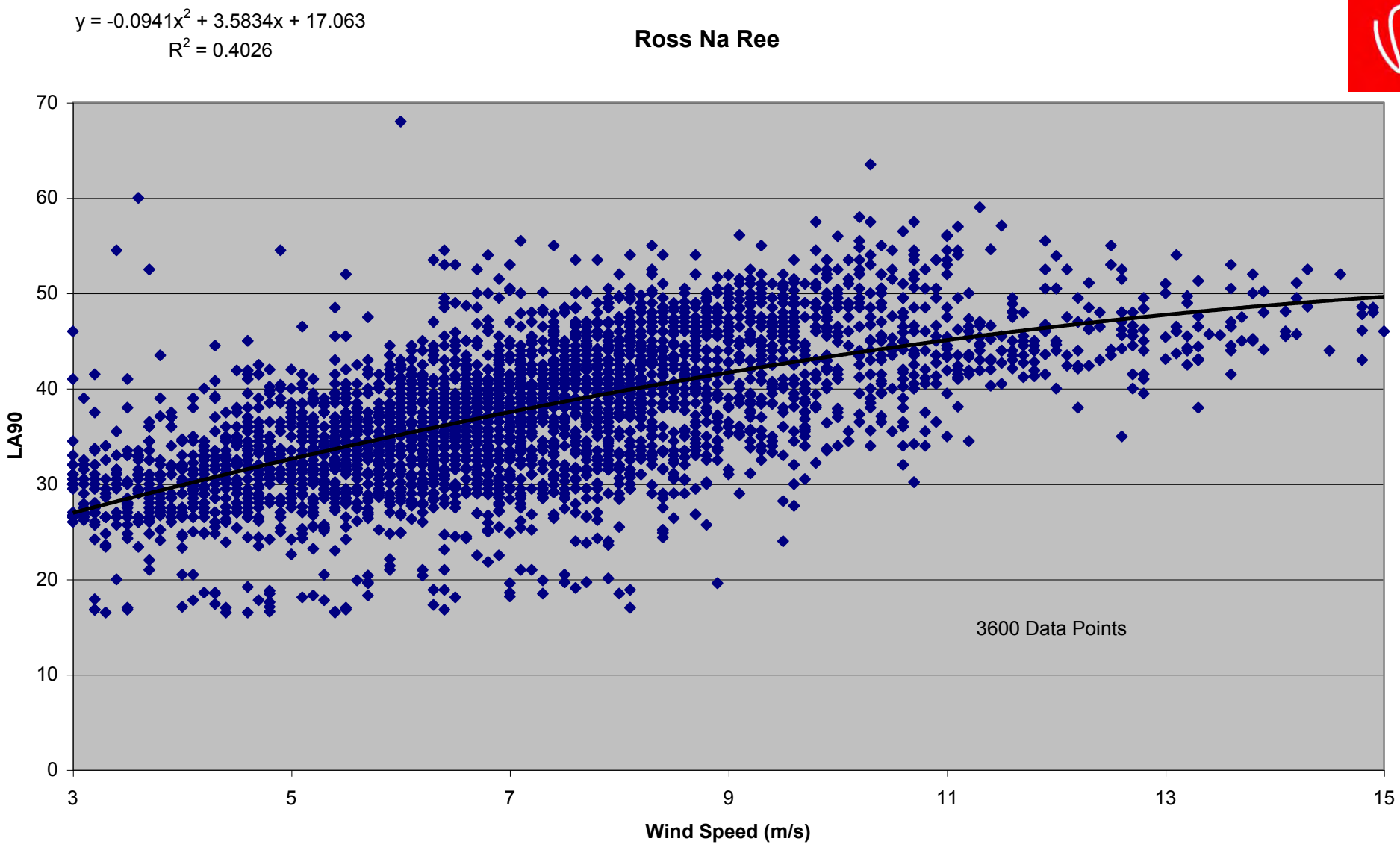
APPENDIX B: Background Noise Data Correlated with Wind Speed

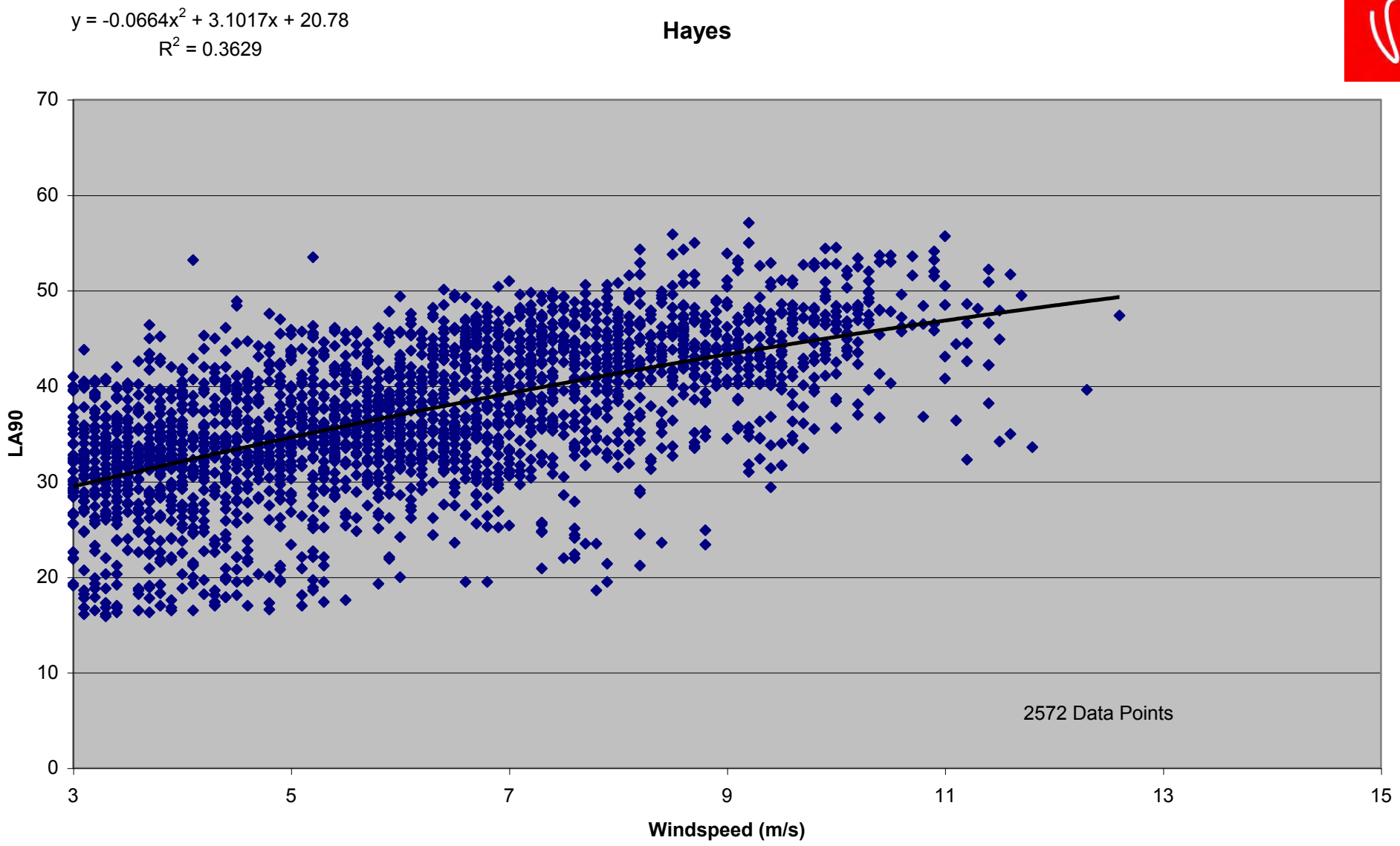


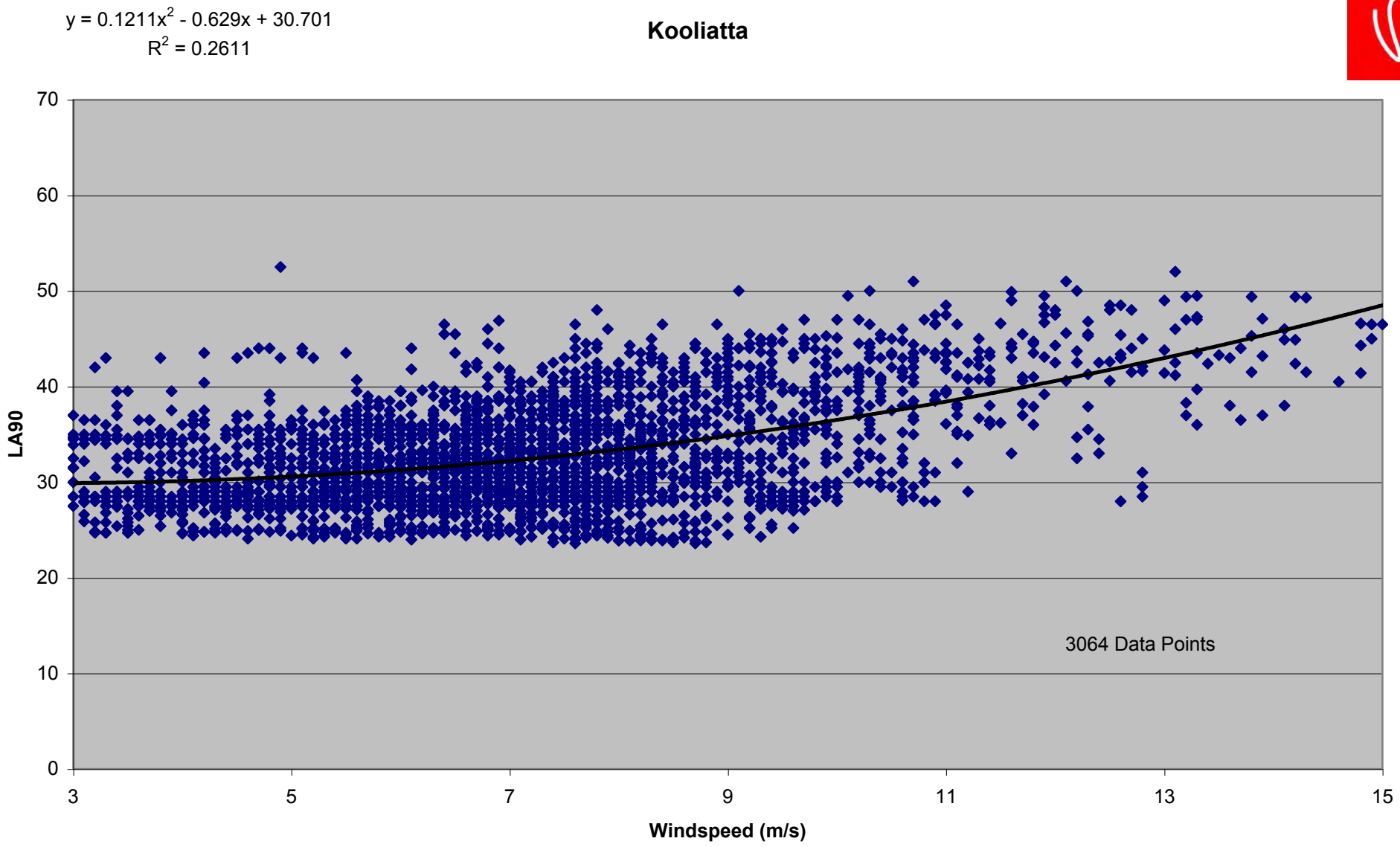

y = -0.0061x3 + 0.1122x2 + 1.5133x + 26.66
R2 = 0.2681
Turner
70
60
50
40
30
20
10
0
LA90
3
5
7
9
11
13
15
Windspeed (m/s)
2572 Data Points

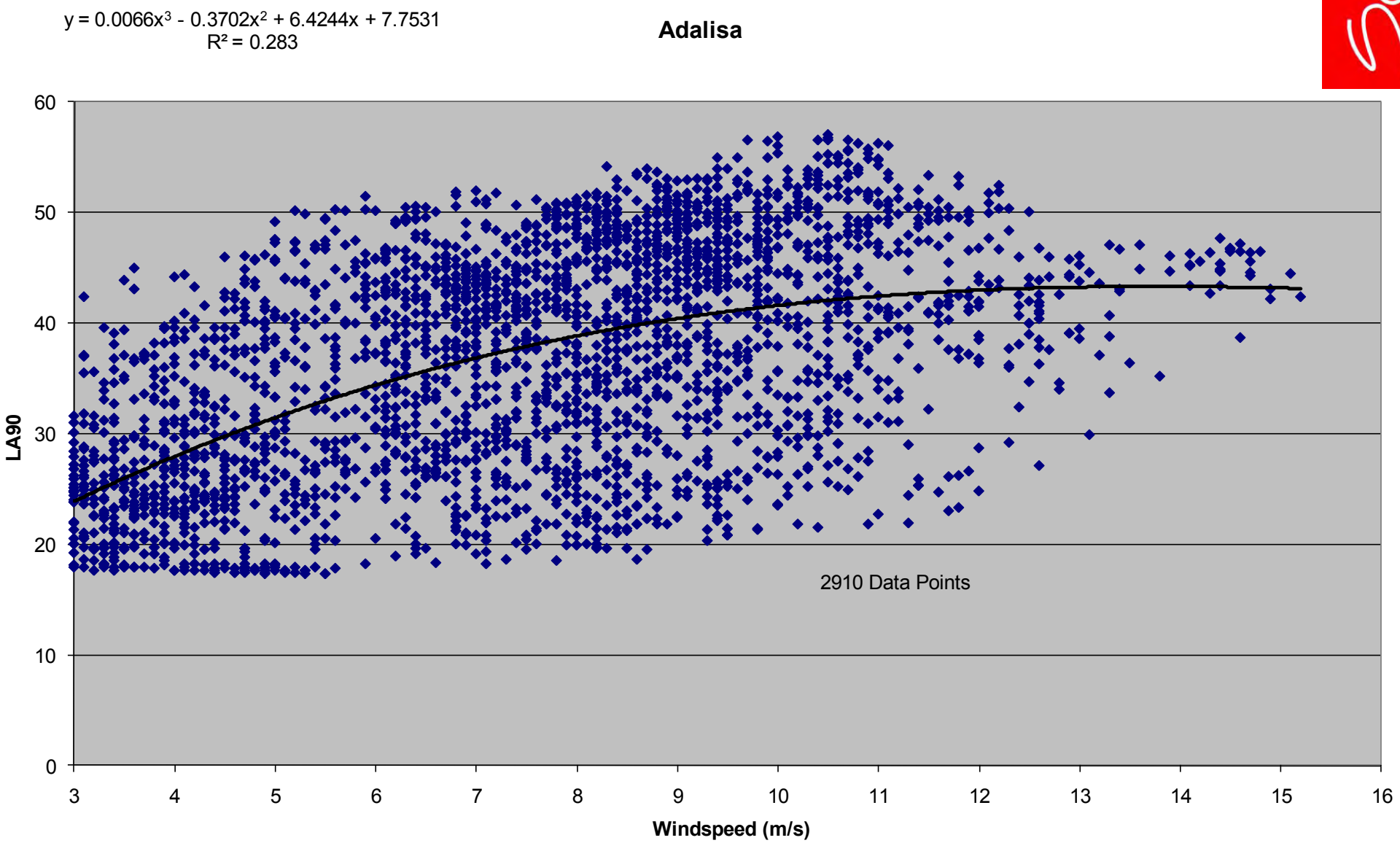

y = -0.0886x2 + 3.2003x + 18.991
R2 = 0.2971
Wilson
LA90
Windspeed (m/s)
2301 Data Points
0
10
20
30
40
50
60
70
3
5
7
9
11
13
15

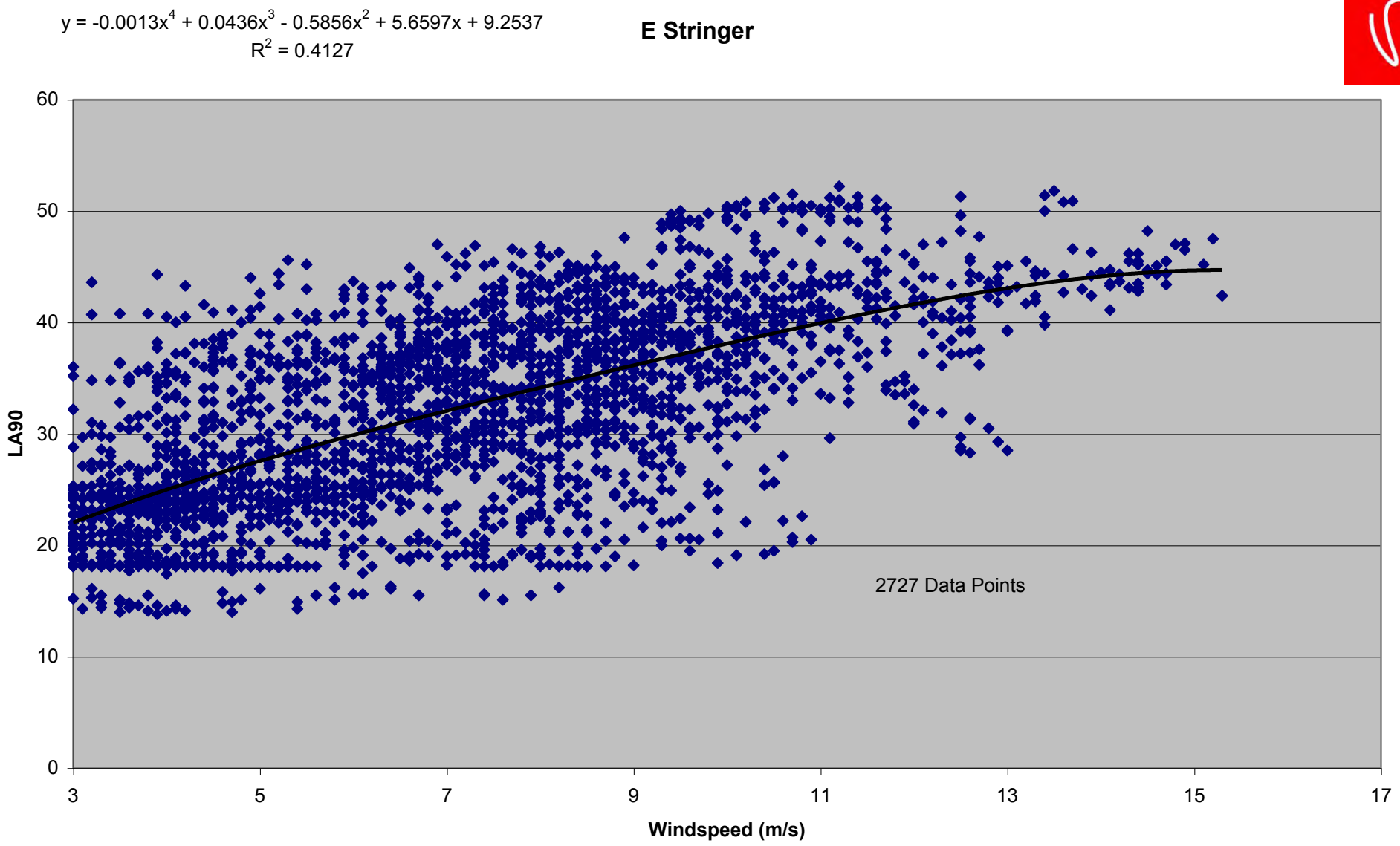

y = -0.0932x2 + 3.2022x + 25.496
R2 = 0.224
Percyton
LA90
Windspeed (m/s)
3142 Data Points
0
10
20
30
40
50
60
70
3
5
7
9
11
13
15

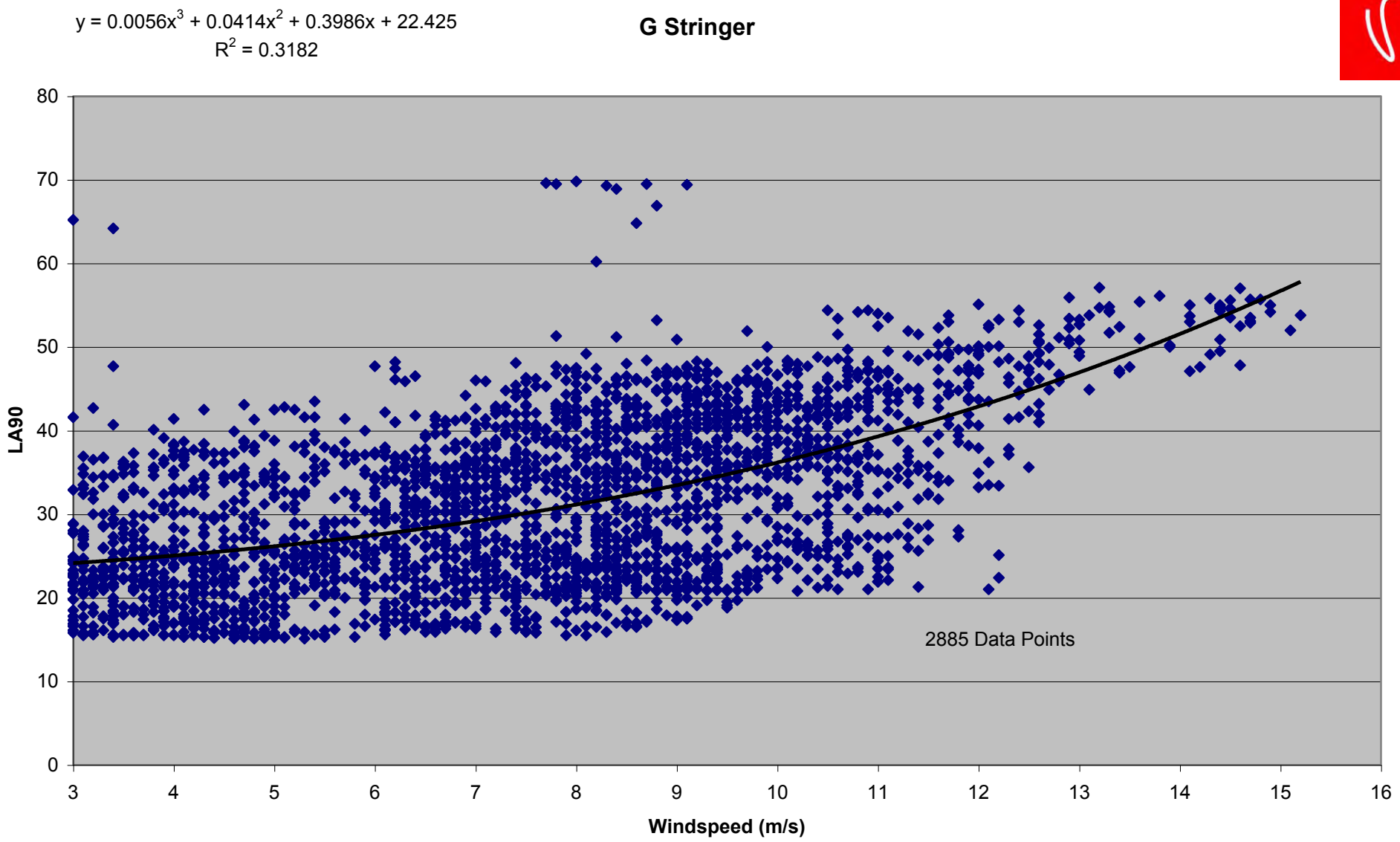

y = -0.0941x2 + 3.5834x + 17.063
R2 = 0.4026
Ross Na Ree
LA90
Wind Speed (m/s)
3600 Data Points
0
10
20
30
40
50
60
70
3
5
7
9
11
13
15


y = -0.0664x2 + 3.1017x + 20.78
R2 = 0.3629
Hayes
LA90
Windspeed (m/s)
2572 Data Points
0
10
20
30
40
50
60
70
3
5
7
9
11
13
15


y = 0.1211x2 - 0.629x + 30.701
R2 = 0.2611
Kooliatta
LA90
Windspeed (m/s)
3064 Data Points
0
10
20
30
40
50
60
70
3
5
7
9
11
13
15


y = 0.0066x³ - 0.3702x² + 6.4244x + 7.7531
R² = 0.283
Adalisa
LA90
Windspeed (m/s)
2910 Data Points
0
10
20
30
40
50
60
3
4
5
6
7
8
9
10
11
12
13
14
15
16


y = -0.0013x4 + 0.0436x3 - 0.5856x2 + 5.6597x + 9.2537
R2 = 0.4127
E Stringer
LA90
Windspeed (m/s)
2727 Data Points
0
10
20
30
40
50
60
3
5
7
9
11
13
15
17


y = 0.0056x3 + 0.0414x2 + 0.3986x + 22.425
R2 = 0.3182
G Stringer
LA90
Windspeed (m/s)
2885 Data Points
0
10
20
30
40
50
60
70
80
3
4
5
6
7
8
9
10
11
12
13
14
15
16

APPENDIX C Photographs of Logger Locations

Price

Turner

Wilson

Percyton

Ross Na Ree

Hayes

Kooliatta

Adalisa

E Stringer

G Stringer

Appendix D Coordinates of Nearest Residences (WGS84 Map Datum)

Residence	Easting	Northing
Davidson	232694	6252327
Price	235642	6259857
Turner	235818	6264340
Michael	235856	6258923
Ross Na Ree	233925	6253393
Wilson	233025	6244948
Nicholls Lot 53	234530	6241586
Percyton	232192	6257562
Ebsary Section 97	232110	6260239
Hayes	240256	6273414
Venning Allotment 1	232077	6257806
Kooliatta	236885	6255643
Venning Section 104	232041	6257370
Nicholls Section 296	233071	6241787
Atkinsons	237618	6263901
Gum Park	232521	6254810
Cummins	242208	6270801
Seafield Farm	232291	6262555
Ebsary Section 771	237189	6257992
Whitings	236392	6253477
Jamiesons	233891	6266465
Adalisa	232558	6264318
Barunga Pastoral	232124	6262265
Pine Lodge	232079	6248729
Fountains	240491	6274362
A Stringer	235717	6274283
Burnsfield	241729	6268364
Snowyview	239533	6259683
E Stringer	234906	6268742
G Stringer	238768	6264411
Taloumbi	234232	6268242
Irelands	235642	6269990
Sharps Well	235643	6270158
House 34	235905	6240805
House 35	236402	6241125
House 36	236279	6240783
House 37	233231	6240073
Maro Creek	237012	6248785
House 39	237339	6251355
Chelsea	237656	6244694
Slattery	240921	6265342
Kilkee	241425	6263283

Appendix F **Turbine Coordinates (WGS84 Map Datum)**

Stage 1

Turbine	Easting	Northing
WTG1	238161	6272793
WTG2	238167	6272424
WTG3	238344	6272022
WTG4	238300	6271614
WTG5	238321	6271182
WTG6	238332	6270815
WTG7	238396	6270423
WTG8	238331	6269966
WTG9	238410	6269481
WTG10	238219	6269130
WTG11	238102	6268845
WTG12	238011	6268540
WTG13	237891	6268238
WTG14	237701	6267934
WTG15	237479	6267779
WTG16	237158	6267838
WTG17	237055	6267180
WTG18	236769	6267087
WTG19	236664	6266700
WTG20	236406	6266584
WTG21	236202	6266400
WTG22	235936	6266321
WTG23	235716	6266152
WTG24	234181	6262974
WTG25	234439	6262617
WTG26	234613	6261511
WTG27	234443	6261234
WTG28	234413	6260778
WTG29	233619	6260381
WTG30	233473	6259834
WTG31	233391	6259458
WTG32	233335	6259109
WTG33	234232	6259225
WTG34	234003	6259088
WTG35	233818	6258881
WTG36	233594	6258729
WTG37	233680	6258330
WTG38	233550	6258063
WTG39	233508	6257721
WTG40	233631	6257232
WTG41	233590	6256794
WTG42	233559	6256444
WTG83	234859	6262885
WTG100	233839	6260722
WTG101	234459	6259358
WTG102	234119	6258154
WTG109	234656	6256964

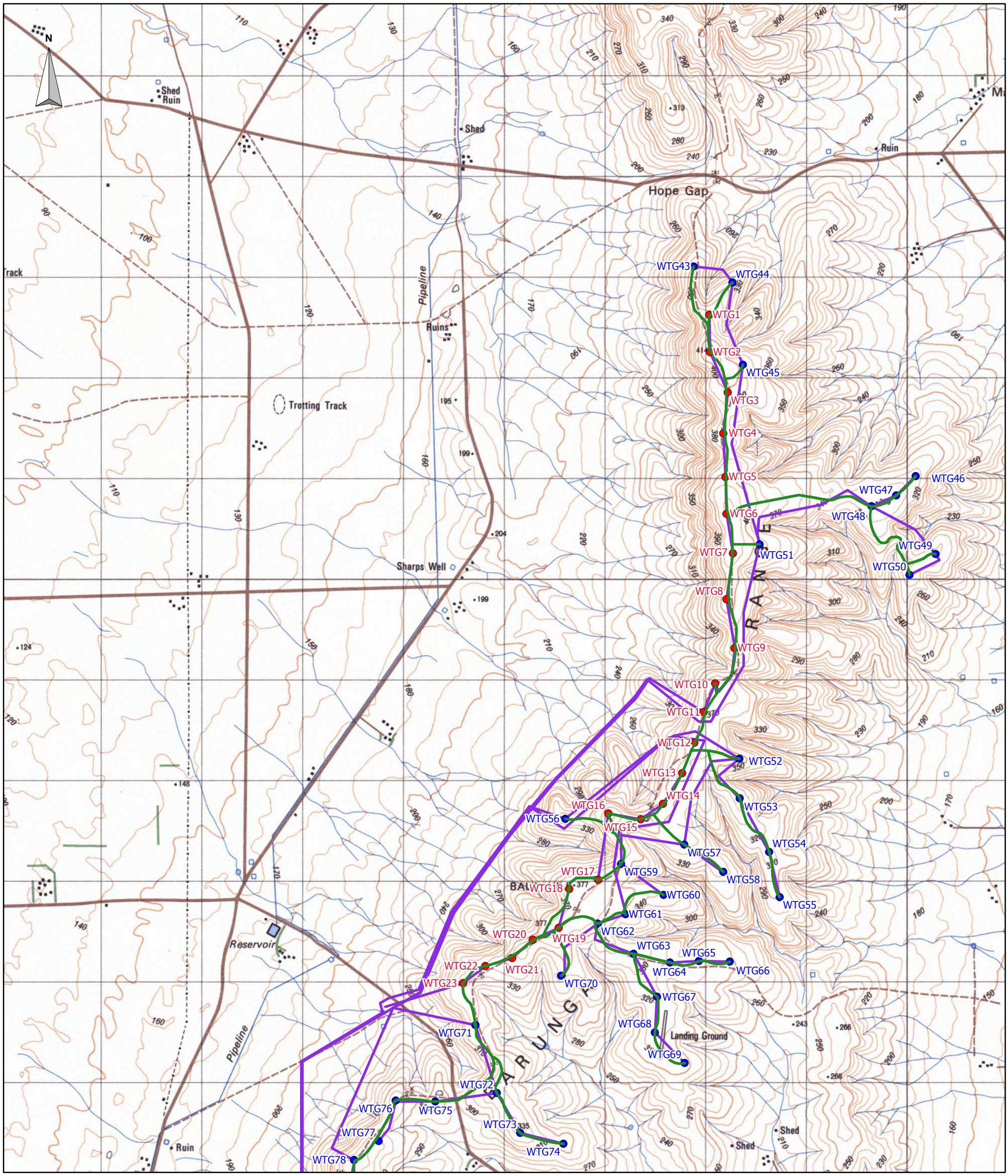
Stage 2

Turbine	Easting	Northing
WTG43	238005	6273274
WTG44	238391	6273115
WTG45	238494	6272297
WTG46	240210	6271191
WTG47	240017	6270999
WTG48	239771	6270891
WTG49	240408	6270416
WTG50	240149	6270209
WTG51	238661	6270513
WTG52	238459	6268382
WTG53	238463	6267989
WTG54	238755	6267455
WTG55	238860	6267006
WTG56	236729	6267785
WTG57	237912	6267528
WTG58	238299	6267257
WTG59	237285	6267337
WTG60	237706	6267028
WTG61	237329	6266836
WTG62	237053	6266744
WTG63	237408	6266443
WTG64	237769	6266356
WTG65	238057	6266372
WTG66	238364	6266365
WTG67	237641	6266017
WTG68	237620	6265662
WTG69	237916	6265358
WTG70	236689	6266225
WTG71	235838	6265735
WTG72	236050	6265059
WTG73	236282	6264663
WTG74	236712	6264555
WTG75	235439	6264975
WTG76	235045	6264984
WTG77	234876	6264583
WTG78	234631	6264393
WTG79	234421	6263836
WTG80	234423	6263421
WTG81	235477	6263365
WTG82	235342	6262938
WTG84	236915	6262358
WTG85	236626	6262330
WTG86	236581	6261980
WTG87	236242	6261944
WTG88	235480	6261930
WTG89	236740	6261568
WTG90	237042	6261542
WTG91	237367	6261364
WTG92	236471	6261495
WTG93	236435	6261031
WTG94	236703	6260689
WTG95	236561	6260427
WTG96	236400	6260000
WTG97	236683	6259496
WTG98	237007	6259263
WTG99	237456	6258900
WTG103	234483	6257926
WTG104	235222	6257901
WTG105	235591	6257949

Turbine	Easting	Northing
WTG106	235900	6257899
WTG107	236227	6257797
WTG108	236556	6257583
WTG110	234948	6256995
WTG111	235276	6256791
WTG112	235665	6256834
WTG113	235976	6256555
WTG114	235514	6256417
WTG115	234107	6256484
WTG116	234044	6256149
WTG117	234157	6255724
WTG118	234740	6255566
WTG119	235070	6255339
WTG120	235398	6255214
WTG121	234122	6255261
WTG122	234238	6254729
WTG123	234377	6254310
WTG124	234768	6253941
WTG125	235122	6253779
WTG126	233400	6252031
WTG127	233743	6251876
WTG128	234156	6251910
WTG129	233716	6251351
WTG130	233978	6251432
WTG131	234367	6251497
WTG132	233528	6251090
WTG133	234013	6250470
WTG134	233475	6250747
WTG135	233727	6250361
WTG136	233484	6250250
WTG137	233833	6249877
WTG138	233547	6249858
WTG139	233535	6249488
WTG140	233838	6249457
WTG141	233586	6249093
WTG142	233613	6248707
WTG143	233639	6248314
WTG144	233734	6247900
WTG145	233821	6247457
WTG146	233866	6247060
WTG147	233931	6246661
WTG148	234002	6246260
WTG149	234003	6245894

APPENDIX I

INDICATIVE STAGE 2 ACCESS ROADS AND CABLE ROUTES



LEGEND

- STAGE 1 WTG
- STAGE 2 WTG
- ACCESS TRACK
- CABLE ROUTE

SCALE BAR

0 — 2 km

COMPANY

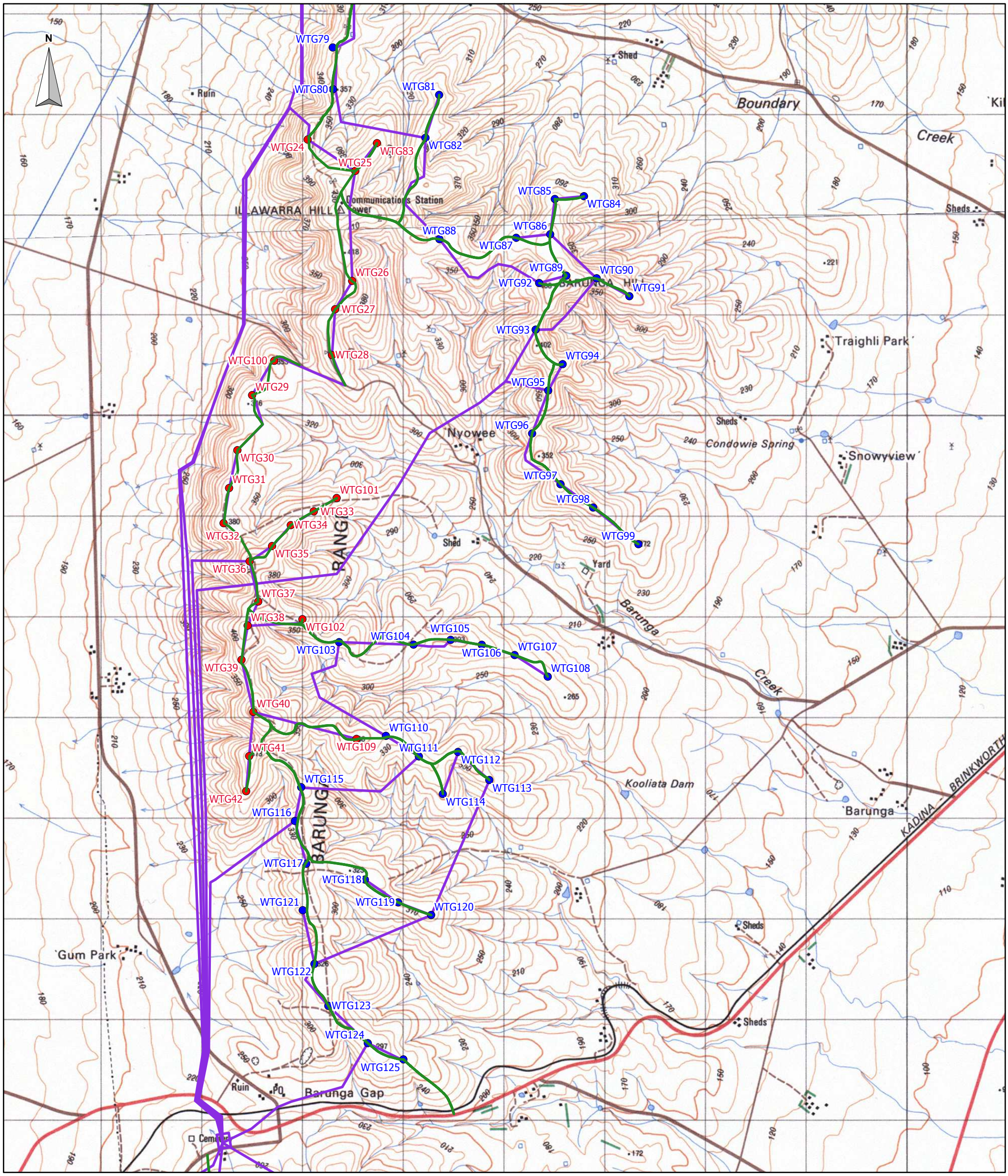
WIND PROSPECT PTY LTD

TITLE

SNOWTOWN INDICATIVE ROAD AND CABLE LAYOUT

DATE	SCALE	DWG NO	REV
08 APR 2010	1:36000	090503_00002	01

DRAWN BY	CHECKED BY	SHEET	SIZE
R. MORETON	A. DICKSON	1 OF 3	A3



LEGEND

- STAGE 1 WTG
- STAGE 2 WTG
- ACCESS TRACK
- CABLE ROUTE

SCALE BAR

0 — 2 km

COMPANY

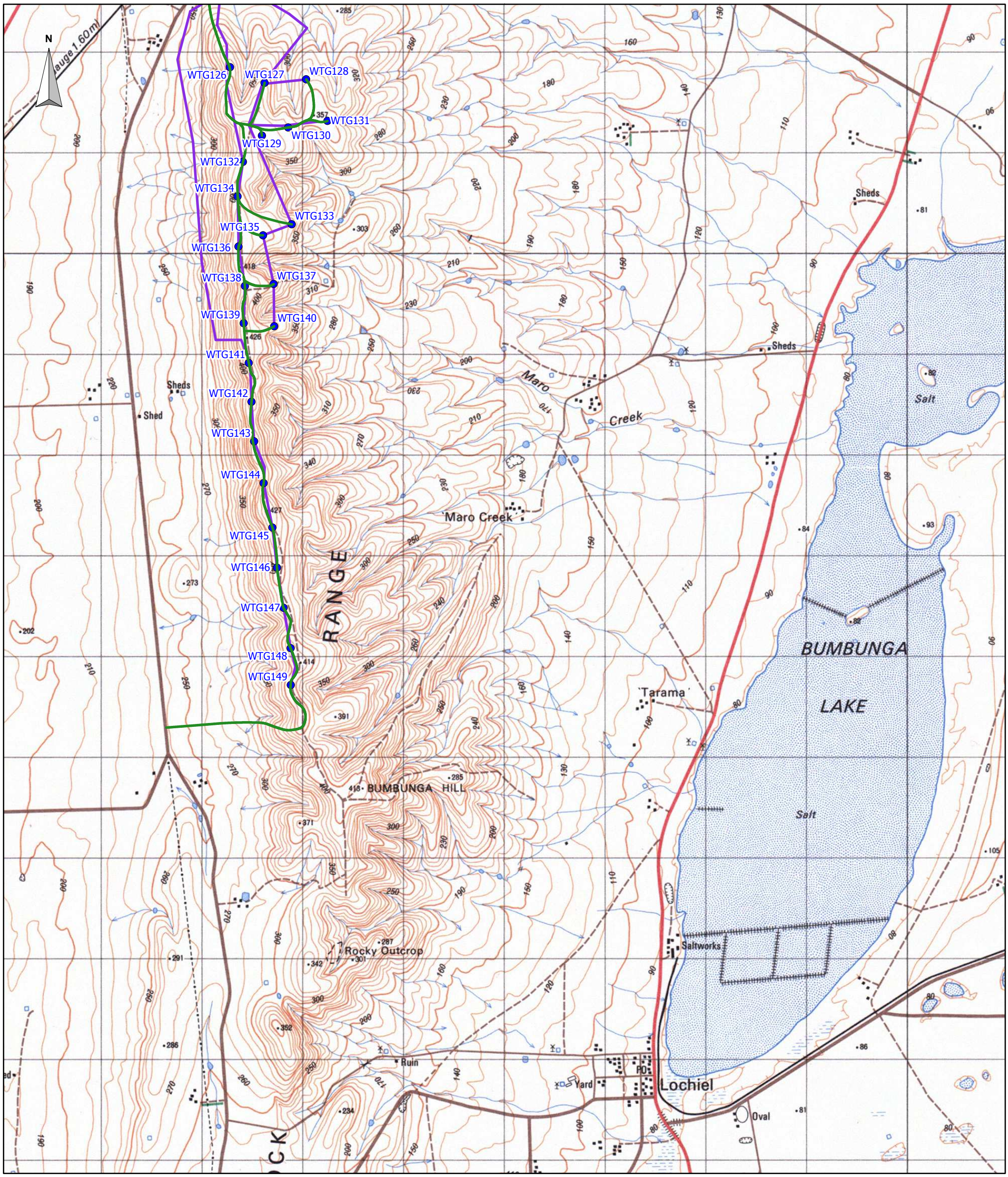
WIND PROSPECT PTY LTD

TITLE

SNOWTOWN INDICATIVE ROAD AND CABLE LAYOUT

DATE	SCALE	DWG NO	REV
08 APR 2010	1:36000	090503_00002	01

DRAWN BY	CHECKED BY	SHEET	SIZE
R. MORETON	A. DICKSON	2 OF 3	A3



LEGEND

- STAGE 1 WTG
- STAGE 2 WTG
- ACCESS TRACK
- CABLE ROUTE

SCALE BAR

0 — 2 km

COMPANY			
WIND PROSPECT PTY LTD			
TITLE			
SNOWTOWN INDICATIVE ROAD AND CABLE LAYOUT			
DATE	SCALE	DWG NO	REV
08 APR 2010	1:36000	090503_00002	01
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APPENDIX J

AVIATION LIGHTING STUDY REPORT
(HART AVIATION PTY LTD)

AVIATION LIGHTING REVIEW

with particular emphasis on the Snowtown Wind Farm.

A study for

WIND PROSPECT

and

TrustPower

HART AVIATION

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1 TERMS OF REFERENCE & BACKGROUND

TrustPower Ltd, through its consultants Wind Prospect Pty Ltd, commissioned HART Aviation to undertake an assessment of wind farm lighting requirements, with particular emphasis on the Snowtown Wind Farm in South Australia and balancing the needs of the surrounding communities, whilst meeting aviation safety needs in respect of obstacle lighting.

The required scope of work was as follows: -

A. Aviation Lighting Review:

i. Conduct a review of the best practice aviation safety lighting practices in other jurisdictions outside of Australia, particularly targeting jurisdictions with a high penetration of wind farms;

ii. Review the withdrawn Civil Aviation Safety Authority (CASA) guidelines for reference and comparison;

iii. Review the work conducted by the Clean Energy Council (CEC) with CASA with regards to changing CASA's regulations for reference;

iv. Develop desktop recommendations for best practice with reference to overall aims:

v. Minimum number of lights, on both machine and within a wind farm;

vi. Maximum level of shielding;

vii. Minimum candescence level; and

viii. Maintaining aviation safety.

B. Conduct a Review of Existing Lighting Regimes:

i. Conduct a review of existing lighting regimes for the Snowtown Wind Farm, comparing those with the recommendations from the desktop review of best practices;

ii. Compare existing lighting regimes with refined best practice recommendations.

iii. Develop recommendations for amending current regimes.

C. Conduct a Review of Proposed Lighting Regimes:

i. Conduct a review of proposed lighting regime for the Snowtown Wind Farm and compare with the refined best practice recommendations; and

ii. Develop recommendations for amending proposed regimes.

2 BACKGROUND

TrustPower and Wind Prospect co-developed the Snowtown Wind Farm in South Australia, and TrustPower now owns this wind farm site. TrustPower is conscious of the cumulative impact that wind farm lighting may have on local communities surrounding the wind farm site and, as such, is seeking a viable, reduced lighting solution if possible.

The principal catalyst for this would seem to have been an apparent lack of flexibility from the Australian aviation regulatory authority, the Civil Aviation Safety Authority (CASA), towards the provision of obstacle lighting for wind turbines.

It is understood that the Civil Aviation Safety Authority (CASA) currently holds the view that wind farms may have an adverse impact on the aviation domain because of the physical size and weight of wind turbine generators (WTGs). Reflecting this view, CASA, in December 2005, developed and published a draft Advisory Circular, AC139-18(0), which related to obstacle marking and lighting of wind farms. CASA published the advisory circular to provide general information and advice to proponents of wind farms (including single wind turbines) and planning authorities with jurisdiction over the approval of such structures on the potential hazards to aviation, and advice as to measures to reduce the hazard and how to implement them. The hazard reduction methods only focussed on the means of marking or lighting wind farms.

The Advisory Circular identified two areas of concern, viz: any obstacle that might penetrate aerodrome obstacle limitation surfaces (OLS) [which can extend up to 15km from an aerodrome in the takeoff and landing directions] and any obstacle which is 110m or more above ground level.

Under Civil Aviation Safety Regulation 1998 (CASR 1998) Part 139.370 CASA may determine that a proposed structure will be a hazardous object because of its location, height or lack of marking or lighting. The available evidence since the issue of the afore-mentioned Advisory Circular would suggest that CASA has consistently recommended the marking and lighting of wind turbines / wind farms as a means of reducing the risks to aircraft safety, regardless of whether the wind turbines / wind farms (obstacles) were within the OLS or outside of the OLS and in uncontrolled air space. The Advisory Circular added that, if CASA's advice was not followed, wind farm project proponents may be liable for any eventual aircraft-related incidents.

As a result, up to mid 2008, a developer proposing wind turbine generators with a tip height above 110 metres would typically seek CASA endorsement and the facility would include obstacle lighting compliant to the requirements of the CASA Advisory Circular. Another influencing factor was that various planning panels in Australia generally required developers to comply with CASA recommendations. Potential liability issues may be a motivating issue in this respect. This practice would seem to have been followed for all wind farms, including those outside the vicinity of an aerodrome.

However, obstacle marking and lighting may be an annoyance to the public residing in the areas surrounding wind farms, which could lead to demands being imposed on the functioning and intensity of obstacle lighting systems. In addition to the contribution to the visual amenity impact of WTGs, the above mentioned approach has led to an increase in the cost of wind farm developments, with typical costs for low intensity aviation night lighting reported to be in the range from $900 to $9,000 per unit, and for medium/high intensity aviation night lighting in the range from $9,000 to $21,000 per unit.

In the twelve months preceding mid-2008, it is reported that a considerable number of wind farm proposals in Victoria, SA and NSW were brought forward to planning authorities. During the planning approval process for these wind farm proposals decision-makers would strive in all cases to minimise the community impacts of obstacle lighting.

The requirements of the CASA circular did not, however, consider these impacts and related exclusively to minimising the risk for aviation. This led to conflicting priorities in some cases that have resulted in incompatible obligations arising from the planning approval and the requirements of the Advisory Circular. Among wind farm project proponents there seems to be widespread agreement that the Advisory Circular took a "blanket rule" approach and appeared conservative in comparison with global practice.

As a result, wind farm developers have encountered difficulties at the project design and assessment stage in their dealings with CASA because of CASA's apparent exclusive reliance on marking and lighting as the only acceptable means of risk mitigation.

Arising from the above, industry complaints considered by CASA's Industry Complaints Commissioner identified a number of other issues with the Advisory Circular, not the least being a questionable legal grounding for the CASA Advisory Circular. As a result, in mid 2008, CASA withdrew Advisory Circular AC139-18(0) and initiated an internal review process to look at how wind farms located near aerodromes are assessed and regulated. The current status of that review is reported in Section 4 of this report.

This particular review for TrustPower will, hopefully, provide guidance in respect of obstacle lighting for the Snowtown Wind Farm and, perhaps in addition, contribute to the above-mentioned CASA review.

As a first step, a review of the international situation was undertaken and compared to the current status within Australia. This will be followed by an analysis of the overall risks to aviation in general and a specific assessment in respect of the Snowtown Wind Farm.

3 INTERNATIONAL SITUATION

3.1 ICAO

The relevant ICAO recommendations are detailed in Annex 14 to the Convention on Civil Aviation.

The relevant parts of Annex 14, specifically dealing with obstacle lighting, are included in the Appendix to this report.

Until quite recently wind turbines have been treated as any other obstacle. However, ICAO recently issued a new Section 6.4 to Annex 14 specifically dealing with the marking and lighting of wind turbines. This amendment, a copy of which is in the Appendix at page 49 of this report, came into effect in March 2009 and becomes applicable in November 2009.

In summary, ICAO has recommended that: -

- A wind turbine shall be marked and/or lighted if it is determined to be an obstacle.
- The rotor blades, nacelle and upper 2/3rd of the supporting mast of wind turbines should be painted white, unless otherwise indicated by an aeronautical study.
- When lighting is deemed necessary, medium intensity lights should be used
- In the case of a wind farm, lights should be installed as follows: -
  - The perimeter of the wind farm should be identified,
  - The spacing of lights should be in accordance with the recommendations of any other widely spaced obstacles, unless an assessment determines otherwise,
  - Flashing lights, when used, should flash simultaneously, and
  - The tallest wind turbines should be identified regardless.
- Obstacle lights should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any direction.

In principle, the above specific requirements for wind turbines vary little from that already existing within Annex 14 for other obstacles. It is noted, however, that only medium intensity obstacle lights have been recommended.

ICAO Contracting States which are signatories to the Convention on Civil Aviation are obliged to uphold the Standards and Recommended Practices (SARPs) of ICAO, unless they lodge a formal difference. It would appear that, in principle, most Signatory States are abiding by the requirements of Annex 14, including those for obstacle lights. As will be seen later, some have imposed slightly stricter requirements.

It should be noted that ICAO recommends that in areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150m or more above ground elevation should be regarded as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplanes. Para 4.3.2 of ICAO Annex 14 refers. As will be seen later, the provision for an aeronautical study as to the need, or otherwise, for marking and/or lighting is a consistent provision within most national regulatory requirements, but the height chosen for the assessment of objects as obstacles does vary.

Prima facie, aircraft operating en route to and from aerodromes will be unlikely to be at an altitude which would necessitate the need for obstacle lighting except, perhaps, a development beyond any OLS, but only marginally clear, laterally or vertically, of controlled airspace. Developments within or close to an aerodrome OLS are, for these reasons, discouraged. The position in respect of this will be further explained later in this report – specifically Sections 7 & 8.

3.2 UK & EUROPE

The **United Kingdom policy** in respect of wind turbines is detailed in the UK CAA Civil Aviation Publication CAP 764 – "CAA Policy and Guidelines on Wind Turbines". This summarises the potential and real impact of both offshore and onshore wind turbines on aircraft radar, fixed wing aircraft and helicopter operations, both civil and military.

On obstacle lighting, the UK CAA position is summarised as: -

1. Obstacle lighting is not a substitute for knowledge of the presence of such structures but is a significant and important aid to their visual acquisition and hence avoidance;
2. obstacles located close to licensed aerodromes are required to be lit;
3. structures away from the immediate vicinity of an aerodrome, which have a height of 150m or more above ground level (AGL) are required to be fitted with obstacle lights;
4. in general terms, structures less than 150m high, which are outside the immediate vicinity of an aerodrome, are not routinely lit, unless the "by virtue of its nature or location such structures could be considered a significant navigational hazard " argument holds fast;

5. if a claim for lighting was clearly outside credible limits (i.e., the proposed turbine(s) was/were many miles away from any aerodrome or was/were at a height that was unlikely to affect even military low flying), the CAA, in isolation, would be unlikely to make a case for aviation warning lighting;
6. where a wind turbine development lies (or would lay) outside any aerodrome safeguarding limits and the turbine height was less than 150m, the aviation industry, including the CAA, is not in a position to demand that turbines are lit.

The European scene: -

It would seem that the **European Aviation Safety Agency (EASA)**, which is charged, inter alia, with encouraging and establishing coordinated and common rules for the safety of aviation operations amongst its members, has not yet established a policy in respect of the wind turbines. However, individual countries have done so.

The following table is a sample of individual country requirements.

This comparative table has been sourced primarily from a 2002 report "Wind Turbines and Aviation Interests – European Experience and Practice" – see Section 12 - Reference Document No 12.

No evidence could be sourced to indicate that, with the passage of time since that report, there has been any change to the main findings listed.

TABLE 1: SUMMARY OF MAIN FINDINGS

Country	Aerodrome safeguarding	Technical site safeguarding			Planning, assessment and approval process[2]	Low flying policy	Charting policy	SAR Ops policy
		Civil[1]		Military				
		Airfield radar	Other					
UK	Assessed if within 17km (civil)	Assessed if within 30km	Assessed if within 34km (ILS); 30km (other systems)	Assessed if within 74km of AD radar; developer to prove no negative effects.	Voluntary; widely used Statutory via Local Planning Authority	Generally not below 250ft	Charted if 300ft	Nil stated
Denmark	ICAO Standards	ICAO Standards	ICAO Standards; VOR stations; not within 1km	Nil stated	Wind energy incorporated into regional plans; planning authorities inform aviation authorities	No objections to structures <100m	Charted if 100m or "if deemed necessary"	Nil stated
Germany	ICAO Standards	ICAO Standards	ICAO Standards	5km protected area; 20km "area of interest"; Military to prove negative effects	Construction Committees inform aviation authorities; plans assessed within two months	Generally not below 1000ft	Charted if 100m or "if deemed necessary"	Statement of concern by SAR operators
Netherlands	ICAO Standards	ICAO Standards; not >150metres within 30km	ICAO Standards	Nil stated	No regulated processes away from safeguarded aerodromes	Generally not below 1200ft	Archive of all structures >300ft	Nil stated
Sweden	ICAO Standards	ICAO Standards	ICAO Standards	None aviation specific	Voluntary	Not below 50m	"FLA" data base (>50m in towns, >20m rural)	As Germany
Norway	ICAO Standards	ICAO Standards, plus assessed within 10nm and on OLS; (ILS; not within 20nm)		Not known	Energy authorities inform aviation authorities	Not known	Obstacles >15m registered	Nil stated.

[1] For primary radar, ICAO Standard is a protected surface slope of gradient 1:100; for Secondary Surveillance Radar a slope of 1:200; for navaids, 1:50.

[2] Note that in most cases, as part of the planning assessment and approval process, the provision exists for an aeronautical study to assess the need or otherwise for marking and/or lighting. Such a study may include a site specific evaluation and risk assessment considerations. See comments on each of the individual countries and the summary Table 2, Section 5.

3.3 USA

In general, the Federal Aviation Administration (FAA) requires that any temporary or permanent structure, including all appurtenances, that exceeds an overall height of 200 feet (61m) above ground level (AGL), or exceeds any obstruction standard contained in FAA Regulations 14 CFR Part 77, should normally be marked and/or lighted. However, an FAA aeronautical study may reveal that the absence of marking and/or lighting will not impair aviation safety. Conversely, the study may show that the object may present such an extraordinary hazard potential that higher standards may be recommended for increased conspicuity to ensure safety to air navigation.

Normally, outside commercial lighting (understood to be such as neon advertising signs, street lights, etc.) is not considered a sufficient reason to omit recommended marking and/or lighting. Recommendations on marking and/or lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design. The FAA may also recommend marking and/or lighting a structure that does not exceed 200 (61m) feet AGL or 14 CFR Part 77 standards because of its particular location. Additional guidance is contained in the FAA Advisory Circular 70/7460-1K, Obstruction Marking and Lighting.

If the structure is on airport property, the nearest FAA Airports' Regional/Airports District Office is tasked with assessing the situation in accordance with the FAA requirements.

If the structure is not on airport property, the Air Traffic Organization Obstruction Evaluation Specialist that services the particular area is tasked with assessing the position.

3.4 CANADA

The Transport Canada obstruction markings and lighting standards are detailed in the Civil Aviation Regulations General Operating and Flight Rules, CAR 621.19.

Summarising, the Rules state that where it is likely that a building, structure or object, including an object of natural growth, is hazardous to aviation safety because of its height and location, the owner, or other person in possession or control of the building, structure or object, may be ordered to mark it and light it in accordance with the requirements stipulated in standard.

Wind farms are not specifically mentioned.

Except in the vicinity of an airport where an airport zoning regulation has been enacted, Transport Canada has no authority to control the height or location of structures. However, all objects, regardless of their height, that have been assessed as constituting a hazard to air navigation require marking and/or lighting in accordance with the CARs and should be marked and/or lighted to meet the standards specified in CAR 621.19.

The following obstructions should be marked and/or lighted in accordance with the standards specified in CAR 621.19:

(a) any obstruction penetrating an airport obstacle limitation surface as specified in TP 312, Aerodrome Standards and Recommended Practices;

(b) any obstruction greater than 90m (300 ft) AGL within two nautical miles of the imaginary centre-line of a recognized VFR route, including but not limited to a valley, a railroad, a transmission line, a pipeline, a river or a highway;

(c) any permanent catenary wire crossing where any portion of the wires or supporting structures exceeds 90m (300 ft) AGL;

(d) any obstructions greater than 150m (500 ft) AGL; and

(e) any other obstruction to air navigation that is assessed as a likely hazard to aviation safety.

Because of the nature of obstructions, Transport Canada has noted that it is not possible to fully define all situations and circumstances. Thus, in certain cases, a Transport Canada aeronautical evaluation will be required to determine whether an obstruction to air navigation is a likely hazard to aviation safety or to specify alternative methods of complying with the obstacle marking and lighting standards while ensuring that the visibility requirement is met.

An aeronautical evaluation may be performed with respect to the following types of obstructions:

(a) obstructions greater than 90m (300 ft) AGL but not exceeding 150m (500 ft) AGL;

(b) catenary wire crossings, including temporary crossings, where the wires or supporting structures do not exceed 90m (300 ft) AGL;

(c) obstructions less than 90m (300 ft) AGL; and

(d) any other obstruction specified in CAR 621.19.

It should be noted that Section 601.19 of the CARs further provides that an Aeronautical Evaluation may be performed by the Minister to approve the use of equivalent methods of obstruction marking and lighting where the application of the marking and lighting requirements specified in the CAR 621.19 Standard may be impractical or present nuisance glare to the surrounding area.

Further, it should be noted that no marking or no lighting may be approved, if: -

i. The object may be so located with respect to other objects or terrain, removed from the general flow of air traffic, or may be so conspicuous by its shape, size, or colour that marking or lighting would serve no useful purpose.

ii. Normally outside commercial lighting is not considered sufficient basis to omit required marking or lighting.

iii. The absence of marking and/or lighting will not impair aviation safety.

3.5 NEW ZEALAND

The CAA NZ requirements relating to the lighting of obstacles are within the Civil Aviation Regulations Part 77 – "Objects and Activities Affecting Navigable Airspace". Advisory Circular AC 139-10, Rev 1, 27th April 2007, is also relevant.

In brief, the objective of Part 77 is to ensure that the Director -

1. is notified of objects and activities which can affect Navigable Airspace; and
2. carries out an aeronautical study and, according to laid down standards, makes a determination as to whether -
    1. marking or lighting is required; or
    2. the aviation industry needs to be given prior notification of the activity.

Part 77 contains the ICAO (International Civil Aviation Organization) standard on the marking of obstructions (see Appendix No 1 to this report) except for the marking of overhead lines. Preliminary investigative work regarding the line marking issue is understood to be underway to determine a set of criteria that could be used to assess whether a line needs to be marked or not. Recommendations will then be made to all interested/affected parties by way of another NPRM (Notice of Proposed Rule Making) dealing specifically with the marking of hazardous lines. This process is likely to take some time.

The current rules require the Director of CAA NZ to determine any structure 120m or higher is a hazard in navigable airspace; allows the Director to determine, based on the circumstances of each proposal, if a structure between 60m and 120m high is a hazard in navigable airspace and allows the Director to impose conditions or limitations for the marking and lighting of structures. There is provision for a decision that marking and lighting may be omitted when an aeronautical study shows the obstacle not to be of operational significance.

The current rules do not cover the marking or lighting of wind turbines specifically and, therefore, by default they would currently be treated as obstacles as per any other structure. However, there is some evidence of the existence of draft conditions and limitations as follows: -

"Unless the aeronautical study finds that there are specific circumstances that:

(a) Require a higher level of lighting; or
(b) In the case of wind farms with turbines between 60m and 120m, allow a lower level of marking or lighting;

the following minimum conditions and limitations are to be included in all determinations:

1. Selected individual turbines at wind farms with turbines over 60m high will be required to have lighting.
2. The highest turbines, those at the extremities of the site, and other turbines around the perimeter of the site will be lit. The spacing between lit turbines will not exceed 1NM (1850m).
3. Lighting will be medium intensity red as defined in Rule Part 77, Appendix B10, i.e., an effective intensity of not less than 1600 candela of red light , and will flash between 20 and 60 times per minute.
4. The obstruction lights shall be located on or above the top of the nacelle, shall be visible from all directions, and may be shielded below the horizontal plane.
5. Obstruction lights at intermediate levels will not be required.
6. The painting of turbines with obstruction marking will not be required.
7. All wind farms will be depicted on aeronautical charts."

The current status of these draft rules for the marking and lighting of wind turbines and wind turbine farms is unknown. However, it does give some indication of the CAA NZ thinking on these matters.

It is presumed that a provision would still exist for a decision that marking and lighting may be omitted when an aeronautical study shows the obstacle (be it a wind turbine of wind turbine farm) not to be of operational significance.

4 AUSTRALIAN REGULATORY SCENE

The Civil Aviation Safety Authority (CASA) powers in respect of the control of obstacles in and around aerodromes flow from the Civil Aviation Regulations 1988 (CAR), Part 9, Subpart 95, which provides for the marking or removal of hazardous objects within the obstacle limitation surfaces (OLS) of any aerodrome.

Civil Aviation Safety Regulation 1998 (CASR) Subpart 139.E covers the specific definitions of hazardous objects and the reporting requirements.

In summary CASR 139.E requires: -

1. Aerodrome operators to monitor the surrounding airspace for any object that might infringe the OLS and to notify CASA;
2. Any person who proposes to construct any structure which will be 110m or more AGL to inform CASA; and
3. CASA may determine whether the proposed structure(s) will be a hazardous object because of its location, height or lack of marking or lighting.

Detailed aerodrome design requirements are within the CASA Manual of Standards 139 – Aerodromes. Chapter 7 covers the detailed requirements for Obstacle Restriction and Limitation.

In support of the above regulations, CASA issued two Advisory Circulars; viz:

- AC 139-08(0) "Reporting of Tall Structures" April 2005
- AC 139-18(0) "Obstacle Marking and Lighting of Wind Farms" December 2005.

There is no doubt that CASA has the necessary regulatory powers to control the marking and removal of hazardous objects in and around aerodromes and for the reporting of tall structures. However, as noted in Section 2 of this report, there is some question as to CASA's powers to insist on marking and / or lighting of obstacles outside the immediate area of an aerodrome. Further, the approach by CASA raised concerns amongst the wind farm industry, particularly in those cases where independent expert aviation advice recommended that marking and lighting was not needed because of low risks, yet CASA recommended to the contrary and noted that failure to follow the CASA advice would mean that the proponent of the wind farm would be "responsible for creating the hazard to aircraft safety and may be liable for their actions".

As a consequence, in mid 2008, CASA withdrew Advisory Circular AC139-18(0) and initiated an internal review process to look at how wind farms located near aerodromes are assessed and regulated. It is understood that CASA aims to undertake an appropriate safety study into the risk to aviation posed by wind farms and for the outcome of that study to be used as a basis for developing a new set of guidelines.

HART Aviation has been advised that CASA selected a consultant to undertake the afore-mentioned study in late July and the study is expected to take some 8 weeks, i.e., this will not be completed until around late September or early October 2009. CASA has announced that this review process will include appropriate consultation with the aviation industry and other stakeholders.

It is understood that the CASA review will look at all obstacles, including wind turbines. There are plans to include a review of the latest regulatory position amongst other authorities throughout the world, including EASA, FAA, Transport Canada and CAA NZ. The ICAO position will also be part of considerations.

HART Aviation is of the opinion that this CASA review, inter alia, may very well lead to a regulatory change to provide CASA with the powers to legislate for the marking and lighting of obstacles outside the boundaries of aerodromes and specifically for en route operations.

5 SUMMARY OF MARKING & ILLUMINATING POLICIES ACROSS VARIOUS COUNTRIES.

The following table is an abbreviated summary of various countries' policies in respect of the marking and lighting of wind turbines.

The Table is designed to enable an easy comparison between countries.

It should be noted that, since wind turbines have not been specifically addressed within the ICAO Annex 14 at this stage, those countries which have accepted Annex 14 as the basic standard are considering wind turbines in the same way as any other defined obstacle.

It should further be noted that most countries have accepted the principle that an aeronautical study may show that obstacle lighting is not necessary. The extent to which this provision has been exercised is unknown.

Country	Marking and Illuminating Policy re Wind Turbines outside obstacle limitation surfaces (OLS)
Australia	Required if 110m or more AGL unless a specific aeronautical study indicates otherwise.
Canada	Required if 90m or higher near recognised VFR routes; 150m or higher AGL elsewhere unless a specific aeronautical study indicates otherwise.
Denmark	Required if equal or higher than 100m AGL.
Germany	Required if 150m or higher within towns; 100m or higher outside towns. May be required if greater than 20m if assessed as hazardous.
Netherlands	As per ICAO Annex 14; i.e., if 150m or more AGL, unless a specific aeronautical study indicates otherwise.
New Zealand	Required if 60m or higher unless a specific aeronautical study indicates otherwise. In the case of wind farms with turbines between 60m and 120m, a lower level of marking or lighting is permitted unless a specific aeronautical study indicates otherwise.
Norway	Uncertain – likely to be comparable to neighbouring Scandinavian countries.
Sweden	As per ICAO Annex 14; i.e., if 150m or more AGL, unless a specific aeronautical study indicates otherwise.
UK	Required if located close to aerodromes or 150m or more AGL. Provision for review exists.
USA	Required if overall height exceeds 200ft (61m) AGL unless a specific aeronautical study indicates otherwise.

Note that the ICAO Recommendation within Annex 14 is: "in areas beyond the limits of the OLS, at least those objects which extend to a height of 150m or more above ground elevation should be regarded as obstacles, unless a specific aeronautical study indicates that they do not constitute a hazard to aeroplanes".

6 POTENTIAL RISKS TO AVIATION

In principle, the potential risk to aviation operations due to the development of wind turbines / wind farms falls into just two areas: -

1. They have the potential of generating unwanted returns on primary radar and affecting the performance and propagation of Secondary Surveillance Radar (SSR), navigation aids and communication facilities, and
2. They represent a physical hazard which creates the potential risk of aircraft collision.

The following summarises the potential risks.

Primary Radar.

A large wind turbine can reflect the radar energy pulse and create unwanted returns on the radar screen. In particular, wind turbine developments can lead to receiver saturation, constant false alarms, obscuration of moving targets, false radar returns (clutter), plot extractor / filter memory overload and obstructions of the primary radar signal leading to shadows.

Secondary Surveillance Radar (SSR).

SSR does not rely on reflections from objects for detection. Instead, aircraft to be detected are required to carry a transponder, which replies to radar interrogations. Wind turbines, like any other large obstacle, can cause reflections if they are sufficiently close to the SSR facility and are within the "Radar Line of Sight". Effects similar to those mentioned for Primary Radar can also occur.

Aeronautical Navigation Aids.

A wide range of systems, including aids such as ILS and VOR/DME, together with air-ground communication facilities, could potentially be affected by wind turbine developments. The wind turbines do not emit RF interference but their physical characteristics, depending on how they are sited in relation to the specific facility, can affect the propagation of the radiated signal from the affected system.

Air Traffic Services.

The effect on radar due to the location of a wind farm development may have an adverse effect on the overall performance of the communication, navigation and surveillance infrastructure.

Physical Obstruction.

The potential hazard created by a physical obstruction is self evident.

Wind turbines can also create turbulence, but this is likely to be of more concern to those involved in light sport aviation.

7 MITIGATING MEASURES

Primary Radar.

There is no evidence to suggest that any wind turbine development in Australia has had any adverse effect on the operation of Primary Radar. Nevertheless, the potential for adverse effects cannot be ignored. The closer a wind turbine is to a radar station, the greater the likelihood it will reflect energy back to the radar receiver. It also follows that the taller a turbine is, the greater the distance from the radar that it will remain within Radar / Radio Line of Sight, depending on the terrain. Further, since the turbines rotate to follow the wind, the cross-sectional area presented to the radar will vary depending on the wind direction. This makes the effect of the wind turbines on Primary Radar more unpredictable. The best mitigating measure, therefore, is to ensure that no turbine or turbine farm is positioned in the line of sight of any Primary Radar.

Secondary Surveillance Radar.

The same mitigating measure as for Primary Radar applies.

Aeronautical Navigation Aids.

There is sufficient empirical evidence to suggest that existing safeguarding arrangements in respect of navigation and landing aids and communication facilities provide adequate protection.

Air Traffic Services.

Ensuring the wind turbines are not positioned in the line of sight of any Primary Radar is likely to provide the necessary mitigation measure to limit any adverse effects on the operation of Air Traffic Services.

Physical Obstruction.

Mitigating the potential risk of an aircraft collision with wind turbines can be achieved by several means; such as one or more of the following: -

1. Obstacle lights,
2. Identification on aeronautical maps,
3. Establishment of a Restricted or Danger Zone on aeronautical maps.
    a. This is an option but has not been done to date for high obstacles.

It is considered that the need, or otherwise, of each or any of the above, should be assessed using recognised risk assessment tools.

Note: With the exception of obstacle lights on the wind turbines themselves, none of the proposed mitigating measures mentioned above are likely to have any increased negative effect on the visual amenity of wind turbines.

Possible Future Alternative Mitigating Measures.

- **Operational Mitigation.**

  The re-routing of aircraft around an area of wind turbine radar clutter may be required for the following reasons:

  a) To maintain radar identification and situational awareness of flights,
  b) To provide radar separation between primary radar returns, where these returns form the basis for separation being applied.

  To date, in Australia, such has not been proven to be necessary.

- **Equipment Mitigation.**

  This is primarily necessary to be considered if there is evidence of the wind farm developments interfering with radar signals.

  Equipment mitigation action includes: -

  a) ***PSR Blanking*** – a procedure which enables blanking out or masking the area over the wind farm,
  b) ***Data-Fusion / In-Fill Radar*** – a technique that enables the inhibition of adversely affected radar returns over a wind farm development and to overlay the radar returns from an alternative unaffected radar.
  c) ***Physical or Terrain masking*** – the use of existing terrain or a man made object to prevent a radar from "seeing" the turbines.
  d) ***Multilateration*** – this is an alternative to traditional SSR systems.
  e) ***Non Auto-Initiation Zones*** – this enables specific programming to inhibit distracting radar tracks from being generated from within the wind turbine cluster.
  f) ***Advanced Tracking Algorithms*** – currently being trialled as a technique to determine the most probable radar target positions and exclude, for example, distorted signals from wind farms.
  g) ***Use of SSR only*** – it may be possible to mask the unwanted primary radar returns generated from a wind farm and use SSR in certain specified areas.
  h) ***Transponder Mandatory Zones*** – creating a requirement for the mandatory carriage and use of transponders in the vicinity of wind farms.
  i) ***Mechanical Beam Tilting*** – the effect of clutter generated from wind farms could be reduced by raising the radar beam so it passes over the wind farm development.

j) ***Radar Absorbent Materials*** – such materials are available and, if used in the construction of the wind turbine towers and nacelles, would reduce the radar cross section of wind turbines / wind farms and, consequently, the potential for interference with the radar systems.

It should be noted that many of the above-mentioned equipment mitigation measures are in the development stage at the moment. In any event, to date, none of the mitigation measures mentioned above has proved to be necessary within Australia.

- **Safeguarding Maps.**

In some cases overseas, in order to assist the consultation process with wind energy developers and Local Planning Authorities, a number of airfield operators have developed specific wind turbine safeguarding maps. These depict those areas where development would be undesirable, possible, tolerated, acceptable, and any particular issues to be considered.

It is likely that any such safeguarding maps would highlight the need to avoid any wind farm developments within the OLS for the particular airport.

In the Australian context, there may be a further possibility of associating such safeguarding maps with the Airservices Australia issued noise exposure forecast (ANEF) charts developed in consultation with the airport operators. These charts are closely linked to land use planning guidelines as detailed in the Standards Association Australia (SAA) AS 2021-2000.

The production of such maps is to be encouraged.

- **Aircraft Detection Systems.**

New technologies have been recently developed for use as an alternative to conventional obstruction markings. These systems activate white flashing strobe lights, and in some cases an audio warning, based on potential aircraft collision but remain inactive at other times. These systems use radar to detect and track aircraft; when a potential collision is determined; the strobe lights are activated, followed by an audio warning.

One such system [Obstacle Collision Avoidance System (OCAS™)] has been approved for use in Canada. It is understood that other systems have been developed and will be approved on an on-going basis.

The OCAS is an all-weather, day and night, low-voltage radar-based obstacle avoidance system. This system is independent and does not require additional installation in the aircraft (e.g. transponder). The system activates strobe lights and, in certain locations, audio signals via the aircraft's VHF radio, to alert pilots of potential collisions with obstacles, such as power lines, wind farms, bridges and towers. The lights and audio warning are inactive when there is no air traffic in the area.

The system detects aircraft on any track that may conflict within 5nm from the surface to 200 ft above the obstacle. The system's first warning is the activation of white strobe lights 30 seconds prior to reaching the obstacle. These strobe lights are medium-intensity during the day and low-intensity at night. A second warning, 20 seconds prior to reaching the obstacle, consists of an audio message that is transmitted on pre-selected VHF frequencies, stating "POWER LINE, POWER LINE," or whatever type of obstruction is applicable. The timing of each warning can be modified as required by the approving authority.

This OCAS has been approved for use in Canada as an alternative to conventional marking systems on a site-specific basis, and is currently being installed at cable crossings and wind farms in the Pacific Region.

HART Aviation is of the view that the installation of an aircraft detection system, as described above, as opposed to obstacle lighting, which would be "on" all the time, is an

operational decision for a wind farm developer and is likely to be based on commercial considerations. If a regulatory authority (e.g., CASA) requires obstacle lighting and the wind farm developer does not want permanent obstruction lighting installed for whatever reason (cost, community resistance, etc) the developer would need to seek approval from the regulatory authority concerned to introduce this system as an equivalent means of compliance with the obstacle lighting requirement. The fact that a system has been accepted by another national regulatory authority (e.g., the OCAS, which has been accepted by Transport Canada) would be a telling point and would almost certainly facilitate acceptance.

8 THE NEED FOR OBSTACLE LIGHTING

The current Australian regulations in respect of obstacle lighting is summarised in Section 4 of this report.

There is no dispute as to the need for obstacle lighting in the vicinity of aerodromes. The matter that is in question is in respect of the need for obstacle lighting in all cases for wind turbines / wind farms outside of the immediate vicinity of aerodromes, in particular outside the OLS, and in uncontrolled airspace.

There is clear evidence that other regulatory authorities have a provision not to require obstacle lighting where there is no perceived hazard to aviation operations. See Table 2, Section 5 in particular.

HART Aviation holds the view that each wind farm development proposal should be the subject of a formal risk assessment to identify the potential risks to aviation operations. Such a risk assessment should include a full appreciation of the need to meet the CASA and Local Planning Authority regulatory requirements and also should consider the needs of all aviation-related operations that might occur in the vicinity of the development. Such aviation-related operations should include, but not be limited to, airline and military operations, general aviation operations in the vicinity, private operations, private airfields, agricultural operations, parachuting operations, hang gliding, para gliding, ultralight, and so on.

HART Aviation is of the view that there will be cases where the needs for obstacle lighting on wind turbines and within wind farms will not be justified on any rational risk assessment.

As an example, if the following conditions existed: -

1. The wind turbines are outside the OLS of any nearby aerodrome,
    a. therefore would not penetrate any OLS;
    b. hence would not interfere with any operations from the aerodromes concerned, and
    c. the further away the lower the risk of any such interference.
2. There is no penetration of the prescribed airspace,
    a. hence would not interfere with aircraft operations within such airspace.
3. There is no interference with any operational procedures due to, such as, radar interference or air navigation aids interference,
    a. hence would not interfere with any operations.
4. The wind turbine / wind farm is, or is to be, identified on aeronautical charts,
    a. hence all aircraft operators should know of the existence of wind turbines / wind farms and can plan to avoid them as necessary as part of standard flight planning procedures.
5. There are other higher obstacles (such as a mountain or radio tower) in close proximity,
    a. which effectively shield the effect of the wind turbines as discreet obstacles.

- then HART Aviation believes it would be reasonable to take a position that obstacle lighting would not be necessary.

Note that, Civil Aviation Regulations require that, unless it is necessary for takeoff and landing, an IFR or a Night VFR aircraft must not be flown at a height less than 1,000ft above the highest obstacle within a 10nm radius of the aircraft in flight. This, therefore, defines the Lowest Safe Altitude (LSALT) for the operation which, by definition will be higher than any wind turbine.

Further, VFR operations require a minimum height AGL of 500ft outside of built up areas and 1,000ft over built up areas. All wind turbines investigated during this study were of a height less than 500ft

AGL. Again, therefore, with the exception of special low level operations as would occur with, such as, agricultural operations, VFR operations would also be clear of any wind turbines.

The optimum position is clearly to locate wind farm developments where they avoid any conflict with aviation operational aspects. Each proposal, however, would need to be assessed on an individual basis.

The view is held that CASA needs to consider the above in the context of its internal review of these issues.

9 AERONAUTICAL CHARTS

An assessment was made as to the extent to which wind turbines and / or wind farms are currently identified on aeronautical maps.

Airservices AIS

Airservices Australia provides World Aeronautical Charts (WAC) through its Aeronautical Information Services Branch.

HART Aviation is advised that there are no restrictions to placing information on the position and height(s) of wind turbines / wind farms on the WAC. However, currently there is no special identification symbol – the normal obstacle symbol is just being used, but the words “wind farm” are usually added. A sample is shown below.

Sample of wind farm identification on Australian World Aeronautical Chart (WAC).

Since the WACs are only updated every four years, there is a need to advise as to changes in the interim. The Airservices AIS does this in two steps.

Firstly, a Notice to Airmen (NOTAM) is issued advising of any changes.

As an example, the following NOTAM is current in respect of the Capital Wind Farm development near Bungendore, NSW.

C0452/09 NOTAMR C1071/08
Q) YMMM/QXXXX/V/NBO/E/000/005/
A) YMMM
B) 0901210056 C) PERM
E) WIND FARM BEING ERECTED BTN CANBERRA-GOULBURN WIND FARM - REF AIP MAP - VNC, VTC, WAC, ERC A NEW 63 TURBINE WIND FARM IS BEING ERECTED BETWEEN CANBERRA AND GOULBURN ON THE HIGH TERRAIN ADJACENT TO THE EASTERN SHORES OF LAKE GEORGE APROX BETWEEN 16DME AND 20 DME CANBERRA - VTC SPOT HEIGHTS 2670, 2959, 3083 AND 3146 ARE RELEVANT. BLADES AND TOWERS UP TO 410FT AGL.
F) SFC
G) 410FT AGL

C0016/09 NOTAMN
Q) YMMM/QOBCE/IV/ BO/A/000/999/
A) YRTI
B) 0904240436 C) PERM
E) AD OBST - WIND TURBINE 289FT, 303DEG M 1.25NM FROM ARP AMD ERSA

The above NOTAM alerts all pilots, who might plan to operate in the area concerned, as to the existence of the wind farm and the various heights of the associated wind turbines.

The NOTAM is withdrawn once the details are included in the Aeronautical Information Publication (AIP) supplement, available to all pilots.

Once the relevant WAC is amended to include an icon, or icons, to identify the wind farm and wind turbines on the chart, the AIP supplement is then withdrawn.

Whilst, in principle, the above process is sound, there is evidence to suggest that wind farms have not been identified on WACs in some cases. However, any such lack of identification of wind farms on the WACs, or through NOTAM or an AIP Supplement, may very well be because Airservices Australia has not been notified of the presence of wind farms. HART Aviation considers that it is essential that appropriate advice in respect of the presence of wind turbines and wind farms be provided to the Airservices AIS. If this is not done there will be no guarantee that such wind farms will be recorded on the WACs. Such recording is essential factor in the reduction of the risks to aviation operations and it should be understood to be a mandatory requirement for any wind farm development.

RAAF AIS

The RAAF Aeronautical Information Service has been assigned the task of maintaining a data base of tall structures, the top measurement of which is: -

- 30m or more above ground level – within 30km of an aerodrome; or
- 45m above ground level elsewhere.

The database is made available for use by mapping agencies such as Australian Surveying and Land Information Group, and domestic and international aviation organisations.

The reporting requirements are detailed in the CASA Advisory Circular AC 139-08(0), April 2005.

Apart from providing the obstacle information to interested parties outside the Defence network, the RAAF AIS develops its own series of maps.

The RAAF AIS has a publication called the Chart Amendment Document (CHAD). This is issued every eight weeks to coincide with every two Aeronautical Information and Regulation Control (AIRAC) cycles. The CHAD is used to promulgate details of amendments to existing charts in the JNC (Jet Navigation Chart), ONC (Operational Navigation Chart), TPC (Tactical Pilotage Chart) and JOG (Joint Operation Graphic) Air series. It also details new editions.

Only data that meets the CHAD criteria are included. Minor differences in height, elevation, length or position of existing features are not changed. The area of coverage includes parts of South East Asia, Australia and the Western Pacific.

It is reported that some of the RAAF AIS charts are decades old. Consequently, the number of amendments for some charts is considerable. Also, some of the amendments, particularly for charts covering Asia, are understood to be questionable as to their validity. This is believed to be due mostly to their unreliable source. There is also a problem of duplicate vertical obstructions caused by different reference datums.

The above mentioned military charts do include wind turbines, if they are notified of their existence. Currently, only the standard vertical obstruction identification is used – there is no specific icon for wind turbines. However, the wind turbines are usually identified as wind motors on the military charts and sometimes marked as individual turbines or a group of turbines. An example is shown below.

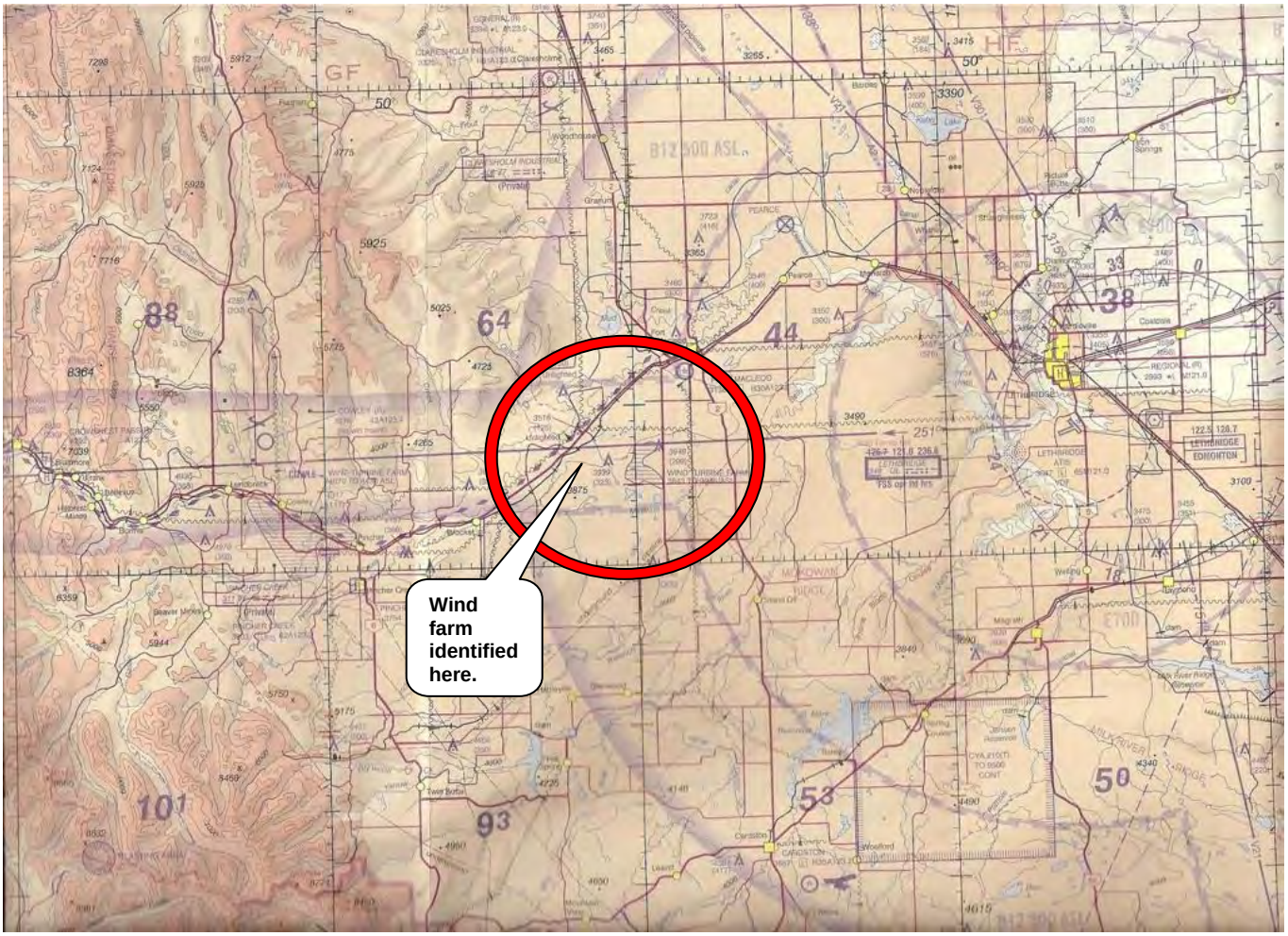
Sample of wind farm identification on RAAF AIS Joint Operation Graphic chart.

The RAAF AIS reports that there is some confusion as to whether to report the wind farms at the planning stage, or the building stage, or the operational stage. As a result, the RAAF AIS area find there is a need for close checking as some proposals do not proceed beyond the planning stage.

The international scene.

A detailed examination of the international scene was not undertaken.

However, it has been noted that Canada does include specific advice as to wind farms on its VHF Navigation Charts. A sample is shown below.



Sample of wind farm identification from Calgary Canada VHF Navigation chart.

It is fully expected that other countries would be taking a similar approach.

10 SNOWTOWN WIND FARM – SPECIFIC CONSIDERATIONS

The Snowtown Wind Farm is situated 125 - 150km north of Adelaide Airport.

Snowtown Wind Farm Stage 1 runs along the ridge line of the Barunga Range from a point just south of Hope Gap to a point almost due west of Snowtown. Stage 1 consists of 47 wind turbines.

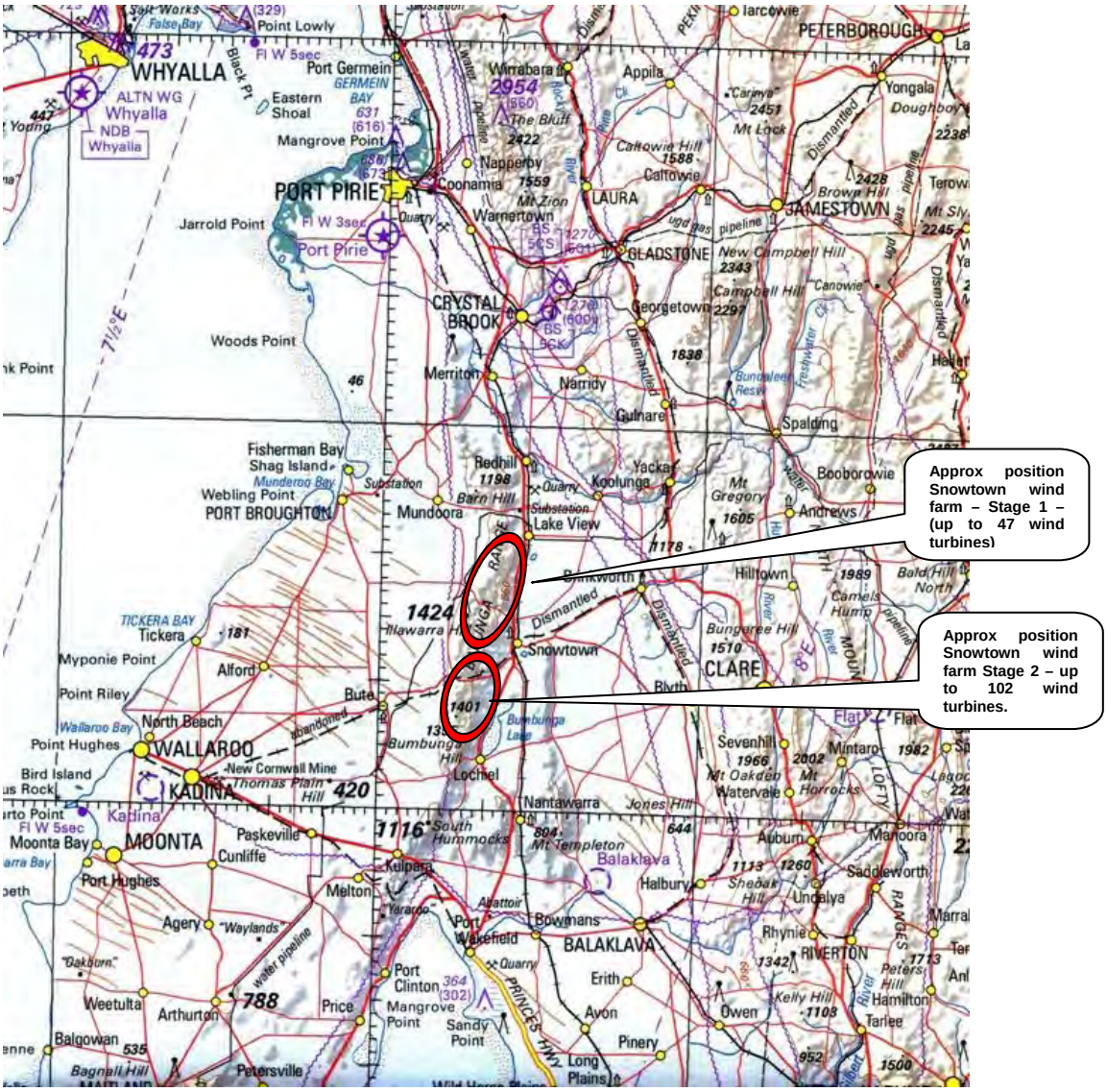
Stage 1 looking south along Barunga Range ridge.

Stage 1 looking north from WTG 23.

Overview of Stage 1 just after completion.

Stage 2 of the Snowtown Wind Farm is currently in the planning stage but the wind turbines will be positioned along the Barunga Range ridge line, possibly commencing from a point just south of Stage 1 near the Barunga Gap and extending south to a point opposite Bumbunga Lake just north of Lochiel. The plans are for up to 102 additional wind turbines.

The approximate positions of the two stages of the Snowtown Wind Farm are as shown in the map below, which has been copied from WAC (3459) ADELAIDE.



Approximate positions of Snowtown Wind Farm developments.

The latest Airservices AIC listing changes to AIP aeronautical charts effective 04 June 2009 identifies, among other things, the following change to the Adelaide VNC: -

> "Snowtown Wind Farm established and shown as lit obstructions. The highest turbine is at S33 40.2 E138 10.7."

It is also worth noting that the AIC Supplement dated 20th November 2008 listed the following changes: -

"**WAC ADELAIDE (3458) -- 16th Edition**

1. Add Group Lit Obstacle S33 43.2 E138 08.3 amsl 1780 and label Windfarm.

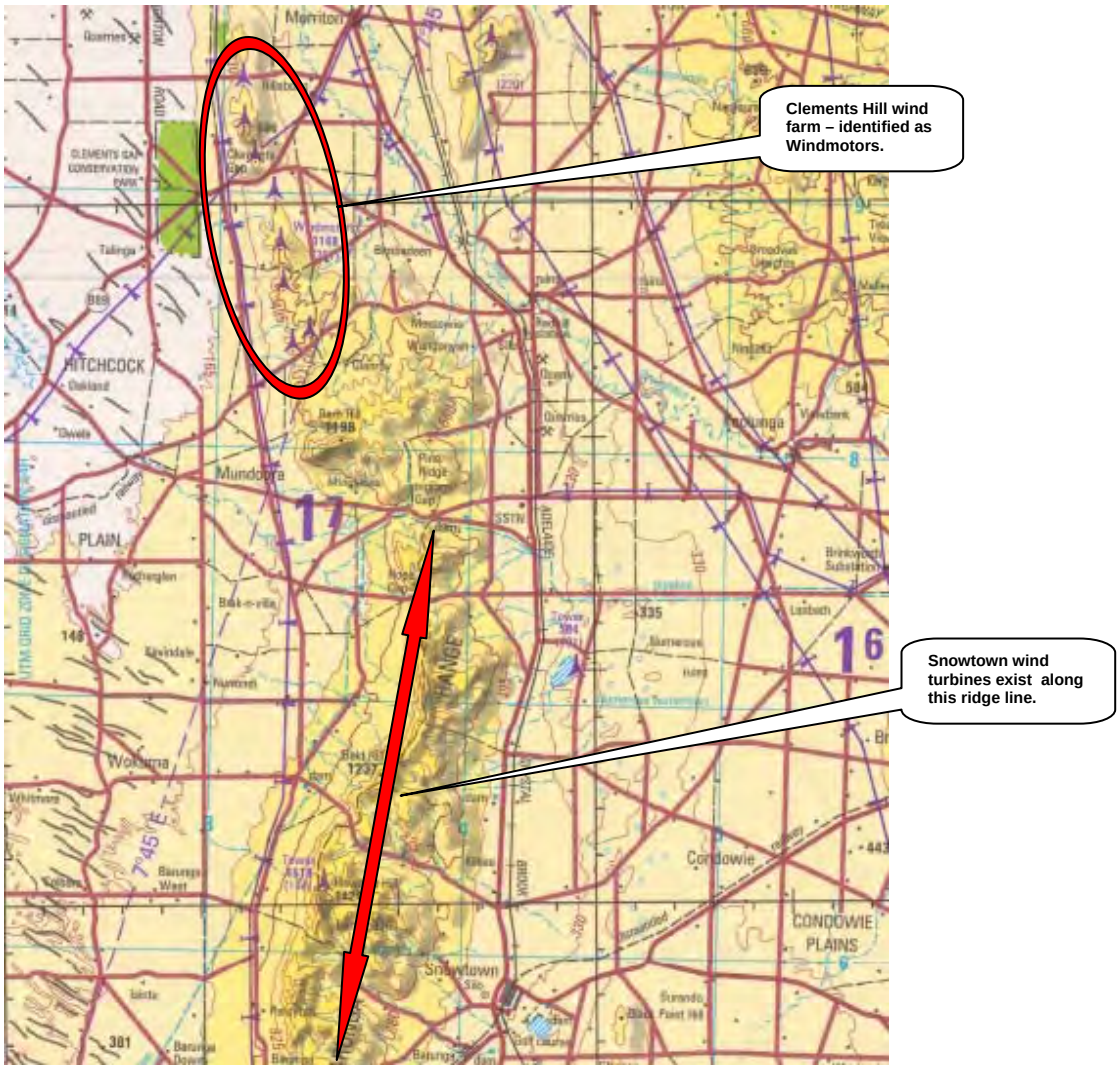
2. Add Group Lit Obstacle S33 21.7 E138 43.5 AMSL 2923 (410) and label Windfarm

Item 1 refers to the Snowtown Wind Farm, but may also be aimed at alerting pilots to the existence of all the wind turbines in this area, including those within the Clements Hill Wind Farm

Item 2 refers to the Hallett 1 Wind Farm north east of Snowtown near Mt Bryan.

Neither the Clements Hill, Snowtown or Hallett wind farms are yet to be shown on the relevant WACs (3458) ADELAIDE and (3459) PORTAUGUSTA, as can be seen in the example above from WAC 3459.

The Clements Hill Wind Farm is on the relevant RAAF AIS Joint Operation Graphic chart as shown below, but neither the Snowtown nor the Hallett wind farms are on any RAAF AIS chart as far as can be determined.



Excerpt from RAAF AIS Joint Operation Graphic chart.

10.1 AVIATION IMPACTS

In assessing the impact, if any, of the Snowtown Wind Farm on aviation operations it was necessary to identify what aviation operations exist within the nominated area.

10.1.1 Aerodromes in the Vicinity.

Taking into account the current Stage 1 and planned Stage 2 of the Snowtown wind farm, the following airfields have been identified in the vicinity: -

Port Pirie – licensed aerodrome – approximately 45km from the most northern wind turbine within the Snowtown wind farm. Regular Public Transport and regional operations occur from this aerodrome but such operations would not be affected in any way by the presence of the wind turbines within the Snowtown wind farm, nor would there be any penetration of any obstacle limitation surfaces established for Port Pirie aerodrome.

Balaklava – unlicensed aerodrome – approximately 31km south east of the anticipated position of the most southern wind turbine within the Stage 2 development of the Snowtown wind farm. This aerodrome is operated by the Balaklava Gliding Club and is mainly used for gliding operations on weekends and public holidays. Winch launching is commonly used for all glider launches with the sole exception of one self launching powered glider on site. In discussions with a representative of the Balaklava Gliding Club at the airfield, HART Aviation was advised that all gliding operations are to the north and the presence of the wind turbines is of no concern. There are very limited operations by light aircraft from the Balaklava aerodrome.

Kadina – unlicensed aerodrome – approximately 46km west of the anticipated position of the most southern wind turbine within the Stage 2 development of the Snowtown Wind Farm. General aviation operations occur from this aerodrome, which could include Night VFR and IFR operations as the aerodrome is equipped with Pilot Activated Lighting (PAL). However, any such operations would not be affected in any way by the presence of the wind turbines within the Snowtown Wind Farm.

Snowtown Aerodrome – There used to be an unlicensed airstrip approximately 18km south east of Snowtown, but this strip has been abandoned and is not operational. The Adelaide University Gliding Club used to operate from this strip, but the Club relocated its operations a year or so ago to a strip near Steinfield, east of Truro, which it shares with the Barossa Valley Gliding Club. The remnants of the Snowtown Aerodrome (about 2km west of the BArunga Range ridge) still remain, including obstacle markings on the nearby electricity lines, but the aerodrome itself is being slowly absorbed into the local farming environment. It is, therefore not an issue of concern.

Private landing grounds: Three private landing grounds have been identified within the vicinity of the Snowtown wind farm developments.

- **Atkinson property** - approximately 2km east of wind turbines Nos 17 to 21.

  The landing ground is approximately 600m long, oriented roughly north – south. In the past this strip has been used for aerial spraying operations but the property owner advised that the strip hasn't been used for some 10 years.

- **Michael property** – approximately 3km south of Snowtown off the road to Balaklava.

  This property has two grass strips each of approximately 700m length oriented roughly north – south and east west. The owner's son operates his privately owned Jabiru aircraft from this landing ground.

Typical Jabiru aircraft.

The property owner advised that, in the past, this landing ground has been used for aerial agriculture operations but these have been discouraged in recent times to minimise damage to the airstrips.

The aircraft operator advised that he had no concerns regarding the wind turbines, nor the obstacle lighting. He reported that he had observed "a lot of night flying" in the vicinity and, therefore, he held the view that there would be an advantage in having the

wind turbines lit "to assist any aircraft flying low dodging the weather". He did admit, however, that such operations would clearly be below LSALT, contrary to the rules and poor practice.

- **Duance property** – reported to be "two paddocks east" of the Michael property on the Bute Road.

  This property has a very small strip approximately 400m long, oriented roughly north – south. Operations are apparently constrained to some extent because of gum trees at one end. The owner operates a Foxbat small aircraft from this property.

Typical Foxbat aircraft.

Approximate locations of private landing grounds.

It has also been reported that there is a small ultralight trike operator near Red Hill, north of the Snowtown Wind Farm and closer the Clements Hill Wind Farm.

HART Aviation was unable to identify any other aerodromes or airstrips in the immediate vicinity of the Snowtown wind farm. Indeed, apart from those identified above, all other aerodromes are more than 50km distance from any wind turbine within the Snowtown Wind Farm.

In effect, there are no regular aviation operations within 30km from the Snowtown Wind Farm and, therefore, none of the wind turbines within the Snowtown Wind Farm as existing as Stage 1, or proposed as Stage 2, will penetrate any obstacle limitation surfaces of any aerodrome.

Note that, it is important to note that there are minimum altitude requirements to be met for any general aviation operations. As indicated above, Kadina aerodrome is equipped with Pilot Activated Lighting (PAL) and, as such, Night VFR and / or IFR flights could be undertaken from this aerodrome. Such operations would be undertaken under either Night VFR or IFR flight plan conditions, which require operations not below the lowest safe altitude (LSALT), except when landing or taking off.

In principle: -

a. where the highest obstacle is more than 360ft above the height determined for terrain, the LSALT must be 1,000ft above the highest obstacle; or
b. where the highest obstacle is less than 360ft above the terrain, or there is no charted obstacle, the LSALT must be 1,360ft above the elevation determined for terrain; except that
c. where the elevation of the highest terrain or obstacle in the tolerance area is not above 500ft, the LSALT must not be less than 1,500ft.

Civil Aviation Regulations require that, unless it is necessary for take off or landing, a Night VFR aircraft must not be flown at a height less than 1,000ft above the highest obstacle within a 10nm (~18.5km) radius of the aircraft in flight.

Whilst there are some exceptions in respect of operations that require low flying (e.g., during take off and landing, search & rescue and agricultural spraying operations) pilots undertaking VFR operations (i.e., during daylight hours) must not fly over:

- any city, town or populous area, at a height lower than 1,000ft; or
- any other area at a height lower than 500ft.

In any event, the wind turbines should be clearly visible to pilots undertaking VFR operations.

In the circumstances, provided aircraft operators abide by the rules, the Snowtown wind farm should have no impact on Night VFR or IFR operations to or from Kadina Aerodrome or any VFR operations to and from this aerodrome – or, for that matter, any other aerodrome.

10.1.2 Other aviation aspects.

Airservices Australia: --- Airservices Australia was consulted during the consent phase of the Snowtown Wind Farm project. Based on the comments made by Airservices Australia in respect of the Hallett wind farm developments to the east of Snowtown, it is assessed that the Snowtown Wind Farm will not affect any sector or circling altitude, nor any approach or departure, or any en route or grid lowest safe altitudes (LSALT). They will not impact on Precision/Non-Precision Navigational Aids, HF/VHF Communications, Advanced Surface Movement Guidance and Control Systems, Radar or Satellite/Links.

Civil Aviation Safety Authority: --- There are no licensed aerodromes within the Snowtown wind farm area nor anywhere in the near vicinity, as indicated above. As such, there are no concerns regarding aerodrome operations or regarding any potential penetration of any OLS that are relevant to the Snowtown wind farm.

CASA regulations, however, stipulate that, if a structure (including a turbine in a wind farm) is proposed to be 110m or higher, the proposal needs to be assessed by CASA for the need for obstacle lighting. Such an assessment will consider the proposed turbine height as well as the amount of aviation traffic at the proposed turbine (or wind farm) site.

In the Snowtown case, CASA assessed that the wind farm would be treated as one extensive object or a group of closely spaced objects and obstacle lighting was required in accordance with the requirements of the, since withdrawn, Advisory Circular, AC139-18(0), as detailed earlier in this report.

HART Aviation is of the view that CASA's position on this matter is questionable based on any legitimate risk assessment considerations as the risk to aviation operations in the vicinity of Snowtown is considered to be negligible.

CASA refused to accept a lower standard of obstacle lighting, similar to that used in Germany, but applied the full requirements of ICAO Annex 14. HART Aviation would support such a decision if obstacle lights were to be shown as warranted. In this case, HART Aviation is of the view that obstacle lights are not warranted.

Department of Defence: --- It is noted that the RAAF has identified the Clements Hill wind farm on the relevant Joint Operation Graphic chart. However, it would seem that no specific comments were offered in respect of the Snowtown wind farm. The view is held that the Snowtown wind turbines will have no adverse effect on any military aircraft operations.

Hang Gliding: --- The South Australian Hang Gliding Association was consulted during the construction and commissioning stage of the Snowtown Wind Farm Stage 1. There are three inland sites flown that have the potential to produce a conflict with the Snowtown wind turbines. These are at Barn Hill (north of the Snowtown Wind Farm Stage 1 and south of the Clements Hill Wind Farm); at Illawarra Hill (within the confines of Snowtown wind farm Stage 1); and at Lochiel Ridge (at the southern edge of the Snowtown wind farm Stage 2). HART Aviation was advised by Wind Prospect that an agreement has been reached between TrustPower and the South Australian Hang Gliding Association that launches can be undertaken from one or more specifically defined areas within the confines of the wind farm, subject to a 250m clearance zone being upheld. In this respect, the potential risks are considered to have been addressed and minimised.

Aerial Agriculture: --- The area in the vicinity of the Snowtown Wind Farm is predominantly used for stock grazing and cereal cropping. Some agricultural aerial spraying is known to occur in the region. Standard operational procedures require that, prior to any such operation, a full check of potential obstacles is undertaken.

10.2 NEED FOR OBSTACLE LIGHTS

HART Aviation is of the view that the risk to aviation operations in the vicinity of the Snowtown Wind Farm (both the existing Stage 1 and the proposed Stage 2) is sufficiently low such that obstacle lights are not required for the wind turbine.

This view is based on the following: -

- There are no licensed aerodromes within the wind farm area or in the near vicinity. The nearest licensed aerodrome is at Port Pirie, approximately 45km from the most northern wind turbine within the Snowtown Wind Farm. As such, there are no concerns regarding aerodrome operations or any OLS that are relevant to the Snowtown Wind Farm.
- There are only two unlicensed aerodromes identified as existing at distances varying between 31km & 46km from the Snowtown Wind Farm. Operations to and from these aerodromes are minimal and it is assessed that the presence of the Snowtown wind turbines / wind farm would not have any adverse impact on such operations.
- With the exception of approved low level operations (such as aerial agricultural spraying, search and rescue, etc.) aircraft are required to operate at minimum heights above the highest point of any of the wind turbines.
- Any approved low level operations, by their very nature, are required to check for any obstacles which might impact on such operations, before undertaking any such operations.
- The Snowtown Wind Farm turbines will not affect any sector or circling altitude, nor any approach or departure, or any enroute or grid lowest safe altitudes (LSALT). They will not

impact on Precision/Non-Precision Navigational Aids, HF/VHF Communications, Advanced Surface Movement Guidance and Control Systems, Radar or Satellite/Links.

- There are no known low level military flight routes within the area.

In effect, there are no regular aviation operations within 30km from the Snowtown Wind Farm and, therefore, none of the wind turbines within the Snowtown Wind Farm as existing as Stage 1, or proposed as Stage 2, will penetrate any obstacle limitation surfaces of any aerodrome. The overall risk, therefore, to aviation operations in the vicinity of the Snowtown Wind Farm is sufficiently low not to warrant the imposition of obstacle lights on any of the wind turbines.

The risk to aviation operations would be further reduced if the wind turbines were identified on the relevant aeronautical charts, both the civil WACs and the RAAF produced chart series.

The CASA decision to require obstacle lights on the wind turbines within the Snowtown Wind Farm is considered to be questionable on any rational risk assessment basis. One's attention is particularly drawn to the position of the UK CAA on this matter as detailed in Section 3.2.

The UK CAA position is summarised as: -

1. Obstacle lighting is not a substitute for knowledge of the presence of such structures but is a significant and important aid to their visual acquisition and hence avoidance;
2. obstacles located close to licensed aerodromes are required to be lit;
3. structures away from the immediate vicinity of an aerodrome, which have a height of 150m or more above ground level (AGL) are required to be fitted with obstacle lights;
4. *in general terms, structures less than 150m high, which are outside the immediate vicinity of an aerodrome, are not routinely lit, unless the "by virtue of its nature or location such structures could be considered a significant navigational hazard " argument holds fast;*
5. *if a claim for lighting was clearly outside credible limits (i.e., the proposed turbine(s) was/were many miles away from any aerodrome or was/were at a height that was unlikely to affect even military low flying), the CAA, in isolation, would be unlikely to make a case for aviation warning lighting;*
6. *where a wind turbine development lies (or would lay) outside any aerodrome safeguarding limits and the turbine height was less than 150m, the aviation industry, including the CAA, is not in a position to demand that turbines are lit.*

HART Aviation is of the view that CASA would do well to consider a similar approach to that being taken by the UK CAA, particularly the clauses 4 – 6 highlighted in *red*.

It should further be noted that no evidence could be found of any collisions by aircraft with any wind turbine anywhere in the world. This, in itself, is a measure of the relative low risk profile of such turbines. Admittedly, some, no doubt, would have had obstacle lights, which it could be argued further reduces the risk.

10.3 EXISTING & PROPOSED LIGHTING REGIMES

As indicated earlier, HART Aviation is of the view that obstacle lights are not required on the Snowtown Wind Farm turbines due to the associated low level of risk of collision of aircraft with the turbines.

However, if one adds lights to the wind turbines, it will further reduce the level of risk and, therefore, the existing lighting regimes will raise the overall level of safety. That begs the question as to whether the investment in such additional safety measures is really warranted. HART Aviation is of the view that in the case of the Snowtown Wind Farm projects it is not.

Having said that, HART Aviation believes that, if one is to install obstacle lights, one should be very cautious about installing any such lights to a lesser standard than that recommended by the International Civil Aviation Organisation (ICAO) as detailed in ICAO Annex 14 (see the Appendix of

this report) or that within the CASA Manual of Standards (MOS) Part 139 – Aerodromes, which, for all practical purposes, replicates Annex 14.

In the event that CASA recommends obstacle lighting in accordance with the standards (as it has done in respect of Snowtown Stage 1), in the absence of a mandatory requirement, TrustPower could, of course, ignore that CASA recommendation and proceed independently, either choosing not to have any obstacle lights installed, or just install a reduced lighting regime as a minimum alerting tool. However, any such action has the potential to expose TrustPower to litigation in the very unlikely event of an aircraft colliding with one of the wind turbines. It is considered possible that such action may very well be defensible on a "reasonable approach" argument, but that is a matter for consideration by, and consultation with, legal experts.

If obstacle lights are to be installed at all on wind turbines, the standards require that they should be medium intensity of 2,000 +/- 25% candescence in accordance with Para 9.4.7 of the CASA Manual of Standards Part 139 - Aerodromes, which is identical to the ICAO Annex 14 SARPs as listed in Table 6.3 of that Annex. However, a lesser alternative may be possible if CASA can be convinced that obstacle lights are not required and TrustPower decides that some should be lit, regardless. In this respect, reference is made to the following note from the CASA Manual of Standards Part 139 - Aerodromes after Para 9.4.6.1: -

> "For objects that do not infringe the obstacle limitation surfaces, and where CASA has not determined that obstacle lights are required, if the object owner wishes, of their own volition, to provide obstacle lights, it is sufficient for these low intensity obstacle lights to have the following intensity distribution: peak intensity 32cd minimum, vertical beam spread of 10°, and 32cd minimum at $+6^o$ and $+10^o$ elevation."

Admittedly, the above note is subordinate to the MOS 139 Paragraph dealing with low intensity lights for general applications (requiring a peak intensity of 100cd minimum, et al), but the principle is clear and may be transferable to the case of wind turbines. It will be necessary, of course, for CASA to be convinced that wind turbines in any particular development (e.g., the Snowtown Wind Farm) do not require obstacle lights. To date it would seem that CASA is not so convinced.

However, HART Aviation is of the view that the apparent default position of CASA in favour of obstacle lights, regardless of any legitimate risk assessment, should be challenged. At the very least, CASA should be obligated to justify its position on sound risk assessment grounds.

HART Aviation notes that shielding is an acceptable practice but highlights the requirement that any such shielding needs to ensure an unobstructed view for aircraft approaching from any direction. Further, it should be noted that shielding will only have a positive effect for any residences close to the turbines themselves and will likely have little effect at a distance.

11 CONCLUDING REMARKS

Apart from the clear need for consultation with Local Planning Authorities (LPAs), environmental and other concerned authorities, there are specific considerations to be addressed from the aviation perspective.

Firstly, there are clear rules regulating obstacles in the vicinity of aerodromes, particularly when there is a possibility that any such obstacle is likely to penetrate the obstacle limitation surfaces (OLS). Any wind farm developer would be well advised to take notice of the regulatory requirements in this respect; (refer Section 4 of this report). HART Aviation is of the view that wind farm developments should always avoid the defined obstacle limitation surface (OLS) areas at any aerodrome and, preferably, keep such developments as far away from aerodromes as possible and practicable. Further, no development should be proposed below any known low level flight route or within any defined general aviation entry lanes.

Any wind farm proponent should be aware of the requirement to report to CASA any obstacle which will extend 110m or more above ground level (AGL).

It should also be noted that there is a requirement to report "tall structures" over 30m AGL to the RAAF AIS - [refer CASA AC 139-08(0)].

In HART Aviation's view, CASA needs to know of any wind farm development at the planning stage so an aeronautical study / risk assessment can be done by CASA and the WTG developer can then know what CASA might or might not require. It is the responsibility of CASA to make the judgement as to whether obstacle lighting is required or not, and to direct accordingly.

From a tactical perspective, wind farm developers should not be proposing any obstacle lighting schemes to CASA in the first instance, just reporting the obstacles in excess of 110m as required by the Civil Aviation Regulations. No lighting schemes should be proposed until such time as the actual need for any such obstacle lighting has been determined and appropriate directions given by CASA are accepted.

It is considered that an independent aeronautical study / risk assessment should be commissioned by the WTG developer. This will equip the developer to challenge a decision by CASA should there be a need to do so. For example, this could be the case where an aeronautical study / risk assessment undertaken on behalf of the developer reaches the conclusion that the risk to aviation operations is so small as not to warrant any obstacle lighting, yet CASA has reached the view that such obstacle lighting is required. In such a case, as a first step, the developer should seek a copy of the CASA aeronautical assessment justifying its decision. If CASA cannot justify its position, then the need for obstacle lighting should be challenged.

The view is held that a formal aeronautical study / risk assessment should be undertaken for all wind turbine / wind farm development proposals. It should not be assumed that all such developments will require obstacle lighting.

HART Aviation is convinced that there will be certain cases where specific wind farm developments will be in such a low risk area from an aviation operational perspective that an aeronautical study / risk assessment and site specific investigation will lead to the conclusion that obstacle lighting will not be necessary. Such a case would be one which was located remote from any aviation operations. The Snowtown Wind Farm is considered to fall into that category.

It is considered that there will also be cases where the risk is not so high as to warrant extensive medium or high intensity obstacle lighting and, in such instances, other risk mitigation options should be considered, including a lower intensity level of obstacle lighting.

There will be cases, of course, where the aeronautical study / risk assessment might demand the use of full high intensity flashing lights (e.g., in the unlikely event that a wind farm development was proposed in an area where the turbines would penetrate the OLS of an aerodrome and CASA has accepted its presence there subject to high intensity obstacle lighting), but HART Aviation is of the view that such should not be the default position and other mitigating measures should also be considered.

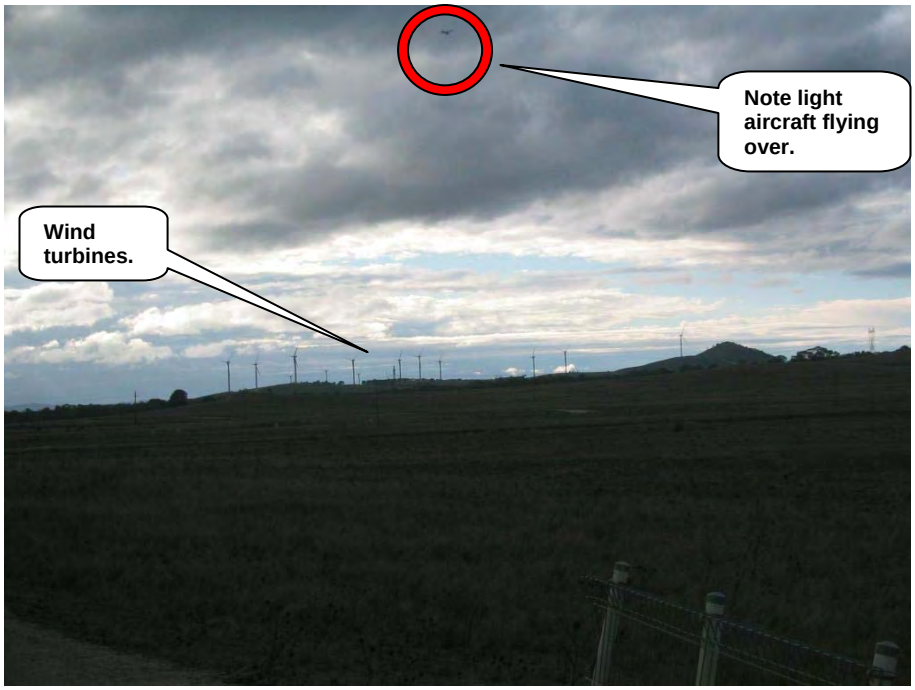
It is considered that it would also be in the WTG developers' interests to alert the RAAF AIS at the planning stage as a matter of courtesy. This is particularly important for the RAAF, which has defined low level operational routes. Advance notification will enable such to be known and avoided. At this time the WTG developers should also advise that they will inform the RAAF AIS when the planned WTG has commenced construction or whether a decision has been made not to proceed. In addition, Airservices AIS should be advised along the same lines.

It is essential that every effort should be made to ensure that the WTGs will eventually be included on all aeronautical charts as this is an important element in minimising the risks. There is some evidence that this has not universally happened to date. The aviation operators must have access to this information. Without it, any argument against the need for obstruction lights will be weakened

Apart from consultation with CASA and the RAAF, during the development stage there is a need to consult any closely located aviation related operations which might be affected by the development. This includes, but is not restricted to, the owners and operators of any nearby private airfields, local agricultural operators, nearby parachuting clubs, local ultralight operators, and such.

Available records indicate that, world wide, there are over 75,000 wind turbines of various sizes in operation, or planned to be in operation, and the number is quickly expanding. This includes both onshore and offshore facilities. There is clear evidence that these wind turbines / wind farms can co-

exist successfully with aviation operations. Indeed, no evidence could be found of any aircraft collision with a wind turbine, or any other related incident. This, of course, is not without precautions in place like obstruction lights (in cases where a particular hazard has been identified), and appropriate identification on aeronautical maps.



Capital Wind Farm near Bungendore NSW.

Aircraft can "live" with wind turbine farms as illustrated by the photo above showing a light aircraft flying above the Capital Wind Farm near Bungendore, NSW, well above the lowest safe altitude and well clear on any of the wind turbines.

To repeat, it is the strongly held view that any proposed WTG development should include a formal risk assessment dealing with the possibility of a collision by an aircraft. If this assessment reveals that the absence of marking and/or lighting will not impair aviation safety, then HART Aviation believes that it would be unreasonable to require any such marking or lighting. This should not be the default position and mitigation measures other than obstacle lighting should be part of the hazard mitigation considerations.

Conversely, if the study shows that the object may present such an extraordinary hazard potential that higher standards may be recommended for increased conspicuity to ensure safety to air navigation, then such higher standards should be imposed.

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12 LIST OF ABBREVIATIONS

AC	Advisory Circular	NM	Nautical Mile
AGL	Above Ground Level	NOTAM	Notice to Airmen
AIP	Aeronautical Information Publication	NPRM	Notice of Proposed Rule Making
AIC	Aeronautical Information Circular	NSW	New South Wales
AIRAC	Aeronautical Information Regulation and Control	NZ	New Zealand
AIS	Aeronautical Information Service	OCAS	Obstacle Collision Avoidance System
ALA	Aircraft Landing Area	OLS	Obstacle Limitation Surface
CAA	Civil Aviation Authority	ONC	Operational Navigation CHART
CAP	Civil Aviation Publication	PAL	Pilot Activated Lighting
CASA	Civil Aviation Safety Authority	PSR	Primary Surveillance Radar
CASR	Civil Aviation Safety Regulation	RAAF	Royal Australian Air Force
CEC	Clean Energy Council	RF	Radio Frequency
cd	Candela	RFDS	Royal Flying Doctor Service
CFR	Code of Federal Regulations	SA	South Australia
CHAD	CHART Amendment Document	SAR	Search and Rescue
DME	Distance Measuring Equipment	SARP	Standards and Recommended Practices
EASA	European Aviation Safety Agency	SSR	Secondary Surveillance Radar
ERC	En Route CHART	TP	Technical Publication
ERSA	En Route Supplement Australia	TPC	Tactical Pilotage CHART
EU	European Union	UK	United Kingdom
FAA	Federal Aviation Administration	USA	United States of America
ICAO	International Civil Aviation Organisation	VFR	Visual Flight Rules
IEA	International Energy Authority	VHF	Very High Frequency
IFR	Instrument Flight Rules	VMC	Visual Meteorological Conditions
ILS	Instrument Landing System	VNC	Visual Navigation CHART
JNC	Jet Navigation CHART	VOR	VHF Omni Directional Radio Range
JOG	Joint Operational Graphic CHART	VTC	Visual Terminal CHART
LPA	Local Planning Authority	WAC	World Aeronautical CHART
LSALT	Lowest Safe Altitude	WTG	Wind Turbine Generator

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APPENDIX

Excerpts from ICAO Annex 14 – Aerodromes Volume 1 – Aerodrome Design and Operations.

CHAPTER 4. OBSTACLE RESTRICTION AND REMOVAL

Note 1.— The objectives of the specifications in this chapter are to define the airspace around aerodromes to be maintained free from obstacles so as to permit the intended aeroplane operations at the aerodromes to be conducted safely and to prevent the aerodromes from becoming unusable by the growth of obstacles around the aerodromes. This is achieved by establishing a series of obstacle limitation surfaces that define the limits to which objects may project into the airspace.

Note 2.— Objects which penetrate the obstacle limitation surfaces contained in this chapter may in certain circumstances cause an increase in the obstacle clearance altitude/height for an instrument approach procedure or any associated visual circling procedure. Criteria for evaluating obstacles are contained in Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS) *(Doc 8168).*

Note 3.— The establishment of, and requirements for, an obstacle protection surface for visual approach slope indicator systems are specified in 5.3.5.41 to 5.3.5.45.

4.1 Obstacle limitation surfaces

Note.— See Figure 4-1.

Outer horizontal surface

Note.— Guidance on the need to provide an outer horizontal surface and its characteristics is contained in the Airport Services Manual, *Part 6.*

Conical surface

4.1.1 *Description.— Conical surface.* A surface sloping upwards and outwards from the periphery of the inner horizontal surface.

4.1.2 *Characteristics.—* The limits of the conical surface shall comprise:

a) a lower edge coincident with the periphery of the inner horizontal surface; and

b) an upper edge located at a specified height above the inner horizontal surface.

4.1.3 The slope of the conical surface shall be measured in a vertical plane perpendicular to the periphery of the inner horizontal surface.

Inner horizontal surface

4.1.4 *Description.— Inner horizontal surface.* A surface located in a horizontal plane above an aerodrome and its environs.

4.1.5 *Characteristics.—* The radius or outer limits of the inner horizontal surface shall be measured from a reference point or points established for such purpose.

Note.— The shape of the inner horizontal surface need not necessarily be circular. Guidance on determining the extent of the inner horizontal surface is contained in the Airport Services Manual, *Part 6.*

4.1.6 The height of the inner horizontal surface shall be measured above an elevation datum established for such purpose.

Note.— Guidance on determining the elevation datum is contained in the Airport Services Manual, *Part 6.*

Approach surface

4.1.7 *Description.— Approach surface.* An inclined plane or combination of planes preceding the threshold.

4.1.8 *Characteristics.—* The limits of the approach surface shall comprise:

a) an inner edge of specified length, horizontal and perpendicular to the extended centre line of the runway and located at a specified distance before the threshold;

b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended centre line of the runway;

c) an outer edge parallel to the inner edge; and

d) The above surfaces shall be varied when lateral offset, offset or curved approaches are utilized, specifically, two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended centre line of the lateral offset, offset or curved ground track.

4.1.9 The elevation of the inner edge shall be equal to the elevation of the mid-point of the threshold.

4.1.10 The slope(s) of the approach surface shall be measured in the vertical plane containing the centre line of the runway and shall continue containing the centre line of any lateral offset or curved ground track.

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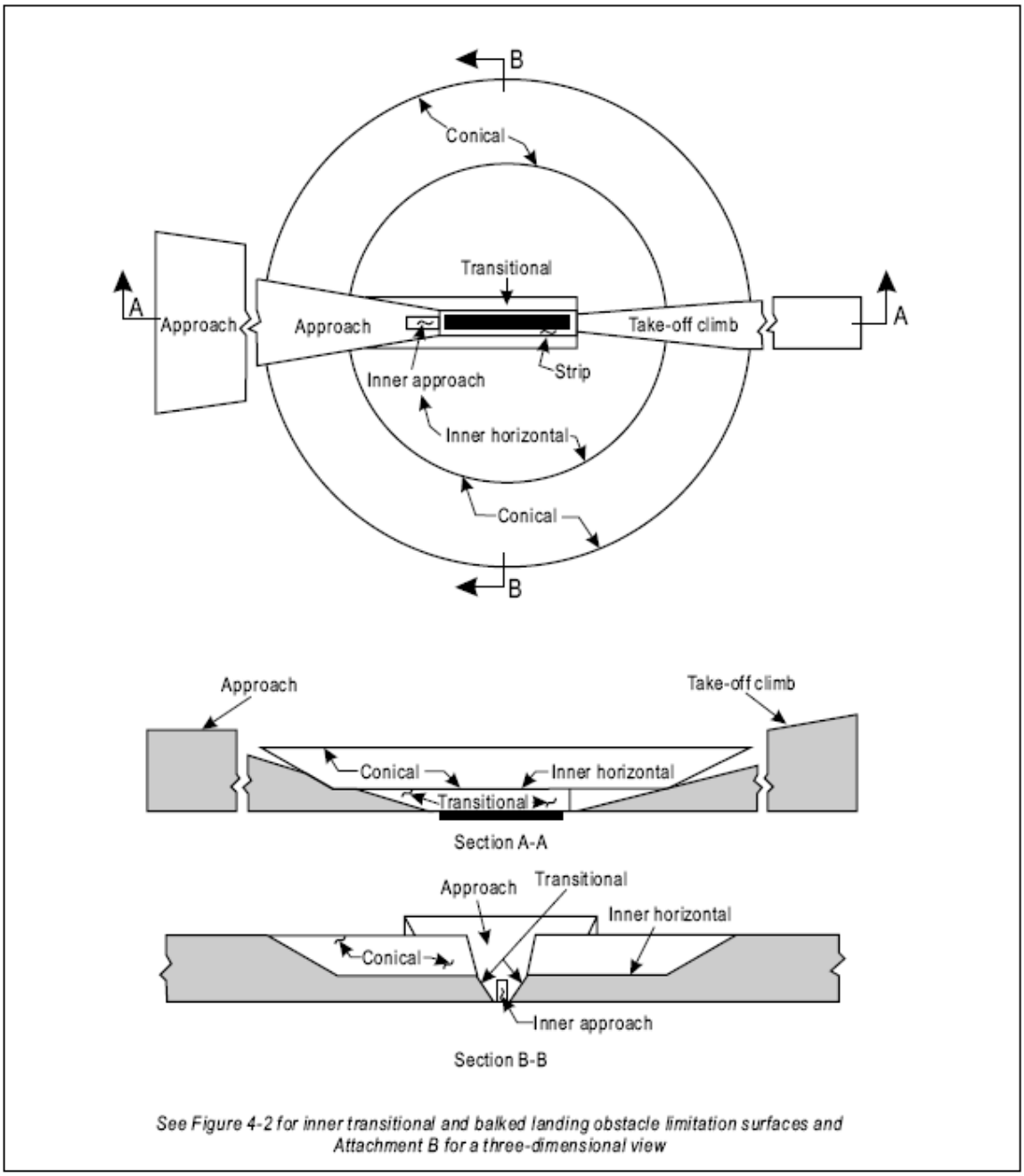


Figure 4-1. Obstacle limitation surfaces

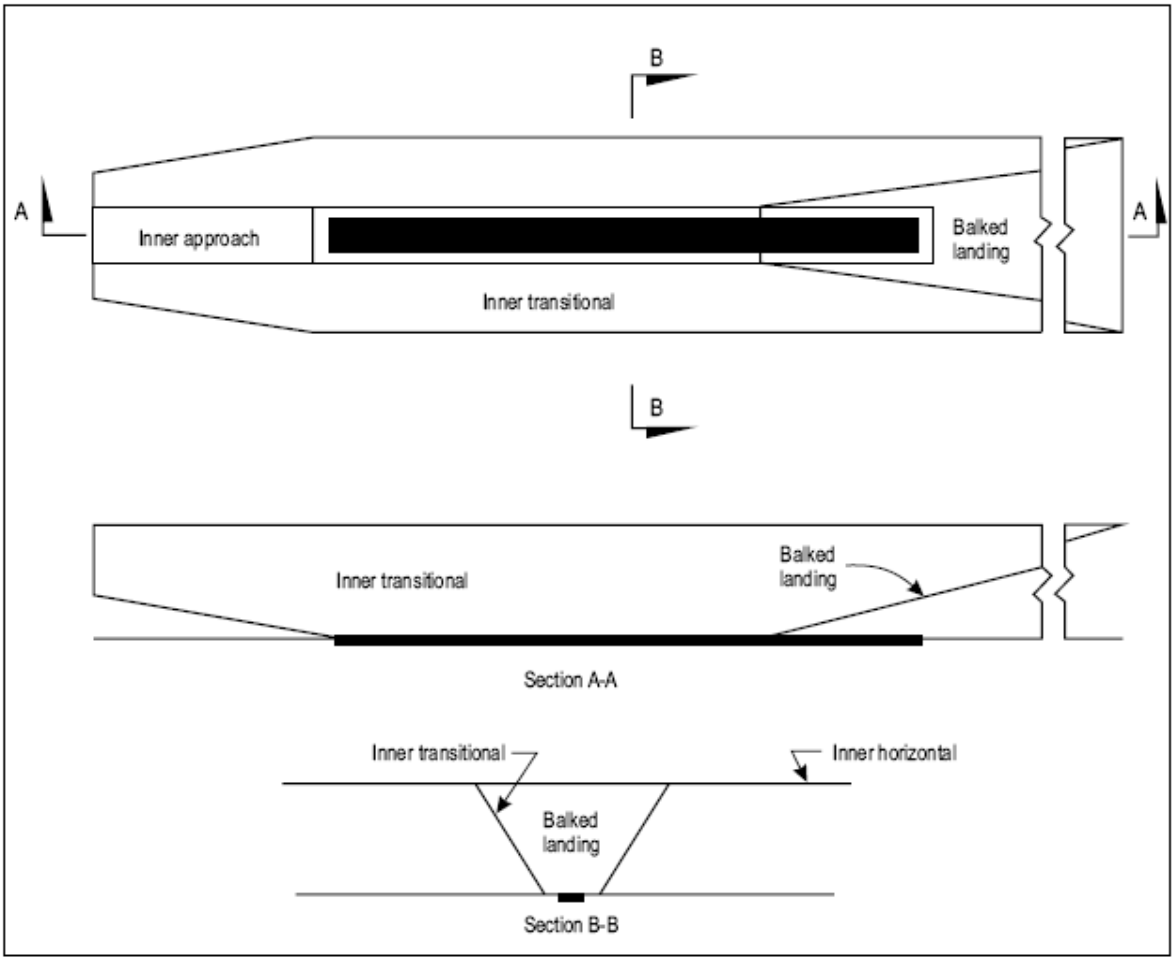


Figure 4-2. Inner approach, inner transitional and balked landing obstacle limitation surfaces

Inner approach surface

4.1.11 *Description.— Inner approach surface.* A rectangular portion of the approach surface immediately preceding the threshold.

4.1.12 *Characteristics.*— The limits of the inner approach surface shall comprise:

a) an inner edge coincident with the location of the inner edge of the approach surface but of its own specified length;

b) two sides originating at the ends of the inner edge and extending parallel to the vertical plane containing the centre line of the runway; and

c) an outer edge parallel to the inner edge.

Transitional surface

4.1.13 *Description.— Transitional surface.* A complex surface along the side of the strip and part of the side of the approach surface, that slopes upwards and outwards to the inner horizontal surface.

4.1.14 *Characteristics.*— The limits of a transitional surface shall comprise:

a) a lower edge beginning at the intersection of the side of the approach surface with the inner horizontal surface and

extending down the side of the approach surface to the inner edge of the approach surface and from there along the length of the strip parallel to the runway centre line; and

b) an upper edge located in the plane of the inner horizontal surface.

4.1.15 The elevation of a point on the lower edge shall be:

a) along the side of the approach surface — equal to the elevation of the approach surface at that point; and

b) along the strip — equal to the elevation of the nearest point on the centre line of the runway or its extension.

Note.— As a result of b) the transitional surface along the strip will be curved if the runway profile is curved, or a plane if the runway profile is a straight line. The intersection of the transitional surface with the inner horizontal surface will also be a curved or a straight line depending on the runway profile.

4.1.16 The slope of the transitional surface shall be measured in a vertical plane at right angles to the centre line of the runway.

Inner transitional surface

Note.— It is intended that the inner transitional surface be the controlling obstacle limitation surface for navigation aids, aircraft and other vehicles that must be near the runway and which is not to be penetrated except for frangible objects. The transitional surface described in 4.1.13 is intended to remain as the controlling obstacle limitation surface for buildings, etc.

4.1.17 *Description.— Inner transitional surface.* A surface similar to the transitional surface but closer to the runway.

4.1.18 *Characteristics.*— The limits of an inner transitional surface shall comprise:

a) a lower edge beginning at the end of the inner approach surface and extending down the side of the inner approach surface to the inner edge of that surface, from there along the strip parallel to the runway centre line to the inner edge of the balked landing surface and from there up the side of the balked landing surface to the point where the side intersects the inner horizontal surface; and

b) an upper edge located in the plane of the inner horizontal surface.

4.1.19 The elevation of a point on the lower edge shall be:

a) along the side of the inner approach surface and balked landing surface — equal to the elevation of the particular surface at that point; and

b) along the strip — equal to the elevation of the nearest point on the centre line of the runway or its extension.

Note.— As a result of b) the inner transitional surface along the strip will be curved if the runway profile is curved or a plane if the runway profile is a straight line. The intersection of the inner transitional surface with the inner horizontal surface will also be a curved or straight line depending on the runway profile.

4.1.20 The slope of the inner transitional surface shall be measured in a vertical plane at right angles to the centre line of the runway.

Balked landing surface

4.1.21 *Description.— Balked landing surface.* An inclined plane located at a specified distance after the threshold, extending between the inner transitional surface.

4.1.22 *Characteristics.*— The limits of the balked landing surface shall comprise:

a) an inner edge horizontal and perpendicular to the centre line of the runway and located at a specified distance after the threshold;

b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the vertical plane containing the centre line of the runway; and

c) an outer edge parallel to the inner edge and located in the plane of the inner horizontal surface.

4.1.23 The elevation of the inner edge shall be equal to the elevation of the runway centre line at the location of the inner edge.

4.1.24 The slope of the balked landing surface shall be measured in the vertical plane containing the centre line of the runway.

Take-off climb surface

4.1.25 *Description.— Take-off climb surface.* An inclined plane or other specified surface beyond the end of a runway or clearway.

4.1.26 *Characteristics.*— The limits of the take-off climb surface shall comprise:

a) an inner edge horizontal and perpendicular to the centre line of the runway and located either at a specified distance beyond the end of the runway or at the end of the clearway when such is provided and its length exceeds the specified distance;

b) two sides originating at the ends of the inner edge, diverging uniformly at a specified rate from the take-off

track to a specified final width and continuing thereafter at that width for the remainder of the length of the take-off climb surface; and

c) an outer edge horizontal and perpendicular to the specified take-off track.

4.1.27 The elevation of the inner edge shall be equal to the highest point on the extended runway centre line between the end of the runway and the inner edge, except that when a clearway is provided the elevation shall be equal to the highest point on the ground on the centre line of the clearway.

4.1.28 In the case of a straight take-off flight path, the slope of the take-off climb surface shall be measured in the vertical plane containing the centre line of the runway.

4.1.29 In the case of a take-off flight path involving a turn, the take-off climb surface shall be a complex surface containing the horizontal normals to its centre line, and the slope of the centre line shall be the same as that for a straight take-off flight path.

4.2 Obstacle limitation requirements

Note.— The requirements for obstacle limitation surfaces are specified on the basis of the intended use of a runway, i.e. take-off or landing and type of approach, and are intended to be applied when such use is made of the runway. In cases where operations are conducted to or from both directions of a runway, then the function of certain surfaces may be nullified because of more stringent requirements of another lower surface.

Non-instrument runways

4.2.1 The following obstacle limitation surfaces shall be established for a non-instrument runway:

— conical surface;
— inner horizontal surface;
— approach surface; and
— transitional surfaces.

4.2.2 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1.

4.2.3 New objects or extensions of existing objects shall not be permitted above an approach or transitional surface except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note.— Circumstances in which the shielding principle may reasonably be applied are described in the Airport Services Manual, *Part 6.*

4.2.4 **Recommendation.—** *New objects or extensions of existing objects should not be permitted above the conical surface or inner horizontal surface except when, in the opinion of the appropriate authority, the object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

4.2.5 **Recommendation.—** *Existing objects above any of the surfaces required by 4.2.1 should as far as practicable be removed except when, in the opinion of the appropriate authority, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

Note.— Because of transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered they may endanger aeroplanes.

4.2.6 **Recommendation.—** *In considering proposed construction, account should be taken of the possible future development of an instrument runway and consequent requirement for more stringent obstacle limitation surfaces.*

Non-precision approach runways

4.2.7 The following obstacle limitation surfaces shall be established for a non-precision approach runway:

— conical surface;
— inner horizontal surface;
— approach surface; and
— transitional surfaces.

4.2.8 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1, except in the case of the horizontal section of the approach surface (see 4.2.9).

4.2.9 The approach surface shall be horizontal beyond the point at which the 2.5 per cent slope intersects:

a) a horizontal plane 150 m above the threshold elevation; or

b) the horizontal plane passing through the top of any object that governs the obstacle clearance altitude/height (OCA/H);

whichever is the higher.

Table 4-1. Dimensions and slopes of obstacle limitation surfaces —Approach runways

APPROACH RUNWAYS

	RUNWAY CLASSIFICATION									
	Non-instrument				Non-precision approach			Precision approach category I		Precision approach category II or III
	Code number				Code number			Code number		Code number
Surface and dimensions[a]	1	2	3	4	1,2	3	4	1,2	3,4	3,4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
CONICAL										
Slope	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Height	35 m	55 m	75 m	100 m	60 m	75 m	100 m	60 m	100 m	100 m
INNER HORIZONTAL										
Height	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m
Radius	2 000 m	2 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m
INNER APPROACH										
Width	—	—	—	—	—	—	—	90 m	120 m[e]	120 m[e]
Distance from threshold	—	—	—	—	—	—	—	60 m	60 m	60 m
Length	—	—	—	—	—	—	—	900 m	900 m	900 m
Slope								2.5%	2%	2%
APPROACH										
Length of inner edge	60 m	80 m	150 m	150 m	150 m	300 m	300 m	150 m	300 m	300 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1 600 m	2 500 m	3 000 m	3 000 m	2 500 m	3 000 m	3 000 m	3 000 m	3 000 m	3 000 m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	—	—	—	—	—	3 600 m[b]	3 600 m[b]	12 000 m	3 600 m[b]	3 600 m[b]
Slope	—	—	—	—	—	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	—	—	—	—	—	8 400 m[b]	8 400 m[b]	—	8 400 m[b]	8 400 m[b]
Total length	—	—	—	—	—	15 000 m	15 000 m	15 000 m	15 000 m	15 000 m
TRANSITIONAL										
Slope	20%	20%	14.3%	14.3%	20%	14.3%	14.3%	14.3%	14.3%	14.3%
INNER TRANSITIONAL										
Slope	—	—	—	—	—	—	—	40%	33.3%	33.3%
BALKED LANDING SURFACE										
Length of inner edge	—	—	—	—	—	—	—	90 m	120 m[e]	120 m[e]
Distance from threshold	—	—	—	—	—	—	—	[c]	1 800 m[d]	1 800 m[d]
Divergence (each side)	—	—	—	—	—	—	—	10%	10%	10%
Slope	—	—	—	—	—	—	—	4%	3.33%	3.33%

a. All dimensions are measured horizontally unless specified otherwise.
b. Variable length (see 4.2.9 or 4.2.17).
c. Distance to the end of strip.
d. Or end of runway whichever is less.
e. Where the code letter is F (Column (3) of Table 1-1), the width is increased to 155 m.

4.2.10 New objects or extensions of existing objects shall not be permitted above an approach surface within 3 000 m of the inner edge or above a transitional surface except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note.— Circumstances in which the shielding principle may reasonably be applied are described in the Airport Services Manual, *Part 6.*

4.2.11 **Recommendation.—** *New objects or extensions of existing objects should not be permitted above the approach surface beyond 3 000 m from the inner edge, the conical surface or inner horizontal surface except when, in the opinion of the appropriate authority, the object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

4.2.12 **Recommendation.—** *Existing objects above any of the surfaces required by 4.2.7 should as far as practicable be removed except when, in the opinion of the appropriate authority, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

Note.— Because of transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered they may endanger aeroplanes.

Precision approach runways

Note 1.— See 9.9 for information regarding siting of equipment and installations on operational areas.

Note 2.— Guidance on obstacle limitation surfaces for precision approach runways is given in the Airport Services Manual, *Part 6.*

4.2.13 The following obstacle limitation surfaces shall be established for a precision approach runway category I:

— conical surface;
— inner horizontal surface;
— approach surface; and
— transitional surfaces.

4.2.14 **Recommendation.—** *The following obstacle limitation surfaces should be established for a precision approach runway category I:*

— *inner approach surface;*
— *inner transitional surfaces; and*
— *balked landing surface.*

4.2.15 The following obstacle limitation surfaces shall be established for a precision approach runway category II or III:

— conical surface;
— inner horizontal surface;
— approach surface and inner approach surface;
— transitional surfaces;
— inner transitional surfaces; and
— balked landing surface.

4.2.16 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1, except in the case of the horizontal section of the approach surface (see 4.2.17).

4.2.17 The approach surface shall be horizontal beyond the point at which the 2.5 per cent slope intersects:

a) a horizontal plane 150 m above the threshold elevation; or

b) the horizontal plane passing through the top of any object that governs the obstacle clearance limit;

whichever is the higher.

4.2.18 Fixed objects shall not be permitted above the inner approach surface, the inner transitional surface or the balked landing surface, except for frangible objects which because of their function must be located on the strip. Mobile objects shall not be permitted above these surfaces during the use of the runway for landing.

4.2.19 New objects or extensions of existing objects shall not be permitted above an approach surface or a transitional surface except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note.— Circumstances in which the shielding principle may reasonably be applied are described in the Airport Services Manual, *Part 6.*

4.2.20 **Recommendation.—** *New objects or extensions of existing objects should not be permitted above the conical surface and the inner horizontal surface except when, in the opinion of the appropriate authority, an object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

4.2.21 **Recommendation.—** *Existing objects above an approach surface, a transitional surface, the conical surface and inner horizontal surface should as far as practicable be removed except when, in the opinion of the appropriate*

authority, an object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.

Note.— Because of transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered they may endanger aeroplanes.

Runways meant for take-off

4.2.22 The following obstacle limitation surface shall be established for a runway meant for take-off:

— take-off climb surface.

4.2.23 The dimensions of the surface shall be not less than the dimensions specified in Table 4-2, except that a lesser length may be adopted for the take-off climb surface where such lesser length would be consistent with procedural measures adopted to govern the outward flight of aeroplanes.

4.2.24 **Recommendation.—** *The operational characteristics of aeroplanes for which the runway is intended should be examined to see if it is desirable to reduce the slope specified in Table 4-2 when critical operating conditions are to be catered to. If the specified slope is reduced, corresponding adjustment in the length of take-off climb surface should be made so as to provide protection to a height of 300 m.*

Note.— When local conditions differ widely from sea level standard atmospheric conditions, it may be advisable for the slope specified in Table 4-2 to be reduced. The degree of this reduction depends on the divergence between local conditions and sea level standard atmospheric conditions, and on the performance characteristics and operational requirements of the aeroplanes for which the runway is intended.

4.2.25 New objects or extensions of existing objects shall not be permitted above a take-off climb surface except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note.— Circumstances in which the shielding principle may reasonably be applied are described in the Airport Services Manual, *Part 6.*

4.2.26 **Recommendation.—** *If no object reaches the 2 per cent (1:50) take-off climb surface, new objects should be limited to preserve the existing obstacle free surface or a surface down to a slope of 1.6 per cent (1:62.5).*

Table 4-2. Dimensions and slopes of obstacle limitation surfaces

RUNWAYS MEANT FOR TAKE-OFF

Surface and dimensions[a]	Code number 1	2	3 or 4
(1)	(2)	(3)	(4)
TAKE-OFF CLIMB			
Length of inner edge	60 m	80 m	180 m
Distance from runway end[b]	30 m	60 m	60 m
Divergence (each side)	10%	10%	12.5%
Final width	380 m	580 m	1 200 m 1 800 m[c]
Length	1 600 m	2 500 m	15 000 m
Slope	5%	4%	2%[d]

a. All dimensions are measured horizontally unless specified otherwise.
b. The take-off climb surface starts at the end of the clearway if the clearway length exceeds the specified distance.
c. 1 800 m when the intended track includes changes of heading greater than 15° for operations conducted in IMC, VMC by night.
d. See 4.2.24 and 4.2.26.

4.2.27 **Recommendation.—** *Existing objects that extend above a take-off climb surface should as far as practicable be removed except when, in the opinion of the appropriate authority, an object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

Note.— Because of transverse slopes on a strip or clearway, in certain cases portions of the inner edge of the take-off climb surface may be below the corresponding elevation of the strip or clearway. It is not intended that the strip or clearway be graded to conform with the inner edge of the take-off climb surface, nor is it intended that terrain or objects which are above the take-off climb surface beyond the end of the strip or clearway, but below the level of the strip or clearway, be removed unless it is considered they may endanger aeroplanes. Similar considerations apply at the junction of a clearway and strip where differences in transverse slopes exist.

4.3 Objects outside the obstacle limitation surfaces

4.3.1 **Recommendation.—** *Arrangements should be made to enable the appropriate authority to be consulted concerning proposed construction beyond the limits of the obstacle limitation surfaces that extend above a height established by that authority, in order to permit an aeronautical study of the effect of such construction on the operation of aeroplanes.*

4.3.2 **Recommendation.—** *In areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150 m or more above ground elevation should be regarded as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplanes.*

Note.— This study may have regard to the nature of operations concerned and may distinguish between day and night operations.

4.4 Other objects

4.4.1 **Recommendation.—** *Objects which do not project through the approach surface but which would nevertheless adversely affect the optimum siting or performance of visual or non-visual aids should, as far as practicable, be removed.*

4.4.2 **Recommendation.—** *Anything which may, in the opinion of the appropriate authority after aeronautical study, endanger aeroplanes on the movement area or in the air within the limits of the inner horizontal and conical surfaces should be regarded as an obstacle and should be removed in so far as practicable.*

Note.— In certain circumstances, objects that do not project above any of the surfaces enumerated in 4.1 may constitute a hazard to aeroplanes as, for example, where there are one or more isolated objects in the vicinity of an aerodrome.

CHAPTER 6. VISUAL AIDS FOR DENOTING OBSTACLES

6.1 Objects to be marked and/or lighted

Note.— The marking and/or lighting of obstacles is intended to reduce hazards to aircraft by indicating the presence of the obstacles. It does not necessarily reduce operating limitations which may be imposed by an obstacle.

6.1.1 **Recommendation.—** *A fixed obstacle that extends above a take-off climb surface within 3 000 m of the inner edge of the take-off climb surface should be marked and, if the runway is used at night, lighted, except that:*

a) such marking and lighting may be omitted when the obstacle is shielded by another fixed obstacle;

b) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;

c) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

d) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.2 **Recommendation.—** *A fixed object, other than an obstacle, adjacent to a take-off climb surface should be marked and, if the runway is used at night, lighted if such marking and lighting is considered necessary to ensure its avoidance, except that the marking may be omitted when:*

a) the object is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m; or

b) the object is lighted by high-intensity obstacle lights by day.

6.1.3 A fixed obstacle that extends above an approach or transitional surface within 3 000 m of the inner edge of the approach surface shall be marked and, if the runway is used at night, lighted, except that:

a) such marking and lighting may be omitted when the obstacle is shielded by another fixed obstacle;

b) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;

c) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

d) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.4 **Recommendation.—** *A fixed obstacle above a horizontal surface should be marked and, if the aerodrome is used at night, lighted except that:*

a) such marking and lighting may be omitted when:

1) the obstacle is shielded by another fixed obstacle; or

2) for a circuit extensively obstructed by immovable objects or terrain, procedures have been established to ensure safe vertical clearance below prescribed flight paths; or

3) an aeronautical study shows the obstacle not to be of operational significance;

b) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;

c) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

d) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.5 A fixed object that extends above an obstacle protection surface shall be marked and, if the runway is used at night, lighted.

Note.— See 5.3.5 for information on the obstacle protection surface.

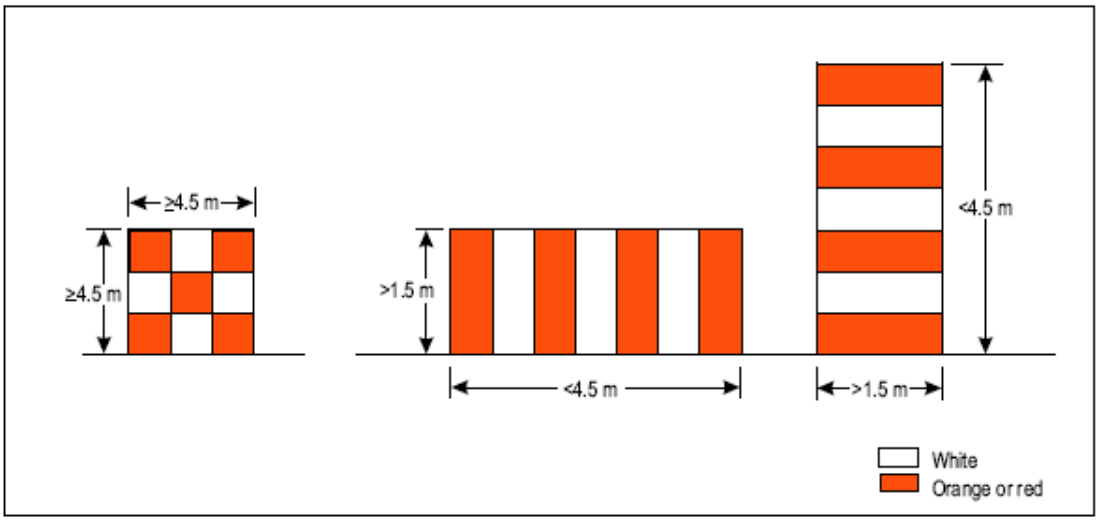


Figure 6-1. Basic marking patterns

6.1.6 Vehicles and other mobile objects, excluding aircraft, on the movement area of an aerodrome are obstacles and shall be marked and, if the vehicles and aerodrome are used at night or in conditions of low visibility, lighted, except that aircraft servicing equipment and vehicles used only on aprons may be exempt.

6.1.7 Elevated aeronautical ground lights within the movement area shall be marked so as to be conspicuous by day. Obstacle lights shall not be installed on elevated ground lights or signs in the movement area.

6.1.8 All obstacles within the distance specified in Table 3-1, column 11 or 12, from the centre line of a taxiway, an apron taxiway or aircraft stand taxilane shall be marked and, if the taxiway, apron taxiway or aircraft stand taxilane is used at night, lighted.

6.1.9 **Recommendation.—** *Obstacles in accordance with 4.3.2 should be marked and lighted, except that the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day.*

6.1.10 **Recommendation.—** *Overhead wires, cables, etc., crossing a river, valley or highway should be marked and their supporting towers marked and lighted if an aeronautical study indicates that the wires or cables could constitute a hazard to aircraft, except that the marking of the supporting towers may be omitted when they are lighted by high-intensity obstacle lights by day.*

6.1.11 **Recommendation.—** *When it has been determined that an overhead wire, cable, etc., needs to be marked but it is not practicable to install markers on the wire, cable, etc., then high-intensity obstacle lights, Type B, should be provided on their supporting towers.*

6.2 Marking of objects

General

6.2.1 All fixed objects to be marked shall, whenever practicable, be coloured, but if this is not practicable, markers or flags shall be displayed on or above them, except that objects that are sufficiently conspicuous by their shape, size or colour need not be otherwise marked.

6.2.2 All mobile objects to be marked shall be coloured or display flags.

Use of colours

6.2.3 **Recommendation.—** *An object should be coloured to show a chequered pattern if it has essentially unbroken surfaces and its projection on any vertical plane equals or exceeds 4.5 m in both dimensions. The pattern should consist of rectangles of not less than 1.5 m and not more than 3 m on a side, the corners being of the darker colour. The colours of the pattern should contrast each with the other and with the background against which they will be seen. Orange and white or alternatively red and white should be used, except where such colours merge with the background. (See Figure 6-1.)*

6.2.4 **Recommendation.—** *An object should be coloured to show alternating contrasting bands if:*

a) it has essentially unbroken surfaces and has one dimension, horizontal or vertical, greater than 1.5 m, and the other dimension, horizontal or vertical, less than 4.5 m; or

b) it is of skeletal type with either a vertical or a horizontal dimension greater than 1.5 m.

The bands should be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension or 30 m, whichever is less. The colours of the bands should contrast with the background against which they will be seen. Orange and white should be used, except where such colours are not conspicuous when viewed against the background. The bands on the extremities of the object should be of the darker colour. (See Figures 6-1 and 6-2.)

Note.— Table 6-1 shows a formula for determining band widths and for having an odd number of bands, thus permitting both the top and bottom bands to be of the darker colour.

6.2.5 **Recommendation.—** *An object should be coloured in a single conspicuous colour if its projection on any vertical plane has both dimensions less than 1.5 m. Orange or red should be used, except where such colours merge with the background.*

Note.— Against some backgrounds it may be found necessary to use a different colour from orange or red to obtain sufficient contrast.

6.2.6 **Recommendation.—** *When mobile objects are marked by colour, a single conspicuous colour, preferably red or yellowish green for emergency vehicles and yellow for service vehicles should be used.*

Table 6-1. Marking band widths

Longest dimension		
Greater than	Not exceeding	Band width
1.5 m	210 m	1/7 of longest dimension
210 m	270 m	1/9 " " "
270 m	330 m	1/11 " " "
330 m	390 m	1/13 " " "
390 m	450 m	1/15 " " "
450 m	510 m	1/17 " " "
510 m	570 m	1/19 " " "
570 m	630 m	1/21 " " "

Use of markers

6.2.7 Markers displayed on or adjacent to objects shall be located in conspicuous positions so as to retain the general definition of the object and shall be recognizable in clear weather from a distance of at least 1 000 m for an object to be viewed from the air and 300 m for an object to be viewed from the ground in all directions in which an aircraft is likely to approach the object. The shape of markers shall be distinctive to the extent necessary to ensure that they are not mistaken for markers employed to convey other information, and they shall be such that the hazard presented by the object they mark is not increased.

6.2.8 **Recommendation.—** *A marker displayed on an overhead wire, cable, etc., should be spherical and have a diameter of not less than 60 cm.*

6.2.9 **Recommendation.—** *The spacing between two consecutive markers or between a marker and a supporting tower should be appropriate to the diameter of the marker, but in no case should the spacing exceed:*

a) 30 m where the marker diameter is 60 cm progressively increasing with the diameter of the marker to

b) 35 m where the marker diameter is 80 cm and further progressively increasing to a maximum of

c) 40 m where the marker diameter is of at least 130 cm.

Where multiple wires, cables, etc. are involved, a marker should be located not lower than the level of the highest wire at the point marked.

6.2.10 **Recommendation.—** *A marker should be of one colour. When installed, white and red, or white and orange markers should be displayed alternately. The colour selected should contrast with the background against which it will be seen.*

Use of flags

6.2.11 Flags used to mark objects shall be displayed around, on top of, or around the highest edge of, the object. When flags are used to mark extensive objects or groups of closely spaced objects, they shall be displayed at least every 15 m. Flags shall not increase the hazard presented by the object they mark.

6.2.12 Flags used to mark fixed objects shall not be less than 0.6 m square and flags used to mark mobile objects, not less than 0.9 m square.

6.2.13 **Recommendation.—** *Flags used to mark fixed objects should be orange in colour or a combination of two triangular sections, one orange and the other white, or one red and the other white, except that where such colours merge with the background, other conspicuous colours should be used.*

6.2.14 Flags used to mark mobile objects shall consist of a chequered pattern, each square having sides of not less than 0.3 m. The colours of the pattern shall contrast each with the other and with the background against which they will be seen. Orange and white or alternatively red and white shall be used, except where such colours merge with the background.

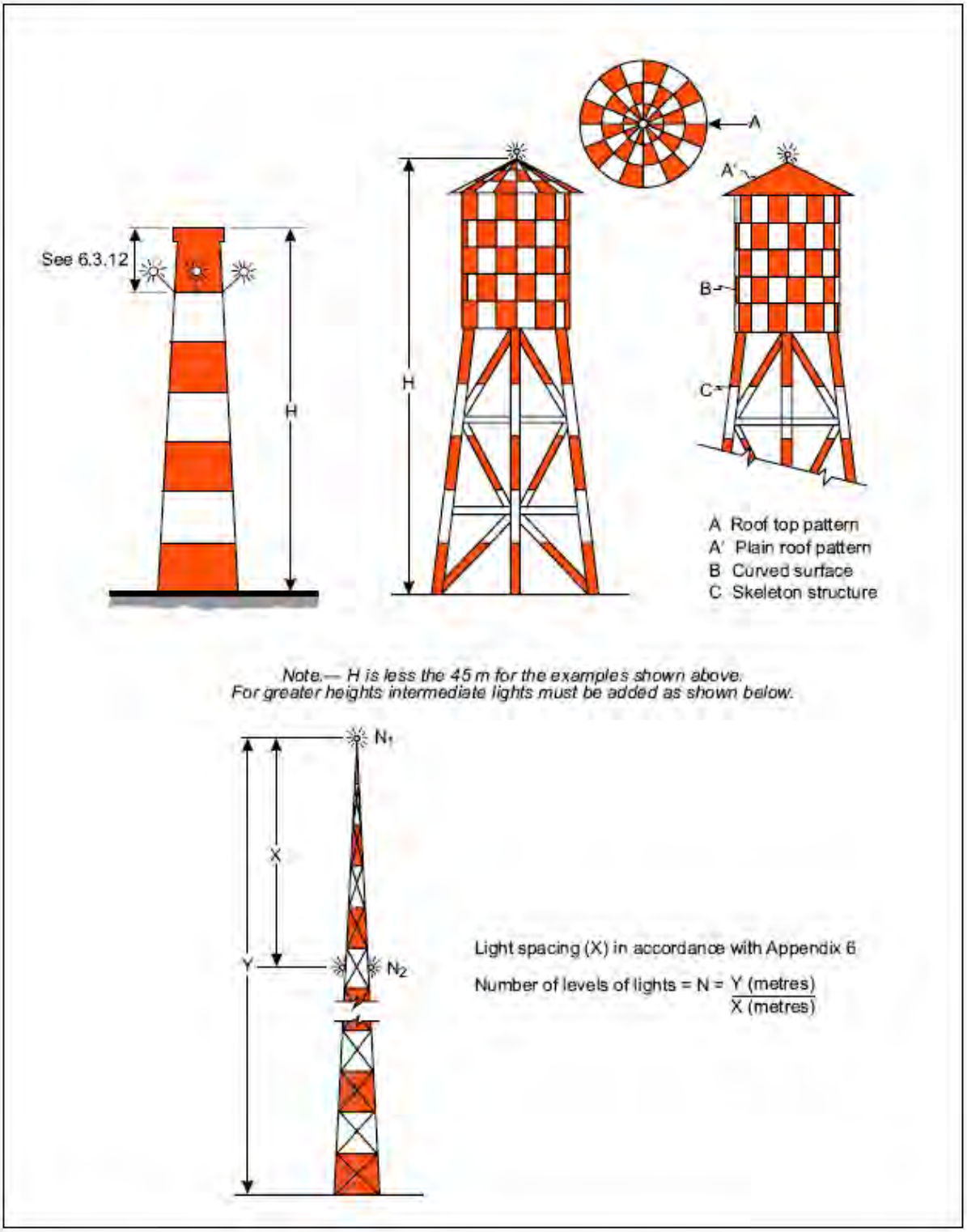


Figure 6-2. Examples of marking and lighting of tall structures

6.3 Lighting of objects

Use of obstacle lights

6.3.1 The presence of objects which must be lighted, as specified in 6.1, shall be indicated by low-, medium- or high-intensity obstacle lights, or a combination of such lights.

Note.— High-intensity obstacle lights are intended for day use as well as night use. Care is needed to ensure that these lights do not create disconcerting dazzle. Guidance on the design, location and operation of high-intensity obstacle lights is given in the Aerodrome Design Manual, *Part 4.*

6.3.2 **Recommendation.—** *Low-intensity obstacle lights, Type A or B, should be used where the object is a less extensive one and its height above the surrounding ground is less than 45 m.*

6.3.3 **Recommendation.—** *Where the use of low-intensity obstacle lights, Type A or B, would be inadequate or an early special warning is required, then medium- or high-intensity obstacle lights should be used.*

6.3.4 Low-intensity obstacle lights, Type C, shall be displayed on vehicles and other mobile objects excluding aircraft.

6.3.5 Low-intensity obstacle lights, Type D, shall be displayed on follow-me vehicles.

6.3.6 **Recommendation.—** *Low-intensity obstacle lights, Type B, should be used either alone or in combination with medium-intensity obstacle lights, Type B, in accordance with 6.3.7.*

6.3.7 **Recommendation.—** *Medium-intensity obstacle lights, Type A, B or C, should be used where the object is an extensive one or its height above the level of the surrounding ground is greater than 45 m. Medium-intensity obstacle lights, Types A and C, should be used alone, whereas medium-intensity obstacle lights, Type B, should be used either alone or in combination with low-intensity obstacle lights, Type B.*

Note.— A group of trees or buildings is regarded as an extensive object.

6.3.8 **Recommendation.—** *High-intensity obstacle lights, Type A, should be used to indicate the presence of an object if its height above the level of the surrounding ground exceeds 150 m and an aeronautical study indicates such lights to be essential for the recognition of the object by day.*

6.3.9 **Recommendation.—** *High-intensity obstacle lights, Type B, should be used to indicate the presence of a tower supporting overhead wires, cables, etc., where:*

a) an aeronautical study indicates such lights to be essential for the recognition of the presence of wires, cables, etc.; or

b) it has not been found practicable to install markers on the wires, cables, etc.

6.3.10 **Recommendation.—** *Where, in the opinion of the appropriate authority, the use of high-intensity obstacle lights, Type A or B, or medium-intensity obstacle lights, Type A, at night may dazzle pilots in the vicinity of an aerodrome (within approximately 10 000 m radius) or cause significant environmental concerns, a dual obstacle lighting system should be provided. This system should be composed of high-intensity obstacle lights, Type A or B, or medium-intensity obstacle lights, Type A, as appropriate, for daytime and twilight use and medium-intensity obstacle lights, Type B or C, for night-time use.*

Location of obstacle lights

Note.— Recommendations on how a combination of low-, medium-, and/or high-intensity lights on obstacles should be displayed are given in Appendix 6.

6.3.11 One or more low-, medium- or high-intensity obstacle lights shall be located as close as practicable to the top of the object. The top lights shall be so arranged as to at least indicate the points or edges of the object highest in relation to the obstacle limitation surface.

6.3.12 **Recommendation.—** *In the case of chimney or other structure of like function, the top lights should be placed sufficiently below the top so as to minimize contamination by smoke etc. (see Figures 6-2 and 6-3).*

6.3.13 In the case of a tower or antenna structure indicated by high-intensity obstacle lights by day with an appurtenance, such as a rod or an antenna, greater than 12 m where it is not practicable to locate a high-intensity obstacle light on the top of the appurtenance, such a light shall be located at the highest practicable point and, if practicable, a medium-intensity obstacle light, Type A, mounted on the top.

6.3.14 In the case of an extensive object or of a group of closely spaced objects, top lights shall be displayed at least on the points or edges of the objects highest in relation to the obstacle limitation surface, so as to indicate the general definition and the extent of the objects. If two or more edges are of the same height, the edge nearest the landing area shall be marked. Where low-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 45 m. Where medium-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 900 m.

6.3.15 **Recommendation.—** *When the obstacle limitation surface concerned is sloping and the highest point above the*

obstacle limitation surface is not the highest point of the object, additional obstacle lights should be placed on the highest point of the object.

6.3.16 Where an object is indicated by medium-intensity obstacle lights, Type A, and the top of the object is more than 105 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 105 m (see 6.3.7).

6.3.17 Where an object is indicated by medium-intensity obstacle lights, Type B, and the top of the object is more than 45 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B, and medium-intensity obstacle lights, Type B, and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

6.3.18 Where an object is indicated by medium-intensity obstacle lights, Type C, and the top of the object is more than 45 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

6.3.19 Where high-intensity obstacle lights, Type A, are used, they shall be spaced at uniform intervals not exceeding 105 m between the ground level and the top light(s) specified in 6.3.11 except that where an object to be marked is surrounded by buildings, the elevation of the tops of the buildings may be used as the equivalent of the ground level when determining the number of light levels.

6.3.20 Where high-intensity obstacle lights, Type B, are used, they shall be located at three levels:

— at the top of the tower;
— at the lowest level of the catenary of the wires or cables; and
— at approximately midway between these two levels.

Note.— In some cases, this may require locating the lights off the tower.

6.3.21 **Recommendation.—** *The installation setting angles for high-intensity obstacle lights, Types A and B, should be in accordance with Table 6-2.*

6.3.22 The number and arrangement of low-, medium- or high-intensity obstacle lights at each level to be marked shall be such that the object is indicated from every angle in azimuth. Where a light is shielded in any direction by another part of the object, or by an adjacent object, additional lights shall be provided on that object in such a way as to retain the

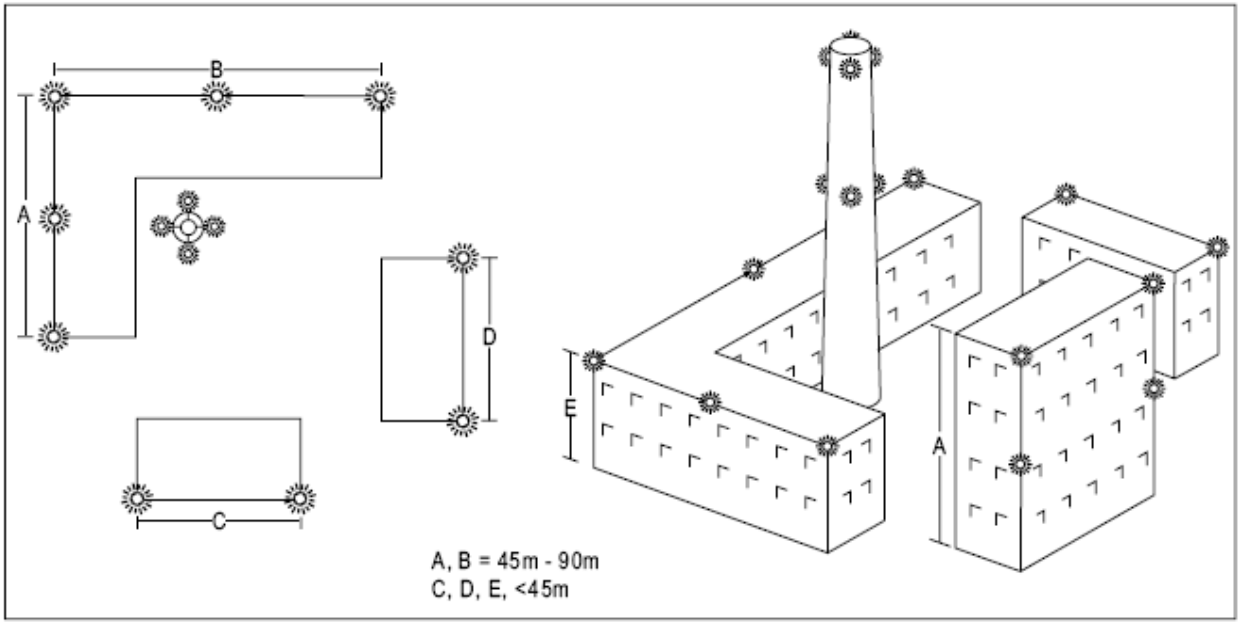


Figure 6-3. Lighting of buildings

general definition of the object to be lighted. If the shielded light does not contribute to the definition of the object to be lighted, it may be omitted.

Table 6-2. Installation setting angles for high-intensity obstacle lights

Height of light unit above terrain	*Angle of the peak of the beam above the horizontal*
greater than 151 m AGL	0°
122 m to 151 m AGL	1°
92 m to 122 m AGL	2°
less than 92 m AGL	3°

Low-intensity obstacle light — Characteristics

6.3.23 Low-intensity obstacle lights on fixed objects, Types A and B, shall be fixed-red lights.

6.3.24 Low-intensity obstacle lights, Types A and B, shall be in accordance with the specifications in Table 6-3.

6.3.25 Low-intensity obstacle lights, Type C, displayed on vehicles associated with emergency or security shall be flashing-blue and those displayed on other vehicles shall be flashing-yellow.

6.3.26 Low-intensity obstacle lights, Type D, displayed on follow-me vehicles shall be flashing-yellow.

6.3.27 Low-intensity obstacle lights, Types C and D, shall be in accordance with the specifications in Table 6-3.

6.3.28 Low-intensity obstacle lights on objects with limited mobility such as aerobridges shall be fixed-red. The intensity of the lights shall be sufficient to ensure conspicuity considering the intensity of the adjacent lights and the general levels of illumination against which they would normally be viewed.

Note.— See Annex 2 for lights to be displayed by aircraft.

6.3.29 Low-intensity obstacle lights on objects with limited mobility shall as a minimum be in accordance with the specifications for low-intensity obstacle lights, Type A, in Table 6-3.

Medium-intensity obstacle light — Characteristics

6.3.30 Medium-intensity obstacle lights, Type A, shall be flashing-white lights, Type B shall be flashing-red lights and Type C shall be fixed-red lights.

6.3.31 Medium-intensity obstacle lights, Types A, B and C, shall be in accordance with the specifications in Table 6-3.

6.3.32 Medium-intensity obstacle lights, Types A and B, located on an object shall flash simultaneously.

High-intensity obstacle light — Characteristics

6.3.33 High-intensity obstacle lights, Types A and B, shall be flashing-white lights.

6.3.34 High-intensity obstacle lights, Types A and B, shall be in accordance with the specifications in Table 6-3.

6.3.35 High-intensity obstacle lights, Type A, located on an object shall flash simultaneously.

6.3.36 **Recommendation.—** *High-intensity obstacle lights, Type B, indicating the presence of a tower supporting overhead wires, cables, etc., should flash sequentially; first the middle light, second the top light and last, the bottom light. The intervals between flashes of the lights should approximate the following ratios:*

Flash interval between	*Ratio of cycle time*
middle and top light	*1/13*
top and bottom light	*2/13*
bottom and middle light	*10/13.*

The following Section 6.4 has only been recently issued by ICAO. It became effective in March 2009 and is applicable in November 2009.

6.4 Wind turbines

6.4.1 A wind turbine shall be marked and/or lighted if it is determined to be an obstacle.

Note.— see 4.3.1 and 4.3.2.

Markings

6.4.2 **Recommendation.—** *The rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines should be painted white, unless otherwise indicated by an aeronautical study.*

Lighting

6.4.3 **Recommendation.—** *When lighting is deemed necessary, medium intensity obstacle lights should be used. In the case of a wind farm, i.e. a group of two or more wind turbines, it should be regarded as an extensive object and the lights should be installed:*

a) to identify the perimeter of the wind farm;

b) respecting the maximum spacing, in accordance with 6.3.14, between the lights along the perimeter, unless a dedicated assessment shows that a greater spacing can be used;

c) so that, where flashing lights are used, they flash simultaneously; and

d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located.

6.4.4 **Recommendation.—** *The obstacle lights should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any direction.*

Table 6-3. Characteristics of obstacle lights

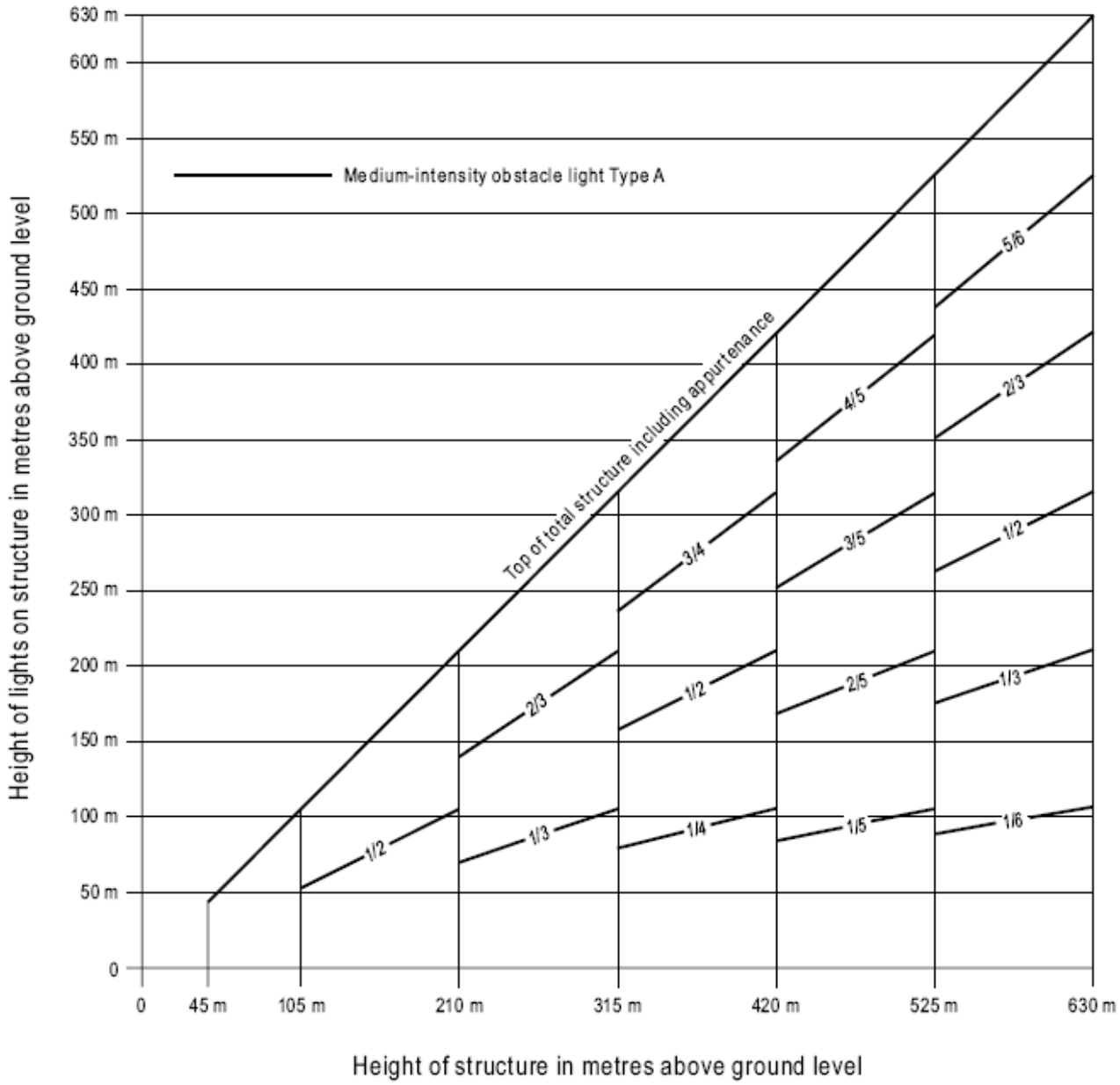
1	2	3	4	5	6	7	8	9	10	11	12
			Peak intensity (cd) at given Background Luminance			Vertical Beam Spread (c)	Intensity (cd) at given Elevation Angles when the light unit is levelled (d)				
Light Type	Colour	Signal type/ (flash rate)	Above 500 cd/m^2	50-500 cd/m^2	Below 50 cd/m^2		−10° (e)	−1° (f)	±0° (f)	+6°	+10°
Low-intensity, Type A (fixed obstacle)	Red	Fixed	N/A	10 mnm	10 mnm	10°	—	—	—	10 mnm (g)	10 mnm (g)
Low-intensity, Type B (fixed obstacle)	Red	Fixed	N/A	32 mnm	32 mnm	10°	—	—	—	32 mnm (g)	32 mnm (g)
Low-intensity, Type C (mobile obstacle)	Yellow/Blue (a)	Flashing (60-90 fpm)	N/A	40 mnm (b) 400 max	40 mnm (b) 400 max	12° (h)	—	—	—	—	—
Low-intensity, Type D Follow-me Vehicle	Yellow	Flashing (60-90 fpm)	N/A	200 mnm (b) 400 max	200 mnm (b) 400 max	12° (i)	—	—	—	—	—
Medium-intensity, Type A	White	Flashing (20-60 fpm)	20 000 (b) ± 25%	20 000 (b) ± 25%	2 000 (b) ± 25%	3° mnm	3% max	50% mnm 75% max	100% mnm	—	—
Medium-intensity, Type B	Red	Flashing (20-60 fpm)	N/A	N/A	2 000 (b) ± 25%	3° mnm	—	50% mnm 75% max	100% mnm	—	—
Medium-intensity, Type C	Red	Fixed	N/A	N/A	2 000 (b) ± 25%	3° mnm	—	50% mnm 75% max	100% mnm	—	—
High-intensity, Type A	White	Flashing (40-60 fpm)	200 000 (b) ± 25%	20 000 (b) ± 25%	2 000 (b) ± 25%	3°-7°	3% max	50% mnm 75% max	100% mnm	—	—
High-intensity, Type B	White	Flashing (40-60 fpm)	100 000 (b) ± 25%	20 000 (b) ± 25%	2 000 (b) ± 25%	3°-7°	3% max	50% mnm 75% max	100% mnm	—	—

Note.— This table does not include recommended horizontal beam spreads. 6.3.22 requires 360° coverage around an obstacle. Therefore, the number of lights needed to meet this requirement will depend on the horizontal beam spreads of each light as well as the shape of the obstacle. Thus, with narrower beam spreads, more lights will be required.

a) See 6.3.25
b) Effective intensity, as determined in accordance with the *Aerodrome Design Manual*, Part 4.
c) Beam spread is defined as the angle between two directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the intensity shown in columns 4, 5 and 6. The beam pattern is not necessarily symmetrical about the elevation angle at which the peak intensity occurs.
d) Elevation (vertical) angles are referenced to the horizontal.
e) Intensity at any specified horizontal radial as a percentage of the actual peak intensity at the same radial when operated at each of the intensities shown in columns 4, 5 and 6.
f) Intensity at any specified horizontal radial as a percentage of the lower tolerance value of the intensity shown in columns 4, 5 and 6.
g) In addition to specified values, lights shall have sufficient intensity to ensure conspicuity at elevation angles between ± 0° and 50°.
h) Peak intensity should be located at approximately 2.5° vertical.
i) Peak intensity should be located at approximately 17° vertical.

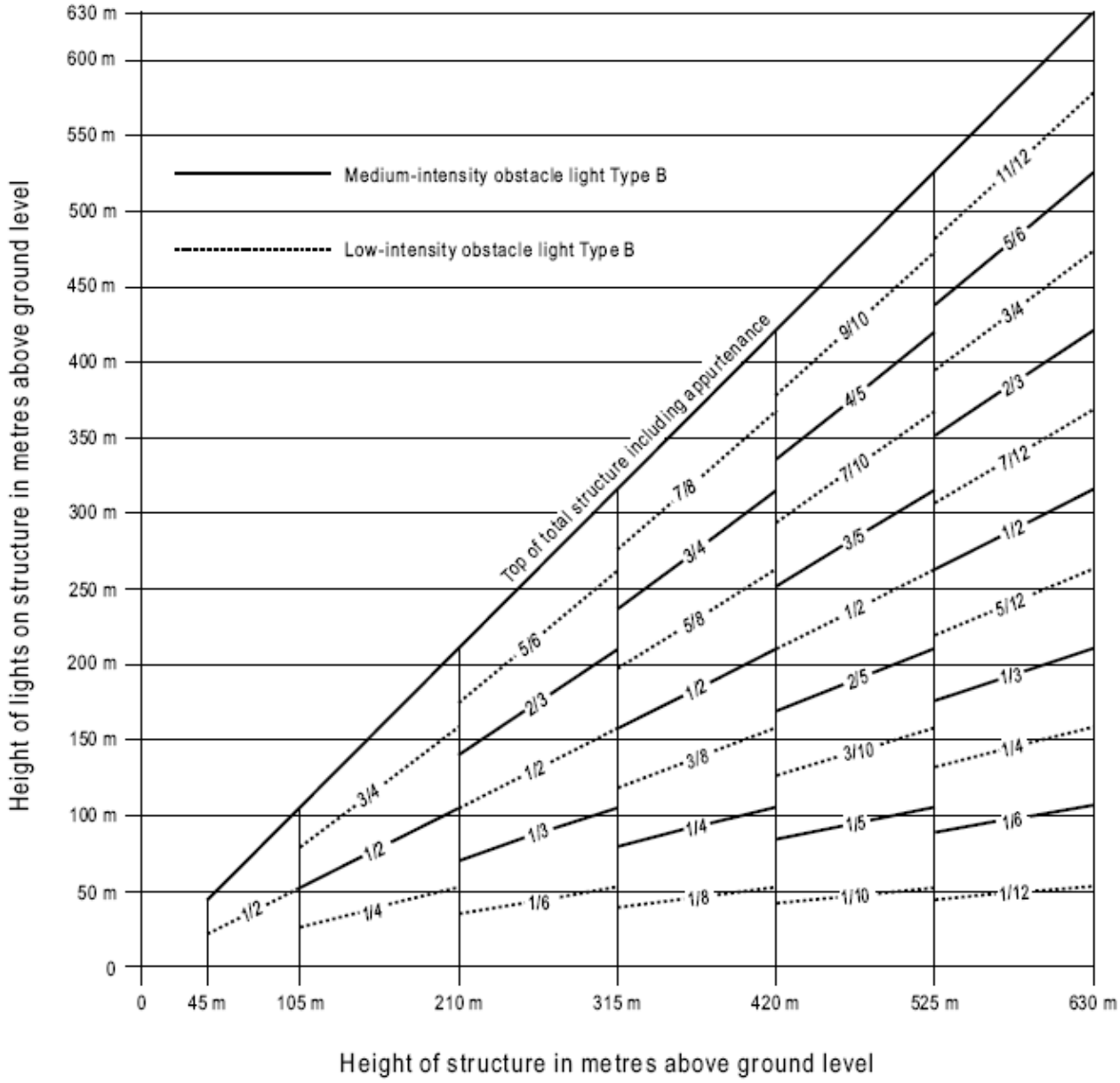
fpm — flashes per minute; N/A — not applicable

APPENDIX 6. LOCATION OF LIGHTS ON OBSTACLES



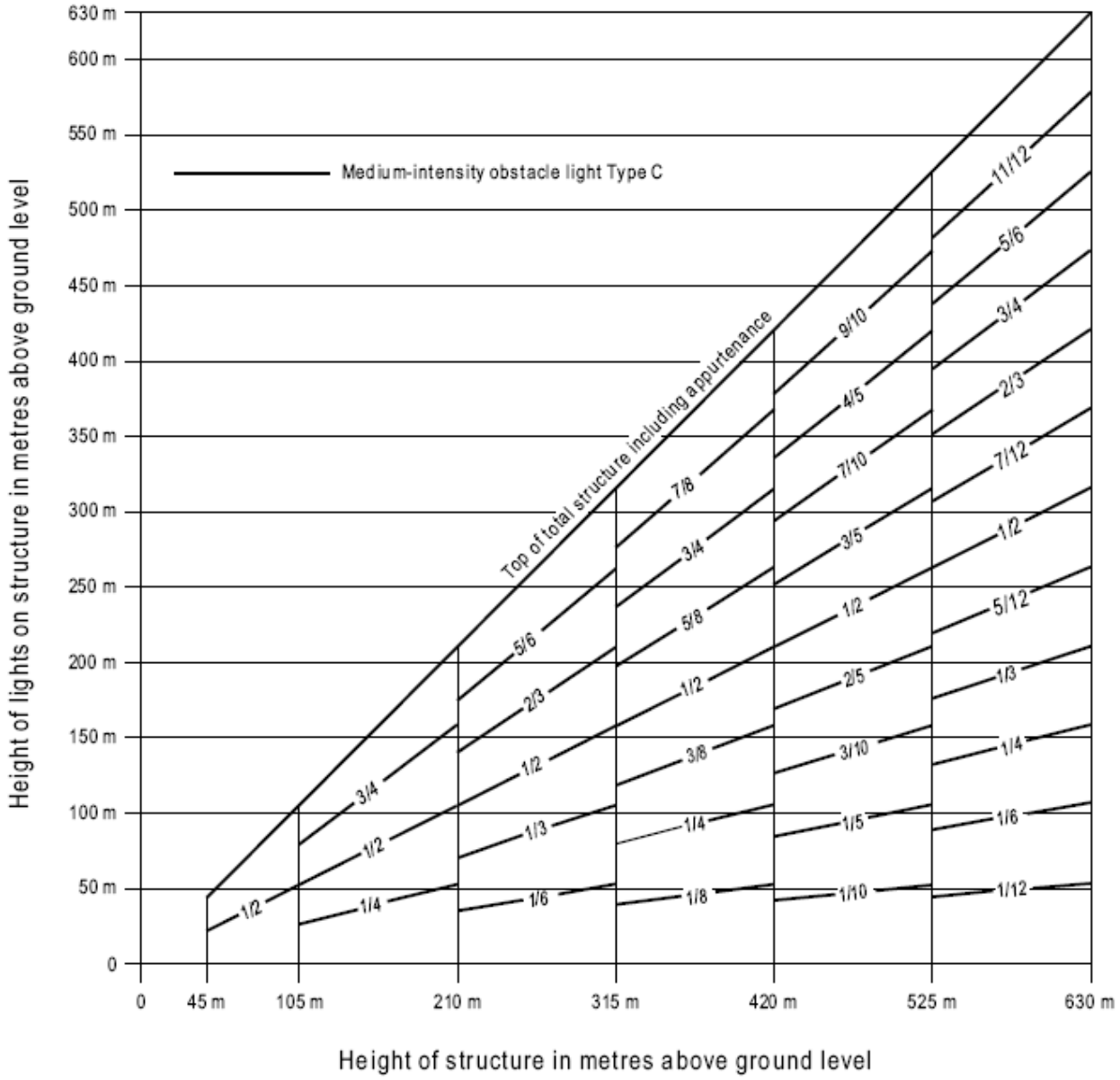
Note.— High-intensity obstacle lighting is recommended on structures with a height of more than 150 m above ground level. If medium-intensity lighting is used, marking will also be required.

Figure A6-1. Medium-intensity flashing-white obstacle lighting system, Type A



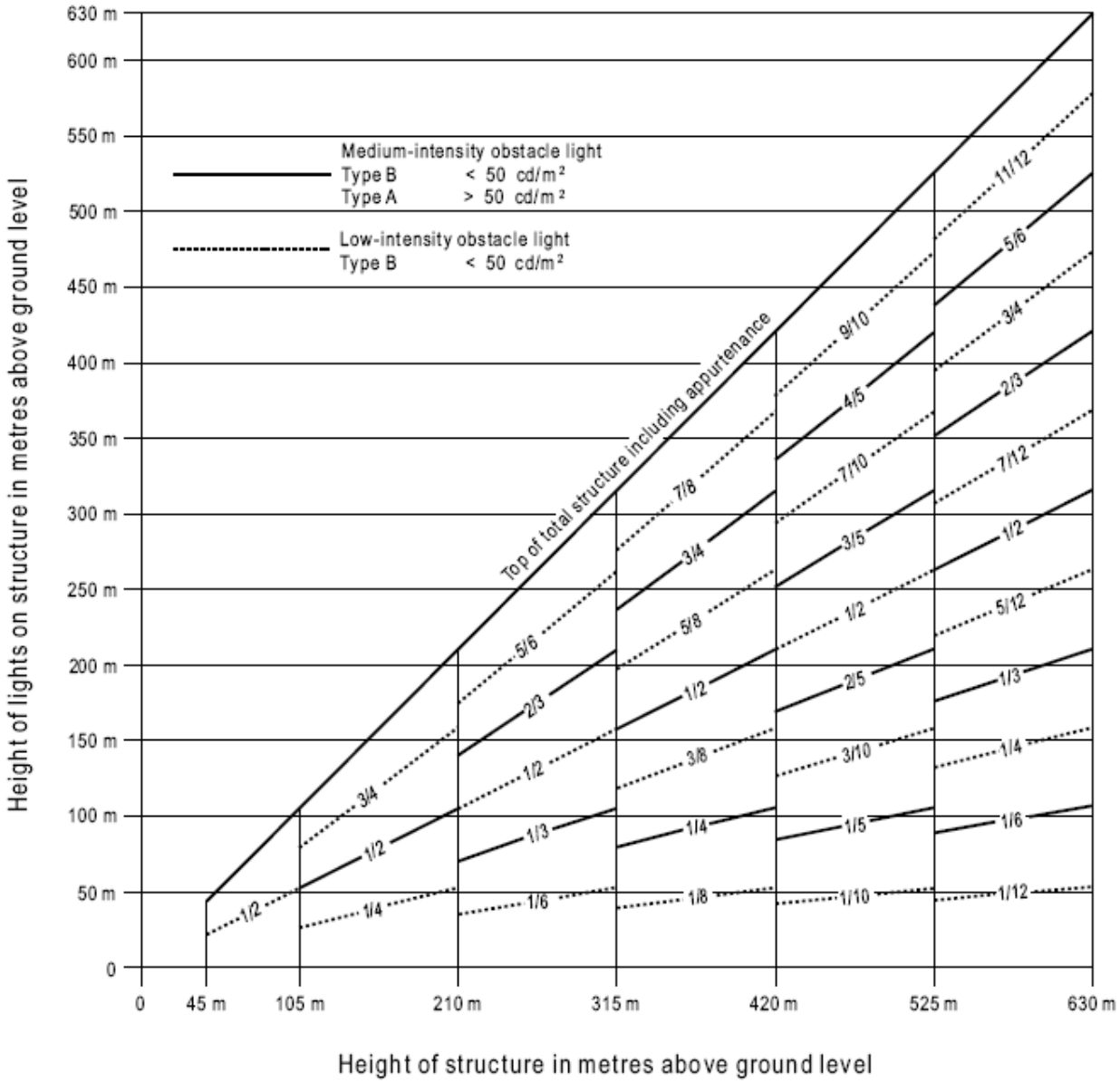
Note.— For night-time use only.

Figure A6-2. Medium-intensity flashing-red obstacle lighting system, Type B



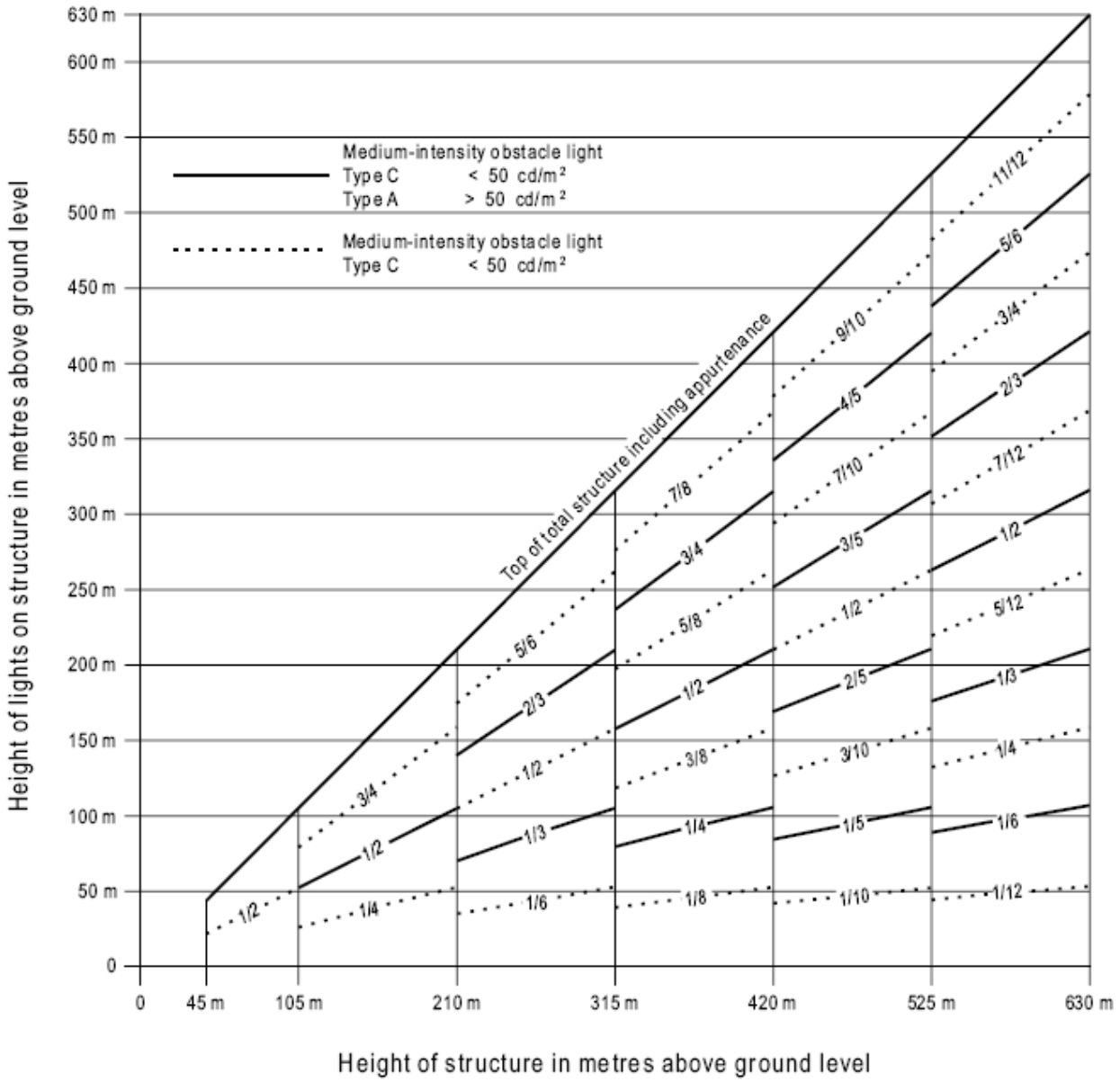
Note.— For night-time use only.

Figure A6-3. Medium-intensity fixed-red obstacle lighting system, Type C



Note.— High-intensity obstacle lighting is recommended on structures with a height of more than 150 m above ground level. If medium-intensity lighting is used, marking will also be required.

Figure A6-4. Medium-intensity dual obstacle lighting system, Type A/Type B



Note.— High-intensity obstacle lighting is recommended on structures with a height of more than 150 m above ground level. If medium-intensity lighting is used, marking will also be required.

Figure A6-5. Medium-intensity dual obstacle lighting system, Type A/Type C

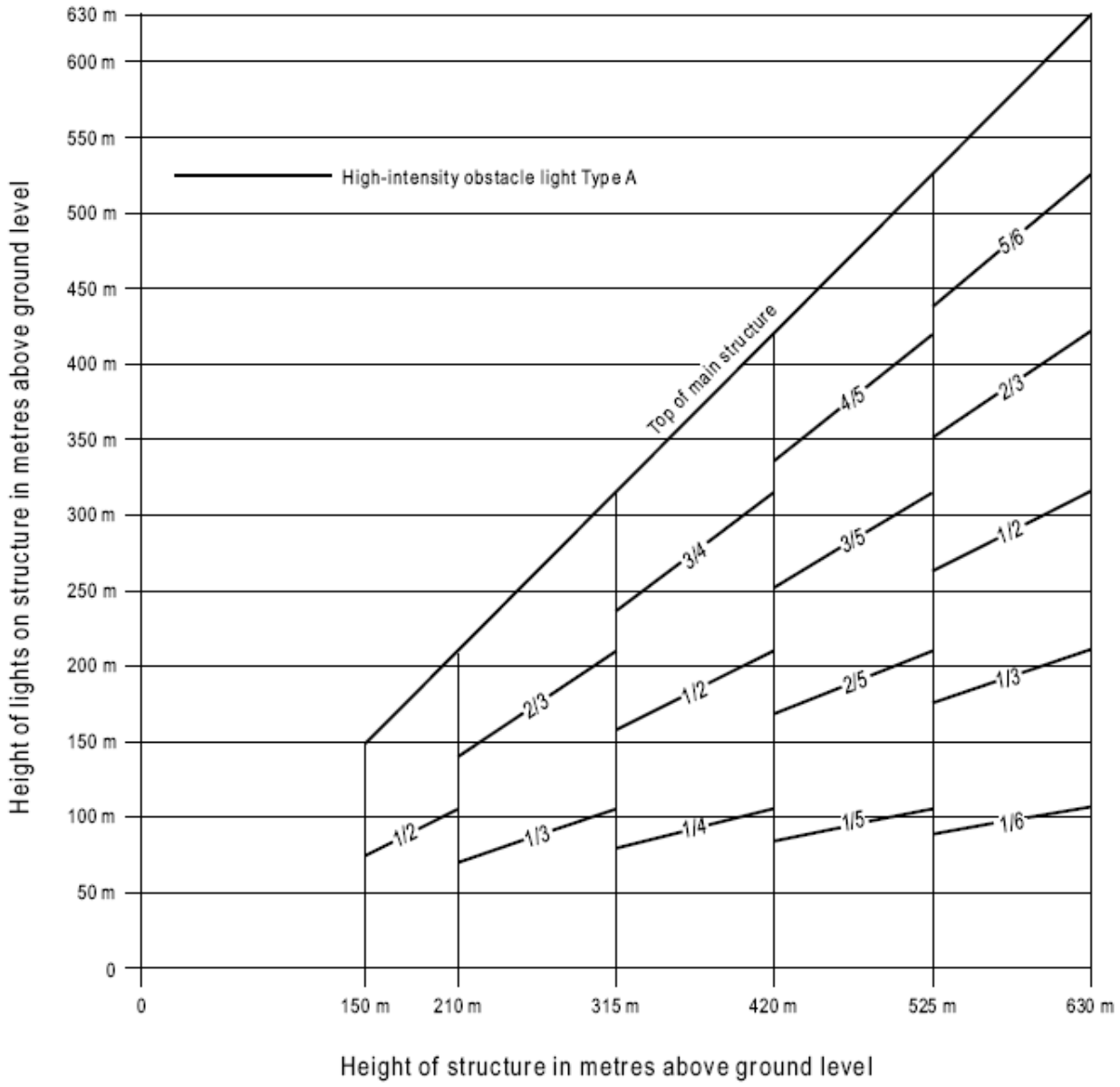


Figure A6-6. High-intensity flashing-white obstacle lighting system, Type A

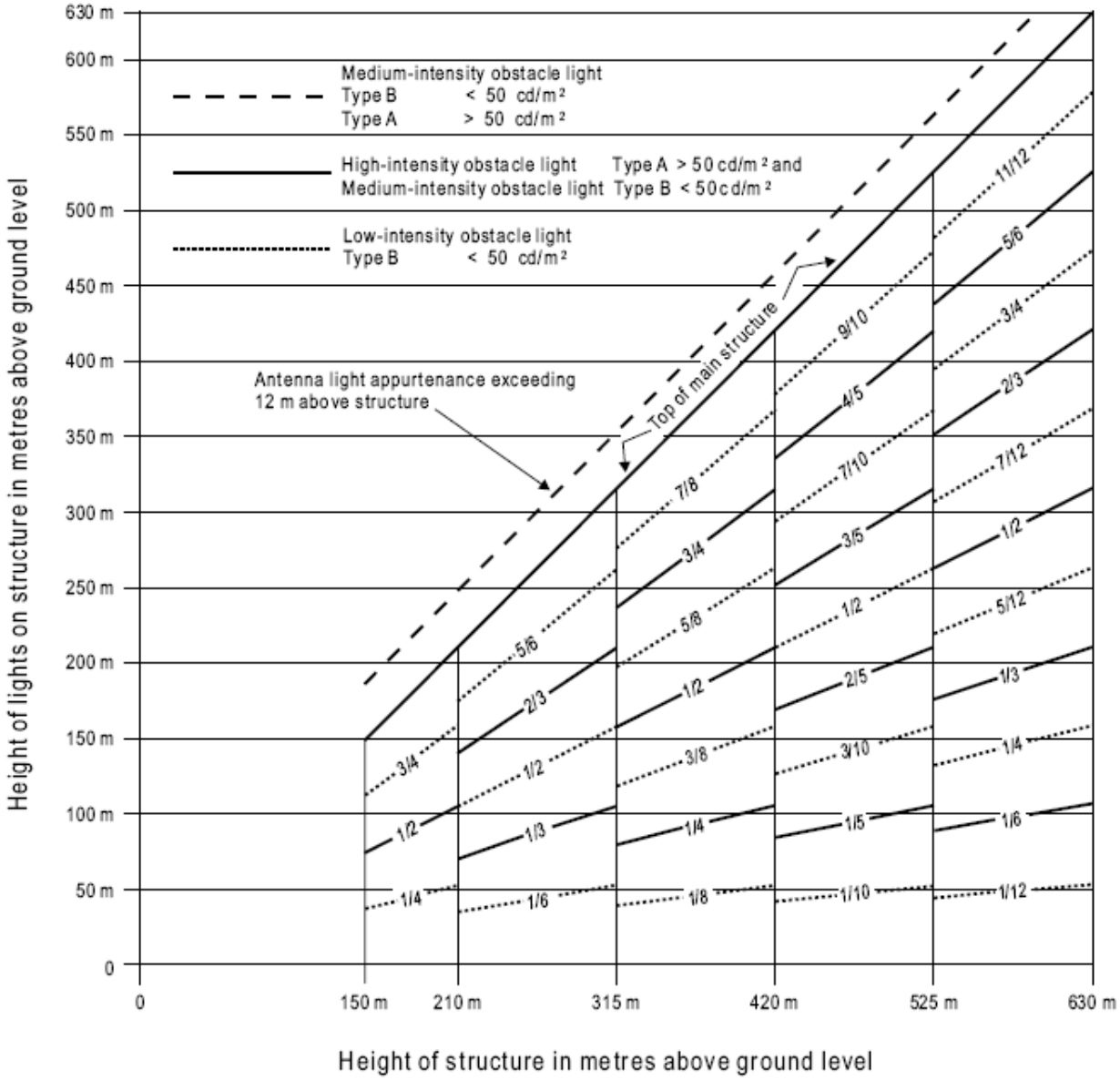


Figure A6-7. High-/medium-intensity dual obstacle lighting system, Type A/Type B

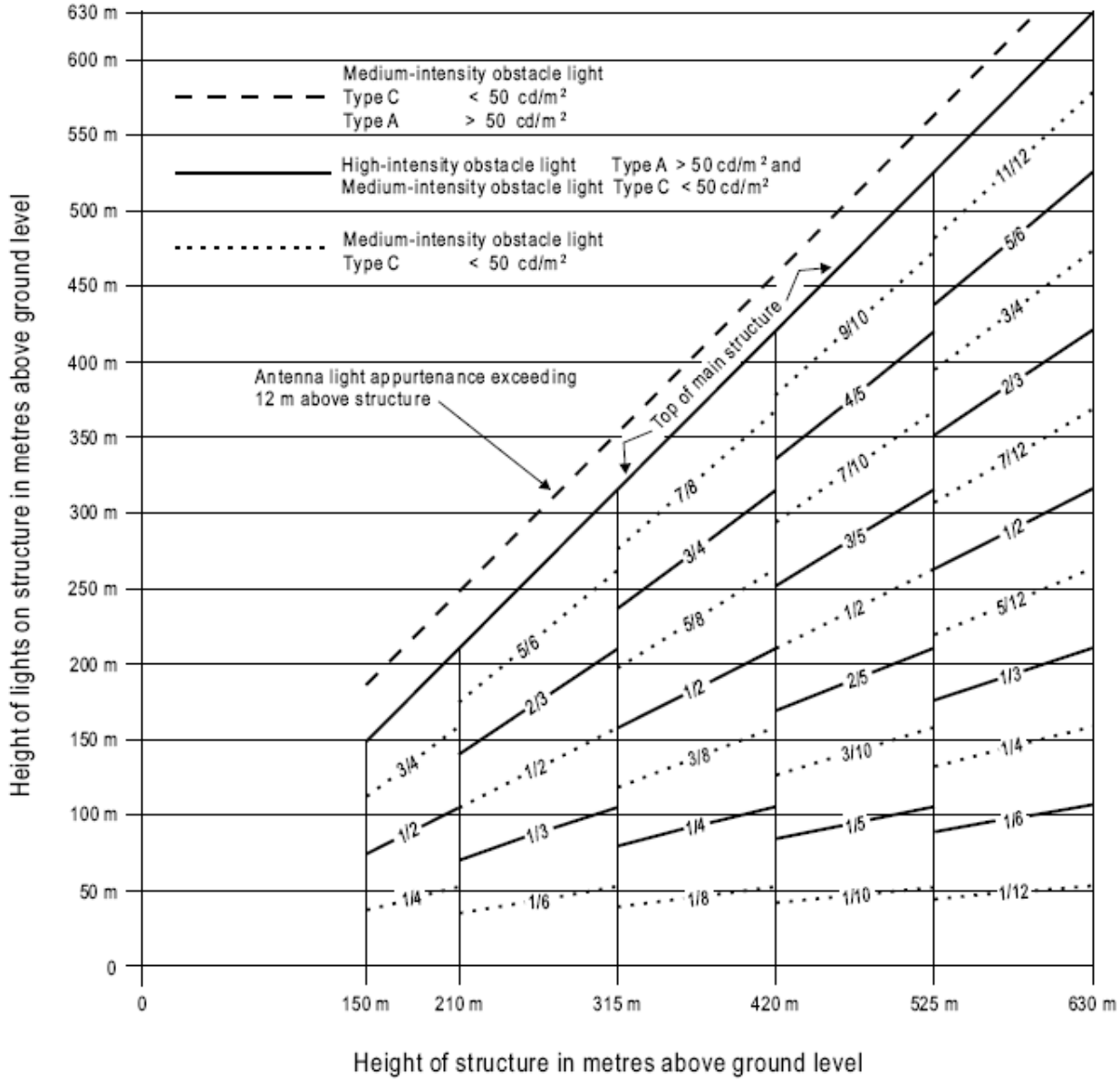


Figure A6-8. High-/medium-intensity dual obstacle lighting system, Type A/Type C

APPENDIX – BIO'S

Mel Dunn, Aviation Advisor, HART Aviation

Mel has 45 years' experience in the aviation industry, including a distinguished career of over 28 years with the Department of Civil Aviation, subsequently the Civil Aviation Authority, of Australia and a period of 18 months as Director of Civil Aviation in the Republic of Vanuatu.

His experience includes 15 years' experience at senior management level in the civil aviation operational and engineering safety regulatory field and 17 years professional engineering experience in aviation system design and regulation and environmental and aviation security issues.

Mel has been consulting on a wide range of aviation issues since leaving Vanuatu in mid 1994, with particular emphasis on engineering, maintenance, and safety-related issues. Mel has presented papers on airworthiness and noise-related matters at international conferences and chaired international noise meetings.

He is a Bachelor of Mechanical Engineering (Honours), a Fellow of the Royal Aeronautical Society, a Fellow of the Institution of Mechanical Engineers and a Chartered Engineer. He was also an inaugural Board Member of the Aviation Safety Foundation Australia, serving from 1996 - 2003. Mel is certified as an International ISO Lead Auditor and trained in Integrated Risk Management.

David Jordan, Vice President – Operations, HART Aviation

David has 39 years of aircraft engineering and flight operations experience encompassing domestic and international operations. During this period David accrued over 15000 flying hours and carried out a number of safety management roles within a major Australian airline.

Commencing his aviation career with Qantas Airways, he acquired qualifications as a Licensed Aircraft Maintenance Engineer (Airframe/Engines) prior to pursuing his flying career.

David joined Ansett Airlines Australia as a B727 Flight Engineer and held both Check and Training positions as a Flight Engineer in conjunction with carrying out a number of project roles within the flight department. During this period David was also part of the Executive Management team of the Australian Airline Flight Engineers Association. As a Flight Engineer, David accrued 7168 flying hours.

With the phasing out of Flight Engineers within Ansett Airlines, David was selected for pilot training and at the completion of training commenced operations with the company as a pilot on the Fokker 50. Since then he has flown extensively on the Airbus A-320 and has an endorsement on Boeing 757/767 aircraft. He has flown throughout Australia and Europe accruing 8100 hours as a pilot.

He was appointed to the position of Manager Flight Safety for Ansett Airlines in January 2000 and held that position until Ansett ceased operations.

David has completed a number of Safety related courses including the highly regarded Aircraft Accident Investigation Course at Cranfield University UK, the BHP Billiton corporate safety Incident Cause Analysis Method (ICAM) course and the Safety Audit & Lead Auditor Training Course with Aerospace Certifications & Training Limited, along with a number of in house airline management development courses.

Since then, David has flown for an international airline in Europe based in Malta and Bristol UK, before accepting an offer to return to Australia to become part of an Airline Management group consulting to the airline industry on safety and airline operational issues.

David joined HART Aviation in mid 2005, heading up the Operations group and our team of Consultants. Since that time, he has conducted more than a 100 audits of air operators across Asia Pacific, advised on airfield, aircraft type selection, pilot experience issues, amongst many others.

HART Aviation
Australia, Canada,
South Africa, UK, USA, Venezuela

Head Office Tel. +61 (0) 3 9347 5444
http://www.HARTaviation.com.au

APPENDIX K

ELECTRANET SA LETTER CONFIRMING TRUSTPOWER'S INTEREST IN THE ELECTRICAL INFRASTRUCTURE

ElectraNet
electricity transmission

ElectraNet Pty Limited
ABN 41 094 482 416
ACN 094 482 416

PO Box 7096
Hutt Street Post Office
Adelaide 5000 South Australia

T (08) 8404 7966
F (08) 8404 7104

W www.electranet.com.au

21 December 2009

Peter Calderwood
Strategic Business Development Manager
Trust Power Limited
Truman Lane, Mt Maunganui
Private Bag 12023
Tauranga NEW ZEALAND

Dear Peter

Re: Development Approval Process for Snowtown Wind Farm Stage 2

ElectraNet acknowledges that Trust Power will manage the Development Variation Approval process for the Snowtown Windfarm stage 2 including the submission of information to the Wakefield Regional Council on behalf of Snowtown Windfarm and ElectraNet.

ElectraNet wishes to be kept informed of progress in this matter, including of any issues that the Wakefield Council may raise prior to granting development approval and particularly of conditions that may relate to transmission line infrastructure approvals.

This will enable ElectraNet to be conversant with any critical matters related to the development approval process of the Snowtown Windfarm stage 2 and could assist in addressing any impediments that may prevent a timely development approvals timeframe.

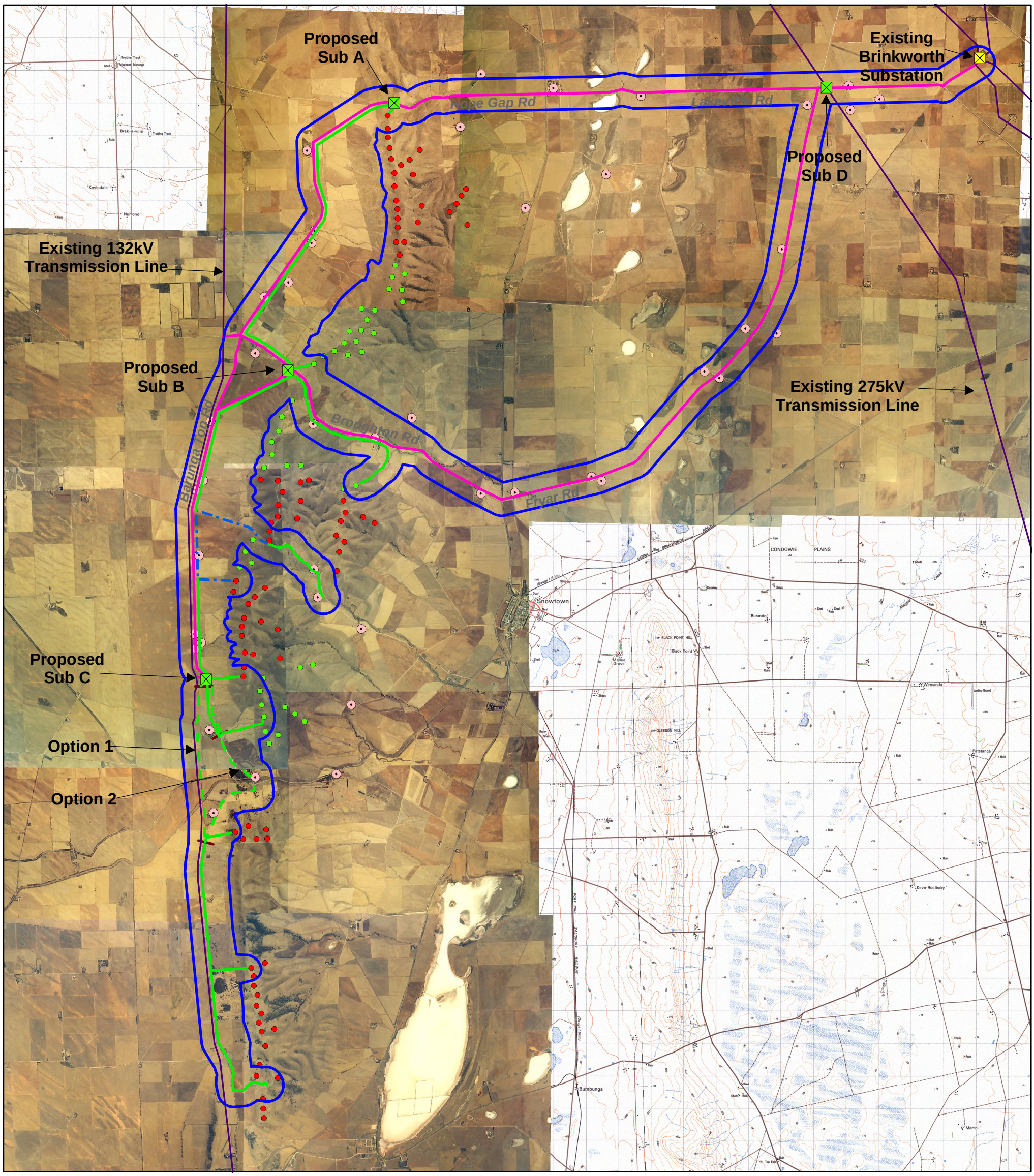
Please do not hesitate to contact me should you have any questions in relation to the above.

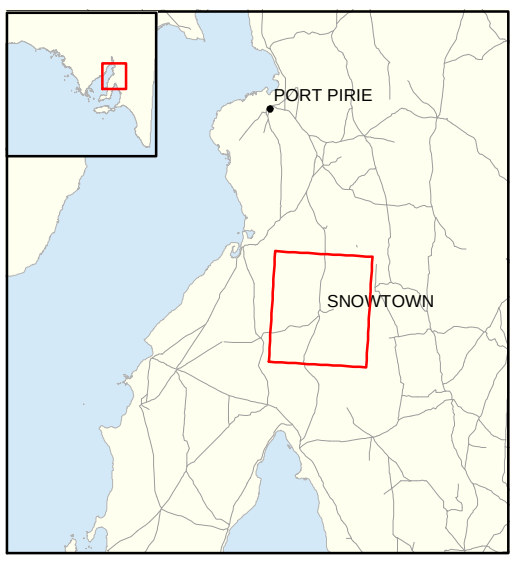
Yours sincerely

PP Dorin Costan
Project Manager

APPENDIX L

ORIGINAL APPROVED SNOWTOWN WIND FARM ELECTRICAL GRID CONNECTION INFRASTRUCTURE





Legend

- Residences
- Proposed Substations
- Existing Substation

Turbines

- Trust Power
- Wind Prospect
- Double Circuit 132kV Line
- Double Circuit 33kV Line
- Optional Double Circuit 33kV Lines
- Triple Circuit 33kV Line
- Existing Transmission Lines
- Transmission Line Corridor

N W E S

0 1 2 3 4 5
Kilometres

Corridor for Transmission Lines and Substations Barunga Ranges
Figure 3.1

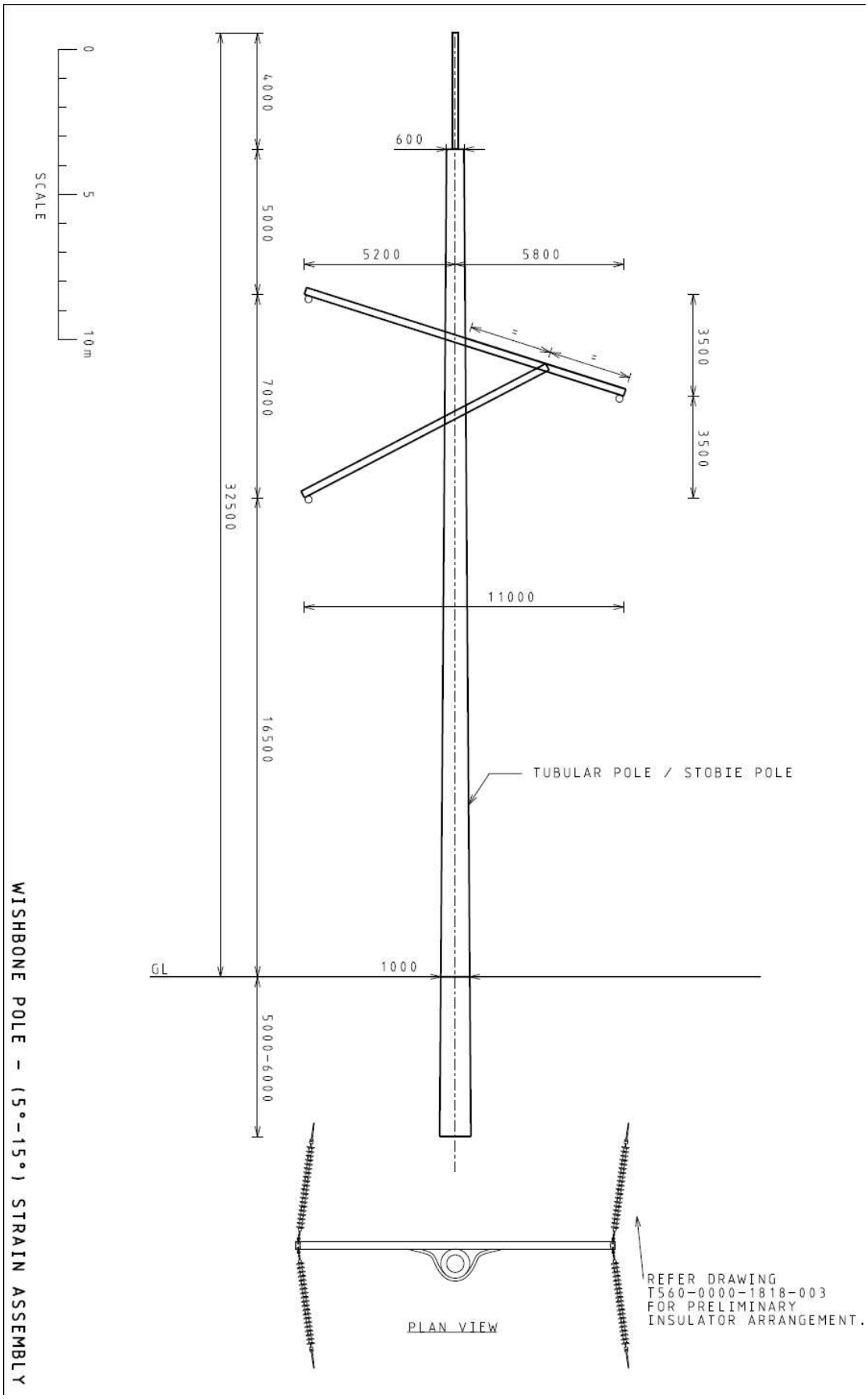
Data Source: DEH
Projection: GDA 1994 MGA Zone 54
Production Date: 1 July 2004
Job Reference: 2103003A

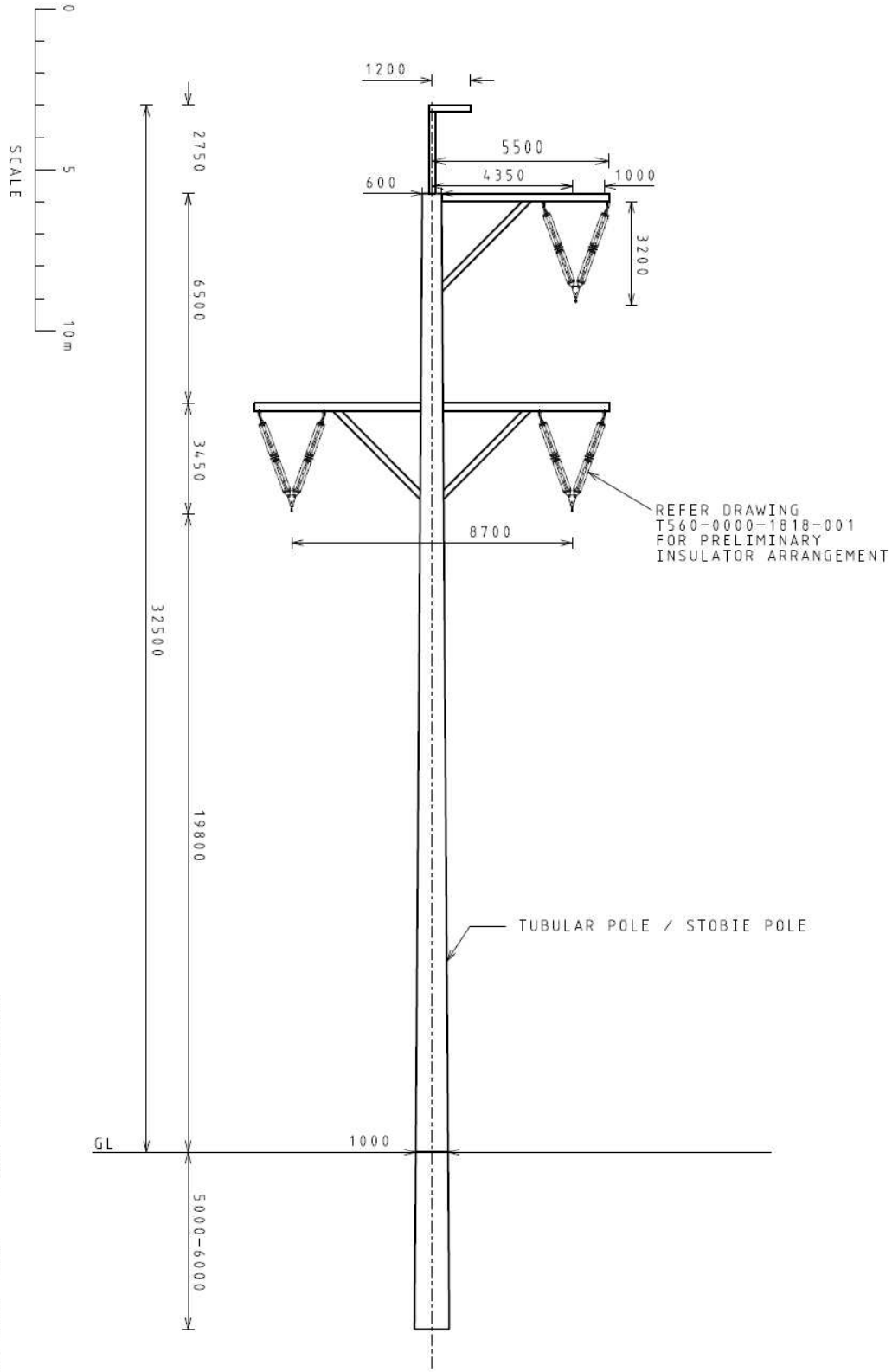
PARSONS BRINCKERHOFF

APPENDIX M

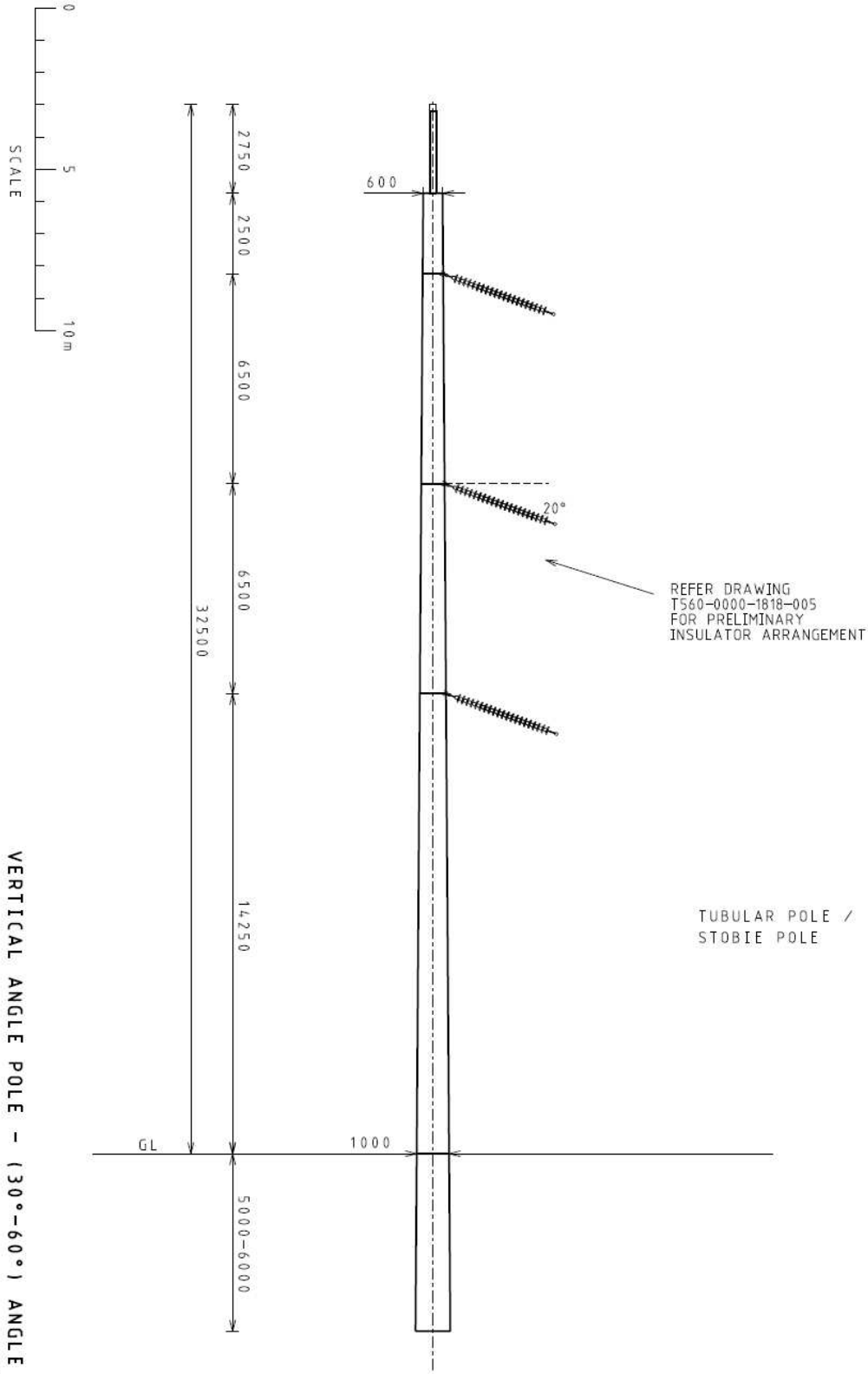
TYPICAL 275KV POLE STRUCTURES

Typical 275kV Pole Structures GA drawings. Nominal Span distance 300m





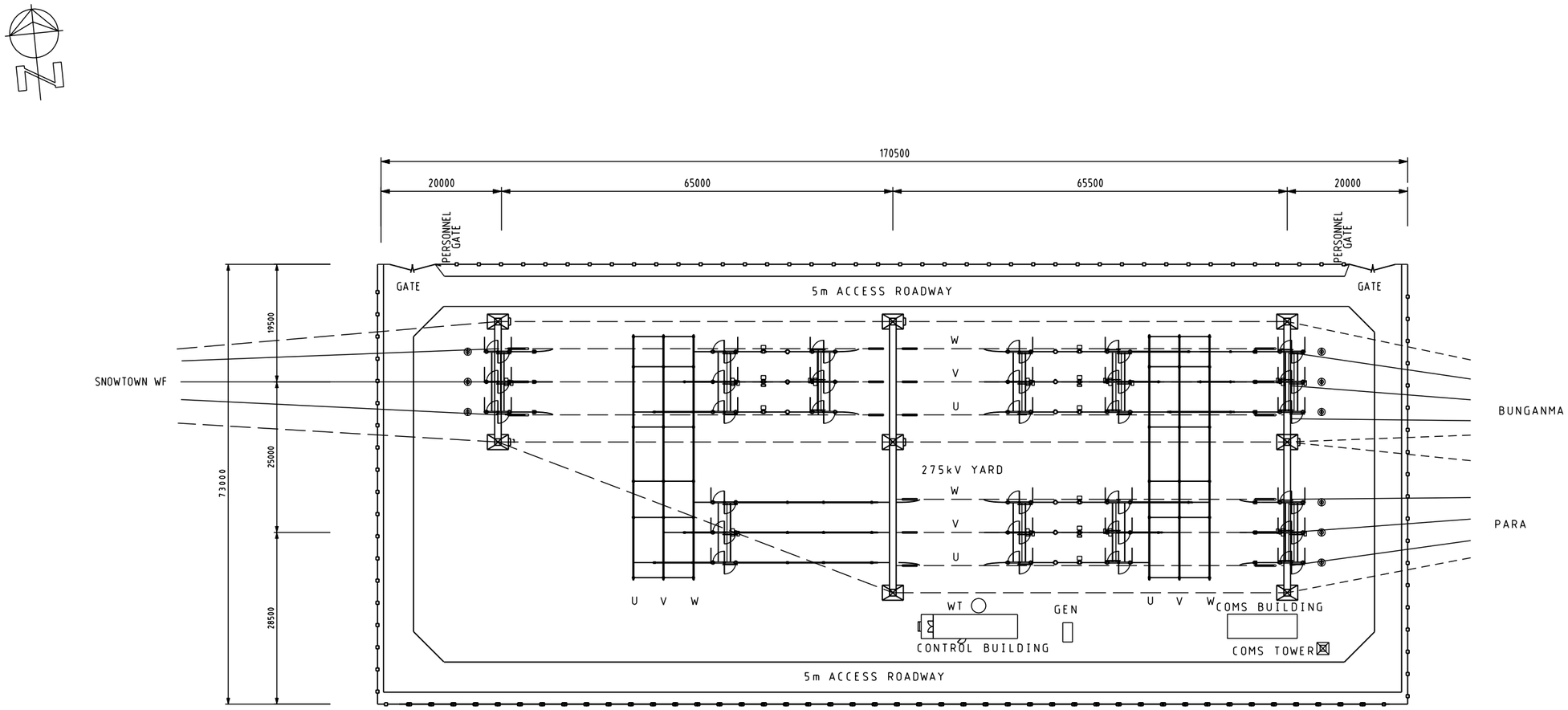
SUSPENSION POLE - (0°-2°) VEE-STRING



VERTICAL ANGLE POLE - (30°-60°) ANGLE ASSEMBLY
DOUBLE AGSU

APPENDIX N

TYPICAL 275KV SWITCHING STATION LAYOUT



275kV SUBSTATION PLAN

REV	DETAILS OF REVISION	RVD	CKD	APD	DATE
A	ISSUED FOR INFORMATION	CPP			05/09

DRN	PM (CPP)	05/09
CKD	EW (CPP)	05/09
INSP		
AUTH		

ElectraNet SA – electricity transmission network

PRELIMINARY LAYOUT
SNOWTOWN PHASE 2 SUBSTATION

SCALE 1:400 | 310-XXXP/05-001 | REV A | DISTB

DO NOT SCALE DRAWINGS FOR WORKING DIMENSIONS

275kV SURGE DIVERTERS
ABB TYPE PEXLIN 0240

AXXXX & AXXXX
DISCONNECTOR 275kV 2500A 40kA
WITH TWO EARTHING SWITCH AEM TYPE

BUNGAMA - F1954
CAPACITIVE VOLTAGE TRANSFORMER
275kV/√3 / 110V/√3 / 110V/√3
TRENCH TYPE 287HC
CLASS IP 0.2M 100VA

AXXXX
DISCONNECTOR 275kV 2500A 40kA
WITH TWO EARTHING SWITCH AEM TYPE

AXXXX
DISCONNECTOR 275kV 2500A 40kA
WITH EARTHING SWITCH AEM TYPE DB362

CBXXXX & CBXXXX
CIRCUIT BREAKER
275kV 2500A 31.5kA
ABB TYPE HLP300B1 (SPAR)

CURRENT TRANSFORMERS
275kV 2500A 40kA
ABB TYPE IMB 300C

AXXXX & AXXXX
DISCONNECTOR 275kV 2500A 40kA
WITH EARTHING SWITCH AEM TYPE DB362

PARA - F1918
CAPACITIVE VOLTAGE TRANSFORMER
275kV/√3 / 110V/√3 / 110V/√3
TRENCH TYPE 287HC
CLASS IP 0.2M 100VA

CAPACITIVE VOLTAGE TRANSFORMER
275kV/√3 / 110V/√3 / 110V/√3
TRENCH TYPE 287HC
CLASS IP 0.2M 100VA

AXXXX
DISCONNECTOR 275kV 2500A 40kA
WITH EARTHING SWITCH AEM TYPE DB362

CURRENT TRANSFORMERS
275kV 2500A 40kA
ABB TYPE IMB 300C

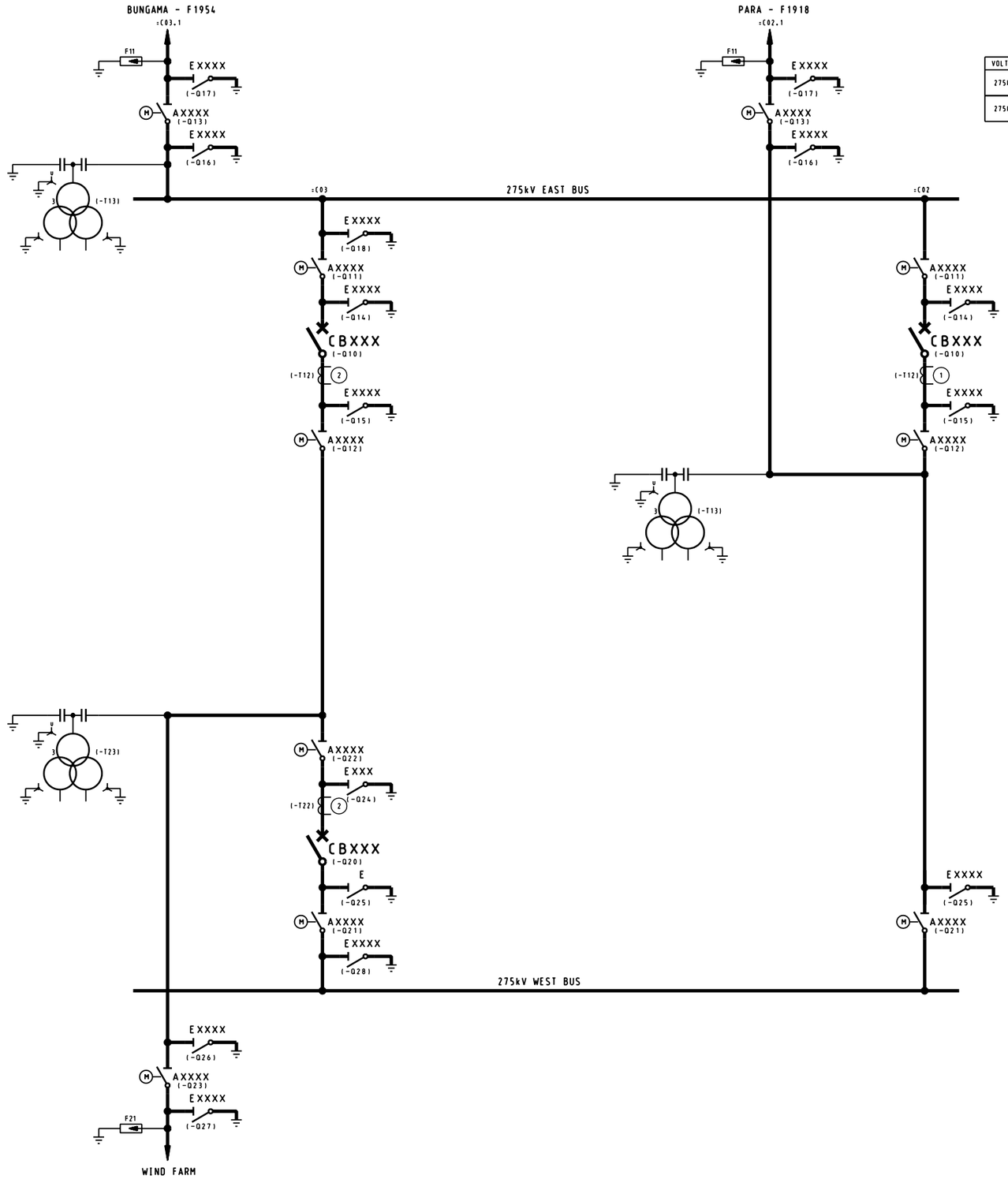
CBXXXX
CIRCUIT BREAKER
275kV 2500A 31.5kA
ABB TYPE HLP300B1 (SPAR)

AXXXX
DISCONNECTOR 275kV 2500A 40kA
WITH TWO EARTHING SWITCH AEM TYPE

AXXXX
DISCONNECTOR 275kV 2500A 40kA
WITH EARTHING SWITCH AEM TYPE DB362

AXXXX
DISCONNECTOR 275kV 2500A 40kA
WITH TWO EARTHING SWITCH AEM TYPE

275kV SURGE DIVERTERS
ABB TYPE PEXLIN 0240



CT LEGEND

VOLTAGE	NUMBER	DESCRIPTION	MANUFACTURER
275kV	1	5 CORE PROTECTION 2400/2000/800/1A 0.1PL3000R12 ON 2400/1A 1 CORE MEASURING 2400/2000/800/1A 0.5M 15Ω	ABB
275kV	2	5 CORE PROTECTION 2400/2000/800/1A 0.1PL3000R12 ON 2400/1A 2 CORE MEASURING 2400/2000/800/1A 0.5M 15Ω	ABB

ISSUED FOR INFORMATION

REV	DETAILS OF REVISION	RVD	CKD	APD	DATE

DRN
CKD
INSP
AUTH

ElectraNet – electricity transmission

PRELIMINARY SINGLE LINE DIAGRAM
SNOWTOWN 2 SUBSTATION

SCALE NTS | 310-XXXX-XX-001 | REV A | DISTB 1

DO NOT SCALE DRAWINGS FOR WORKING DIMENSIONS

APPENDIX O

LANDOWNERS AND LAND TITLES ALONG 275KV OVERHEAD POWER LINE ROUTES

Listing of Affected Parcels 2/03/2010

Parcel No.	CT	Description	Landowner	Address
BG-001	5809/688	Section 459 Hundred of Cameron in the area named Barunga Gap	Darryl James Davidson	273 Cemetery Road, Snowtown SA 5520
BG-001	5960/585	Allotment 42 Deposited Plan 67644 Hundred of Cameron in the area named Barunga Gap	Darryl James Davidson	273 Cemetery Road, Snowtown SA 5520
BG-001	5960/585	Allotment 45 Deposited Plan 67644 Hundred of Cameron in the area named Barunga Gap	Darryl James Davidson	273 Cemetery Road, Snowtown SA 5520
BG-001	5567/463	Section 277 Hundred of Cameron in the area named Barunga Gap	Darryl James Davidson	273 Cemetery Road, Snowtown SA 5520
BG-002	5674/88	Section 579 Hundred of Cameron	Donald Stuart Whiting	C/- Post Office, Snowtown, SA 5520
BG-002	5674/89	Section 580 Hundred of Cameron	Donald Stuart Whiting	C/- Post Office, Snowtown, SA 5520
BG-003	5392/897	Allotment 3 Deposited Plan 43160 in the area named Snowtown Hundred of Cameron	Darryl Richard Welke	Section 23, Barunga Road, Snowtown SA 5520
BG-005	5392/898	Allotment 4 Deposited Plan 43160 in the area named Snowtown Hundred of Cameron	Salvatore Luigi Marando and Maria Rosa Marando	20 Theta Street, Salisbury SA 5108
BG-006	5732/608	Section 559 Hundred of Cameron in the area named Snowtown	Maro Creek Pty Ltd	3 Stuart Tce, Longueville NSW 2066
BG-006	5641/582	Sections 134 and 139 Hundred of Cameron in the area named Snowtown	Maro Creek Pty Ltd	3 Stuart Tce, Longueville NSW 2066
BG-007	5732/102	Allotment 91 Filed Plan 215836 Hundred of Cameron in the area named Snowtown	Darryl James Davidson and Graham Douglas Perrin	273 Cemetery Road, Snowtown SA 5520
BG-007	5819/933	Section 135 Hundred of Cameron in the area named Snowtown	Darryl James Davidson and Graham Douglas Perrin	273 Cemetery Road, Snowtown SA 5520
BG-007	5388/462	Allotment comprising piece 93 Filed Plan 178395 in the area named Snowtown Hundred of Cameron	Darryl James Davidson and Graham Douglas Perrin	273 Cemetery Road, Snowtown SA 5520
BG-008	5952/242	Allotment 759 Filed Plan 176079 in the area named Snowtown Hundred of Cameron	Australian Rail Track Corporation	Off Sir Donald Bradman Drive, Mile End SA 5031
BG-007	5388/462	Allotment comprising piece 94 Filed Plan 178395 in the area named Snowtown Hundred of Cameron	Darryl James Davidson and Graham Douglas Perrin	273 Cemetery Road, Snowtown SA 5520
BG-001	5389/312	Allotment comprising pieces 91 and 92 Filed Plan 178394 Hundred of Cameron in the area named Snowtown	Darryl James Davidson	273 Cemetery Road, Snowtown SA 5520
BG-007	5647/170	Section 321 Hundred of Cameron in the area named Snowtown	Darryl James Davidson and Graham Douglas Perrin	273 Cemetery Road, Snowtown SA 5520
BG-009	5639/28	Section 208 Hundred of Everard in the areas named Snowtown and Condowie	Maxine Edith Combe	Combe Road, Crystal Brook SA 5523
BG-009	5638/28	Section 209 Hundred of Everard in the are named Condowie	Maxine Edith Combe	Combe Road, Crystal Brook SA 5523
BG-009	5639/28	Sections 207 Hundred of Everard in the area named Condowie	Maxine Edith Combe	Combe Road, Crystal Brook SA 5523
BG-009	5639/28	Section 210 Hundred of Everard in the are named Condowie	Maxine Edith Combe	Combe Road, Crystal Brook SA 5523
BG-009	5690/994	Allotment 1 Deposited Plan 52115 in the area named Condowie Hundred of Everard	Maxine Edith Combe	Combe Road, Crystal Brook SA 5523
BG-009	5517/438	Section 228 Hundred of Everard in the area named Condowie	Maxine Edith Combe	Combe Road, Crystal Brook SA 5523
BG-010	5459/415	Section 199 Hundred of Everard in the area named Condowie	Edward Diment Jenkin	PO Box 130, Kybunga SA 5453
BG-010	5834/396	Section 413 Hundred of Everard in the area named Condowie	Edward Diment Jenkin	PO Box 130, Kybunga SA 5453
BG-001	5567/464	Section 409 Hundred of Everard in the area named Condowie	Darryl James Davidson	273 Cemetery Road, Snowtown SA 5520
BG-011	5430/958	Section 408 Hundred of Everard in the area named Condowie	J.H.P. Pty Ltd	C/- "Hundred of Hall" Lot 672, Balaklava SA 5461
BG-011	5430/958	Section 278 Hundred of Everard in the area named Condowie	J.H.P. Pty Ltd	C/- "Hundred of Hall" Lot 672, Balaklava SA 5461
BG-011	5833/883	Section 164 and 166 Hundred of Everard in the area named Condowie	J.H.P. Pty Ltd	C/- "Hundred of Hall" Lot 672, Balaklava SA 5461
BG-011	5833/883	Section 130 Hundred of Everard in the area named Everard Central	J.H.P. Pty Ltd	C/- "Hundred of Hall" Lot 672, Balaklava SA 5461
BG-013	5409/487	Sections 382 Hundred of Blyth in the area named Blyth	Andrew Roy Hentschke and Lynne Michelle Hentschke	New Road, Blyth SA 5462
BG-014	5434/808	Section 381 Hundred of Blyth, in the area named Blyth	Gumlyn Pastoral Co Pty Ltd	Gumlyn Farm, Snowtown SA 5520
BG-015	5194/720	Section 380 Hundred of Blyth in the area named Blyth	Robert Arthur Kennett	C/- Post Office, Blyth SA 5462
BG-016	5643/124	Section 379 Hundred of Blyth in the area named Blyth	Robert Arthur Kennett and Suzanne Heather Kennett	C/- Post Office, Blyth SA 5462
BG-016SS	5643/124	Section 379 Hundred of Blyth in the area named Blyth	Robert Arthur Kennett and Suzanne Heather Kennett	C/- Post Office, Blyth SA 5462

APPENDIX P

MARO CREEK LAND TITLES

The land titles owned by Maro Creek Pty Ltd which have been incorporated into the Snowtown Wind Farm project area are:

Land Title	Landowner	Landowner Address
CT 5674 Folio 786	Maro Creek Pty Ltd	3 Stuart Tce, Longueville NSW 2066
CT 5674 Folio 787	Maro Creek Pty Ltd	3 Stuart Tce, Longueville NSW 2066
CT 5674 Folio 788	Maro Creek Pty Ltd	3 Stuart Tce, Longueville NSW 2066
CT 5814 Folio 490	Maro Creek Pty Ltd	3 Stuart Tce, Longueville NSW 2066
CT 5803 Folio 882	Maro Creek Pty Ltd	3 Stuart Tce, Longueville NSW 2066
CT 5803 Folio 882	Maro Creek Pty Ltd	3 Stuart Tce, Longueville NSW 2066
CT 5803 Folio 881	Maro Creek Pty Ltd	3 Stuart Tce, Longueville NSW 2066
CT 5819 Folio 564	Maro Creek Pty Ltd	3 Stuart Tce, Longueville NSW 2066
CT 5177 Folio 737	Maro Creek Pty Ltd	3 Stuart Tce, Longueville NSW 2066