7.2.3 Mitigation measures

	Impact	Objective	Mitigation tasks	Project phase	Site area-Stage 1	Site area-Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC1	Visual Impact to nearby receivers	Minimise view of Infrastructure	Design and construct site control room and facilities buildings sympathetically with nature of locality	Construction	X	X		
SOC2	Visual Impact to nearby receivers	Minimise view of Infrastructure	Locate substations to minimise views from public roads and residences. Locate transmission lines where practical to follow the corridor of existing transmission lines	Construction	X	X	X	X
SOC3	Visual Impact to nearby receivers	Minimise view of Infrastructure	Minimise activities that may require night time lighting, and if necessary use low lux (intensity) lighting designed to be mounted with the light projecting inwards to the site to minimise glare at night	Construction Operation	X	X		
SOC4	Visual Impact to nearby receivers	Minimise view of civil earth works	Rehabilitate any site access track not required during the operation of the wind farm at the completion of the construction phase	Construction	X	X		
SOC5	Visual Impact to nearby receivers	Minimise view of civil earth works	Use local materials wherever possible for access track construction	Construction	X	X	X	X
SOC6	Visual Impact to nearby receivers	Minimise view of civil earth works	Enforce protocols to control and minimise fugitive dust emissions	Construction	X	X	X	X
SOC7	Visual Impact to nearby receivers	Minimise view of civil earth works	Restrict the height of stockpiles to minimise visibility from outside the site	Construction	X	X		
SOC8	Visual Impact to nearby receivers	Minimise view of civil earth works	Minimise cut and fill for site tracks and stabilise disturbed ground as soon as possible after construction	Construction	X	X		
SOC9	Visual Impact to nearby receivers	Minimise view of civil earth works	Rehabilitate disturbed areas, as appropriate, in consultation with landholders	Construction Operation	X	X	X	X
SOC10	Visual Impact to nearby receivers	Minimise view of wind farm	Offer screening (planting of vegetation) to dwellings categorised as having a moderate or high visual impact	Construction Operation	X	X		

7.3 NOISE IMPACTS

7.3.1 Approach

An operational and construction noise assessment was completed by Heggies Pty Ltd for Silverton Wind Farm Developments. The noise impact assessment report addresses the potential noise impacts as a result of both construction and operation of the proposed wind farm. The methodology of the noise assessment undertaken by Heggies is detailed below.

- The methodology and acceptability limit criteria that were applied to the noise impact assessment was based upon the South Australia EPA Noise Guidelines for Wind Farms (February 2003) (SA Guidelines). The principal acceptability limit criteria is that wind farm L_{Aeq} noise should not exceed the greater of an amenity limit of 35dBA or the pre-existing background noise by more than 5dBA (for any given wind speed)
- Noise emissions as a result of the wind farm were modelled at sensitive receivers based on ISO 9613 as implemented in the SoundPLAN computer noise model. This model predicts noise levels through geometrical spreading and includes the effect of air absorption (as per ISO 9613), ground attenuation and shielding. The algorithms allow for down wind propagation or medium temperature inversion conditions
- Predicted L_{Aeq} noise levels calculations were based on sound power levels determined in accordance with IEC-61400-11 (Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques), where available, for the wind range 3 to 10 m/s
- The turbine modelled is a REpower MM92 on a 100 metre hub and is representative of the range of turbines under consideration for the project. The data used for the modelling is from independent noise emission tests in accordance with International Standard IEC 61400-11. An additional calculation for a noisier wind turbine, a Vestas V90-3MW is also included
- The noise character of WTG noise emission was assessed for any special audible characteristics, such as tonality or low frequency content, which would be deemed annoying or offensive. If characteristics such as tonality are identified then the predicted noise level would be penalised by the addition of 5dBA. Characteristic noise level modulation of WTGs, commonly referred to as 'swishing', is considered to be a fundamental part of wind farm noise and is taken into account by the SA Guideline assessment procedure
- To facilitate the establishment of the noise limit, background noise monitoring is required to establish the pre-existing ambient noise environment as a function of wind speed. As wind speed increases the ambient noise level at most receivers generally increases as natural sources, such as wind in trees, begin to dominate. The variation of background noise with wind speed is usually site specific and related to various physical characteristics such as topographic shielding and the extent and height of exposed vegetation
- Noise monitoring was completed for approximately two weeks and then correlated to synchronous wind speed and direction data for a reference height of 10 metre at the wind farm monitoring mast. The captured data is screened for validity, with data monitored during periods of rain or where the average wind speed at the microphone position likely exceeded 5m/s being discarded from the data set. Other data that was obviously affected by external noise sources (eg pond pumps, grass mowing, birds at dawn) was also removed from the data set. Data below the cut-in speed of 3m/s is also excluded. A regression analysis of all valid data is used to determine a line of 'best fit' from which the noise limit is established.

7.3.2 Assessment

Wind farm site

Background

There are a limited number of residential dwellings that surround the proposed turbine site with the majority located to the south in the township of Silverton. The assessment locations include all dwellings located within 10km of a proposed WTG. These dwellings locations are presented in Figure 7.6.

Background noise monitoring was conducted at three locations which were chosen based on the potential for acoustic impact and their proximity to the wind farm. The SA Guidelines require a set of approximately 2,000 valid data points which corresponds to a monitoring period of approximately two weeks.

The three locations that were subject to the background noise monitoring were Eldee Station, Umberumberka Reservoir and Penrose Park. The typical daytime background noise level, determined for the construction noise impact assessment for the three locations are presented below.

Table 7.4 Background noise levels at the three monitoring locations

Location	Average background noise level (dBA)
Eldee Station	36.4
Umberumberka Reservoir	39.0
Penrose Park	48.5

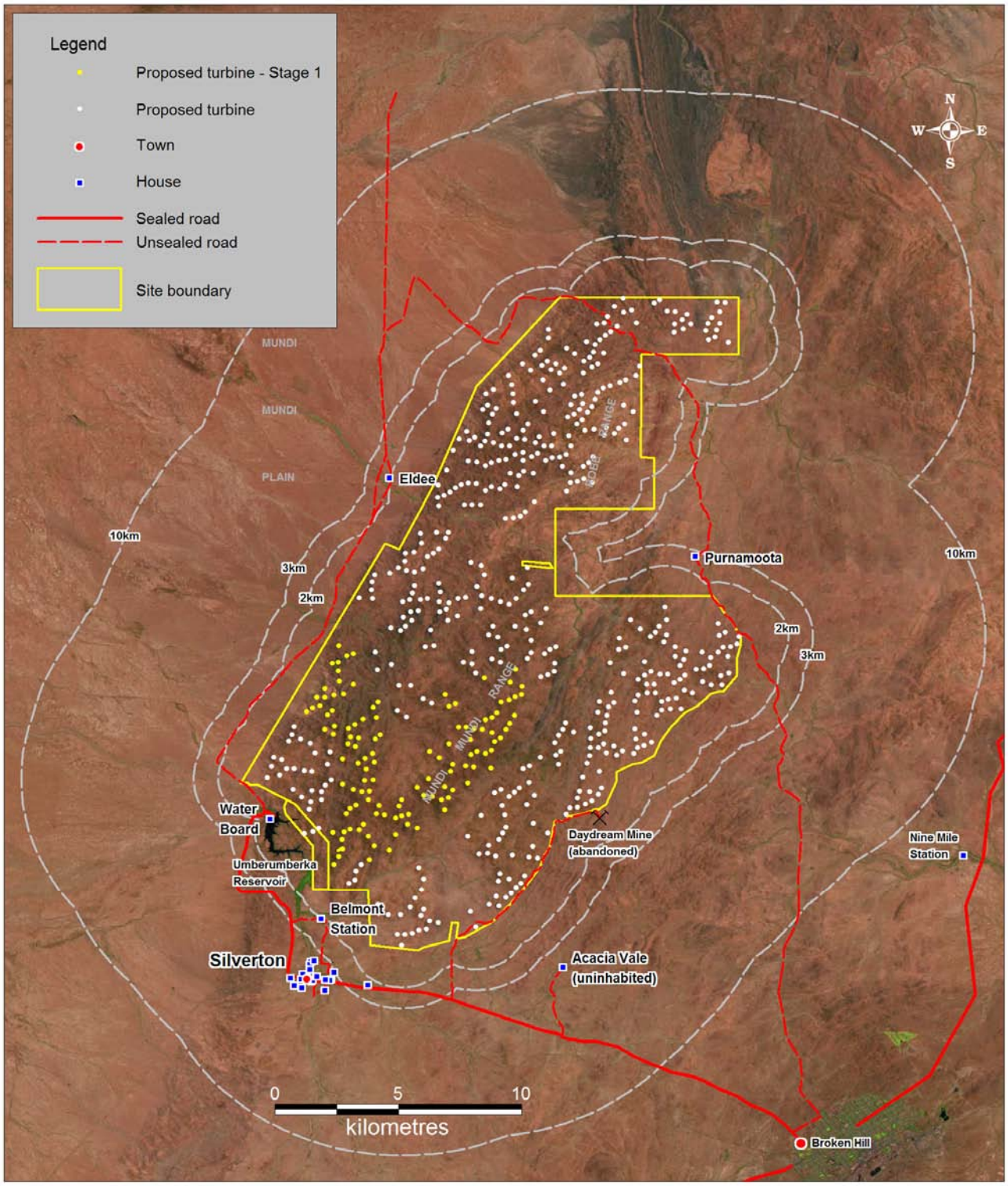

Figure 7.6 Location of Silverton Wind Farm in relation to surrounding receivers

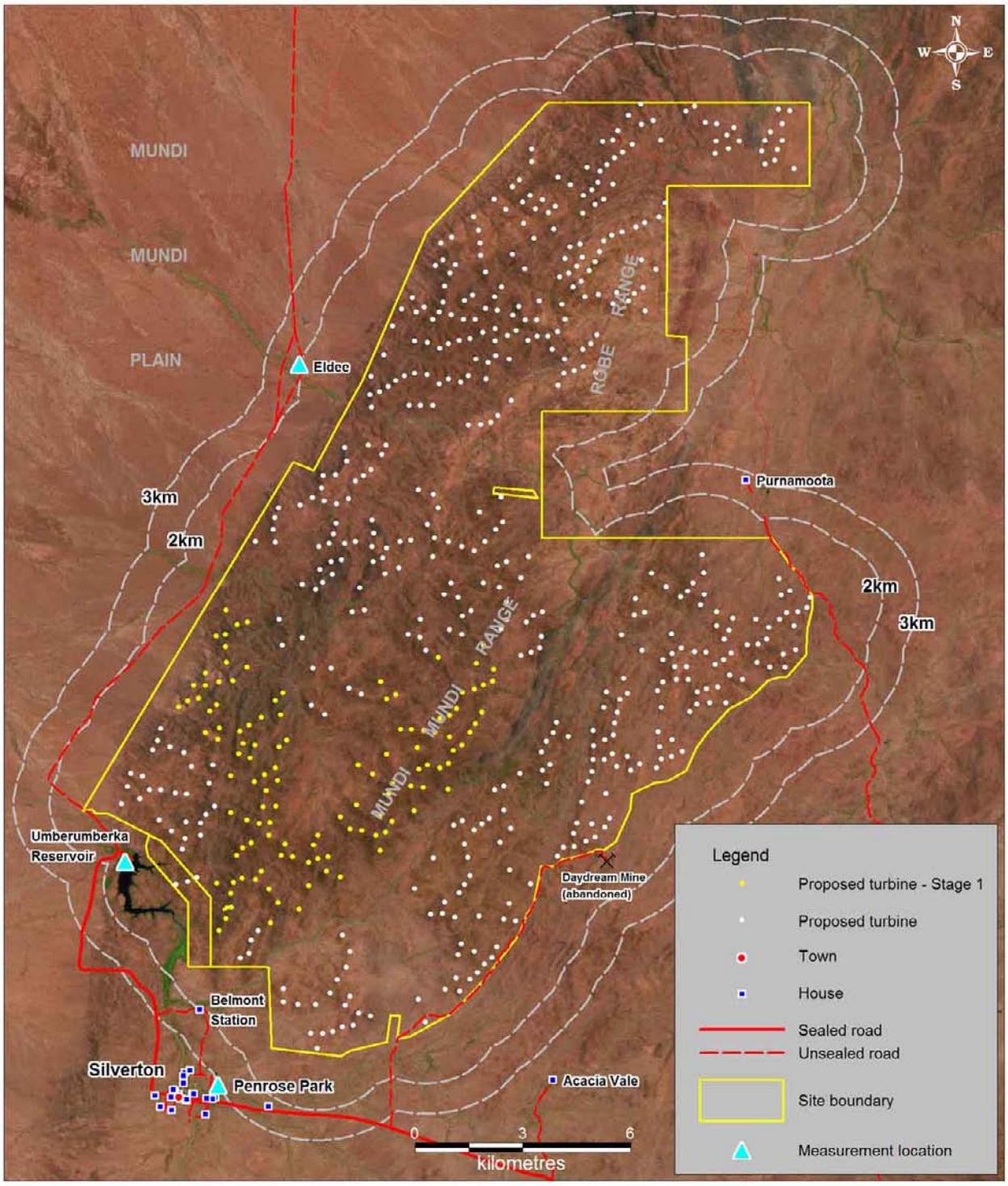

Figure 7.7 Background noise monitoring locations.

Impact assessment – construction

Noise generating construction activities would include:

- Construction of access roads
- Concrete batching

HEGGIES

Project Number : 40-1487
Name: Silverton Wind Farm
Description: Stage 1 Layout
Turbine Model: MM92
Hub Height: 100 metres

WTG
Noise level
Leq in dB(A)

= 15
= 20
= 25
= 30
= 35
= 40
= 45
= 50

Signs and symbols
WTG
Receivers
35 dB(A) Limit

Scale 1:200000
0 1 2 4 6 8 km

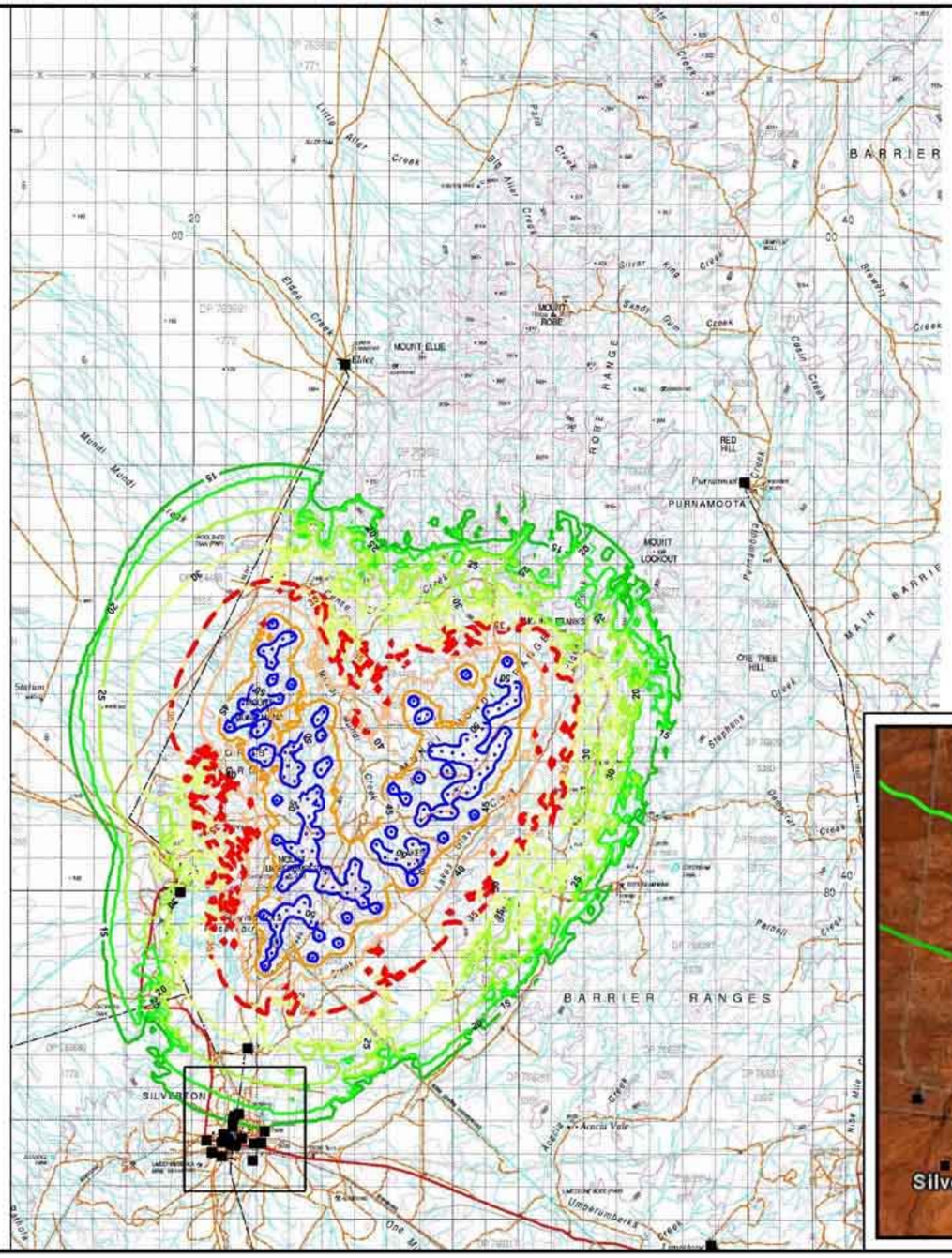

Figure 7.8: Stage 1 layout – L_{Aeq} noise contour map at V_{ref} = 8 m/s

The predicted worst-case construction noise impacts for most receivers are below the existing typical daytime background level. Some nearby receivers are anticipated to receive elevated construction levels when turbine foundation civil works, specifically the rock breaker, are located nearby. However, due to the anticipated short period of localised works would likely to be considered satisfactory. In consideration that the predicted levels represent worst-case construction scenarios and are within limits that would be considered acceptable, it is unlikely that construction noise will cause any unnecessary impacts.

The noise generated from construction traffic, based on the predicted traffic volumes in Section 7.6 (Traffic Assessment), should not lead to an increase in existing levels of more than 2dBA. The greatest impact would be along haulage routes used continuously over the construction or decommissioning phases (for example, the Silverton Road; refer to Section 7.6 for a discussion of traffic impacts) and the maximum predicted peak hour noise at 10 metres from the roadside is 63dBA.

Blasting may be undertaken during construction. The ground vibration and airblast levels that cause concern or discomfort to residents are generally lower than the relevant building damage limits. The NSW EPA advocates the use of the ANZECC guidelines for assessing potential residential disturbance arising from blast emissions.

The ANZECC guidelines for control of blasting impact at residences are as follows:

- The recommended maximum level for airblast is 115dB Linear. The level of 115 dB Linear may be exceeded on up to 5 per cent of the total number of blasts over a period of 12 months. The level should not exceed 120 dB Linear at any time
- The recommended maximum for ground vibration is 5mm/s, Peak Vector Sum (PVS) vibration velocity. It is recommended however, that 2mm/s (PVS) be considered as the long-term regulatory goal for the control of ground vibration. The PVS level of 5 mm/s may be exceeded on up to five per cent of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time
- Blasting should generally only be permitted during the hours of 9:00am to 5:00pm Monday to Friday and 9:00am to 1:00pm Saturday. Blasting should not take place on Sundays and public holidays.

The Australian Standard 2187.2-1993 ‘Explosives – Storage, Transport and Use. Part 2: Use of Explosives’ does not present human comfort criteria for ground vibration from blasting. It does however make mention of human comfort level for airblast in saying that ‘a limit of 120dB for human comfort is commonly used’. This is consistent with the ANZECC guidelines.

As part of the civil works it is expected that infrequent blasting would be required to clear obstacles and prepare foundations for wind turbines when required.

The closest anticipated distance between blasting and residences would be approximately 1,600 metres (location Umberumberka Reservoir). At this distance the predicted MIC of up to 2,000 kilogram is likely to produce an airblast overpressure below the acceptable level of 115dB Linear. It should be noted that typically an MIC of 50 to 100 kilograms is sufficient for blasts with a typical hole size and spacing and overburden and therefore it is expected that blasting works would be easily compliant with the general EPA Human Comfort criteria of 115dB Linear.

Impact assessment – operation

An assessment of the acceptability of wind farm noise levels at all assessment receivers located within a distance of 10 kilometre of the proposed wind farm was made in accordance with SA EPA Guideline criteria and the pre-existing background noise level regression analysis. The noise assessment identified that there are no receivers that would be impacted by noise levels above the appropriate criteria.

WTG manufacturers are obliged to conduct independent tests in accordance with IEC 61400-11. A part of this assessment is to conduct a tonal audibility test. For the wind speed range analysed (6–10m/s) tonality was not deemed to be audible (ΔLta <-3) and hence no penalty was applied. Infrasound is not tested as an obligatory part of IEC 61400-11. It should be noted that in general modern WTGs do not exhibit significant infrasound emissions.

The noise impact assessment of operational noise modelled a REpower MM92 turbine for both Stage 1 and the fully built wind farm (598 turbines). This turbine model has a rotor diametre of 92 metres and is assumed to be mounted on towers at a hub height of 100 metres. This turbine is representative of the range of turbines under consideration in this proposal. The noise assessment concluded that Stage 1 and Stage 2 (598 turbines) predicted operational noise levels comply with criteria at all locations and the contour plots are presented in Figure 7.8 and Figure 7.9.

Additional analysis of the sensitivity of turbine heights was undertaken to determine the effect of physical size of the turbines on noise propagation. Reducing the hub height from 100 to 80 metres resulted in an average increase of 0.2dBA across the site which is statistically insignificant. The noisiest turbine of the group under consideration, for which data exists, was modelled to provide a worst case assessment of noise impacts. This turbine was the Vestas V90 – 3MW and identifies that mitigation would be required in certain places if this turbine was ultimately used.

The noise assessment results will vary with different turbines and therefore further noise modelling would be required on the turbine selected for construction and the final layout (Statement of Commitment 15 refers).

There would also be a need for the construction and operation of an onsite substation. It is understood that the substation transformers could potentially be enclosed by blast protection walls in which case they would also serve as noise walls.

Australian Standard AS 2374 Part 6 1994: Power Transformers – Determination of Transformer and Reactor Sound Levels indicates that a transformer of this capacity (2 x 300MVA) may produce sound power levels up to 112dBA. The dominant frequency of such a transformer is 100Hz.

Noise predictions for transformers have been made by using a conservative model (CONCAWE) assuming worst case meteorological conditions and Pasquill Stability Class F temperature inversions. For Stage 1, predicted noise levels from the transformer installation is expected to be less than 24dBA in the township of Silverton, up to 27dBA at Belmont Station and up to 12dBA at Umberumberka Reservoir, which is below the existing ambient background and predicted future WTG levels and as such would not affect the compliance assessment of the proposed wind farm.

For final Stage 2, the predicted noise levels from the transformer installations are expected to be less than 25dBA in the township of Silverton, up to 27dBA at Belmont Station and up to 17dBA at Umberumberka Reservoir, which is below the existing ambient background and predicted future levels with installed wind turbines. Therefore they will not effect the compliance assessment of the proposed wind farm. The highest predicted transformer noise is for Purnamoota Station, with a worst case noise level of 34dBA, which would comply with the minimum INP criteria limit.

HEGGIES

Project Number : 40-1487
Name: Silverton Wind Farm
Description: Stage 1 Layout
Turbine Model: MM92
Hub Height: 100 metres

WTG
Noise level
Leq in dB(A)

= 15
= 20
= 25
= 30
= 35
= 40
= 45
= 50

Signs and symbols
WTG
Receivers
35 dB(A) Limit

Scale 1:200000
0 1 2 4 6 8 km

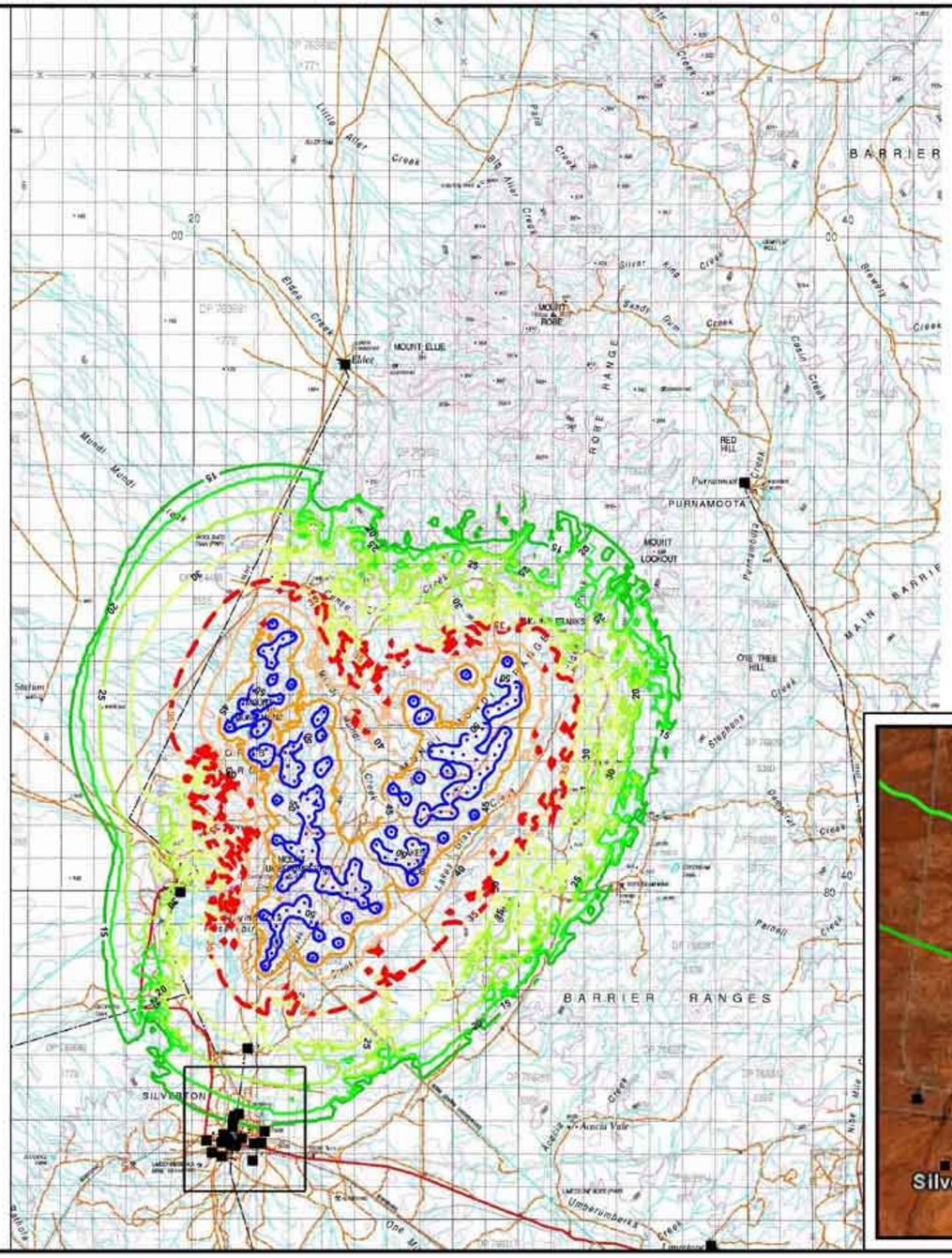

Figure 7.8: Stage 1 layout – L_{Aeq} noise contour map at V_{ref} = 8 m/s

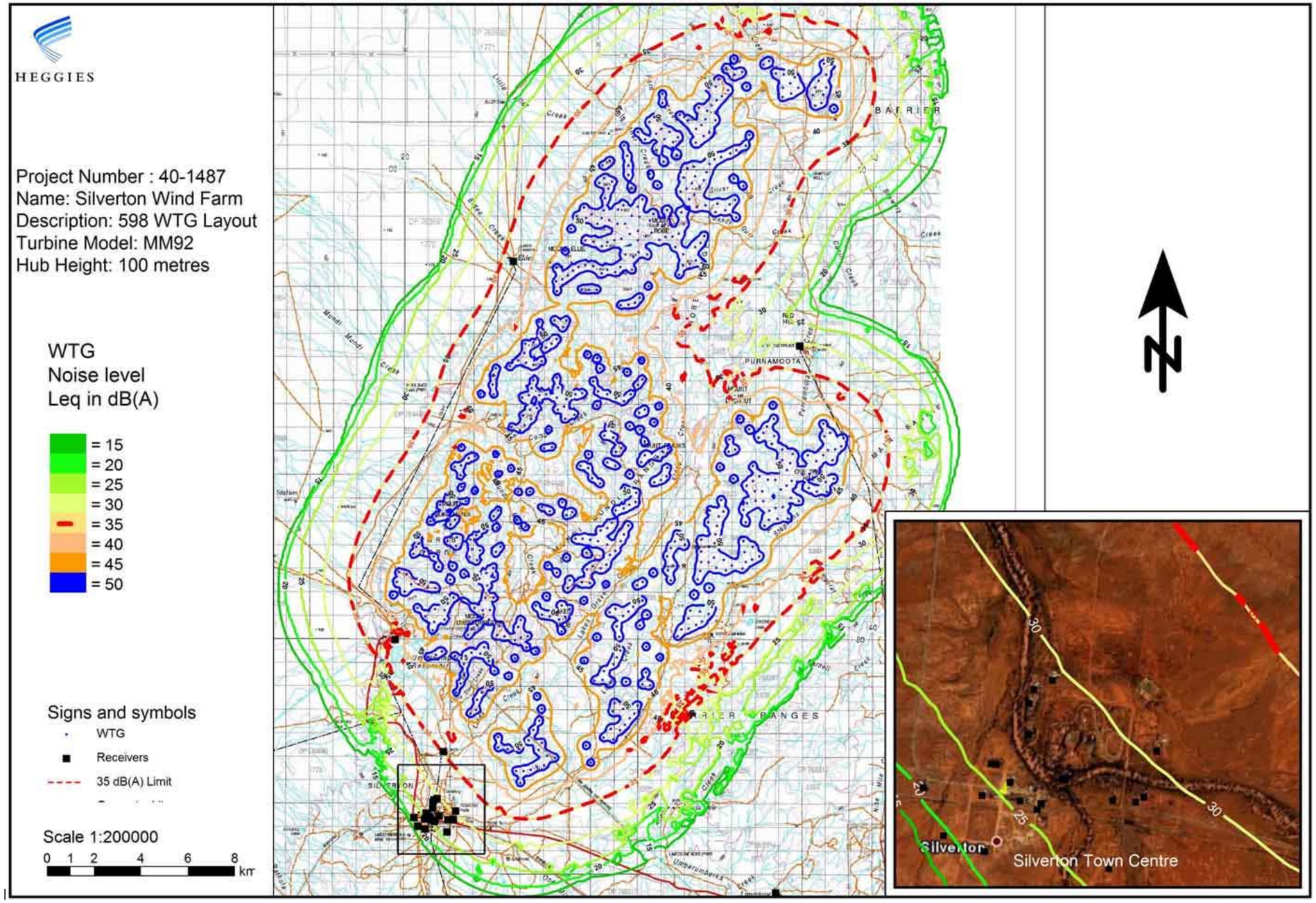

Figure 7.9: Final Stage 2 layout – L_{Aeq} noise contour map at V_{ref} = 8 m/s

Transmission line route (Site to Broken Hill, Site to Red Cliffs)

Background

The current route for the proposed transmission line between Broken Hill, Buronga and Red Cliffs runs adjacent to the current transmission line easement. A new section of transmission line is required between Site and Broken Hill. Both routes run through predominately grazing and farming land in both the unincorporated area of NSW and the Wentworth Shire Council.

The transmission line crosses the Silver City Highway at a number of locations, however is predominately located within farming and grazing land. Although there are a number of potential receivers, these receivers are predominately farming homesteads that are generally not located in the near vicinity of the power line route. In addition, the route is proposed to replicate the current transmission line to minimise the potential impacts associated with the construction and operation of the proposed transmission line.

Impact assessment – construction

The construction of the transmission line route would be completed using similar machines and techniques to those used at the proposed turbine site. It is considered that due to the dynamic nature of the construction of the power line, any impacts as a result of the construction of the power line are considered manageable.

Impact assessment – operation

Corona noise is caused by the partial breakdown of the insulation properties of air surrounding the conducting wires. It generally only occurs in humid conditions, as provided by fog or rain, which is uncommon in the generally arid Western NSW region where the project is located. A minimum line potential of 70kV or higher is required to generate corona noise depending on the electrical design.

Assuming a minimum rating background level (RBL) value of 30dBA, the minimum intrusive criteria as determined by the NSW Industrial Noise Policy (INP) would be 35dBA. An assessment based on measurements of corona noise was conducted and a conservative estimate of the minimum criteria level of 35dBA would be complied with at a distance of 240 metres. Therefore under a worst case scenario, INP criteria would be achieved at a distance of 240m.

The proposed Stage 1 power line has no residences within 240 metres of the proposed route as it has been planned to avoid existing houses. The proposed Stage 2 power line to Red Cliffs follows the route of the existing 220kV and generally traverses remote and sparsely populated land. There is only one house known to be close to the existing power line route. It is anticipated that sufficient buffer distances will be incorporated into the final design to render occasional corona noise inaudible at residential receivers.

7.3.3 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC11	Construction noise	Minimisation	Employ appropriate noise reduction strategies to ensure the recommendations of the NSW Environmental Noise Control Manual are met. Strategies may include the re-orientation machinery, re-scheduling of noisy activities, installation of temporary noise barriers, improved vehicle noise control, reduced work times and the use of 'quiet work practices' (such as reducing or relocating idling machinery)	Construction	X	X	X	X
SOC12	Construction noise	Minimisation	Use appropriate and effective exhaust mufflers and compressor silencers on machinery	Construction	X	X	X	X
SOC13	Construction noise	Minimisation	Respond to noise complaints in a timely manner	Construction	X	X	X	X
SOC14	Construction noise	Minimisation	Meet ANZECC guidelines for control of blasting impact at residences	Construction	X	X		
SOC15	Operational noise	Compliance	A final noise assessment will be completed prior to construction based on the final turbine layout and turbine selection to confirm noise criteria are likely to be met at identified residences	Construction	X	X		
SOC16	Operational noise	Minimisation	Implement an adaptive management approach if noise exceedences are identified during wind turbine operation	Operation	X	X		

7.4 BIODIVERSITY

7.4.1 Approach

Two separate biodiversity investigations have been completed in order to assess the constraints, evaluate the potential impacts and to derive specific mitigation measures to minimise risk that the Proposal would have a significant adverse impact on local and regional biodiversity values.

- A comprehensive Biodiversity Assessment was undertaken for Stage 1 turbine site and the transmission route between the proposed substation and Broken Hill. This assessment involved desktop research, consultation with specialists, a fieldwork program involving early and late spring surveys, data analysis and report compilation. Information was sourced on threatened species, populations and communities having potential to be present at the subject site and in the wider study area. Site fieldwork was carried out by a team of five ecologists in representative habitats onsite. Field activities included vegetation and habitat assessments, and targeted threatened species surveys. Evaluations of potential impact, significance assessments, impact assessment and risk assessment were undertaken, focusing on species of conservation significance.
- A Biodiversity Constraints Technical Report was prepared that covered the Stage 2 site area and transmission line corridor between Broken Hill and Red Cliffs. Vegetation communities in the Stage 2 study area and habitat types equivalent to those occurring in the Stage 1 area were identified and mapped using high-resolution orthophotos and ArcView GIS. (An assumption of this approach was that key vegetation communities at Stage 2 would be similar to those recorded in Stage 1, an assumption supported by site visits to Mount Robe). Field validation of vegetation mapping covering the proposed transmission easement from Broken Hill to Red Cliffs was undertaken, recording the vegetation communities within a 100 metre corridor either side of the existing easement. No targeted threatened flora surveys were conducted, however incidental sightings of threatened species and fauna habitat were recorded. The Biodiversity Constraints Report provides key constraints and recommended strategies to manage these constraints.

The results of these reports are summarised in the following sections, both reports are attached in full as Appendices 3 and 4.

7.4.2 Assessment: Flora

Wind farm site

Background

Diverse vegetation communities occur across the Broken Hill Complex Bioregion, varying according to topography, soils and micro-climate. Mulga (*Acacia aneura*) communities and chenopod shrubland communities dominate the vegetation of the bioregion (Morgan & Terrey 1992). Although 95 per cent of the Western Division of NSW is uncleared, the composition and structure of vegetation communities with the bioregion has been modified as a result of grazing by stock and feral animals such as goats, and altered fire regimes (DNR 2005).

Over 300 flora species occur in the region. There are nine threatened plant species known to or predicted to occur in the Barrier Range CMA subregion: five are listed as endangered, four are listed as vulnerable (DECC 2007). Two endangered ecological communities are also known to or are predicted to occur in the subregion (Neila Woodland and the Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River).

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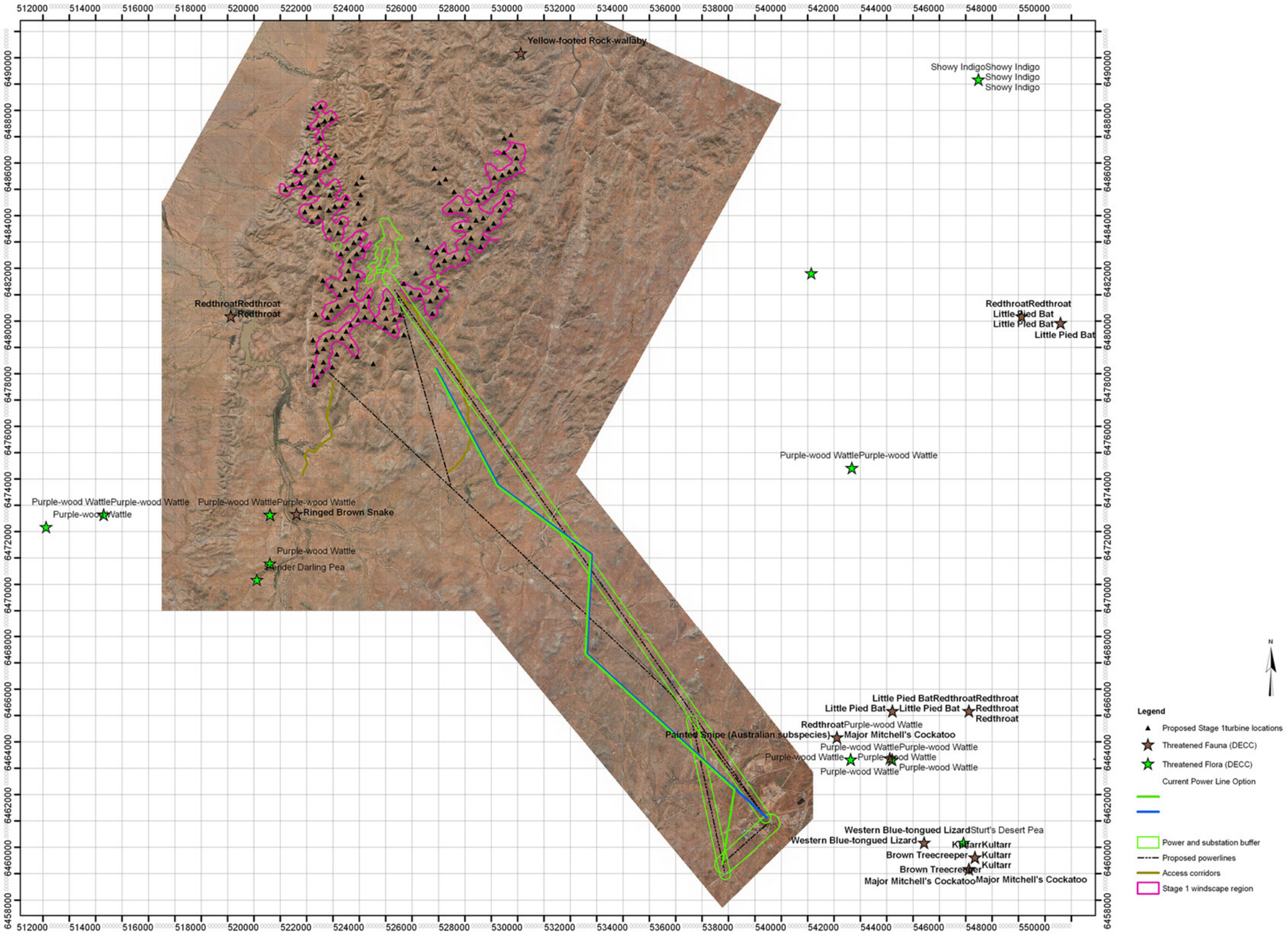

Figure 7.10: Previous threatened flora and fauna records in the district

(source: DECC 2007)
(Several iterations of the power line route have been assessed all with the same type and degree of constraints. Mitigation has been developed specific to the need to retain some flexibility in the final route location.)

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Based on comprehensive biodiversity assessment of the Stage 1 works area, ten vegetation communities were identified from a mix of air photo interpretation and on-ground validation (and mapped in the full report, Appendix 3, Map 4-3). These include:

- Mulga – dead finish on stony hills
- Prickly wattle open shrubland of drainage lines
- Bluebush shrubland on stony rises and downs of the arid zone
- Bladder saltbush shrubland on stony plains and downs of the arid zone
- River red gum open woodland
- River red gum woodland of rocky creeks
- Porcupine grass/red mallee/gum coolibah/hummock grassland/low sparse woodland
- Black bluebush low open shrubland of the alluvial plains and sand plains of the arid and semi-arid zones
- Sand plain mulga
- Black oak woodland.

A total of 89 plant species were recorded during the Stage 1 flora survey, including 11 exotic species (refer to full list of species recorded, Appendix 3, Appendix A). No threatened plant species or Endangered Ecological Communities (EECs) were detected within areas that would be affected by Stage 1 works.

While it is not listed as an Endangered Ecological Community, the occurrence of porcupine grass/red mallee/gum coolibah/hummock grassland/low sparse woodland on metamorphic ranges on the Barrier Range Broken Hill Complex Bioregion is considered to be significant. The extent of its occurrence within the wind turbine envelope area (all stages) has been mapped as part of the Biodiversity Assessment report and the infrastructure layout has been modified to minimise impact on this community within Stage 1 (refer to Map 4-6, Biodiversity Assessment Appendix 3).

There are nine threatened plant species known to or predicted to occur in the Barrier Range CMA subregion. These include species listed under either the *NSW Threatened Species Conservation Act* or the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999* (Bionet and DECC threatened species predictor tool based on the Barrier Range subregion of the Broken Hill Complex Bioregion and Protected Matters search tool using a 30 kilometre buffer, respectively). Three of these species were evaluated as having potential to occur and if present be affected by the Proposal:

- Showy indigo Indigofera longibractea
- Yellow-keeled swainsona *Swainsona flavicarinata*
- Creeping darling pea *Swainsona viridis.*

Impact assessment – construction

There is potential for direct and indirect impacts to native vegetation. The foremost impacts of the Proposal would occur during the construction phase, when excavation and clearing is required to establish footings for infrastructure, install infrastructure and to accommodate additional tracks, turn-around areas and stockpile areas.

An indication of the development impact areas is included in Table 3.3.

Vegetation surrounding the development footprint would be affected by vehicle access and parking, materials lay down and spoil deposition and retrieval. Peripheral impacts may include soil compaction, soil erosion and sedimentation. Pollution risks are associated with the concrete batch plant, fuels and lubricants and construction chemicals used at the site.

Mitigation measures have been developed to avoid and, where avoidance is not possible, to reduce impacts to native vegetation within the Stage 1 and Stage 2 works envelopes. For both stages, the vegetation community recently named

porcupine grass/red mallee/gum coolibah/hummock grassland/low sparse woodland would present a constraint to development. Similarly, the EEC *Acacia loderi* shrublands may occur within the Stage 2 envelope and would require field surveys and a more detailed assessment to assess occurrence and condition. Additional evaluation is required to consider thoroughly the potential for impact on all species listed as threatened with potential to occur within the Stage 2 works.

Impact assessment – operation

Maintenance of the structures would require minor additional impact to vegetation. The operational impacts of the Proposal may include alteration to the prevailing grazing regime at the wind farm sites. Maintenance of Asset Protection Zones (APZs) around the substation and control rooms would be required. Inspection, maintenance and monitoring visits would be required, although existing tracks would be used and impact on vegetation is expected to be minimal. Access tracks would be maintained to minimise ongoing erosion and sedimentation impacts. The maintenance program would also include regular inspections for weed and rabbits, and control as required. Maintenance access would be confined to existing tracks, hardstand or heavily disturbed areas. The impacts of major repairs would be similar in nature to construction impacts, but more limited in extent and to previously disturbed ground.

The operational impacts of the Proposal on vegetation are not expected to significantly affect flora values at the site with the implementation of mitigation measures.

The link between goat grazing and the degradation of native vegetation and threatened species habitat has been well established (Benson et al 2006; Auld 1993; DNR 2005; Murphy 1996; NSW NPWS 2000) and there is an opportunity to manage their impact within the study area by active control to improve the condition of native vegetation.

Impact assessment – decommissioning

Decommissioning impacts would be similar but not as extensive as construction impacts. The area of impact would be reduced because underground footings and cabling would not be removed from the site. Access tracks would be upgraded as required and appropriate weed hygiene and rehabilitation measures would be implemented. The decommissioning phase of the Proposal is not expected to significantly affect local flora in the medium to long term.

Transmission line route (site to Broken Hill)

Background

The transmission route from the wind farm site to Broken Hill is dominated by two vegetation communities, Bluebush shrubland on stony rises and Bladder saltbush shrubland on stony plains, however, seven additional communities occur in lesser quantity:

- Mulga – dead finish on stony hills
- Prickly wattle open shrubland of drainage lines
- River red gum open woodland
- River red gum woodland of rocky creeks
- Black bluebush low open shrubland of the alluvial plains and sand plains of the arid and semi-arid zones
- Sand plain mulga
- Black oak woodland.

The vegetation and species of conservation significance found within the transmission route from the Stage 1 area to Broken Hill have already been covered in the above description of the turbine site. No additional communities or species apply specifically to this transmission route.

Impact assessment – construction

The routing of the transmission line is predominantly through plains from Mundi Mundi Creek, south-east. This infrastructure would require a loss of vegetation including trees and shrubs, in small, well defined areas (poles footings and line lay down area). Vegetation is sparse in this landscape and the overall pattern and extent of clearing is unlikely to have an adverse effect on local flora.

Mitigation measures have been developed to minimise impacts. Several iterations of the power line route have been assessed, all with the same type and degree of constraints. Mitigation has been developed specific to the need to retain some flexibility in the final route location.

Impact assessment – operation

The easement of the transmission route, once established, would require a maintenance program. The Electricity Supply Association of Australia Limited states that:

— A system of maintenance should be instituted for all overhead lines, including structural parts, electrical equipment, protection devices, earth wires and earth electrodes to ensure that the line is maintained in proper working order.

This is likely to require some amount of periodic clearing of any vegetation encroaching on the safe clearance distance within the easement. The measures above are considered sufficient to mitigate operational impacts of the transmission route from the substation to Broken Hill.

Transmission line route (site to Red Cliffs)

Background

Vegetation along the route includes agricultural land (semi-cleared, cropped land with scattered blackbox remnants, irrigated cropping for vineyards and charcoal farms consisting of cleared and regrowth mallee) and native vegetation. 23 native vegetation communities and one undescribed vegetation community were identified along the transmission easement. Vegetation description, condition and structure are included in the full report, Appendix 4. Communities include:

— River red gum – Lignum forest or woodland on flood plains

— Blackbox – Lignum woodland of the inner flood plains

— Blackbox open woodland with chenopod understorey mainly on the outer flood plains

— Slender cypress pine – sugarwood – western rosewood open woodland

— Black oak – western rosewood open woodland

— Sand plain mulga shrubland

— Sandhill wattle shrubland

— Nelia tall open shrubland

— Prickly wattle tall open shrubland

— Black bluebush low open shrubland

— Pearl bluebush low open shrubland

— Bluebush shrubland on stony rises and downs

— Cotton bush open shrubland

— Derived corkscrew grass grassland/forbland

— Chenopod sand plain mallee woodland/shrubland

— Spinifex linear dune mallee

— Australian boxthorn open shrubland

— Hooked needlewood – needlewood – mulga – turpentine bush open shrubland

— Black oak – pearl bluebush open woodland

— Sugarwood open woodland.

Acacia loderi shrublands was identified along approximately 1.8 per cent of the transmission route and is classified as an Endangered Ecological Community (EEC) under the *NSW TSC Act 1995*. At four of the 25 locations where it occurred, it was observed to be in good to very good condition.

Similarly, slender cypress pine woodland was also observed along the route (referable to the Sandhill pine woodland Preliminary Determination EEC). At two of the nine locations where it occurred, it was observed to be in good condition.

One threatened species listed under the *Threatened Species Conservation Act 1995* was identified at five locations along the route: Bitter Quandong (*Santalum murrayanum*).

Impact assessment – construction

The foremost impacts along the transmission route would occur during the construction phase, when excavation and clearing is required to access the route, install footings and to lie down and raise the lines.

As the proposed route is located immediately adjacent to an existing transmission easement, there may be an opportunity to make use of existing cleared areas and thereby reduce the amount of clearing required. In particular, use of the existing access track would allow the Proponent to minimise new access track requirements. Furthermore, most vegetation is low growing (refer to structural description in full report, Appendix 4) and therefore is likely to be an opportunity to reduce the amount of clearing required by designing the towers of sufficient height to maintain appropriate clearance of the power line and thus avoid the need to clear a large proportion of the canopy.

In general, the development of the transmission route appears manageable with respect to potential flora impacts. Mitigation measures have been developed to ensure that impacts are avoided where possible and minimised where avoidance is not possible.

Impact assessment – operation

The easement of the transmission route, once established, would require a maintenance program as described above by the Electricity Supply Association of Australia Limited.

This is likely to require some amount of periodic clearing of the easement, however, the proposed route is located immediately adjacent to an existing transmission easement and there may be an opportunity to make use of existing cleared areas and thereby reduce the amount of clearing required for maintenance purposes.

7.4.3 Assessment: Fauna

Wind farm site

Background

A range of habitats occur in the IBRA Broken Hill Bioregion, including acacia shrublands, chenopod shrublands, wetlands and rocky ranges. 37 mammal, 195 bird, 5 frog and 58 reptile species have been recorded in the Broken Hill Complex bioregion (NSW NPWS 2003). The fauna habitats over much of the region are threatened by feral goats, rabbits and weed infestation. Within the Barrier Range CMA subregion, there are 33 fauna species listed as threatened, consisting of seven mammals, 15 birds, one fish, one invertebrate and nine reptiles (DECC 2007).

Many areas of the bioregion have been degraded by grazing, altered fire regimes, feral animals and weed invasion, which are recognised as threats to fauna habitats. Many species of ground nesting bird and fauna species that feed on terrestrial invertebrates have undergone a serious decline in the bioregion (NSW NPWS 2003).

Waterbirds are likely to move between large bodies of water and wetland habitats at the regional scale. Bancannia Lake (approximately 100 kilometres northeast of the subject site), part of the Menindee Lakes (120 kilometres to the southeast), Stephens Creek Reservoir (20 kilometres to the southeast), major rivers in the region and to a lesser extent Umberumberka Reservoir (two kilometres south of the subject site) are likely to form part of the foraging range for several mobile waterbird species. Bancannia Lake is an important aggregation site for waterbirds, including the threatened freckled duck (*Stictonetta naevosa*) and blue-billed duck (*Oxyura australis*) (NSW NPWS 2003). The blue-billed duck has also been recorded at Stephens Creek Reservoir.

Specific to the wind turbine site (all stages), four general habitat types are present:

- Rocky outcrops and ridges
- Woodland and grassland slopes
- Plains
- Ephemeral drainage lines.

Additional habitat features include hollow-bearing trees and mature vegetation, mine shafts and caves. These habitats have been identified as playing an important role in sustaining native fauna populations in the area. An existing impact of the local area is habitat degradation by feral goat grazing.

Spinifex grassland and rocky outcrops provide potential habitat for several threatened species (marble-headed snake-lizard, slender mallee blue-tongue lizard, tawny rock dragon). These features have been mapped using aerial photography for all stages (Appendix 4, Appendix 1). This mapping was validated during site visits for Stage 1 (Appendix 3, Map 5-2). An opportunity exists to improve the condition of vegetation within the Stage 2 turbine envelope, through the management of rabbit and particularly goat grazing.

122 fauna species were recorded during the Stage 1 field surveys. These include 78 bird species, 27 reptile species, 16 terrestrial mammal species (including six microchiropteran bat species and six introduced species) and one frog species. The site features high avian and reptile diversity, found to be concentrated in the more intact rocky ridges, grassland and drainage line habitats. Low native mammal diversity was recorded. Foxes and rabbits were recorded onsite but appeared in low abundance. This is most likely attributable to recent drought in combination with heavy grazing, which has produced a paucity of ground cover and feed. Goats were the most abundant mammal onsite and the effect of their grazing was evident across all habitat types. Riparian lines appear important bird movement corridors onsite. Regional information suggests that the site is not within an important regional bird movement corridor.

Eight threatened fauna species were recorded during field work: pied honeyeater, painted honeyeater, redthroat, pink cockatoo, little pied bat, slender mallee blue-tongue lizard (not previously recorded in the region, nor predicted to occur), marble-headed snake-lizard (not previously recorded in the region, nor predicted to occur), tawny rock dragon (previously only known from Mutawinjii NP in NSW). Two regionally significant reptile species were also identified: eastern blue-tongue lizard and spinifex snake-lizard.

Based on intensive surveying within the Stage 1 turbine envelope, a number of species were identified as having moderate to high potential for impact. No targeted threatened fauna surveys have been carried out in the Stage 2 site area.

Table 7.6 Threatened species with moderate to high unmitigated potential for impact

Birds	
Thick-billed grasswren	Rufous fieldwren
Pink cockatoo	Scarlet-chested parrot
Painted honeyeater	Pied honeyeater
Rainbow bee-eater	White-throated needletail
Barking owl	Masked owl
Black-breasted buzzard	Square-tailed kite

Australian bustard	Grey falcon
Mammals	
Little pied bat	Inland forest bat
Kultarr	Forrest's mouse
Stripe-faced dunnart	Yellow-bellied sheathtail-bat
Sandy inland mouse	
Reptiles	
Tawny rock dragon	Slender mallee blue-tongue lizard
Ringed brown snake	Marble-headed snake-lizard
Woma	

Additional evaluation is required to consider thoroughly the potential for impact on all species listed as threatened at the State and Commonwealth level with potential to occur within the Stage 2 site area.

However, given the close proximity and similarity of habitat, the results of this assessment are expected to be broadly similar to the assessment of the Stage 1 site area.

Impact assessment – construction

Habitat loss and modification would result from the installation of wind turbines, focused on upper slope and ridge locations where native vegetation is sparse, the switchyard and substations, and associated tracks and cabling (note: cabling between turbines would generally be installed within the access road easement which would not necessitate additional disturbance).

Removal of habitat in ridge locations would include substrate for reptiles and small mammals. Mallee trees provide habitat for birds, particularly perch sites for wedge-tail eagles and other raptors. Some mallee tree removal would be required. Track and turbine footprints would be discrete and are not likely to substantially alter the forage and refuge habitat available to most species. For rock outcrop and spinifex specialist fauna, development on these habitats may reduce important areas of habitat affecting the viability of local populations.

The installation of tracks, turbines, cable laying and associated infrastructure would generate temporary dust, noise, vibration and activity and may affect the foraging behaviour of local fauna species, particularly birds and macropods. Trenches required for the installation of cabling, predominantly within access roads, would present a trap hazard for local fauna for the time that they are open. Given the local abundance of similar habitat, this temporary effect on habitat utilisation is not likely to significantly affect local populations of these generally highly mobile species.

The concrete batch plants, construction activities using concrete and the storage and use of fuels, lubricants and construction chemicals carry a pollution risk.

In general, if the locations of works (including temporary activities such as concrete batching) are situated in already cleared areas or sparsely vegetated areas, biodiversity impacts should be low.

Management of fauna impacts during the construction phase would centre on the identification and protection from impact of key habitats, including threatened species habitat. The results of comprehensive surveying in the Stage 1 area have provided a good picture of key constraints for the entire turbine envelope; however some additional work would be required to adequately mitigate risks related to development of the Stage 2 site area.

Impact assessment – operation

The key operational impacts of the Proposal relate to the operation of the wind turbines. The potential blade sweep area of the turbines would range from approximately 34 to 155 metres above the ground depending on turbine selection. For example, a hub height of 100 metres and blade diameter of 100 metres would result in a blade sweep area from 50 to 150 metres above the ground. The impacts of the wind farm would be most acutely felt by those species utilising aerial habitat within the blade sweep zone: birds and microchiropteran bats. Other terrestrial fauna may be affected by turbine

noise and blade flicker although, given the low fauna diversity and abundance at the site, these impacts are likely to be minimal.

A qualitative risk assessment for birds and bats, combining assessments of likelihood and consequence, was carried out to produce a final risk rating of low, moderate or high risk for selected species. The assessment draws on the Interim Standards for Risk Assessment relating to birds and wind farms (Brett Lane and Associates 2005) and the Australian Standards for Risk Assessment (AS/NZS 4360) and Environmental Risk Management (HB203:2000). The risk assessment is summarised below for species rating moderate or higher risk rating.

Table 7.7 Overall impact risk for bird and bats (blade strike and avoidance impacts)

The risk assessment focuses on bird groups which have been shown to be at particular risk in studies at other wind farms (raptors, waterbirds, migratory species), as well as rare, threatened or protected birds and bats with potential to be present in the study area. They are listed in order of decreasing risk to a local population.

Species	Risk to individuals at site	Risk to local population
Wedge-tailed eagle	Moderate	Moderate–high
Brown falcon	Moderate	Moderate
Diamond firetail	Low	Moderate
Parrots: Superb parrot, turquoise parrot, scarlet-chested parrot, night parrot	Low	Moderate
Pink cockatoo	Low	Moderate
Ducks: blue-billed duck, freckled duck	Low	Moderate
Owls: Barking owl, masked owl, grass owl, barn owl	Low–moderate	Low–moderate
Bats: Yellow-bellied sheathtail-bat, inland forest bat, little pied bat	Low	Low–moderate

A series of mitigation measures have been formulated to address the potential operational impacts of the Proposal and these are detailed below:.

- Infrastructure placement should avoid the constraints identified in the Biodiversity Assessment (Appendix 3)
- Marker lights, if required should be minimised in number and fitted to reduce their ability to attract migrating birds and insects. Red lights are preferred, with the least number of flashes per minute. Cowls may also shield the light when viewed from the ground and reduce potential to attract wetland birds taking off at dusk. However, it is understood that aviation obstacle lighting will be required on a number of turbines in accordance with CASA standards (see 7.13.1 for further details).
- Guy lines should not be fitted to towers or associated structures, where practical.
- The turbine towers should not provide perching opportunities.
- Electrical connection lines should be installed underground where practical.
- Power poles and overhead power lines would be designed to reduce impacts to birds (for example by using flags or marker balls, large wire size, wire insulation, wire conductor spacing) in areas of elevated risk of bird strike.
- To reduce the attractiveness of the site to foraging raptors, rabbits and goats should be controlled onsite and carrion should be removed from beneath turbines as quickly as practical.

— An adaptive management monitoring program should be designed to document mortalities, remove carcasses and assess the effectiveness of controls. Timing should be specific to the most at-risk target species. Standardised and publicly available data should be collected to increase the knowledge base on this subject. If mortalities exceed a pre-determined threshold (set out in the monitoring program), additional mitigation measures should be considered, such as diversion structures, blade painting (refer Hodos *et al.* 2001), turning off turbines at critical times, further turbine ridge habitat modification and enhancement of off-site habitats.

— There would be benefits for several subject species in controlling heavy grazing by feral goats onsite. Implementation of a feral goat management program as part of the development of the wind farm site would assist in offsetting environmental impacts and halt the degradation that heavy goat grazing is causing across many areas of the site.

Impact assessment – decommissioning

Decommissioning impacts would be similar but not as extensive as construction impacts. The area of impact would be reduced because underground footings and cabling would not be removed from the site. Access tracks would be upgraded as required. The decommissioning phase of the Proposal may temporarily affect the use of habitat at the site by fauna, but is not expected to significantly affect local fauna populations in the medium to long term.

Transmission line route (site to Broken Hill)

Background

The wind farm background section above incorporates the transmission route to Broken Hill. Field surveys for Stage 1 included this area. The route is predominantly within the plains and ephemeral drainage lines habitats. Only one of the threatened fauna species was identified within the route, the pied honeyeater.

Impact assessment – construction

The routing of the transmission line is predominantly through plains from Mundi Mundi Creek, in the southeast. Again, this infrastructure would require a discrete loss of habitat including trees and shrubs. Vegetation is sparse in this landscape and the overall pattern and extent of clearing is unlikely to have an adverse effect on local fauna.

Several iterations of the power line route have been assessed all with the same type and degree of constraints. Mitigation has been developed specific to the need to retain some flexibility in the final route location. No measures additional to those described above are considered to be required.

Impact assessment – operation

The easement of the transmission route, once established, would require a maintenance program. Mitigation measures stated for the protection of native vegetation would similarly address fauna habitat impacts. One additional measure is considered to be required and has been added to the fauna mitigation table, Section 7.4.4 That is, power poles and overhead power lines should be bird-safe using flags or marker balls, large wire size, wire insulation, wire and conductor spacing, where practicable.

Transmission line route (Broken Hill to Red Cliffs)

Background

No fauna surveying has been undertaken for the transmission route however, fauna recorded incidentally during the transmission field assessment included:

— Nankeen kestrel

— Common wallaroo

— Pink cockatoo (listed as Vulnerable in NSW, recorded at E553522, N6343381)

— Mulga parrots

— Peregrine falcons (many nests in existing transmission towers).

Additionally, good potential habitat for mallee fowl, listed as Endangered in NSW and Vulnerable nationally, was observed at two locations (details provided in the full report, Appendix 4).

Impact assessment – construction

Field assessment of the transmission route identified several features of value to native fauna. Additional evaluation is required to consider thoroughly the potential for impact on all species listed as threatened with potential to occur within the works area. Based on the nature and scale of the works proposed, it is likely that impacts on threatened species would be manageable with the implementation of mitigation measures.

Impact assessment – operation

The easement of the transmission route, once established, would require a maintenance program. Mitigation measures stated for the protection of native vegetation during the operation of the transmission line (Section 7.4.4) would similarly address fauna habitat impacts. No additional measures are considered to be required.

7.4.4 Mitigation measures: Biodiversity

	Impact	Objective	Mitigation tasks	Project Phase	Site area-Stage 1	Site area-Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC17	Loss of biodiversity value	Avoid or minimise impact	Design infrastructure layout to minimise clearing. Confine works wherever practical to cleared or sparsely vegetated areas	Construction	X	X	X	X
SOC18	Loss of biodiversity value	Avoid or minimise impact	Use existing clearings wherever practical for materials lay down, stockpiling and the deposition and retrieval of spoil	Construction Decommissioning	X	X	X	X
SOC19	Loss of biodiversity value	Avoid or minimise impact	Implement weed and sediment erosion controls to minimise onsite habitat degradation resulting from the proposed works	Construction Operation Decommissioning	X	X	X	X
SOC20	Loss of biodiversity value	Minimise impact	Undertake site stabilisation and rehabilitation on completion of works as required	Construction Decommissioning	X	X	X	X
SOC21	Loss of biodiversity value	Minimise impact	Minimise works where practical during and immediately following heavy rainfall events to protect soils and vegetation	Construction Decommissioning	X	X	X	X
SOC22	Loss of biodiversity value	Minimise impact	Store excavated topsoil, subsoil and weathered rock on site and replace in a manner that approximates the original ground profile	Construction	X	X	X	X
SOC23	Loss of biodiversity value	Minimise impact	Replace at least 20 centimetres of cement-free fill as the top layer where cement is included in cable trench backfill	Construction	X	X		
SOC24	Loss of biodiversity value	Minimise impact	Source imported materials such as sand and gravel from sites which do not show evidence of noxious weeds or Phytophthora infection	Construction	X	X	X	X
SOC25	Loss of biodiversity value	Minimise impact	Undertake post-construction weed monitoring after the first significant rainfall event to ensure that no weed infestations have resulted from the works	Construction Decommissioning	X	X	X	X

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC26	Loss of biodiversity value	Minimise impact	Procure an appropriately qualified ecologist to assist in locating tracks, cabling routes and other infrastructure in the vicinity of the Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland identified on site	Construction	X	X	X	X
SOC27	Loss of biodiversity value	Minimise impact	Make contractors and staff aware of the threatened species that may occur within the site, by disseminating information during 'toolbox' talks, to minimise impacts should any become present	Construction Operation Decommissioning	X	X	X	X
SOC28	Loss of biodiversity value	Minimise impact	Minimise track width through Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland where practical. Strategies would include avoiding routes that require extensive cut and fill, and maximising the use of single lane access tracks. Establish clear demarcation (including signage) of the Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland to minimise work and access within this community	Construction	X	X	X	X
SOC29	Loss of biodiversity value	Minimise impact	Prepare and implement recovery plan for the Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland vegetation community which occurs onsite and the threatened reptile fauna which rely on it. This plan would aim to achieve a net gain within this ecological community	Operation	X	X		
SOC30	Loss of biodiversity value	Minimise impact	Prepare and implement a goat management plan across vegetation in the stage one area with a particular focus on porcupine grass/red mallee/gum coolibah/hummock grassland	Operation	X	X		
SOC31	Loss of biodiversity value	Avoid or minimise impact	Carry out further field work to ground validate the extent and condition of vegetation of conservation significance and threatened fauna in the stage 2 site area and stage 2 transmission corridor	Construction		X		X
SOC32	Loss of biodiversity value	Avoid or minimise impact	Carry out additional evaluation of the potential for impact on all flora and fauna species listed as threatened with potential to occur within the stage 2 site area and stage 2 transmission corridor	Construction		X		X
SOC33	Loss of biodiversity value	Avoid or minimise impact	Peg or otherwise delineate the boundaries of EECs in good condition and flora species listed as threatened which are in the vicinity of proposed works to minimise direct and indirect impacts in these areas	Construction Decommissioning	X	X	X	X
SOC34	Loss of biodiversity value	Avoid or minimise impact	Design transmission lines to minimise EEC impact. Strategies may include ensuring that the height of the transmission structure over EECs is sufficient to allow minimal impact on these communities, and making use of the existing cleared transmission easement to reduce the clearing required for the new line	Construction			X	X

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC35	Loss of biodiversity value	Minimise impact	Establish a Vegetation Management Plan to ensure that the ongoing maintenance of the transmission easement has minimal impact on the integrity of any EEC vegetation within the easement	Operation			X	X
SOC36	Loss of biodiversity value	Minimise impact	Maintain access tracks to minimise ongoing erosion and sedimentation impacts	Operation	X	X	X	X
SOC37	Loss of biodiversity value	Minimise impact	Confine maintenance access to existing tracks, hardstand or heavily disturbed areas	Operation	X	X	X	X
SOC38	Loss of biodiversity value	Minimise impact	Design site substations to ensure that the transformers are adequately bunded against any spill	Construction	X	X		
SOC39	Loss of biodiversity value	Minimise impact	Discuss options to reduce grazing pressures on EEC identified to be in good condition with existing landholders	Operation	X	X	X	X
SOC40	Loss of biodiversity value	Avoid or minimise impact	Avoid significant clusters of rocks and boulders where these provide shelter to threatened fauna. Where rocks and boulders cannot be avoided, they should be placed directly adjacent to the works area to preserve the availability of refuge	Construction	X	X		
SOC41	Loss of biodiversity value	Avoid or minimise impact	Avoid standing dead trees and woody debris where practical. Where they require removal to allow for the tracks and hardstand areas, they should be placed adjacent to the impact areas, to retain these refuges in the immediate area	Construction	X	X		
SOC42	Loss of biodiversity value	Avoid or minimise impact	Open trenches required for the installation of cabling for the minimal period practical. Check trenches at first light and remove any trapped fauna	Construction	X	X		
SOC43	Loss of biodiversity value	Avoid or minimise impact	Apply a buffer to mature hollow-bearing trees where practical to minimise indirect impacts (such as noise and dust)	Construction	X	X		
SOC44	Loss of biodiversity value	Avoid or minimise impact	Apply an appropriate buffer (50m) to identified Tawny Rock Dragon habitat to ensure that it is not adversely affected	Construction	X	X		

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC45	Loss of biodiversity value	Avoid or minimise impact	Design power poles to minimise perching and roosting opportunities where practical Design power poles and overhead powerlines to reduce impacts to birds (for example by using flags or marker balls, large wire size, wire insulation, wire and conductor spacing) in areas of elevated risk of bird strike	Construction	X	X	X	X
SOC46	Loss of biodiversity value	Avoid or minimise impact	Design and implement an adaptive management monitoring program to document bird and bat mortalities, remove carcasses and assess the effectiveness of controls. If the results of assessment demonstrate that further mitigation is required, undertake further turbine ridge habitat modification and enhancement of off-site habitats	Operation	X	X		
SOC47	Loss of biodiversity value	Avoid or minimise impact	Undertake an appropriate fauna assessment, pertinent to applicable legislation at the time of decommissioning	Decommissioning	X	X	X	X

7.5 HYDROLOGY (WATER, WATER QUALITY AND WATER-TABLE IMPACTS)

7.5.1 Assessment

Wind farm site

Background

The proposed wind farm is located within the Broken Hill Complex Bioregion. There are a number of ephemeral creeks that drain onto the lowland flats both east and west of the Barrier Ranges. In addition, there are a number of creeks, that drain directly and indirectly into the Umberumberka Reservoir; Umberumberka Creek, Lakes Grave Creek, Lakes Creek, Eldee Creek and Mundi Mundi Creek. These creeks are subject to local flooding events in periods of heavy rainfall.

There are two potential water supplies for water required during construction; the primary supply would be Umberumberka Reservoir and the secondary supply would be Stephens Creek Reservoir. Country Water administer surface water resources and have been consulted in relation to use of these resources. Although not a preferred option, should groundwater extraction be required to supplement surface water sources, appropriate investigations and subsequent approval from the *Department of Water and Energy under the Water Act 1912/Water Management Act 2000* would be sought prior to any groundwater extraction. As discussed, the nearest significant water body is the Umberumberka Reservoir, within the Umberumberka Creek Special Area, which is currently used as a water supply for Silverton and Broken Hill. The capacity of the Umberumberka Reservoir is 9,000ML (pers comm. Country Water 2008). It is located to the southwest of the proposed wind farm site (Figure 7.11). Records obtained from Country Water dating back to 1971 indicate that the reservoir has been empty eight times since its construction, with the longest period being 26 June 1981 to 2 March 1983. The most recent period in which the reservoir was empty was from 30 October to 12 December 2006.

The other major local water supply reservoir is the Stephens Creek Reservoir located approximately 12.5 kilometres northeast of Broken Hill. Water from the Stephens Creek Reservoir is transported via pipeline to a Country Water filtration plant in Broken Hill then to Silverton.

It is understood that the Umberumberka Reservoir would be an appropriate water source for the Proposal, predominately required during the construction phase.

A search of the Natural Resources Atlas website identified two groundwater bores in the vicinity of the study area that had standing water level (swl) information. Drillers log summaries, as detailed on the Natural Resources Atlas, is presented in Attachment 7. Groundwater bore locations are identified in Table 7.8 and Figure 7.11. It should be noted that there are a number of other bores located across the site, however these bores do not have information relating to standing water levels and have been omitted from the table below.

Table 7.8 Groundwater bore locations

Groundwater bore	Easting	Northing	Standing water level (swl)	Location
GW022270	537130	6492547	7.60 metres	Purnamoota Station
GW005658	524686	6495263	120.90 metres	West of proposed development envelope
GW010135	522797	6474146	2.40 metres	Immediately south of development envelope
GW022221	537156	6499628	15.20 metres	Immediately north of development envelope

There is also an underground water pipeline located within the proposed wind farm site. This pipeline currently supplies water from the Umberumberka Reservoir to Silverton and Broken Hill and has the potential to be tapped to access the required construction water.

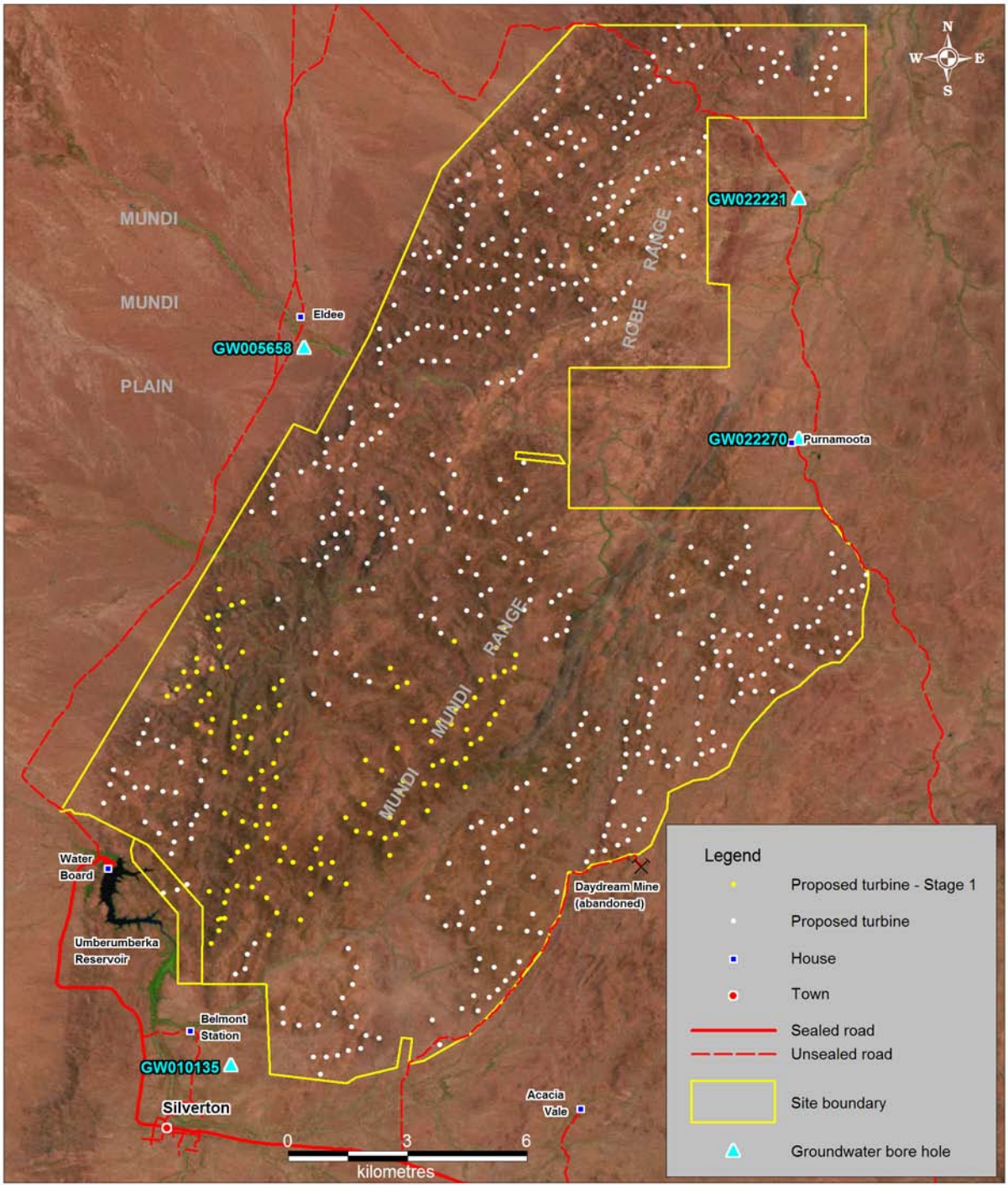

Figure 7.11 Groundwater bore locations

Impact assessment – construction

Direct hydrologic impacts relate to water extraction during construction. Indirect impacts relate to dust and sediment generation and pollution risk, which have the potential to affect water quality. Rock blasting also has the potential to affect the amount of water stored in perched aquifers, if present within the impact area.

At present, water supplied from the Umberumberka Reservoir is transported via a pipeline to Silverton and Broken Hill. It has been estimated that approximately 200 kilolitres per day of water would be required for the construction of the concrete footings for the turbines, control rooms and the substations. In addition, water or chemical treatment may be used on site access tracks in times of high wind to assist with dust suppression. It is proposed that water is sourced from the Umberumberka Reservoir for the duration of the construction period. Water pipeline infrastructure connected from the pipeline between the Umberumberka Reservoir and Broken Hill would be installed during the construction phase to transport the water either to the concrete batching plants and other areas at the site or to large tanks from where it would be transported to the location required

A number of creek/drainage line crossings would be required for access to and throughout the wind farm site during the construction and decommissioning phases. The construction and maintenance of these crossings have the potential to impact on water quality and hydrologic regimes. Some of these areas are subject to flooding.

Water would be reused where possible to reduce the amount required. No waste-water would be discharged into creeks and drainage lines during any phase of the Proposal. Water used for dust suppression would be used at a controlled rate to minimise runoff. It is considered that water used for dust suppression would infiltrate directly into the soil where it was released and thereby avoid transporting additional sediment into drainage lines. The amount of water that is to be drawn from the reservoir would be managed in consultation with Country Water to facilitate appropriate management of this resource. In the event of water extraction being restricted at Umberumberka Reservoir, Stephens Creek has been identified as an alternate water source for the Proposal.

As Umberumberka Reservoir is a primary drinking water supply, the importance of managing sediment and nutrient input from runoff is magnified. The majority of the works are concentrated away from the reservoir and drainage lines; however, the topography within the southern area of the site is steep and susceptible to erosion. Chemicals that could pollute waterways (such as hydrocarbons) would be used throughout the construction phase and some of the construction activities would occur within a few hundred metres of the reservoir and other drainage lines. This is particularly relevant to areas of road works, where they are in close proximity to drainage lines within the catchment of the Umberumberka Reservoir. Therefore, there is the potential for sediment or pollutant-laden runoff to enter local drainage lines and be transported to Umberumberka Reservoir during wet weather. Construction materials such as fuels, alkaline concrete wash, concrete products, concrete-curing compounds and soil additives used for stabilisation, when used or stored improperly, can become mixed with stormwater and carried by sediment and runoff from construction areas. Eutrophication of surrounding waters could also occur from nutrient release from sediments as a result of erosion and release of turbid waters during construction. Dust, erosion and potential pollutants (hydrocarbons, cement and aggregates) would require careful management.

The installation of wind turbine infrastructure would be focussed in high elevation areas, avoiding drainage lines. The concrete batching plant would be located on elevated land away from drainage lines or securely bunded to contain all materials in the event of high rainfall events.

Rock blasting may be required to establish footings for the turbines, control rooms and substations. This activity has the potential to affect the integrity of perched aquifers and alter the hydrology of the site. Several rock overhangs and mine shafts are present within the wind farm site and may also be affected by blasting. The Barrier Ranges are known to store water from runoff. It is understood that this water supplies springs and wells in the locality.

Existing tracks would require upgrades (approximately 76 kilometres). In addition, new tracks would be required (approximately 378 kilometres) to facilitate access between the turbines. A number of small to medium drainage lines traverse the wind farm site. Therefore, there would be a need to construct crossings at drainage lines.

The majority of the creeks and drainage lines are ephemeral in nature. Although they are dry for extended periods, peak flow events would need to be considered.

There is also potential for the underground water pipeline to be impacted during the construction phase of works by being ruptured by construction activities including excavation.

Based on information obtained from the Natural Resource Atlas, regionally, the groundwater table is likely to be well below ground surface, particularly at the turbine sites that are proposed for construction on the more elevated ridges of the Barrier Ranges. Groundwater bores at four sites in the vicinity of the proposed wind farm site provided indicative information describing standing water levels, Table 7.8. The standing water levels from these two bores indicate that ground water on the ridges of the Barrier Ranges is well below ground level. The standing water level at bore GW005658 was measured to be 120.9 metres below the ground surface. Additionally, GW022270 which is located on Purnamoota Station had a measured standing water level of 7.6 metres below ground surface. Purnamoota Station is located on relatively flat land with Purnamoota Creek located in the close vicinity. It is considered that for the blasting planned in areas of relatively high topographical relief, the potential impact to groundwater would be negligible due to the likely depth to groundwater. The potential to impact groundwater is increased when blasting activities are planned in areas closer to the plains and flat lands at the base of ranges. The potential impacts to regional groundwater would be assessed in a detailed geotechnical assessment undertaken to determine ground conditions for detailed footing design for turbines.

The construction of the turbines is unlikely to require water sourced from groundwater. Although considered very unlikely, should water need to be extracted from a source additional to Umberumberka Reservoir for use during the construction phase, appropriate investigations and approvals would be sought from the NSW Department of Lands prior to any water being extracted.

It is considered that construction and decommissioning works associated with the Proposal would not alter the recharge rate of any rainfall that may enter the groundwater system.

As the Proposal would not be altering the existing groundwater supplies within the wind farm site, it is considered that impacts to Groundwater Dependent Ecosystems would be negligible.

The guiding principle of the development with regard to water quality is to have neutral or beneficial impact. The Proponent would consult with Country Water on the scope of any further work to be undertaken in relation to the Umberumberka Creek Special Area. Effective implementation of mitigation measures would improve water quality onsite by arresting erosion. Combined with more intensive management of goats onsite (discussed in Section 7.4), which would allow increased native vegetation recruitment, these measures should result in a net gain in terms of water quality onsite.

Impact assessment – operation

The operation of the wind farm and associated infrastructure would likely require only minimal traffic for ongoing monitoring and maintenance activities. These activities would not require the construction of any new roads or access tracks in addition to those developed during construction. Water tanks may be installed to collect rainwater from the control buildings, in order to supply water for staff facilities. If required, water for fire management may be located at a small number of locations around the site. No additional water connections are required. Septic systems may be installed in the control buildings. These would meet appropriate Australian Standards. Infrastructure, including the substation and turbines, would be bunded to ensure that oil and other chemicals could not escape. Potential hydrological impacts are considered to be negligible. The effective implementation of construction phase mitigation measures are considered sufficient. For the operation and maintenance of the wind farm, all tracks would be maintained as required in line with the OEMP. It is considered that no additional mitigation measures to those described in the construction section above are considered to be required.

Transmission line route (site to Broken Hill)

Background

The area for the transmission line from the wind farm site to Broken Hill is located within the Broken Hill Complex Bioregion. The area for the proposed transmission line to Broken Hill is located predominately within the Lake Frome Catchment (DECC 2003). There are no major rivers within the Lake Frome Catchment; however there are a number of creeks and drainage lines throughout the Barrier Ranges and on the Mundi Mundi Plain. It is understood that these creeks and drainage lines may fill with water during large rainfall events.

Impact assessment – operation

A number of small to medium drainage lines traverse the transmission line route to Broken Hill. There would be a need to construct crossings at drainage lines where vehicle access is required. The majority of the creeks and drainage lines are ephemeral in nature. Although they are dry for extended periods, peak flow events would need to be considered.

Transmission line route (site to Red Cliffs)

Background

The area for the transmission line to Buronga and Red Cliffs is located within two bioregions: the Broken Hill Complex Bioregion in the north and the Murray-Darling Depression Bioregion in the south. There are two major river systems, both located within the Murray-Darling Depression Bioregion, the Murray River and the Darling River including the Darling River Anabranch. Additionally, some areas in the vicinity of the proposed route of the transmission line to Buronga are subject to flooding.

Groundwater information in the general area of the proposed transmission line was obtained from the NSW Natural Resources Atlas. Results from this search indicated that the standing water levels were generally deeper in the north, becoming shallower further south, particularly close to rivers.

Impact assessment – construction

A number of creek/drainage line crossings would be required for access to the transmission easement during the construction phase. The construction and maintenance of these crossings have the potential to impact on water quality and hydrologic regimes. Some of these areas are subject to flooding.

The proposed transmission line would cross the Great Darling Anabranch, Darling River and Murray River. Construction activities associated with the transmission line have the potential to impact these three rivers. Further investigation based on the final engineering design would be undertaken to assess the potential impacts. This assessment would inform erosion and sediment control plans for these construction works. The transmission line is proposed to be overhead and therefore there is not expected to be any impact to the flow regime of the each of these three rivers.

The proposed construction of the transmission line infrastructure is not anticipated to intersect any aquifers. In addition, similar to the proposed construction of the turbines, the construction of the transmission line infrastructure would not require the extraction of groundwater from purpose-built bores, nor would the construction of the transmission line infrastructure likely alter the volume of recharge into the surrounding groundwater system. It is considered that impacts to groundwater as a result of the construction of the transmission line infrastructure would be manageable.

Impact assessment – operation

The maintenance of the transmission line corridor may require clearing activities. This would require minimal traffic. These activities would not require the construction of any new roads or access tracks in addition to those developed during construction. Potential hydrological impacts are considered to be negligible.

7.5.2 Mitigation measures

	Impact	Objective	Mitigation tasks	Project phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC48	Deterioration of water quality	Minimise risk	Consult with Country Water on the scope of all further work to be undertaken in relation to the legislative requirements associated with the works in the Umberumberka Creek Special Area Undertake detailed geotechnical investigations to ensure that the project would have no material adverse effect on groundwater/aquifers Identify important springs and other water sources through consultation with leaseholders	Construction	X	X		
SOC49	Deterioration of water quality	Minimise risk	Establish a Sediment/Erosion Control Plan including the following provisions: – Install sediment traps wherever there is potential for sediment to collect and enter waterways – Bund stockpiles generated as a result of construction activities with silt fencing, (hay bales or similar) to reduce the potential for runoff from these areas – Establish soil and water management practices guided by the Best Practice guidelines contained within Soils and Construction Vol. 1 (Landcom 2004) – Ensure all vehicles onsite follow established access tracks and minimise onsite movements – Operate and maintain machinery in a manner that minimises risk of hydrocarbon spills	Construction Decommissioning	X	X	X	X
SOC50	Deterioration of water quality	Minimise risk	Prepare a Site Restoration Plan including protocols for restoration works such as: – Site preparation – Site stabilisation – Measures to encourage native vegetation recruitment – Monitoring	Construction Decommissioning	X	X	X	X
SOC51	Deterioration of water quality	Minimise risk	Carry out dust suppression as required through either watering or chemical means (environmentally friendly polymer based additives to the water).	Construction Decommissioning	X	X	X	X

	Impact	Objective	Mitigation tasks	Project phase	Site area-Stage 1	Site area-Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC52	Deterioration of water quality	Minimise risk	Incorporate spill control procedures in the CEMP and OEMP including: – Identify persons responsible for implementing the plan if a spill of a dangerous or hazardous chemical/waste should occur – Locate Material Safety Data Sheets (MSDS) for all chemical inventories on site and readily available – Comply with manufacturers recommendations in relation to application and disposal where chemicals are used – Report any spill that occurs, to the Construction Manager regardless of size or type of spill – Notify the NSW EPA should the spill or hazard reach surface waters – Identify and bund chemical/fuel storage areas to prevent loss of any pollutants – Establish clearly defined works and refuelling areas – Store adequate hydrocarbon spill kits at the site and train site staff in their use	Construction Operation Decommissioning	X	X	X	X
SOC53	Deterioration of water quality	Minimise risk	Design water crossings to prevent impact on existing banks, water flow, animal passage and on the movement of substrate flows (sand moving through the channel). Strategies may include gabion baskets excavated to near ground level, which would facilitate heavy loads without trapping sand carried during high rainfall events	Construction	X	X	X	X
SOC54	Destruction of infrastructure	Minimise risk	Identify and mark out the underground pipe line that currently supplies water from the Umberumberka Reservoir. No excavation works would be undertaken within a specified (10m) buffer of the identified pipe line without the consent of Country Water	Construction Decommissioning	X	X	X	X
SOC55	Deterioration of water quality	Minimise risk	Design of concrete batching plants would ensure concrete wash would not be subject to uncontrolled release. Areas of the batching plants would be bunded to contain peak rainfall events and remediated at the completion of the construction phase	Construction	X	X		
SOC56	Deterioration of water quality	Minimise risk	Monitor and maintain all sediment and erosion controls implemented during the construction phase along the access tracks	Construction Operation Decommissioning	X	X	X	X

	Impact	Objective	Mitigation tasks	Project phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC57	Deterioration of water quality	Minimise risk	Monitor bunded infrastructure to ensure that the amounts of oil could be fully contained in the event of a leak	Operation	X	X		
SOC58	Deterioration of water quality	Minimise risk	Maintain septic systems, if installed, to meet appropriate Australian Standards	Construction Operation Decommissioning	X	X		

7.6 TRAFFIC AND TRANSPORT

7.6.1 Approach

A Traffic Impact Study was prepared by Bega Duo Designs (February 2008) assessing the potential traffic implications that may arise as a result of the construction of all stages of the Proposal (attached in full, Appendix 5). The Traffic Impact Study report was completed in accordance with the Guide to Traffic Generating Developments as recommended by the NSW Roads and Traffic Authority (RTA). The report provides recommendations for the minimisation of potential traffic impacts during the construction and operation of the proposed wind farm. It is considered that potential traffic impacts are likely to be primarily associated with the construction phase and as such the study focussed on this phase.

7.6.2 Assessment

Wind farm site

Background

The majority of the wind farm Proposal is located within the unincorporated area of western NSW, administered by the Department of Lands, Western Division. The roads, shown in Figure 7.12, in the unincorporated area can be considered in three groups:

- **Classified roads maintained by the NSW Roads and Traffic Authority (RTA).** These roads are generally sealed and in good condition. Classified roads include Silverton Road (M.R. 81), Silver City Highway (S.H. 22) and Barrier Highway (S.H. 8)
- **Unclassified roads maintained by the NSW RTA.** These roads are generally unsealed roads for public use and include the road through Eldee Station, Daydream Mine Road, part of Purnamoota Road and Stephens Creek Road
- **Property access roads**, which are the responsibility of the lessee.

Broken Hill City Council administers the roads and road reserves within their Local Government Area which includes part of the Purnamoota Road, as far as the Living Desert Reserve (approximately 10 kilometres northwest of Broken Hill). The Silver City Highway is the main road in the area for the proposed transmission line and would likely act as the access and haulage road for the area. There are also a number of smaller, generally dirt roads along the Silver City Highway that would facilitate access to the transmission line site.

A number of specific routes were considered for their feasibility to be used as haulage routes: the Barrier Highway, Silver City Highway, the road train route on the Barrier Highway from Wentworth, the Silverton and Eldee Station Route, the road to Daydream Mine, the Nine Mile Road route to Purnamoota Station, and Stephens Creek Road. For these routes, constraints were assessed. Existing traffic volumes for these routes were determined to understand their capacity. Predicted daily traffic rates were calculated to model the traffic volumes during construction (presented in full, Appendix 5).

The road capacity (primarily described as 'level of service') was then assessed for each route. The level of service is based on Austroads' 'Guide to Traffic Engineering Practice, Part 2 Roadway Capacity'. Capacity is expressed in total vehicles per day. The level of service descriptions are presented in Table 7.9.

Table 7.9 Level of service (LOS) descriptions

LOS A :	Free-flow condition, high degree of freedom for drivers to select desired speed and manoeuvre within traffic stream
LOS B :	Zone of stable flow. Reasonable freedom for drivers to select desired speed and manoeuvre within traffic stream
LOS C :	Zone of stable flow. Restricted freedom for drivers to select desired speed and manoeuvre within traffic stream
LOS D :	Approaching unstable flow condition. Severely restricted freedom for drivers to select desired speed and manoeuvre within traffic stream
LOS E :	Condition close to capacity. Virtually no freedom for drivers to select desired speed and manoeuvre within traffic stream. Small increases in flow would generally cause operational problems

All routes were categorised as LOS A:

- Silverton Road route, at approximately 210 vehicles per day (vpd) operates at LOS A and would not reach LOS B until the volume reaches 1800vpd. The estimated maximum design volume (see Section 4.4 of the Traffic Impact Study) is 460vpd.
- Nine Mile Road at approximately 60vpd operates at LOS A and would not reach LOS B until the volume reaches 1800vpd. The estimated maximum design volume (see Section 4.4 of the Traffic Impact Study) is 520vpd.
- The impact of an additional 290vpd on the highways and heavy vehicle routes through Broken Hill is considered to be minor
- All other roads with lower traffic volumes (less than 100vpd) would operate at LOS A and would not reach a lower level of service until the volume reaches approximately 700vpd. The estimated maximum design volume (see Section 4.4 of the Traffic Impact Study) is 360vpd.

The above determinations are based on two-lane, two-way rural roads in rolling terrain and the whole of the predicted maximum design volume which has been applied to each road separately to model the 'worst case' scenario. This indicates that the anticipated volume of traffic for each route is within its capacity.

Concrete batching plants would be located on the wind farm site (Figure 3.19), which would reduce the number of vehicles carrying raw materials to the wind farm site. For the purpose of the traffic assessment it was assumed that the traffic for the northern section of the wind farm would access the site via:

- Nine Mile Road from Broken Hill to Purnamoota Station or
- Silver City Highway and Stephens Creek Road to Purnamoota Station

with access for the southern section via:

- Silverton Road (Brookfield Avenue, Horslington Drive) and Daydream Mine Road or
- Silverton Road (Brookfield Avenue, Horslington Drive) to Umberumberka Reservoir and UR4 towards Eldee Station.

As the traffic study was undertaken prior to the community consultations and electrical study results being known, alternative routes enabling the site to be connected internally where feasible had not been developed. Such internal linkages have now been identified to enable the construction traffic to be minimised along the Purnamoota Road and through Silverton in line with the stated desires of the community.

Decisions on the final road routes to the site entrance would be the subject of negotiations between the haulage contractor and the road authorities.

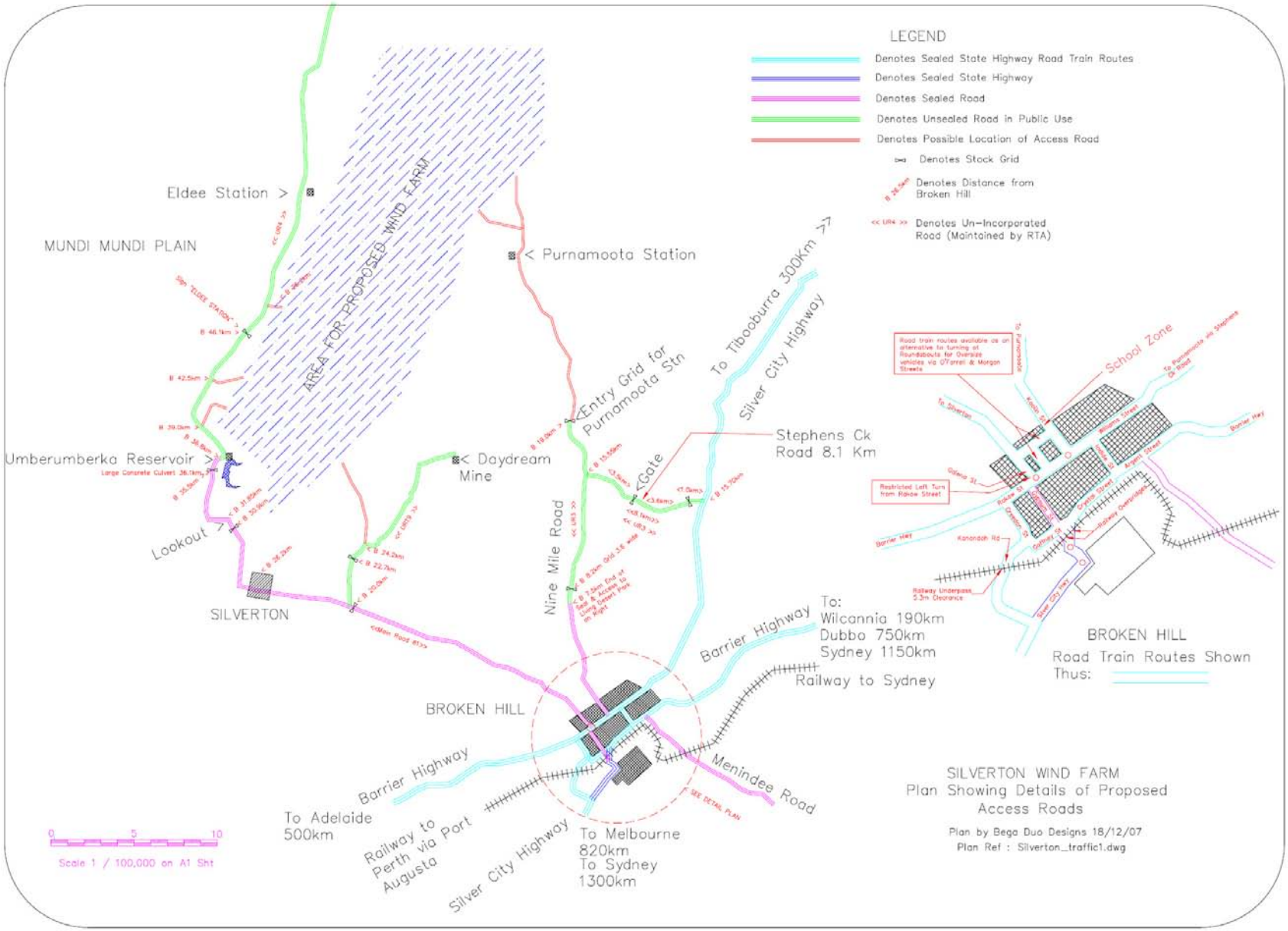

Figure 7.12 Site location and relevant access roads

Impact assessment – construction

The key traffic impacts associated with the Proposal would be focused in the construction and decommissioning phases, when large volumes of equipment would be transported along local roads. A range of potential impacts to these routes need consideration due to the potentially large increase in the number of vehicles.

The low standard of horizontal and vertical alignment would likely assist in controlling speed on many sections; however, isolated curves between higher speed sections could increase the risk of vehicles losing control. The location of trees and other roadside objects have the potential to obstruct the passage of long, wide loads and high loads. Lack of roadside delineation in some locations may impact traffic safety during periods of poor visibility.

Larger vehicles would occupy the majority of the road width at many locations thus increasing the chance of 'head on' collisions. Traffic noise and dust nuisance for property owners and a need to control stock from straying on the roads that are not fenced are other potential impacts that would require management.

It is considered that the gravel road surfaces would likely deteriorate, forming potholes under increased traffic loads, particularly during wet weather when water ponds or floods across the road. The NSW RTA would close the unincorporated roads if traffic is likely to damage the gravel surface during rain periods. Dust would be generated on the unsealed roads affecting visibility and resulting in the loss of pavement materials. Structural damage may occur to some of the culverts, concrete causeway crossings, stock grids and traffic islands as a result of the increased traffic conditions.

The routes through Broken Hill are likely to impact local residents particularly during the passage of heavy vehicles. Increased noise and traffic delays could occur during the passage of vehicle convoys. Any increase of traffic in school zones has a potential impact on pedestrian safety in Broken Hill. There is no longer a school in Silverton.

There are a number of intersections that have inadequate pavement width to safely accommodate the turning manoeuvres of over-sized vehicles.

It is considered that the introduction of an additional 250 vehicles per day for approximately five years would be likely to have an impact on the existing road users adjacent to the site, particularly on the unsealed roads. As the area in the vicinity of the proposed wind farm is sparsely populated with a relatively small number of potential road users, these impacts are considered manageable. Road closures would occur during rainfall events which may impact on turbine construction schedules as well as on local traffic. It is considered that traffic impacts to sealed roads in and around Broken Hill would be minimal.

These impacts would be confined to the construction phase, as the equipment haulage is not a continuous program. The majority of heavy haulage would be in the form of convoys and would be managed through a number of specific mitigation measures developed and implemented in conjunction with both RTA and local councils.

Adoption of safeguards for minimising traffic impacts for the sealed and unsealed roads should reduce community disruption and the risk of traffic accidents to an acceptable level and minimise structural and environmental damage.

Impact assessment – operation

Once operational, the wind farm would be managed and operated by several crews of technicians, likely to be based at Broken Hill. The wind farm would be accessed regularly for operational and maintenance activities. It is estimated that the operational phase would generate up to 24 trips per day on each route.

It is considered that the operational wind farm may generate tourist traffic on the roads surrounding the Proposal site. Anecdotal information obtained from Tourism Broken Hill indicated that Broken Hill is currently visited by approximately 300,000 tourists per annum. In addition, Tourism Broken Hill indicated that it is likely that a large per centage of the tourists would visit Silverton as it is highly promoted in tourist information (Silverton Road has approximately 210 vehicles per day). It has been observed that many visitors travel to the Mundi Mundi Lookout, five kilometres west of Silverton, for a view of the Mundi Mundi Plains. Some travel on to the Umberumberka Reservoir. Few visitors travel further than this on the unsealed gravel road. The Daydream Mine also attracts some visitors. This tourist traffic may share the initial four kilometres of Daydream Mine Road with wind farm construction traffic.

The proposed wind farm would generate interest as a visual feature in the Silverton/Broken Hill area. However it is considered that this would not significantly increase the number of tourists visiting Broken Hill and therefore the increase in traffic volumes and subsequent impacts on the Silverton route are likely to be low. It is likely that many visitors would stop beside the roadside before arriving at Silverton to view the wind farm possibly causing a disruption to through traffic. The number of tourists visiting the Mundi Mundi Lookout west of Silverton may increase as the wind turbines along the Barrier Range would be highly visible.

Transmission line route (site to Broken Hill)

Background

The Traffic Impact Study assessed the potential traffic implications that may arise as a result of the construction of all stages of the Proposal (attached in full, Appendix 5). No additional issues relate specifically to the transmission line corridor from the wind farm to Broken Hill.

Impact assessment – construction/operation

The Traffic Impact Study assessed the potential traffic implications that may arise as a result of the construction of **all stages** of the Proposal (attached in full, Appendix 5). No additional mitigation measures relate specifically to the transmission line corridor from the wind farm to Broken Hill.

Transmission line route (site to Red Cliffs)

Background

The Silver City Highway, state highway 22 runs in a general north–south direction linking Broken Hill with Wentworth and Buronga in NSW. It is administered by the NSW RTA. It is likely that this highway would be utilised for construction and operational maintenance traffic to access the proposed transmission line between Broken Hill, Buronga and Red Cliffs substations. In addition, it is likely that some access would be required on the Sunraysia Highway to Red Cliffs (approximately 16 kilometres south of Buronga) which is administered by the Victorian Roads Corporation (Vicroads). The Silver City Highway between Broken Hill and Wentworth, from which the majority of the transmission line would likely be accessed, is approximately 275 kilometres long. Being a state highway and an approved route for the operation of road trains, the road is maintained to a high structural and geometric standard. The route is therefore appropriate as the primary access to the transmission line during its construction and operation.

The topography of the land on which the highway is located is generally undulating to flat resulting in a relatively straight road alignment with a high standard of vertical alignment. Safe travel speeds are in excess of 100 kilometres per hour with many overtaking opportunities available with current traffic volumes. The relatively flat topography along the route generally results in adequate safe intersection sight distances at existing road junctions. The road pavement provides 3.5-metre lanes in each direction with sealed shoulders and painted edge lines. Permits from the RTA are required for over size and over mass to ensure that pavement damage does not occur therefore upgrading of the road pavement is considered unlikely. Annual Average Daily Traffic (AADT) data obtained from the NSW RTA website suggests that the highway has enough capacity to accommodate the expected increase in traffic particularly during the construction phase. AADT data is presented in Table 7.10. The highest level of service (LOS A) is obtained when a road user is permitted a high degree of freedom to select desired speed and manoeuvre within the traffic stream. It is envisaged that these conditions would continue on the Silver City Highway while the AADT remains less than approximately 2400. Lower levels of service are acceptable in urban areas along the route (where the higher AADT has been recorded) and unstable flow (LOS D) would not occur on a two-lane, two-way section until the AADT reaches 7900 (ref. Guide to Traffic Engineering Practice, Part 2).

Table 7.10 AADT data for selected locations along the Silver City Highway

Traffic station location	Year	AADT	Year	AADT
Broken Hill – south of Bonanza St	1999	2574	2002	2745
Broken Hill – south of Eyre St	1999	371	2002	387
Buronga – North of Sturt Highway	2000	1675	2003	1771

There is a large number of existing property roads that could be utilised as access roads for traffic during the construction of the proposed transmission lines. These roads are predominately dirt roads and would likely assist traffic in gaining access to the proposed transmission line easement. It is understood that the majority of these roads are public access roads that have the potential to be used for access during construction.

Impact assessment – construction

The impact assessment has been completed based on a desktop of review of the likely main access route, the Silver City Highway. The transmission line corridor and easement has not been finalised, although at this stage it is planned for the new transmission line to be constructed adjacent to the existing line. It is considered that the construction phase of the proposed transmission line would likely lead to the majority of the potential impacts. It is understood that operational maintenance vehicles would be able to access the transmission lines via an internal track to be made as part of the construction phase.

The likely potential impacts associated with using the Silver City Highway as access during construction for the proposed transmission lines are considered to be the safe intersection sight distances, turning radii at intersections, the high speed of highway traffic and debris being deposited on the sealed road.

Safe intersection sight distance would be required for proposed intersections from the primary road, Silver City Highway to the secondary roads. Safe intersection sight distances can be restricted by roadside vegetation and topography of the land. As discussed, the topography of the land is generally flat and the highway is relatively straight which decreases the potential for unacceptable sight distances both to and from the side roads.

The turning radii of the proposed intersections are required to be of sufficient size that a turning heavy vehicle does not cross onto the opposite lane of traffic when executing a turn to or from the side road.

The current speed limit for the majority of the Silver City Highway is 110 kilometres per hour. Construction and operational vehicles turning from the Silver City onto access roads may hinder traffic travelling at high speed. The speed differential may produce unsafe manoeuvres by through vehicles attempting to maintain their high speed.

The surface of some construction tracks may consist of clay sections that would be carried on to the sealed roads by construction traffic during wet weather producing a potential safety impact when dislodged at high speed.

Impact assessment – operation

There would be a requirement for crews of service technicians to access the proposed transmission line for ongoing maintenance. These crews would likely use the private access track used for construction works and, as such, the impact to the Silver City Highway as a result of the ongoing operation of the transmission line would be negligible.

No mitigation measures have been described for the ongoing operation of the transmission line.

Table 7.11 Recommended route-specific mitigation measures

Specific route	Description	Mitigation measures
Barrier Highway	The roundabout at Galena Street gives access to Main Road 81 (to Silverton). The left turn from the Barrier Highway is of insufficient width to be negotiated by oversize vehicles in safety. Convoys of oversize vehicles would generate noise and traffic delays	Road trains negotiating the left turn at O'Farrell Street (one street to the west) is available as an alternative route. Haulage contractors should consider this route in their planning Residents along the road train routes should be informed when convoys are expected via a public information program
Silver City Highway	The roundabouts at South Broken Hill may restrict turns by oversize vehicles	Haulage contractors need to consider this in their planning
Silverton Road	Increased vehicle movements particularly by heavy vehicles increase the potential of vehicle conflicts. Visiting motorists may be distracted by the view of the proposed wind farm	Visitor information facilities should be provided along Silverton Road between Broken Hill and Silverton and at the existing lookout site west of Silverton
Eldee Station route west of Umberumberka Reservoir	The gravel road north from Umberumberka Reservoir is closed during wet weather. Existing road users could experience increases in traffic flow during the construction phase. Increased traffic can accelerate road deterioration particularly during wet weather causing road closure. This road is the only vehicular access for a large area west of Broken Hill and additional closures may have significant economic and social impacts to residents. Increased traffic would require residents and regular users to be exposed to an increased dust hazard. As the road is not fenced, potential hazards exist from straying stock and native animals	The existing road should be reconstructed and sealed along the length that is required for access Establish speed limits and erect warning signs for potential hazards along the route
Daydream Mine Road from Silverton Road to proposed access point	The gravel road from Silverton Road to the preliminary access point (4.2km) is occasionally closed due to wet weather. Existing road users to Daydream Mine could experience large increases in traffic during the construction phase. Increased traffic can accelerate the road deterioration particularly during wet weather causing road closure. This road is the only access to the Daydream Mine, which is a popular tourist destination and road closures may have an economic impact on their business. Increased traffic would require road users to be exposed to an increased dust hazard. The existing track junction point has insufficient sight distance towards the Daydream Mine Road	The existing road should be reconstructed and sealed along the length required for access The road junction at the access point requires reconstruction, including relocation towards the east Establish speed limits and erect warning signs for potential hazards along the route
Purnamoota route junction with Barrier Highway at Kaolin Street	The roundabout at Kaolin Street could have insufficient width to be negotiated by some oversize vehicles in safety. Convoys of oversize vehicles would generate noise and traffic delays	A road train route turning into O'Farrell Street (four streets to the east) is available as an alternative route. Haulage contractors need to consider this route in their planning Residents along the road train routes should be informed when convoys are expected via public information program

Specific route	Description	Mitigation measures
Nine Mile Road from Broken Hill to the Living Desert Park	A school zone with a median pedestrian refuge is located along this route. Heavy traffic would generate potential conflicts with pedestrians	Residents along the road train routes should be informed when convoys are expected via public information program
Nine Mile Road from Living Sculpture Park to Purnamoota Station	This gravel section of the road is occasionally closed due to wet weather. Existing road users could experience increases in traffic during the wind farm construction phase. Increased traffic can accelerate the road deterioration particularly during wet weather causing road closure. Increased traffic would require road users to be exposed to an increased dust hazard	The existing gravel road should be reconstructed and sealed Establish speed limits and erect warning signs for potential hazards along the route
Stephens Creek Road	This gravel road is frequently closed due to wet weather. Stephens Creek Road is suggested as an alternative to Nine Mile Creek Road for access to Purnamoota Station. If this route is adopted, existing road users could experience large increases in traffic during the construction phase of the wind farm. Increased traffic can rapidly accelerate the road deterioration, particularly during wet weather causing road closure. Increased traffic would require road users to be exposed to an increased dust hazard. As the road is not fenced, potential hazards exist from straying stock and native animals	The existing gravel road should be reconstructed and sealed if it is adopted as the major access route Establish speed limits and erect warning signs for potential hazards along the route

7.6.3 General mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC59	Safety and asset protection	Minimise risk	Develop and implement a Traffic Management Plan (TMP) in consultation with roads authorities to facilitate appropriate management of potential traffic impacts. The TMP would include provisions for: – Scheduling of deliveries and managing timing of transport through Broken Hill to avoid peak hours (beginning/end of the school day) – Limiting the number of trips per day – Undertaking community consultation before and during all haulage activities – Designing and implementing temporary modifications to intersections and street furniture – Installing required signage to direct traffic flows appropriately during haulage through Broken Hill The erection of warning signs and/or advisory speed posting prior to isolated curves reinstating pre-existing conditions after temporary modifications to the roads and pavement along the route	Construction Operation Decommissioning	X	X	X	X

	Impact	Objective	Mitigation tasks	Project Phase	Site area-Stage 1	Site area-Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC60	Safety and asset protection	Minimise risk	Use a licensed haulage contractor with experience in transporting similar loads, responsible for obtaining all required approvals and permits from the RTA and Councils and for complying with conditions specified in those approvals	Construction	X	X	X	X
SOC61	Safety and asset protection	Minimise risk	Adopt route-specific mitigation measures as appropriate based on guidance provided in the attached Traffic impact study	Construction	X	X	X	X
SOC62	Safety and asset protection	Minimise risk	Establish procedures to ensure that soil is not carried onto the highway on the wheels of construction traffic	Construction	X	X	X	X
SOC63	Safety and asset protection	Minimise risk	Provide a contact phone number to enable any issues or concerns to be rapidly identified and addressed, through appropriate procedures	Construction	X	X	X	X
SOC64	Safety and asset protection	Minimise risk	Prepare road dilapidation reports covering pavement and drainage structures in consultation with roads authorities for the route prior to the commencement of construction and after construction is complete Repair any damage resulting from the construction traffic (except that resulting from normal wear and tear) as required during and after completion of construction at the Proponent's cost or, alternately, negotiate an alternative for road damage with the relevant roads authority	Construction	X	X	X	X
SOC65	Safety and asset protection	Minimise risk	Assess the geometric layout of proposed intersections along the Silver City highway to ensure adequate turning paths are available to allow safe turning for construction vehicles For any intersection determined to be unsuitable, identify mitigation strategies included intersection widening in consultation with the roads authority	Construction	X	X	X	X
SOC66	Safety and asset protection	Minimise risk	Upgrade and seal the initial section of Daydream Mine Road and negotiate with roads authority to place a speed restriction on the road consistent with Silverton Road (90km/h)	Construction	X	X		
SOC67	Safety and asset protection	Minimise risk	To the extent that it will be extensively used for site access, upgrade and seal the initial section of Eldee Road and negotiate with roads authority to place a speed restriction on the road consistent with Silverton Road (90km/h)	Construction	X	X		
SOC68	Safety and asset protection	Provision of information	Provide information signage about the project at the Mundi Mundi lookout 5km west of Silverton and on the Silverton Road in the vicinity of Daydream Mine Road	Construction	X	X		

7.7 INDIGENOUS HERITAGE

7.7.1 Approach

An Indigenous Heritage Assessment was undertaken by NSW Archaeology for the proposed Silverton Wind Farm. This included a detailed assessment of the Stage 1 works area, with a subsequent desktop review of the Stage 2 area, including the proposed transmission line from Broken Hill to Red Cliffs.

The assessment of the Stage 1 area has sought to identify and record the presence of Aboriginal objects and Non Indigenous heritage items in the proposed impact areas, to assess the archaeological potential of the landform elements present and to formulate management recommendations based on the results of background research, a field survey and site significance assessment.

The New South Wales Department of Environment and Climate Change (NSW DECC) Aboriginal Heritage Information Management System (AHIMS) search indicates that there are a number of previously recorded sites located within the Stage 1 area (AHIMS #20121 and AHIMS #20122: 26 September 2007).

The field survey encompassed the majority of the proposed impact areas associated with the Stage 1 Proposal. Areas not subject to a direct field inspection were subject to a predictive modelling assessment based on an extrapolation of survey results.

A landscape-based approach and methodology has been implemented for the survey and assessment conducted during this study. The Proposal area has been divided into a number of Survey Units, each of which has been defined on the basis of a combination of environmental variables. These areas have been defined according to landform element, gradient and aspect. Survey Units are utilised as a framework for artefact recording and analysis.

7.7.2 Assessment

Wind farm site

Background

The Proposal area falls within the Barrier Ranges archaeological region as defined by Witter (2004). This region has been subject to very few previous archaeological investigations and accordingly is not well understood. Given that the environmental context is semi-arid, and the Proposal area is far from rivers or lakes, the region would seem to be unfavourable for Aboriginal occupation. Nevertheless, Witter (2004) indicates that open camp sites are abundant and present on all landscapes. Witter (2004) suggests that occupation of the region may have been highly dynamic with occupation fluctuating in accordance with seasonal variability, and perhaps longer term climate changes.

The site types found in the Barrier Ranges include camp sites comprised of stone artefacts and heat retaining hearths commonly located along streams and around clay pans, and at water holes in the ranges, and stone quarries and rock art.

There has been one previous archaeological study conducted within the Proposal area itself and several studies have been undertaken within the immediate local area and those results have been taken into account in this assessment. Given the different environmental contexts present in the Proposal area, stone artefacts were predicted to be present in variable densities ranging from very low to moderate. Soil formations in the majority of the proposed turbine impact areas are skeletal and rocky and as such stone artefacts were considered unlikely to be present on ridges in deep or stratified subsurface contexts. Soils on the plains and along drainage depressions are considerably deeper and have the potential to contain subsurface archaeological deposits. Quartz is the most common stone type found in artefact assemblages in the region (Witter 2004). It is ubiquitous as cobbles and gibber deposits flanking foothills, reefs and isolated pockets of macrocrystals in pegmatite bedrock.

The study area for the Archaeological assessment was divided into 232 Survey Units. The area surveyed during this assessment is estimated at approximately 822.4 hectares. Ground exposures, visually inspected, are estimated to have measured 342.4 hectares in area.

Of that ground exposure area, archaeological visibility (the potential artefact bearing soil profile) is conservatively estimated to have been 267.8 hectares. Effective Survey Coverage (ESC) was calculated to have been 32.6 per cent of the total survey area. ESC achieved during the site inspection is considered to be reasonably high and adequate for the purposes of establishing the archaeological status of the proposed impact areas.

A total of 262 Aboriginal object locales were recorded within the Proposal area. A detailed list and description of the observed locales are outlined in the Indigenous Heritage Report presented in Appendix 6.

Five different Aboriginal object types were observed during the field survey. The majority of locales are distributions of predominantly quartz stone artefacts across individual Survey Units. Quartz outcrops with evidence of exploitation, Stone Procurement Areas (SPAs), accounted for 78 locales. In addition, 14 locales are stone artefacts with heat retaining ovens/hearths. There were also three isolated artefact recordings identified. One locale is a complex of two small, circular stone arrangements, which is assessed to be a possible Aboriginal stone arrangement.

The observed density of stone artefact distributions varies significantly from very low (< one per square metre) to moderate (30/50 per square metre). It is considered that the density of the stone artefact distribution is related to environmental factors including the nature of the terrain and the proximity to water and other resources. These distributions were noted to be variable with regards to the types of raw materials present and the nature of the artefacts. Differences are likely to reflect differences in site function (i.e. different activities undertaken in different places). It is considered that stone artefact distributions, while common, would each have the potential to provide unique archaeological data and hence interpretive value within a research context.

The majority of the locales have been assessed to be of low archaeological significance. However many locales are assessed to be of low/moderate and moderate significance; several locales are assessed to be of high significance.

Generally, Aboriginal heritage sites can have high cultural value to the local Aboriginal community given that they provide direct physical and symbolic linkages to their ancestral past and to the landscape. The cultural values of the identified sites may possibly differ to the archaeological significance values.

Impact assessment – construction

As previously noted the majority of the Aboriginal object locales recorded in the proposal area are low or very low density stone artefact distributions; these are assessed to be of low archaeological significance. In addition a number of Aboriginal object locales have been identified which are assessed to be of low/moderate, moderate or high archaeological significance.

The construction of the Silverton Wind Farm will result in substantial physical impacts to any Aboriginal objects which may be located within direct impact areas – irrespective of their archaeological significance. That is, any Aboriginal object situated within an area of direct impact will be comprehensively disturbed, and/or destroyed during construction.

As with any development the chances of impacting Aboriginal objects, particularly stone artefacts, is high given that they are present in a continuum across the landscape and located on or within ground surfaces. Silverton Wind Farm is no exception in this regard and it would be impossible to have a development of this nature without causing direct physical impact.

However in regard to the majority of Aboriginal object locales such as artefact scatters assessed to be of low significance, the impacts can be viewed as being of correspondingly low significance. On the other hand, impacts to any object locales which are assessed to be of higher archaeological significance can be viewed as being of correspondingly higher significance. This assessment forms the basis for the formulation of management strategies which aim to mitigate impacts.

Management and mitigation recommendations are listed in respect of each Survey Unit and Aboriginal object locale in Table 22 in Section 12 of archaeological report. In addition, strategies for management of unexpected finds are addressed within the SoC 70.

No Survey Units have been identified in the proposal area to warrant further archaeological investigation such as subsurface test excavation; the Effective Survey Coverage achieved during the field survey was relatively high and can be considered to have been generally adequate for the purposes of determining the archaeological status of the proposed impact areas.

None of the Survey Units in the proposal area have been assessed to surpass archaeological significance thresholds which would act to entirely preclude proposed impacts. However two discrete Aboriginal object locales have been identified to warrant total exclusion of impacts. It is recommended that an active conservation strategy is implemented in regard to these locales to ensure that they are not inadvertently impacted during the construction, operation and decommissioning of the wind farm. It is noted that these locales are either situated outside areas in which impacts are proposed or within areas in which a strategy of conservation, and hence impact avoidance, is expected to be highly feasible.

The majority of the Aboriginal object locales recorded are very low (< one artefact per square metre) or low density (between one and ten per square metre) distributions of quartz stone artefacts. The archaeological significance of these locales is assessed to be low. Accordingly a management strategy of unmitigated impact is considered to be appropriate.

Many of the Aboriginal object locales and/or discrete areas within wider stone artefact distribution locales (including those which are predicted to contain subsurface archaeological deposit), stone procurement areas and locales with heat retainer hearths, are assessed to be of low/moderate or moderate archaeological significance. Accordingly, in regard to these areas it is generally recommended that avoidance of impacts, or limiting the extent of impacts to these locales, if at all feasible, should be given consideration. In respect of some locales suggestions are outlined as to how a strategy of impact avoidance may be achieved.

In regard to these locales further recommendations are made in the event that avoidance of impacts is not feasible. In some cases especially those relating to small stone procurement area locales it is recommended that if avoidance is not feasible unmitigated impacts are appropriate. However, in other cases such as locales containing deep soils and hence potential subsurface archaeological deposit with predicted moderate density artefact distribution, locales containing heat retaining hearths and larger and more complex stone procurement areas, it is recommended that if impact avoidance is not feasible a strategy of impact mitigation is appropriate. Impact mitigation will entail surface collection and sub-surface excavation of Aboriginal objects and subsequent analysis and research. Ideally such a program would entail an adequately designed research program which would aim to address research questions similar to those currently being pursued in the region.

It is recommended that additional archaeological assessment is conducted in any areas which are proposed for impacts that have not been surveyed during the current assessment. It is predicted that significant Aboriginal objects can occur anywhere in the landscape and accordingly if present they need to be identified and impact mitigation strategies implemented prior to impacts.

The proponent should, in consultation with an archaeologist, develop a Cultural Heritage Management Protocol, which documents the procedures to be followed for impact avoidance or mitigation.

Personnel involved in the construction and management phases of the project should be trained in procedures to recognise and avoid disturbance to any recorded (if necessary) and/or unrecorded cultural heritage places and items.

Identification of potential artefacts in the Stage 2 area is based on the knowledge obtained during the detailed Stage 1 assessment and a subsequent desktop review of the areas proposed for Stage 2. The types of artefacts considered likely to be located within the concept approval areas include:

- Stone artefacts
- Stone quarry and procurement sites
- Heat retainer hearths/ovens.

The construction of the wind turbines and associated access roads has the potential to impact any indigenous artefacts that may be located in the vicinity. It is considered that any potential impact from construction of turbine infrastructure would be manageable. It is considered management of any artefacts located would consist of one of the three options as detailed below.

- **Unmitigated impacts** – appropriate when sites are assessed to be of low heritage significance
- **Mitigated impacts** – appropriate when avoidance of impacts is not feasible and when sites are assessed to possess higher significance values. Mitigated impacts can take the form of partial site conservation and/or salvage excavation
- **Conservation** – avoidance of impacting a site is appropriate when a site is assessed to be of high scientific or cultural significance.

Impact assessment – operation

It is considered that there would be no impacts to Indigenous heritage as a result of the operation of the wind farm.

Transmission line route (site to Broken Hill)

Background

The proposed transmission line to Broken Hill is located in part in the Nine Mile land system. The Nine Mile system is defined as lower ridges, slopes and major drainage plains of the Barrier Range with relief to 30 metres. The Mundi Mundi land system conforms to a plain landform pattern; that is with a typical relief of <9 metres while the Nine Mile land system conforms to a Rises landform pattern; that is with a typical relief between 9 and 30 metres (cf. McDonald et al. 1998).

Impact assessment – construction

Field survey of a transmission route between the site and Broken Hill revealed no additional impacts to those described for the wind farm site. Since this survey, the proposed transmission route has been modified following consultation with the local community (refer to Figure 3.12). An archaeological assessment of this transmission line route is currently being undertaken and appropriate management and mitigation strategies will be implemented in regard to any cultural heritage recorded. Undertaking this additional survey work is a Statement of Commitment.

Impact assessment – operation

It is considered unlikely that there would be any impact to archaeological sites form the operation of the transmission line.

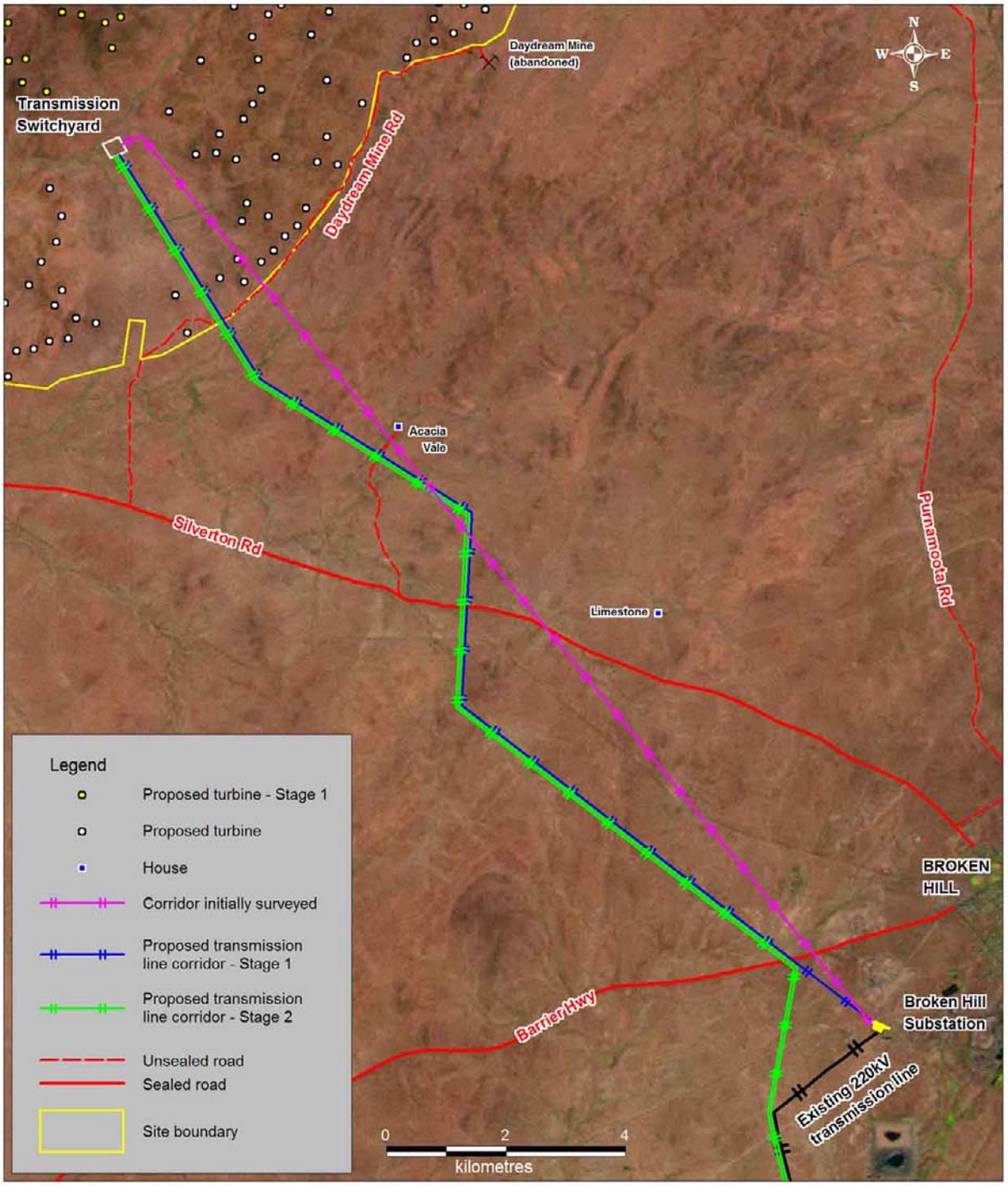

Figure 7.13 Transmission line from Silverton Wind Farm to Broken Hill.

Transmission line route (Broken Hill to Red Cliffs)

Background

Aborigines have inhabited the Murray-Darling Basin for over 35,000 years. One of the earliest dates associated with Aboriginal occupation within Australia comes from this region at Lake Mungo, where a shell midden has been dated to 35,750±1650 Before Present (BP).

During a survey of the existing transmission line in 1977, a total of 132 sites comprising 106 open camp sites, five shell middens, ten Potential Archaeological Deposits, seven burial sites and four isolated finds were recorded. The route traverses a range of land systems, each possessing differing hydrological systems and vegetation communities. Generally, the broad land system itself is not expected to be archaeologically sensitive, however. some of the landform elements present in a broader land system are likely to be. The following predictions regarding sensitivity of landform elements is derived primarily from the Johnston and Witter (1996) study; other sources are listed where relevant.

- Swales – low archaeological sensitivity (Johnston and Witter 1996)
- Sand plain flat – low archaeological sensitivity (Johnston and Witter 1996)
- Dune – low archaeological sensitivity (Johnston and Witter 1996)
- Lakebed – low archaeological sensitivity (Johnston and Witter 1996)
- Colluvial slope – moderate sensitivity; lithic scatters (Johnston and Witter 1996)
- Lake margin – moderate archaeological sensitivity; middens, lithic scatters, hearths (Johnston and Witter 1996)
- Box swamps – high archaeological sensitivity; middens, lithic scatters, hearths (Johnston and Witter 1996; McIntyre)
- Lunettes/source bordering dune – high sensitivity – these landforms can contain burials, middens, hearths and lithic scatters
- Alluvial flat – high sensitivity – these landforms can contain burials, middens, hearths and lithic scatters (Johnston and Witter 1996)
- Ridge range – high archaeological sensitivity; lithic scatters (Dibden 2008; Johnston and Witter 1996)
- Water course – high archaeological sensitivity; middens, lithic scatters, hearths (Dibden 2008, Johnston and Witter 1996)
- Flood plain margin – high archaeological sensitivity; middens, hearths (Johnston and Witter 1996)
- Valley/gorge – high archaeological sensitivity; lithic scatters, hearths (Dibden 2008; Johnston and Witter 1996).

Recent searches of the AHIMS databases were completed for the proposed transmission line route and those results have been taken into account in this assessment.

Impact assessment – construction

There are a number of types of indigenous artefacts likely to be located along the corridor of the proposed transmission line.

The types of artefacts considered likely to be located within the concept approval areas include:

- Stone artefacts
- Stone quarry and procurement sites
- Heat retainer hearths/ovens
- Middens
- Burials
- Scarred and carved trees.

Similar to the wind farm site, it is expected that potential impacts to Indigenous sites would be manageable through either the implementation of unmitigated impacts, mitigated impacts or conservation. Specific measures would be formulated after comprehensive surveying of this transmission line.

Impact assessment – operation

It is considered that there would be no impacts to Indigenous heritage as a result of the operation of the transmission lines.

7.7.3 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area-Stage 1	Site area-Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC69	Destruction of Indigenous heritage items	Minimise impact	Develop in consultation with an archaeologist and the Local Aboriginal Land Council a Cultural Heritage Management Protocol which documents the procedures to be followed for impact avoidance or mitigation in relation to indigenous heritage with reference to the recommended management strategies outlined in Table 22 of the archaeological report	Construction Operation Decommissioning	X	X	X	X
SOC70	Destruction of Indigenous heritage items	Minimise impact	Train specified personnel involved in the construction and operation phases of the project in procedures to avoid disturbance to any cultural heritage places and items	Construction Operation	X	X	X	X
SOC71	Destruction of Indigenous heritage items	Minimise impact	Conduct additional archaeological and heritage assessment in any areas which are proposed for impacts that have not been surveyed Undertake field assessment in partnership with the local Aboriginal community If Aboriginal objects are identified implement appropriate impact mitigation strategies	Construction	X	X	X	X
SOC72	Desctruction of Indigenous heritage items	Minimise impact	Implement an active conservation strategy with regard to the two discrete object locales identified in Stage 1 to ensure that they are not inadvertently impacted during the construction, operation and decommissioning of the wind farm. (Note that these locales are either situated outside areas in which impacts are proposed or within areas in which a strategy of conservation, and hence impact avoidance, is expected to be highly feasible.)	Construction	X			
SOC73	Destruction of Indigenous heritage	Minimise impact	Conduct an adequate field survey and assessment of the Stage 2 area and formulate appropriate mitigation and management strategies	Construction		X		X

7.8 NON INDIGENOUS HERITAGE

7.8.1 Approach

A field survey carried out by NSW Archaeology in November 2007 included the majority of the proposed impact areas associated with the Stage 1 Proposal. The non indigenous heritage component of this assessment has been conducted with reference to historical literature and mapping relating to the area and a field inspection aimed at locating historic items, features or potential archaeological sites. The resulting Indigenous and non indigenous Heritage Assessment (NSW Archaeology 2008) has been used as a source for much of the information in this section of the EA. Searches of relevant registers were conducted for the entire area that would be affected by all stages of the Proposal, including the transmission corridor to Red Cliffs, Victoria.

In Australia, there are heritage registers protecting places of heritage significance at the Commonwealth, State and local levels. The Proposal area is on unincorporated land and, as such, local government instruments are not applicable. The construction of transmission lines for the wind farm operation would be located mainly within the Local Government Area of Wentworth, NSW with a smaller area within Broken Hill Shire.

Places of heritage significance at the National level are listed on the Australian Heritage Database (AHD), under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. This database includes places listed on the National Heritage List and the Commonwealth Heritage List. The AHD also includes places listed on the Register of the National Estate (RNE), however as the RNE pre-dates the current three-tiered system for heritage conservation, it has become largely an informational list. Many places that were originally listed on the RNE are now protected under legislation at the local and state level.

The *NSW Heritage Act 1977* is a statutory tool designed to conserve the cultural heritage of NSW and used to regulate development impacts to the State's heritage assets. In addition to buildings and items listed on the State Heritage Register (SHR), archaeological features and deposits are afforded automatic statutory protection by the relic's provisions of the Act. The Act details the statutory requirements for protecting historic buildings and places, archaeological sites and shipwrecks. Section 4 of the Act considers a heritage item to include any place, building, work, relic, movable object, which may be of historic, scientific, cultural, social, archaeological, natural or aesthetic value. Under s.170 of the Act, State Government agencies keep Heritage and Conservation Registers that are also held in the NSW Heritage Office's State Heritage Inventory (SHI), an electronic database of statutory listed heritage items in NSW. The SHI also holds place of significance within local government areas.

The NSW Heritage Office provides the following eight points outlining the potential impacts of wind farms on heritage items:

- Wind development is a relatively young industry in Australia. While growth over the last three years has been huge on an international scale, Australia still has a relatively small uptake of wind power
- While the Heritage Council supports renewable energy development, it recognises that if inappropriately planned, wind farm developments can potentially adversely affect heritage items and cultural landscapes
- The Heritage Council encourages strategic approaches to renewable energy planning, development and management to eliminate or minimise these effects. It is important that any issues regarding this young industry are identified and addressed in its early stages
- An impact is any effect on heritage items, including cultural landscapes, which would not have occurred in the absence of the development. An adverse impact is one that leads to the loss of heritage value
- Identifying the significance of an impact requires consideration of not only the magnitude of the impact and its likelihood of occurring but also the value and importance placed on the heritage item
- There are two major concerns when considering the appropriateness of a wind farm in or near a heritage item: wind farms within the curtilage of a heritage item and wind farms outside the curtilage of a heritage item

— A wind development has the potential to affect any of the seven criteria for the assessment of a heritage item. It is these criteria that the Heritage Council of NSW bear in mind when assessing applications for change to a heritage item. If the proposed change is likely to materially affect the item, it is likely that amendments to the Proposal would be requested

— Heritage is a non-renewable resource. Once it is lost it cannot be replaced. Early consideration, planning and intervention are essential to ensure that we conserve our most valued heritage items.

These points have been applied to the assessment of impact of the proposed Silverton Wind Farm and the development of mitigation measures.

7.8.2 Assessment

Wind farm site

Background

The first Europeans to see the region were members of Thomas Mitchell's exploring party, who travelled down the Darling River from Bourke to Menindee and back in 1836. They did not leave the river, but Mitchell could see the high country to the west, and named two peaks. Nine years later, Charles Sturt led an expedition from the Darling River to Stephens Creek, just east of the later location of Broken Hill, and then on to the centre of the continent (Hope 2006).

Charles Sturt named the Barrier Range, which impeded his progress when he explored the area near Broken Hill in 1844–45, referring to a 'broken hill' in his diary (HO and DUAP 1996). Prior to 1858, there were many hopeful finds of silver to the west of Broken Hill at Silverton and Umberumberka. However, it was not until December 1858 that a serious prospecting party set out from Adelaide to search for gold in the Barrier Ranges; nonetheless, even this exploration did not result in gold or other mineral finds. Soon after pastoralists settled in the Barrier Ranges, reports went back to South Australia of quartz outcrops similar to those in the Bendigo goldfields. While some reports suggest that gold was discovered in the Barrier Ranges in the 1860s, it was not until after 1875 that major exploration for gold, silver and tin took place (HO and DUAP 1996). The impetus for this renewed exploration was the news of silver-lead ore discovered at Thackaringa. In 1875, silver-lead ore was discovered on Thackaringa Station. The Pioneer Mine was worked on and off by Patrick Green and his brother Richard. It was not until 1878, however, that a shipment of ore successfully reached England and was assayed to contain 65 per cent lead and an assayed 35 ounces of silver per ton (Kearns 1973).

The discovery of a rich silver-lead ore started a flurry of prospecting in the district with miners arriving in numbers, especially from the declining copper fields of South Australia, and the early 1880s saw many encouraging finds of silver in the district (AUCTA 2007). In 1883, Charles Rasp collected samples of what he thought was tin and although these turned out to be from rich lodes of silver and lead, it was almost two years before the ore body was discovered to be the largest and richest of its kind in the world (Department of Mineral Resources 2008). In 1884 alone, 1,222 mineral leases, 937 business permits and 114 miners' rights were issued. That same year, 6,000 tonnes of ore was extracted, three-quarters of which was sent to South Australia for processing. The year 1884 saw the formation of the Barrier Ranges Miners' Association in Silverton, which was a forerunner to the trade union movement in Broken Hill (Kearns 1973).

The early to mid 1880s were Silverton's heyday. Located, as it was, central to the surrounding mines and on reasonably flat ground, Silverton naturally became a district centre that served mines such as The Daydream, Umberumberka, Purnamoota, Pinnacles and Pilgrim Mine (Cox & Stacey 1973). The Daydream Mine was worked from 1882 to 1889, then briefly in the early 1900s. For a short time it reopened in the 1960s. One of the first smelters in the district, the Daydream, was opened here in 1885 (Hope 2006). This site is now on the State Heritage Register, but not located near the Proposal site.

By the late 1880s, Silverton's better ore had been exhausted and with the opening up of the far richer lodes at Broken Hill, Silverton started to decline. By 1891, the population of Broken Hill had exploded to 20,000 and it became the third largest metropolis in NSW, although it retained its strong ties with South Australia (HO and DUAP 1996).

Rail transport was logical for a major mining area such as Broken Hill, with the need to transport bulk freight to the coastal port, the closest being in SA. Then its strategic position and existing railway made it an obvious hub on the trans-Australian route (Hope 2006). With the growth of Broken Hill, the population of Silverton began to decline and its status as a municipality was removed in 1907, the same year that Broken Hill was declared a municipality (HO and DUAP 1996).

Several new mines developed in the 1920s, ensuring the continued growth of Broken Hill. As it was some distance from the nearest major river, the water supply in the Broken Hill area had to be transported by the Silverton train from 1888. Historic buildings in the region are concentrated in Broken Hill and Silverton townships; however, several occur at a greater distance and lower density around the local region, including relics of mostly mining and also homesteads and pastoral sites. These scattered features add to the historic outback rural character of the area.

The heritage study completed for the unincorporated area (UA) by Hope 2006 states that the town of Silverton should be regarded as a heritage precinct comprising the important buildings and ruins as well as the Silverton Tramway line. The study adds that the most significant threat to heritage places in the UA is climate; buildings no longer used and historic items from abandoned towns and mining sites would gradually deteriorate due to weathering. Despite this, some relics have survived and are still in good condition today.

Searches have been undertaken of historic databases including the Australian Heritage Database, the NSW Heritage Inventory and National Trust Register. One previously recorded heritage item (Daydream Smelter) is listed on the State Heritage Register and the National Trust of Australia (NSW) Register as being present immediately adjacent the Stage 2 area; there are no previously listed heritage items located within areas of direct impacts. There are no heritage items present in the Silverton Wind Farm Stage 1 Proposal area that are listed on any of these databases. Nonetheless, historical research and the results of a recent heritage study across the unincorporated area (Hope 1996) indicate that there are a number of potential heritage items within the Proposal areas and it is likely that field survey would reveal additional sites. Historical themes that are most likely to be evidenced are mining, pastoralism and the transport industry.

In the course of the field survey (NSW Archaeology 2008), 17 historical features were recorded. These recordings largely include sites that relate to mining activities, although there are also a small number of recordings that relate to pastoral and transport activities. Of those recordings that correspond to impact zones, there are two recordings of old road alignments that appear to be associated with nearby mines (SU93/HS1, SU191/HS3), eight recordings of building remains (SU62/HS1, SU90/HS2, SU90/HS3, SU90/HS4, SU94/HS1, SU94/HS2, SU191/HS1, SU191/HS2), three recordings of prospecting pits and other small mining explorations (SU32/HS1, SU54/HS1, SU226/HS1), one recording of a stone cairn that appears to be a mine lease marker (SU191/HS1), one recording of infrastructure associated with the Umberumberka Reservoir (SU53/HS1) and two recordings of more substantial mine workings that appear to be associated with the Iron Duke mine (SU90/HS1, SU92/HS1).

A number of these were identified as meeting the criteria for heritage listing and therefore a Statement of Heritage Impact (SoHI) was required. The survey units subject to the SoHI were SU93/HS1, SU62/HS1, SU90/HS2, SU90/HS3, SU90/HS4, SU94/HS1, SU94/HS2, SU191/HS1, SU191/HS2, SU53/HS1, SU90/HS1 and SU92/HS1). In addition, SOHI were completed for Lake's Grave, Stone Ruins, Zinc sintering works, Corruga and the Silverton Tramway. The SoHI is presented in Appendix 6.

There were no constraints with regard to those sites assessed as not meeting the criteria for heritage listing (NSW Archaeology 2008). Nonetheless, in most cases it has been recommended that impacts be avoided if possible.

For the majority of recordings it is recommended that impacts be avoided if feasible and that, where such a course of action is not feasible, mitigation in the form of archival recording and/or salvage excavation be undertaken.

Impact assessment – construction

A variety of items have been recorded in the course of fieldwork and research for this project. It should be noted however that there are no previously recorded heritage items within the proposal area that are on any statutory lists. The vast majority of identified items are assessed to be of local significance and eight of the recordings are assessed to be of insufficient heritage value to warrant any sort of formal listing.

One of the recorded heritage items is assessed to be of potential state significance (Corruga zinc sintering works) while the Silverton Tramway is assessed to be of state significance and potentially national significance. Neither of these sites is formally listed on any current heritage register. Impacts to these sites can be minimised, and effectively avoided, through adoption of a strategy of impact avoidance or realignment of the proposed transmission line from the wind farm site to Broken Hill.

Direct impacts can be avoided to all heritage items within the proposal area. Given that none of the identified heritage items have been assessed to have a significant aesthetic component to their heritage value and, given that the development could effectively avoid all physical impacts to heritage items within the proposal area., the overall impact on items of Non-Indigenous heritage would be minimal. Strategies for the management of impact avoidance are addressed within SoC's 74, 79, 80, 81 82 and strategies to manage unexpected finds are addressed within SoC 75.

Statements of Heritage Impact, which detail the nature of these impacts to individual heritage items are provided in Appendix 7 of the heritage report.

Impacts to the broader cultural landscape are unavoidable; a full Statement of Heritage Impact is included in Appendix 7 of the heritage report. Nonetheless, the visual impacts assessment indicates that the cumulative impact on landscape character would be low to moderate only (URS 2008). Furthermore, the proposed development fits within a theme of previous landuse, i.e. exploitation of natural resources and could usefully contribute to an adaptive reuse of the landscape. A result such as this could be ensured if the development was accompanied by a more comprehensive research project on the history and heritage of the area. Primary objectives of such a study would be to fill in the gaps in the existing history of mining for the region and compilation of a more complete record of heritage items in the Barrier Ranges. This would in turn aid in conservation of heritage values across the landscape, which would serve as a considerable mitigation of the abovementioned impacts to that landscape.

Research has revealed that there is high potential for historical features associated with mining and pastoral activities for the area covering Stage 2 of the wind farm site. The construction and decommissioning phases have the potential to materially affect heritage items that may be present in the area.

In the event that ground disturbance would take place at a heritage item, a strategy of impact mitigation would be implemented where warranted.

Impact assessment – operation

It is considered that there would be no impacts to non indigenous heritage sites as a result of the operation of the wind farm.

Transmission line route (site to Broken Hill)

Background

In the course of the field survey, five items were recorded. These comprise two small twentieth century sites that relate to farming activities (SU141/HS1: Farm equipment/stockpile; SU141/HS2: Stockyards), one recording of building remains (SU143/HS1), the Corruga zinc sintering works and a nearby section of the Silverton Tramway. Pending the results of the current assessment of the revised transmission line route it is possible that additional items would be recorded.

Impact assessment – construction

Impacts associated with construction and decommissioning of the proposed power line, range from increased traffic levels through to ground disturbance in discrete locations. While impacts such as increased traffic levels would not materially affect the heritage significance of the identified items, ground disturbance works have the potential to result in destruction of heritage items or parts thereof. Strategies for impact avoidance are detailed within SoC 74, 79, 81, 82 and 83.

In the event that ground disturbance would take place at a heritage item, a strategy of impact mitigation should be implemented, where warranted.

Impact assessment – operation

It is considered that there would be no impacts to non indigenous heritage sites as a result of the operation of the transmission lines.

Transmission line route (Broken Hill to Red Cliffs)

Background

Searches have been undertaken of historic databases including the Australian Heritage Database, the NSW Heritage Inventory and National Trust Register. There are no previously recorded heritage items listed on any of the above mentioned registers within the proposed overhead transmission line corridor.

Impact assessment – construction

There is some potential for features and items relating to occupation with the historic period to be present within the proposed overhead transmission line (NSW Archaeology 2008). The construction of the overhead transmission line has the potential to materially affect heritage items that may be present in the area.

Impact assessment – operation

It is considered that there would be no impacts to non indigenous heritage sites as a result of the operation of the transmission lines.

7.8.3 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC74	Loss of non indigenous heritage items	Minimise impact	Develop in consultation with an archaeologist a Cultural Heritage Management Protocol which documents the procedures to be followed for impact avoidance or mitigation in relation to non-indigenous heritage. A strategy of impact avoidance is entirely feasible for all of the recorded heritage items which warrant such an approach	Construction	X	X	X	X
SOC75	Loss of non indigenous heritage items	Minimise impact	Train personnel involved in the construction and management phases of the project in procedures to recognise and avoid disturbance to cultural heritage places and items	Construction	X	X	X	X
SOC76	Loss of non indigenous heritage items	Minimise impact	Conduct an additional heritage assessment in any areas which are proposed for impacts that have not been surveyed during the current assessment. The proposed impact areas would be subject to an appropriate level of field survey and assessment for the purposes of identifying non indigenous heritage sites	Construction	X	X	X	X
SOC77	Loss of non indigenous heritage items	Minimise impact	Subject any non indigenous heritage sites found in the proposed impact areas to a site significance assessment in order to form the basis for the development of appropriate mitigation and management strategies. This may involve the preparation of more detailed heritage assessments or heritage impact statements for sites if required. These would follow guidelines of the NSW Heritage Office publications 'Statements of Heritage Impact' and 'Assessing Heritage Significance'	Construction	X	X	X	X
SOC78	Loss of non indigenous heritage items	Minimise impact	Minimise impacts where practical to items assessed not to meet the criteria for heritage listing (e.g. SU32/HS1, SU54/HS1, SU141/HS1, SU141/HS2, SU143/HS1, SU190/HS1, SU191/HS3 & SU226/HS1)	Construction	X	X	X	X

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC79	Loss of non indigenous heritage items	Minimise impact	Avoid impacts where practical to items assessed to meet the criteria for heritage listing (e.g. SU62/L1, SU90/L1, SU90/L2, SU90/L3, SU90/L4, SU92/HS1, SU93/HS1, SU94/HS2, SU191/L1, SU191/L2 and the Stone Ruins) and where avoidance is not feasible mitigate impacts in the form of archival recording and/or salvage excavation	Construction	X	X	X	X
SOC80	Loss of non indigenous heritage items	Minimise impact	Avoid impacts on individual recordings where practical in SU94, which contains a recording assessed to be of local significance and high research potential. Avoid or minimise impacts to the southeast of grid reference 526696e 6480400n	Construction	X			
SOC81	Loss of non indigenous heritage items	Minimise impact	Conserve infrastructure associated with the Umberumberka Reservoir (SU53/HS1, SU57 and SU58) where practical	Construction	X		X	
SOC82	Loss of non indigenous heritage items	Minimise impact	Conserve Lake's Grave which is assessed to be of high local significance	Construction	X		X	
SOC83	Loss of non indigenous heritage items	Minimise impact	Avoid impacts at the zinc sintering works if practical or mitigate by archival recording and/or salvage excavation	Construction			X	
SOC84	Loss of non indigenous heritage items	Minimise impact	Keep all direct impacts associated with the transmission line at least 30m off the permanent way of the Silverton tramway	Construction			X	X
SOC85	Loss of non indigenous heritage items	Minimise impact	Train specified personnel involved in the construction and operation phases of the project in procedures to avoid disturbance to any non-indigenous cultural heritage places and items	Construction Operation	X		X	

7.9 ECONOMIC IMPACTS

7.9.1 Approach

A socioeconomic study of the Broken Hill area including Silverton was completed by SGS Economics and Planning (SGS 2008). Methodology for the study is presented below.

- Review of Australian and international literature
- Socioeconomic profiling of Broken Hill
- Consultation with elected representatives, council and community associations
- Economic modelling of direct expenditure effects
- Economic model of indirect flow-on effects.

A more detailed description of the methodology undertaken is detailed in SGS 2008 presented in Appendix 7. The impact assessment has been adapted from the socioeconomic report prepared by SGS (2008).

7.9.2 Assessment

Wind farm site/both transmission lines

Background

The nearest township to the proposed wind farm site is Silverton, with Broken Hill being the nearest major township approximately 25 kilometres southeast of the site. The area surrounding the wind farm sites and power line to Broken Hill is generally sparsely populated. Due to the low population density, there is limited information from the 2006 Australian census, published on the Australian Bureau of Statistics website, for the Silverton area. Results from the census indicated that there are 28 families with a total of 89 usual residents within Silverton.

The township of Silverton was the basis of the original mining boom in the late 1880s. With the discovery of new, larger mines in Broken Hill, Silverton's population moved into the newly discovered Broken Hill. Tourism, art and filming are the predominate industries that are now in Silverton. Due to the size of Silverton, there is little information publicly available with regards to the socioeconomic climate.

Broken Hill region's prosperity has traditionally been reliant on the success of the local resources and agricultural sectors. There has been a weakening in these sectors over the last 20 to 25 years as well as a regional population decline in excess of 30 per cent. The rate of decline has slowed (-0.89 per cent) in recent times and there are prospects of new industry developments that (largely driven by the mining sector) have the potential to retain and attract population and boost economic growth.

Broken Hill has an ageing population with the greatest proportion of residents in the 45 to 54 years age bracket. In addition, this ageing population is somewhat exaggerated by the youth and young families leaving the area. Weekly household and individual income data suggest that Broken Hill contains a disproportionate number of low income households compared to NSW. The difference in the weekly household income proportion by income cohort is greatest for the $150 to 249 and $250 to 349 low income bracket.

The current unemployment rate is 9.1 per cent in Broken Hill, which is considered 'high' given that the corresponding figure for NSW is 5.9 per cent. As a result of the employment demand in the area, this figure is likely to indicate a core of long-term unemployed persons and low-skilled persons. The unemployment profile has changed over time, with the number of older unemployed persons (persons aged 35 years and over) increasing relative to the number of younger unemployed persons (persons aged under 35 years). This pattern may be explained by the overall decrease in the number of 15–34 year olds. Persons aged 35 years and over also appear to be finding jobs (the number of unemployed persons has decreased while the total number of persons of this age has increased). The greatest number of unemployed persons continues to be in the 15 to 19, 20 to 24 and 25 to 29 years age groups.

An occupation profile shows the three most prominent occupations for residents in 2006 include technicians and trades workers (12 per cent), professionals (12 per cent) and community and personal service workers (9 per cent). The apparent downturn of mining activity and a concerted effort to capture the outback tourism market is reflected by a weak but indicative shift over the decade from 'traditional' to service sector industries such as Retail Trade, Personal Services, and Accommodation, Cafes and Restaurants.

Impact assessment – construction

The total estimated economic impact across the region from the construction and operation of the Proposal over the 30-year period is:

- Employment increased by 3,988 full time equivalent (FTE) jobs
- Gross Regional Product (GRP) increased by $701 million.

This estimate includes the direct and indirect potential stimulus by the proposed Silverton Wind Farm on the Broken Hill and surrounding economy. It is estimated that 80 to 85 per cent of the economic benefits stimulated by the Proposal would occur in Broken Hill and the surrounding area based on the proportion of the population being located in Broken Hill relative to the broader the surrounding areas, and upon its higher concentration of construction and related industries. The potential total impact of the Proposal include benefits to local upstream industries resulting from the increased demand for their goods and services, and consumption induced effects that relate to increased regional spending from wage earners and the resulting increase in expenditure from local suppliers. These would likely include concreting, earthworks, steel works and electrical cabling. As well, other service-related employment would follow, with the provision of food, fuel, accommodation and other services to contractors.

Based on a construction phase spanning five years, employment would likely increase by 2,040 FTE jobs across the local area and GRP would increase by $270 million. Construction (667 jobs), Property and Business Services (399), Retail Trade (206) and Wholesale Trade (205) would make up most of the employment growth. Potential impacts related to Tourism and filming have been addressed separately and are presented in Section 8.3 and 8.3.

The provision of a Community Fund that the Proponent would instigate and contribute to throughout the life of the Proposal, would assist in improving the equity of financial benefits to the community. This locally administered fund could be used to provide environmental and social services in the area.

Precise economic benefits would vary depending on final site design, turbine suppliers, timing of works and other details. It is estimated that up to $701 million could be spent within the region as a result of the wind farm over its life. This would be split between the construction phase and operation phase.

The Proponent's preference is to use local companies for the construction and decommissioning. Companies in the local area have concrete, steel and earthworks capabilities. There may be potential to manufacture the towers and potentially the nacelles locally. Turbine blades could also be manufactured in Australia.

There are a number constraints related to the potential socioeconomic impacts described. These predominately include supply-side constraints; primarily the supply of labour and the capacity of local business to service new contracts together with the quality of local housing and other physical and social infrastructure and amenities needed to attract and retain workers. The Broken Hill economy is likely to affect the degree to which economic benefits, and hence aggregate employment growth, can be realised.

Supply of labour to satisfy employment opportunities

The population of Broken Hill is characterised as one that is declining, ageing, low-skilled and with lower incomes that their NSW counterparts. The proportion of persons within the labour force is also lower than for NSW as a whole, and a significant proportion of those within the labour force are either low-skilled, approaching retirement age or unemployed.

As a result, the estimated demand for skilled labour is unlikely to be met through local supply and would depend upon the capacity of Broken Hill to attract large numbers of skilled labour. According to employers, the local market for labour is already stretched, with those persons able to transition into mining from other industries having already done so. Many of those in higher paid and skilled positions are already from overseas and elsewhere in Australia.

The project would require labour to be brought in during construction activities. Broken Hill, which accommodates seasonal tourism, may provide the majority of accommodation for these workers. Dedicated construction camps closer to the site may also be considered.

It is considered that an influx of construction personnel to the Broken Hill area may have benefits to the local economy. An increase of the labour force would likely lead to an increase of money entering the local economy for accommodation, food and other services for workers.

Local business capacity

The high demand for labour locally has reportedly had detrimental effects on industries such as trades, manufacturing and engineering, from which labour has reportedly been 'poached' by the mining sector. There is not only a skilled labour shortage but an undersupply of labour being experienced by Broken Hill's small business sector. Overall, a lack of skills, business development know-how and investment would in turn have a detrimental effect on local productivity. This lack in local productivity has lead to suppliers from Adelaide, Mildura and elsewhere being used more frequently; alternatively large (mining) companies are turning to 'in-house' support services.

A further supply-side constraint relates to Broken Hill's capacity to retain skilled labour beyond the period of their initial contract. Factors influencing labour supply retention commonly cited during consultations include the provision of a commensurate quality of social and community infrastructure, services, retail trade attractions and quality housing.

As described previously, the local unemployment rate is above that of the remainder of New South Wales. Additionally, there is an observed out-migration of people in the younger age bracket, under 30 years old. It is considered that there is the potential for an extensive community gain in relation to both reducing the unemployment rate of the area and retaining the younger generation in the area. This impact is considered beneficial for the local community.

Impact assessment – operation

Wind farms are an economically viable means to generate electricity (refer to Section 4). The Proposal would be privately funded. There would be no ongoing financial expenses to the community or any government agency. The assessment of the likely economic impacts to the local area as a result of the operation of the proposed wind farm was based on a 30-year life cycle. Employment would increase by 1,948 FTE jobs and GRP would increase by $431 million. Employment in Electricity, Gas and Water – of which wind energy is an industry – is estimated to increase by around 500 jobs over the 30-year period. The employment figure for Electricity, Gas and Water includes the direct employment at the wind farm during its operation. Property and Business Services (339) and Wholesale Trade (209) would also see a strong increase in employment.

The proposed Stage 1 works are considered economically justifiable and would provide no ongoing financial expenses to the community or any government agency. Revenue provided to the government as landowner would, according to statements made publicly by the Minister for Lands, most likely be channelled into a budget that addresses the needs of the Western District.

7.9.3 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC86	Affect on local community	Maximise positive impact of Proposal	Liaise with local industry representatives to maximise the use of local contractors and manufacturing facilities in the construction and decommissioning phases of the project	Construction	X	X	X	X
SOC87	Affect on local community	Maximise positive impact of Proposal	Liaise with the local visitor information centres to ensure that construction and decommissioning timing and haulage routes are known well in advance of works and to the extent practical coordinated with local events	Construction	X	X	X	X
SOC88	Affect on local community	Maximise positive impact of Proposal	Liaise with Broken Hill City Council and the Department of State and Regional Development to provide information to assist in attracting people to the local area to facilitate meeting the expected demand for human resources for both construction and operation of the Proposal	Construction Operation	X	X	X	X
SOC89	Affect on local community	Maximise positive impact of Proposal	Make available employment opportunities and training for the ongoing operation of the wind farm to local residents where reasonable	Operation	X	X		

7.10 LAND VALUE IMPACTS

7.10.1 Assessment

Wind farm site

Background

Land values are influenced by prevailing and permitted land uses, economic conditions, access and proximity to markets and workplaces, demand for lifestyle as well as a range of other factors. There are few studies examining the effects of wind farms on land values in Australia and these are difficult to compare across geographic and land use boundaries.

While public perception of wind farms is highly variable and subjective (SRSC 2005), there is potential for a section of the market to be negatively affected by perceived visual or noise impacts, or by changes to compatible land uses. As such, this issue has been investigated, with reference to existing wind farms and a limited number of land value studies.

The wind farm site is located in an area where grazing capacity has traditionally been the largest determinant of land value. Additional land values relate to mineral exploration and also to aesthetic values, such as 'peace and quiet' and the scenic attributes of the area. Furthermore, particularly around Silverton, there is an historic appeal that may influence land values. The proposed transmission route would cross many land uses, including more dense residential settlements. Agricultural productivity, however, would again be the largest determinant of land value for the majority of the proposed route.

There are examples of successful residential estates being developed near existing wind farms in Australia (an informal study of the Salmon Beach estate near the Esperance wind farm in Western Australia showed a strong trend of increasing house prices; AusWEA 2004a). However, the interplay of multiple determining factors complicates comparability of existing studies and the assessment of impact.

Henderson and Horning Property Consultants (2006) assessed the likely impact of the proposed Cullerin wind farm near Goulburn NSW, on local land values, with recourse to the impacts resulting from other wind farm developments, in Australia and overseas. The report made use of a statistical analysis in the United States and two perceptual studies (United Kingdom and Australia) and also looked at land transactions around the existing Crookwell wind farm. Henderson and Horning found no impact of the Crookwell wind farm on property values in the area.

The United States report (Sterzinger *et al.* 2003) was an empirical review where data from ten wind farm sites was collected and subjected to a statistical regression analysis to determine price changes in three ways:

- How property values changed over the entire period of the study for the view shed and comparable region
- How prices changed in the view shed before and after the projects came online
- How property values changed for both the view shed and comparable community but only for the period after the project came online.

This study concluded:

- There is no support for the claim that wind development will harm property values.

It was qualified with a statement that more data would need to be analysed as it becomes available.

The United Kingdom perceptual study gauged professional property opinions about the impact wind farm development had on both residential and agricultural land values. It received 405 responses of which 81 indicated they had dealt with residential transactions affected by wind farm development. The report concluded the main negative impact on property values are visual impact, fear of blight and the proximity of a property to a wind farm. 72 per cent of the sample believed wind farm development had no impact or a positive impact on agricultural land values. 60 per cent believed wind farms decreased the value of residential properties where the wind farm was in view. The perceived negative impact was reported to continue but become less severe two years post completion.

In Victoria, Australia, the Bald Hills Wind Farm Panel Inquiry examined the issues of property devaluation for neighbouring properties in a similar manner; property valuers and real estate agents provided submissions and appeared before the Panel Inquiry as expert witnesses. The Panel Inquiry report concluded:

> *All that appears to emerge from the range of submissions and evidence on valuation issues is the view that the effect of wind energy facilities on surrounding property values is inconclusive, beyond the position that the agricultural land component of value would remain unchanged. On this there appeared to be general agreement.*

The Crookwell wind farm was developed in NSW in 1998. It has similar surrounding land uses (agricultural and rural residential) and several sales have taken place since the development of the wind farm. Sales transactions over a 15-year period were searched (1990 to 2006). Properties that surround the development and have some direct impact from a valuation perspective were investigated (principally aesthetic influences including visual, noise and shadow effects). The context of the study was a general trend of larger properties being sold and broken up into smaller lots commencing in the late 1990s, with very few sales occurring in the period prior to the development of the wind farm. This trend is an example of the changing nature of land use in the area, from commercially operating grazing land to a more passive rural residential use. Market forces appear to value the rural residential amenity above that of the agricultural productive capacity of the land.

Discussions with local Crookwell agents generally indicated that although topical, the existing wind farm had little or no effect on land values in Crookwell. However, the perception of the proposed wind farm (Crookwell II) planned close to the existing farm could have an effect. The analysis of sales evidence indicated that no detectable discount exists for properties deemed directly affected by the existing wind farm. That is, the market evidence suggested that having a view of the wind turbines did not affect land value.

The Land Value Assessment report (Henderson and Horning 2006) concluded that further research would be required to determine what value the market would place on the wind farm revenue streams; however it is suggested that the capitalisation rates would be similar to other infrastructure improvements like mobile communication towers and signage investments. Therefore the wind farm development has the potential to slow down the process of productive agricultural land changing to rural residential uses in the short to medium term with the shift caused by the additional income generated from the wind farm revenue making the agricultural use of (involved properties) more viable.

Primarily, land value impacts for this Proposal are likely to relate to community, visual, noise, traffic, mineral exploration, lifestyle and tourism impacts. Successful mitigation of these impact areas would be necessary to ensure a cumulative adverse effect is not generated and manifested in the lowered value of nearby properties. These impact areas are considered within this EA (Sections 7.2, 7.3, 7.6, 7.12, 8.2 and 8.2) and mitigation measures have been developed to manage identified impacts.

Impact assessment – construction

During the construction and decommissioning phases of the wind farm, a temporary increase in traffic loads, as well as increased noise and visual impacts would occur. These impacts would be temporary but would be distributed over a three- to five-year construction period and two-year decommissioning period. This may have an adverse effect on properties for sale near to the works area of haulage routes during this time. Management of these impacts is discussed in Section 7.6.

When the site is decommissioned, it could continue to be used for grazing activities. All disturbed soil, excluding access trails which the landowners may wish to retain, would be stabilised and rehabilitated. Concrete footings used to anchor turbines and buildings during the development would remain onsite. This may have a minor impact on land use; however the lease agreements during the life of the project are intended to compensate the landowner for this. This impact would not be anticipated to be reflected in the land value of the site or land values in the area.

Post decommissioning, the minor amount of land affected by in-ground footings is not anticipated to affect other land uses such as rural residential subdivisions or other commercial activities. Apart from access tracks, the site would not look considerably different from prior to the Proposal and therefore no ongoing land value impact is anticipated.

Impact assessment – operation

The operational impacts of the development may have the greatest bearing on land value. While the lease agreements are intended to compensate the involved landowners during the life of the Proposal, the development may potentially affect the land values of the surrounding properties that are in some way affected by the development; those with a view of the site or near enough to experience operational noise. Visual impact is considered to constitute the key impact on land value in the vicinity of the wind farm, as no sensitive noise receivers are present close enough to the site to be affected by operational noise. Visual impact has been assessed in Section 7.2 in detail.

Large grazing land holdings are considered largely resilient to visual impact, as carrying capacity and not aesthetic values is the key determinant of land value. Nonetheless, the decision to purchase a property in the vicinity of the wind farm for grazing may still be influenced by views to a wind farm. Tourism and artistic enterprises, such as wilderness tours and galleries of which there are several in the vicinity, may be more vulnerable to this impact.

Evidence of the response of land values to wind farm development has been presented in Section 7.10. As such it is considered that there are potential opportunities as well as negatives. Negatives appear to attenuate with time. Specific to the site, it is considered that the tourism potential to the area may offer significant opportunities. Operational traffic impacts would be negligible during the operational phase and, if anything, access improvements may positively influence local land values.

The conclusions of the studies considered in this section suggest:

- The agricultural productive capacity of land affected by the wind farm (including the site itself as well as surrounding properties) is not anticipated to be affected by the development of the wind farm
- The revenue stream from the wind farm and associated benefits (such as improved access) plus the underlying agricultural production capacity of the sites directly affected may positively affect the land value of involved properties
- The evidence suggests that having a view of the wind turbines would not adversely affect the land values of surrounding properties. Any negative perceptions that this is the case are likely to decrease two years post construction
- The wind farm may dampen a sensitive section of the property buying market; however this effect is balanced by other influences. In this case, the tourist appeal of such a large-scale renewable energy development, together with the economic benefit and establishment of the community fund, may well enhance the value of neighbouring properties
- As the site would be returned to its current appearance at the end of the Proposal's life, the potential impacts to land values are reversible in the long term.

While the wind farm cannot be developed without the risk of some land value impact on surrounding properties during the construction and operational phases, it is considered by this assessment that on balance the benefits of the Proposal are sufficient to outweigh this risk. The risk is not dissimilar to that posed by other large-scale infrastructure developments undertaken to meet increasing energy demands. In this case, it is considered that the fact the energy would be emission-free renewable energy goes some way to spreading the benefits of the Proposal to the wider community and lessening the anticipated negative perceptions of neighbours and potential buyers.

No mitigation is considered to be required for the potential impacts to land values. As a large component of this issue is related to community perceptions, visual, noise, mineral exploration, traffic and lifestyle values, measures outlined in elsewhere in this EA specific to these subject areas are considered sufficient mitigation.

Transmission line route (site to Broken Hill, site to Red Cliffs)

Background

It is considered that the existing environment has been described above.

Impact assessment – construction

The potential for visual impact related to the transmission line constitutes the major factor in any potential land value impact. The LVIA carried out in Section 7.2 concluded that the transmission line would have a low cumulative impact on the landscape character and therefore it is considered that the potential impact to land values would be negligible.

Impact assessment – operation

No operational impacts are anticipated.

7.10.2 Mitigation measures

No measures are considered to be required.

7.11 FARMING AND GRAZING IMPACTS

7.11.1 Assessment

Wind farm site

Background

The area for the proposed wind farm site is located on land that is currently administered by the NSW Department of Lands, Western Division. There are four working stations across which the proposed turbines are planned to be built. The stations are held under a number of perpetual grazing leases issued under the *Western Lands Act 1901*. These station owners currently graze sheep and harvest feral goats within the proposed works area. Horses, donkeys and camels are kept on nearby properties and graze the Silverton Common.

Changes to farming practices may be expected under climate change projections. Global warming is increasing evaporation and water demand, potentially reducing the capacity of the land. Pittock (2003) observed that a significant proportion of Australian exports are agricultural products sensitive to changes in climate, water availability, carbon dioxide, fertilisation, and pests and diseases. As well as direct impacts, agricultural profits could be affected by a projected increase in agricultural production in mid to high latitude northern hemisphere countries (Pittock 2003). The development of land uses compatible with agricultural activities, such as wind power, has the potential to provide increased economic security to rural industries. As well, they provide a substitute for carbon-emission producing electricity, by providing electricity generation that is stable (not dependent on other countries) and renewable and an opportunity to reduce grazing pressure with resultant benefits for native vegetation recruitment.

There is potential for wind power to become a new rural industry, providing a significant new income stream for rural communities at a time when traditional land uses are under pressure (Warren et al. 2005). Agriculture has been identified as having a significant role to play in carbon offsetting by a CSIRO report commissioned by the Agricultural Alliance on Climate Change, which includes farming and green organisations (posted 16 October 2007 on http://www.abc.net.au/news/stories/2007/10/16/2060466.htm). The report states that farmers could make an extra $3 billion a year by helping to produce clean energy and by offering carbon offsets to polluters. The Climate Institute states this is a key step needed to cut greenhouse gases. These points are particularly relevant to the Lower Murray-Darling CMA area where agriculture is impacted by highly variable, winter-dominant rainfall (LMD CMA 2006).

The Proposal would provide a supplementary income stream for involved landholders. Therefore, land managers could afford to manage the land more sustainably (such as with reduced stocking rates, improved pasture management, increased funds to address erosion, benefiting water quality, and feral animal management, particularly goats).

It is noted that the site area is highly degraded by a combination of feral goat grazing and drought. Native vegetation recruitment has been inhibited and there is a low density of vegetation at the ground and mid-strata level (more detailed information on land capability can be found in the attached Biodiversity Assessment Stage 1, Appendix 3). A number of surrounding stations also graze sheep within their station boundaries, although the stocking rate on steep ridges is restricted. Domesticated horses, donkeys and camels are located nearby.

Impact assessment – construction

Adverse impacts affecting the agricultural use of the site and surrounding properties are likely to be greatest during the construction and decommissioning phases of the development.

During construction and decommissioning, stock would need to be excluded from the works area and, in some cases, restricted from access roads to minimise the risk of vehicles colliding with stock. This would be temporary and in some cases adherence to low speeds may adequately mitigate the risk. The construction of access roads to facilitate the construction of the turbines would improve general access to the site thus creating the potential for enhanced land and stock management. There is also an opportunity to improve the management of goats within the wind farm site area.

At present, the native vegetation within the area was observed to be degraded by goats. It is considered that improvement in goat management (namely, more intensive harvesting of feral goats with a target of eradicating or minimising goats onsite) would enhance the condition of the native vegetation within the turbine area, thus positively impacting the site. Due to the relatively small impact area foot print (approximately three per cent), it is considered that the ability of these landholders to manage their land would not be greatly impacted but would be facilitated by the improved tracks. These impacts are considered to be largely temporary and minor in nature.

Noise and dust generated during the construction and decommissioning are manageable and considered to represent negligible impacts for agricultural activities, given the mitigation proposed (detailed in Sections 7.3 and 8.6).

Feral goats (a species harvested by leaseholders) range freely, and so restricting stock access to works areas would be difficult. It is likely that the construction traffic and other activity would cause goats to withdraw from the works area during the construction and decommissioning phases, somewhat mitigating the risk of collision. Evidence suggests that rock outcrops in the area are preferred camps for goats, however observations made of the goats during the biodiversity assessment and subsequent site visits demonstrate they would move freely to other areas.

Feral goats are usually sedentary when feed is available but are capable of moving large distances when feed is limited (Henzell 2000) and, presumably, when disturbed. Individuals are known to move freely through most fences in pastoral areas and are able to reinvade areas from which they have previously been removed. The distances and patterns of movement of feral goats in a semi-arid woodland of western New South Wales have been found to be 3.1 kilometres with the movement patterns predictable, moving small distances around intermittent lakes and creeks with abundant tree and shrub cover (Freudenberger and Barber 1999). No change to goat movements in the long term is expected to be attributable to the construction or decommissioning of the wind farm. The development of the turbines and associated infrastructure would result in some loss and modification of existing habitat for the goats onsite. Considering the development footprint calculations and the distribution of the infrastructure, this is likely to be minor. In addition, there are potential positive impacts specifically on the wind farm site with improved management of feral goats.

Impact assessment – operation

The operational wind farm would result in a minor loss of grazing area taken up directly by the footprint of the Proposal. The total development footprint during the operational phase has been calculated as 659.5Ha. The operational wind farm provides a benefit to involved landowners, a supplementary drought-resistant income stream throughout the life of the Proposal.

The operational wind farm itself would not affect the way that involved landowners or neighbouring landowners currently manage their agricultural activities. It would not affect the production capacity of the land, apart from a minor loss of grazing area taken up directly by the footprint of the Proposal. However, the Biodiversity Assessment (summarised in Section 7.4) recommends the design and implementation of a goat management program that would change the way goats are currently managed within the turbine envelope, as discussed below. The operational wind farm provides a benefit to landowners, a supplementary drought-resistant income stream throughout the life of the Proposal that would allow for more sustainable agricultural use of the properties.

Sheep and feral goats are currently managed within the site. Wind energy organisations promote the capability to graze stock right to the base of wind turbines without ill effect (Union of Concerned Scientists 2005; AusWEA undated (a)). Given the number of wind farms and duration of their operation on grazing land and the lack of data available to indicate adverse impact, it is assumed that the turbines would have minimal impact on livestock grazing onsite.

A 'settling in period' is likely to occur during which livestock become accustomed to the turbines (I. Newton, Wind Farm Manager, Eraring pers. comm. Jan 2005; AusWEA undated (b); British Wind Energy Association undated). There is no evidence to suggest that this would be drawn out or adversely impact animal welfare or agricultural productivity. It is considered that the operational impact would be negligible and as such no mitigation measures are considered to be required.

As part of this Proposal, measures to address native vegetation degradation (Section 7.4) have recommended significant reduction of the feral goat population onsite. This measure would reduce the profitability of goat harvesting. Rather than leaving 'breeders' to maintain and even increase the existing population, the aim of a management plan would be to reduce as far as practical the abundance of goats onsite. The wind farm payment to the landholders provides compensation for this effect.

The potential impact on horses has been raised by members of the local community (this discussion is expected also to apply to donkeys and camels which occur in the area). The British Horse Society has prepared a wind farm advisory statement (British Horse Society 2005). This statement suggests that wind farms have safety implications for horses and their riders and drivers of horse-drawn vehicles during the construction and operational stages. The safety issues arise due to the natural instinct of the horse, when faced with a perceived threat, to flee. Equally important, the statement notes, is the rider's/driver's ability to handle the horse.

The characteristics listed by the British Horse Society as potentially eliciting a dangerous response include:

- The sudden appearance of the turbines in the horse's line of sight
- Low frequency noise emitted by operational turbines
- Shadows caused by the operational turbines
- Unexpected start-up of turbines.

The development is situated such that riders traversing local roads would not suddenly come upon a dominating view of the turbines. On properties near to the Proposal, it is considered that riders and horses within such close proximity of the site would be aware of the turbines and therefore not susceptible to this risk.

Low frequency or infrasonic noise and vibration has been an impact associated with wind turbines. Improvements to turbine design, particularly the development of upwind blade configurations, have reduced this component to a very low level, below the level of human perception (British Wind Energy Association 2005). This has been determined through measurements taken at turbines in the United Kingdom, Denmark, Germany and the USA over the past decade. In response to concerns about associated health problems, it has been stated categorically that there is no significant infrasound emitted from current designs of wind turbines (British Wind Energy Association 2005).

Shadow flicker is produced by the shadow cast by moving turbine blades when the sun is at a low angle (morning and evening). The flickering can cause a nuisance, or if between 8 to 30 Hz can be a health hazard (Epilepsy Association of Australia). The operational wind turbines do not produce a flicker frequency high enough to pose a health risk to riders or horses (comparable turbines have been rated 0.45 to 0.95Hz). The effect of 'chopping the light' attenuates with distance and is not considered by modellers of shadow flicker (Danish Wind Industry Association 2003) to be noticed beyond 500 to 1,000 metres from a turbine.

As this impact is able to be predicted it can be managed most practically by signage in affected areas. Due to the location of the development, this impact is only expected to affect involved property owners who would be made aware of the risk.

The impact of the unexpected start-up of turbines would vary depending on the horse, the rider and also the location at the time of turbine start-up (turbines start up and shut down independently of each other). Due to the location of the development, this impact is only expected to affect involved property owners who would be made aware of close range shadow flicker.

The British Horse Society advisory statement goes on to suggest that all these features are diminished with distance from the turbines and a 200 metre buffer was suggested. The impact of the development on rights of way or other access routes is also suggested as requiring consideration. A similar width minimum buffer distance from access ways is suggested by this report.

Transmission line route (site to Broken Hill, Broken Hill to Red Cliffs)

Background

The area for the proposed transmission line between the Site and Broken Hill is located within the Western CMA. The area between Broken Hill and the Murray River are within the Lower Murray-Darling CMA (CMA). The CMA is characterised into three land management units: Rangelands, Rangelands and Mixed Farming, and Riverine.

The northern area of Lower Murray Darling CMA area is characterised by rangelands and riverine areas located adjacent to the Darling River and the Darling Anabranch while the south of the CMA area is characterised by rangelands and mixed farming and riverine areas adjacent to the Darling River and the Darling Anabranch. Farming activities include dry land cropping, horticulture, wool and meat production and water storage. Approximately 5 per cent of the catchment area has been cleared for cropping or horticultural purposes. The remaining 95 per cent of native vegetation has been subject to varying amounts of modification as a result of land use impacts including grazing and fire regimes (LMD CMA 2006). There are a number of privately managed and public conservation areas within the catchment.

Impact assessment – construction

The farming properties located within the Western CMA and Lower Murray-Darling CMA have the potential to experience impacts. Impacts would include restrictions to stock movement and loss of grazing land. In the area of the proposed transmission line between Broken Hill, Buronga and Red Cliffs, the level of impact is considered manageable. The transmission line would require an easement of approximately 50 to 100 metres each. During construction, stock would have to be excluded from the construction zone. However, as the construction of the transmission line would be constantly moving, this impact is considered to be low. Where clearing of shrubs and woodland vegetation occurs, this may increase the availability of native pasture. Additionally, the potential impact to these farmers as a result of increased traffic along the Silver City Highway is expected to be slight as the highway has adequate carrying capacity.

The potential impacts to grazing and farming are considered manageable through the implementation of appropriate mitigation strategies.

Impact assessment – operation

The potential impacts to current landholders along the proposed easement route are considered to be low. The addition of the additional easement is unlikely to greatly impact on the property owner's ability to use their land for the purpose of farming and grazing. Sections of the current transmission line are unfenced and it is understood that the additional transmission easement would not require fencing. The likely impact to current landholders would be confined to specific areas where the pole structures are located. This impact is likely to be minimal and is considered manageable through lease agreements.

7.11.2 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC90	Impact on current land use	Minimise impact	Develop protocols for construction traffic on access roads where stock may be grazing as part of the Traffic Management Plan	Construction Decommissioning	X	X	X	X
SOC91	Impact on current land use	Minimise impact	Restrict stock from works areas where there is a risk of stock injury	Construction Decommissioning	X	X	X	X
SOC92	Impact on current land use	Minimise impact	Ensure the Site Restoration Plan considers farming and grazing opportunities and impacts	Construction Decommissioning	X	X	X	X
SOC93	Impact on current land use	Minimise impact	Liaise with neighbouring landowners to provide information about the timing of construction activities	Construction Decommissioning	X	X	X	X
SOC94	Impact on current land use	Minimise impact	Provide a point of contact to all landholders adjacent to the infrastructure	Construction Operation Decommissioning	X	X	X	X
SOC95	Impact on current land use	Minimise impact	Surround switchyard and substation areas with a security fence as a safety precaution to prevent trespassers and stock ingress	Construction	X	X		

7.12 MINERAL EXPLORATION IMPACTS

7.12.1 Assessment

Wind farm site

Background

The proposed wind farm is located in the Proterozoic Curnamona Craton, represented by the Broken Hill and Euriowie Blocks. These blocks are defined along its eastern margin by the unconformable overlying Koonenberry Belt. The cratonic units consist of strongly deformed and metamorphosed sedimentary and igneous rocks termed the Willyama Supergroup (NSW DPI 2008).

The Broken Hill deposit is one of the world's largest natural accumulations of base metals. An estimated 280 million tonnes of ore containing better than 30 per cent combined metal existed prior to mining. The ore currently mined at Broken Hill has grades ranging from 2.5–15 per cent Pb, 20–300 g/t Ag and 5–20 per cent Zn. The presence of the giant Broken Hill silver-lead-zinc deposit has led to a strong focus of modern exploration effort on this style of mineral deposit. Due to this quirk of history, exploration for other desirable commodities in this domain remains immature despite their proven high prospectivity.

Exploration targets include:

- Broken Hill type deposits (Pb, Zn, Ag)
- Platinum group metals
- Sediment-hosted Zn-Pb mineralisation (Mt Isa -type)
- Porphyry-skarn mineralisation (Cu, Au)
- Fe-oxide Cu-Au mineralisation (Olympic Dam-type, Tennant Creek-type).

Information obtained from the NSW DPI website indicates that there are four current exploration leases over the proposed wind farm site. These leases are held by three different companies. A brief description of these leases is presented in Table 7.12. Consultation has been undertaken with lease holders to ensure that they are aware of the wind farm Proposal and its implications.

Table 7.12 Current exploration leases for the wind farm site

Title reference	Grant date	Expiry date	Company	Minerals	Consultation
EL6452	22 March 2006	22 March 2008	Mining Exploration Pty Ltd	Group 1	Email + response, 23 April 2008
EL5646	23 November 1999	22 November 2008	Broken Hill Operations	Group 1	Meeting, Letter + response CBH Resources 29 April 2008
EL 6147	10 November 2003	9 November 2007	Broken Hill Operations	Group 1	
EL 6475	17 November 2005	16 November 2007	Platsearch NL	Group 1	
EL 6070	28 April 2003	27 April 2009	Broken Hill Operations	Group 1	
EL6002	30 September 2002	29 September 2009	Broken Hill Operations	Group 1	
EL6836	19 July 2007	19 July 2009	Alliance Fuel Cells PEM	Group 1	Letter sent 7 March 2008, no response

Impact assessment – construction

Potential sterilisation of the mineral resource and inhibition of an active or future exploration program would be the key mineral resource concern posed by the Proposal. As discussed, there are four current exploration leases located within the proposed wind farm site. Final turbine and infrastructure layouts will be provided to the licence holders, and DPI.

There is a potential for any planned exploration to be impacted during the construction and decommissioning phase of the Proposal. At this stage it is unknown if the three companies have plans to explore the region in short term. In addition, the exploration leases expire by late 2009 and it is unknown if the leases are planned to be extended. Although there is a potential for the construction of the wind turbines to impact the potential for exploration, the construction phase is of relatively short duration. It is considered that future exploration project schedules could be managed in relation to the planned timeframe for construction.

Impact assessment – operation

In principle, there is no reason why the exploration of minerals could not occur around the operational wind turbines as the direct footprint of the wind farm infrastructure is less than 3 per cent of the total site area. The Proposal would not prevent access to the site or exploration of minerals except in the vicinity of infrastructure where there may be safety, structural, operational or engineering limitations. In this context, it is possible that the operational wind farm may impede the exploration of minerals within the lease areas, in close proximity to infrastructure such as turbines and substations. This may be due to restrictions on the manoeuvrability of exploration machinery, localised sensitivity of magnetic and gravity remote sensing methods and occupational health and safety considerations. However, the access roads constructed for the proposed wind farm would likely facilitate future exploration works via the creation of easier access as well as making a greater portion of the exploration lease area more accessible. Impacts to manoeuvrability and occupational health and safety considerations would be reversed at the end of the project's life, allowing exploration of all areas except for those discussed above; including substation, turbines and control building footings. This combined area is small in relation to the lease area and as stated in relation to construction and decommissioning impacts, the impact is considered to be well justified.

There is potential for future extraction mining activities to be impacted as a result of the operation of the wind farm. Future exploration of the area within the boundaries of the wind farm may 'prove up' an economically viable mineral resource that could be exploited. The NSW DPI indicated during the Planning Focus Meeting that a number of exploration bore holes had been drilled within the boundaries of the proposed wind farm. Furthermore, the NSW DPI indicated that results from these bore holes had indicated that the resources grades would not be economical to mine in the current climate. Due to the nature and topography of the proposed wind farm site, it is considered that mining in the area would be relatively difficult. It is considered that the operation of the wind farm has the potential to limit the nature and type of future extractive mining operations. Should exploration activities identify an economically viable resource in the vicinity of the wind farm, extraction of this resource may be possible during wind farm operation depending on the type of mining, such as underground mining as currently proposed beneath the proposed Woodlawn wind farm. Otherwise the resource can extracted at the end of the decommissioning phase of the wind farm. As discussed previously, the NSW DPI indicated that a small level of exploration had been completed in the general area of the Barrier Ranges and results from those works had not discovered an economically viable resource in the areas explored.

While only Exploration Leases occur over the area at this time, if a mineral deposit is discovered then an application for a Mining Lease can be made. There is no certainty that a discovery would be made or a Mining Lease would be granted and accordingly the amount of potential lost mining revenue cannot be known in advance. In comparison to the lease area, the relatively small land area that would be sterilised and the level of reversibility of the Proposal suggest that this impact is justifiable; the temporary loss of access to these areas for mining would be offset by the utilisation of a renewable resource during the project's life. The benefits of the wind farm Proposal would extend to involved property owners including the government (via commercial agreements), the community (via the Community Fund), Silverton Wind Farm Developments and its shareholders as well as the end users of the renewably generated electricity.

Transmission line route (site to Broken Hill, Site to Red Cliffs)

Background

The majority of the power line is located within the Murray-Darling Depression Bioregion. The Murray Basin is a shallow crustal depression filled with marine and terrestrial sediments to a maximum depth of 600 metres over the last 50 to 60 million years (DECC 2004). Furthermore, the sandy surface sediments have been extensively reworked into dunes and

sand plains that have blown onto the Cobar peneplain (DECC 2004). Saline ground waters have formed salt basins in many places with a few bed rock ridges rising above the dunes on the sand plains as isolated ranges.

Information obtained from the NSW DPI website indicated that there are 15 exploration leases along the proposed transmission line between the Site, Broken Hill and Red Cliffs. Details of these exploration leases are presented in Table 7.13.

Table 7.13 Current exploration leases for the transmission line route

Title reference	Grant date	Expiry date	Company	Minerals
EL5542	30 November 1998	29 November 2008	ILUKA RESOURCES LIMITED	Group 10
EL6407	3 May 2005	2 May 2009	ILUKA RESOURCES LIMITED	Group 10
EL6543	22 Mar 2006	21 March 2008	BEMAX RESOURCES LIMITED	Group 10
EL6689	2 January 2007	1 January 2009	PERILYA BROKEN HILL LIMITED	Group 1
EL6703	17 January 2007	16 January 2009	ILUKA RESOURCES LIMITED	Group 1
EL6774	8 May 2007	8 May 2009	PERILYA BROKEN HILL LIMITED	Group 1
EL6858	16 August 2007	16 August 2009	MINERAL SANDS LIMITED	Group 10
EL6866	5 September 2007	5 September 2009	MORELLO EARTHMOVING PTY LTD	Group 2
EL6963	4 December 2007	4 December 2009	EAGLEHAWK GEOLOGICAL CONSULTING PTY LTD	Group 1
EL6973	13 December 2007	13 December 2009	MINERAL SANDS LIMITED	Group 10
EL6977	7 December 2007	7 December 2009	PERILYA BROKEN HILL LIMITED	Group 1
EL6980	7 December 2007	7 December 2009	PERILYA BROKEN HILL LIMITED	Group 1
EL6984	7 December 2007	7 December 2009	EAGLEHAWK GEOLOGICAL CONSULTING PTY LTD	Group 1, Group 6
EL5646	23 November 1999	22 November 2008	BROKEN HILL OPERATIONS PTY LTD	Group 1

Impact assessment – construction

Similar to the wind farm site, the potential inhibition of exploration in the future is considered the most significant impact to minerals exploration as a result of the construction of the power line. The typical power line easement is approximately 50 to 100 metres wide and it is considered that while exploration would not be feasible directly under the power lines, exploration in the immediate vicinity of the power lines would be achievable. In addition, the construction of the transmission line may assist any future proposed mining development in the local area by providing additional infrastructure likely to be required for new mining operations.

Impact assessment – operation

Similar to the proposed wind farm site, there is a potential for the operation of the transmission line to impact on both exploration and extraction planned for the future. At this stage it is unknown if there is any exploration works planned along the leases in the vicinity of the transmission line. The likely width of the easement required for the transmission line is approximately 50 to 100 metres each. Although the operation of the transmission line would preclude both exploration and extraction related mining activities, due to the relatively small area of land surface unavailable for these works, the impact to proposed future mining works is considered low.

7.12.2 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area-Stage 1	Site area-Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC96	Conflict with mineral exploration	Minimise conflict	Liaise with current mineral lease holders, providing a final turbine and infrastructure layout, prior to the construction phase	Construction	X	X		
SOC97	Conflict with mineral exploration	Minimise conflict	Provide a point of contact to the current mineral lease holders	Construction Operation Decommissioning	X	X		

7.13 AIRCRAFT HAZARD IMPACTS

7.13.1 Assessment

Wind farm site

Background

The development of the Silverton Wind Farm would involve the construction of up to 598 wind turbines, each with a height of up to 155 metres to the blade tip, as well as the construction of a high-voltage transmission line between the wind farm site and Broken Hill and high-voltage transmission lines from the site to Red Cliffs substation in Victoria. Due to the height of the wind turbines, potential impacts to aviation safety have been assessed. The potential for aircraft hazard is likely to occur during the construction, decommissioning and operational phases of the wind farm. The air safety issues that have been considered for the proposed wind farm include:

- Proximity of the proposed wind farm to landing fields
- Potential intrusion into air traffic zones and regulatory requirements
- Potential effects on activities such as use of private landing strips.

Due the current land use of the proposed wind farm site, potential impacts to aerial spraying of agricultural areas are considered negligible.

Landing fields are classified according to whether instrument landings are available. The nearest airfield to the wind farm site providing instrument landings is the Broken Hill Certified Aerodrome. CASA advised that the Obstacle Limitation Surfaces[1] reach a distance of 15 kilometres from the field. The Obstacle Limitation Surfaces (OLS) are conceptual surfaces associated with a runway, which identify the lower limits of the aerodrome airspace above which objects become obstacles to aircraft operations and must be reported to CASA. The Broken Hill aerodrome is approximately six kilometres south of Broken Hill and 29 kilometres southeast of the proposed wind farm site.

The operator of a certified aerodrome (in this case Broken Hill City Council) must monitor the airspace around the aerodrome to ensure that buildings and structures do not infringe the OLS. On the advice of CASA, the Proponent notified Broken Hill City Council on 23 October 2007. A response from Broken Hill City Council dated 21 January 2008 confirmed the wind farm to be clear of the Obstruction Limitation Surfaces for the Broken Hill Aerodrome, a copy of which is presented in Appendix 8.

Airservices Australia was notified on 16 January 2008 in relation to the Proposal. A preliminary high level assessment of the Proposal was carried out and at the time, EPURON was advised that there were no radar or satellite links in the vicinity of the wind farm and that there is not expected to be a navigational aid issue as the majority of services are located at Broken Hill which is a sufficient distance from the wind farm.

A response by email was received from Mr Joe Doherty of Airservices Australia on 4 April 2008 which indicated that:

“The wind farm development will affect several procedures at Broken Hill Airport. The Lower Safe Altitude (LSALT) route W428 west of Broken Hill Airport will need to rise from 2600 to 2900 and the 25MSA must rise from 2700 to 3100 – and consequent changes to all starting altitudes for the instrument procedures to the airport.

These changes are within acceptable limits and can be managed safely by Airservices provided we receive prior notification of the commencement of construction for publication by NOTAM (Notice to Airmen).

Parts of the associated transmission lines, in the vicinity of the airport, connecting the wind farm to Broken Hill and on to Red Cliffs (Vic) may also require assessment when details of the location and elevations are available.

[1] The Obstacle Limitation Surfaces (OLS) are conceptual (imaginary) surfaces associated with a runway, which identify the lower limits of the aerodrome airspace above which objects become obstacles to aircraft operations and must be reported to CASA.

The wind farm will not impact on Precision/Non-Precision Nav Aids, HF/VHF Comms, Cables, ASMGCS, Radar or Satellite/Links."

The Department of Defence was notified in writing on 21 January 2008 in relation to the Proposal. A response from Mr John Kerwan of the Department of Defence dated 11 March 2008 was sent to Mr Neville Osborne, Manager, Water and Energy of the Department of Planning with a copy to the Proponent.

The letter stated that the Department of Defence had finalised an assessment with regard to the possible impact of the Silverton Wind Farm on military aircraft operations, radio communications and the operation of navigational aids and radars.

The Department of Defence advised that the proposed development will be outside any areas affected by the Defence (Areas Control) Regulations (DACR). The DACR control the height of objects (both manmade structures and vegetation) and the purpose for which they may be used within approximately 15 kilometre radius of Defence airfields. In addition, the Proposal has been assessed as unlikely to affect existing Defence communications within the region.

The RAAF AIS has requested that the Proponent supply location and height details once the final position of the wind turbines have been determined and before construction commences. After construction is complete, the Department of Defence requests that the Proponent provide RAAF AIS with 'as constructed' details for the wind turbines, wind monitoring masts and electricity transmission lines if applicable.

Subject to the conditions stated in the letter (consultation with CASA in relation to Obstacle Marking and provision of location and height details to RAAF AIS) the Department of Defence has no objection to the proposed wind farm.

The minor, private airstrips in the local area rely on visual rather than instrument-based landings and, as the turbines are clearly visible structures, it is considered unlikely that the development would pose any additional hazard to the users of these airstrips. The location of these airstrips in relation to the Proposal is presented in Figure 7.14.

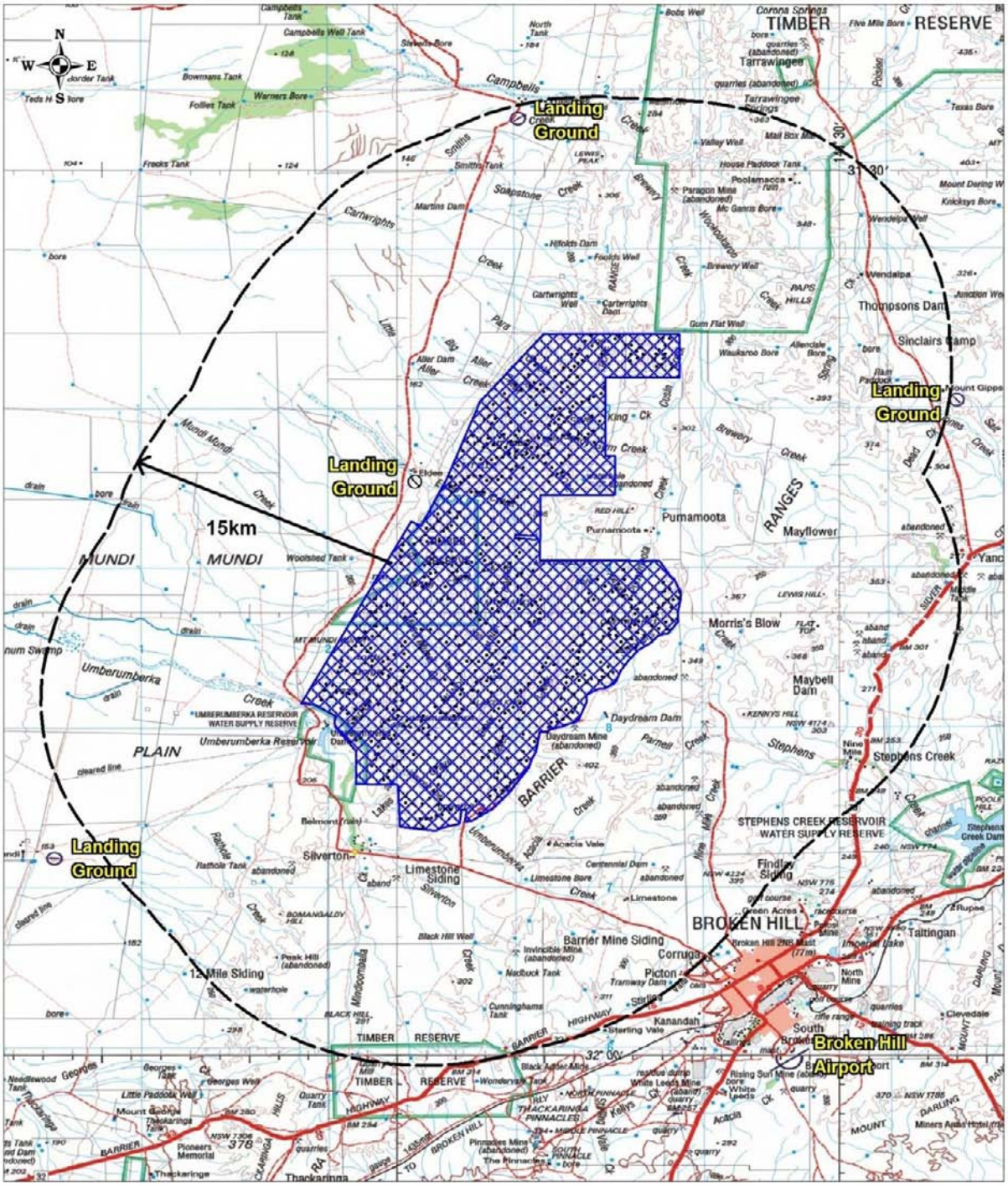

Figure 7.14 Location of airstrips in relation to the Proposal

Impact assessment – construction

Wind turbines would be erected throughout the construction phase of the Proposal. As such, it is considered that the potential impacts to aviation would occur both during the construction and operational phases of the Proposal.

Under Civil Air Safety Regulations, any person who proposes to construct a structure 110 metres or greater above ground level must inform CASA of that intention and the proposed height and location of the structure. The Proponent advised CASA of the Proposal and is subsequently working with them to identify their view of requirements for the obstacle marking of turbines at the site.

As described in Section 3, the heights of the proposed turbine would be in excess of 110 metres and, as such, it is likely that warning lights would be fitted to a number of the turbines. CASA draft guidelines for aviation warning lighting for a group of wind turbines require that sufficient wind turbines should have red obstacle beacons to indicate the extent of the group. CASA recommends the interval between beacons should not exceed 900 metres. Accordingly, it is expect that in excess of 80 turbines in the Proposal would require aircraft warning beacons.

Impact assessment – operation

Potential impacts to aviation safety as a result of the operation of the wind farm site are expected to be similar to those potential impacts associated with the construction of the turbines. The heights of the structures would be in excess of 110 metres and therefore would require the installation, operation and ongoing maintenance of the aviation warning beacons and lights.

The use of aeroplanes and helicopters for agriculture and mineral exploration may occur in the vicinity of the Proposal. This is significant to the safety of aircraft operating in the vicinity of wind turbines and the potential limitation of aerial operations due to the presence of turbines.

Operations that involve low level flying can only occur in good conditions (high visibility) in accordance with the aviation regulations, where wind turbines would be highly visible. Pilots who are engaged in low level flying and agricultural operations are required to undertake a risk assessment for each flight. This would identify specific hazards such as trees and powerlines. Wind turbines would be treated no differently. Therefore the operation of low flying aircraft in the vicinity of wind turbines does not represent an unacceptable risk if normal operational procedures are followed.

Transmission line route (site to Broken Hill, site to Red Cliffs)

Background

The transmission line between Broken Hill, Buronga and Red Cliffs substations would require approximately 300 kilometres of transmission line and associated structures. There is currently a transmission line that runs between these three substations and, at this stage, it is planned that the new transmission line would be constructed adjacent to the current line.

Impact assessment – construction

General structures heights that are typically used by TransGrid range from 16 metres above ground level to approximately 55 metres above ground level (TransGrid 2007). Under Civil Air Safety Regulations, any person who proposes to construct a structure 110 metres or more above ground level must inform CASA of that intention and the proposed height and location of the structure. As the potential structures are all well below 110 metres above ground level, and the proposed line would be constructed adjacent to an existing line, no impacts to aircraft safety are envisaged.

A recent letter from the Department of Defence noted that the as-built reference location of pylons should be provided to the department for safety during low-flying training.

Impact assessment – operation

There are no expected impacts to aviation safety as result of the operation of the proposed transmission lines due to the expected heights of the structures, however, the information about pylon or tower structure locations as built would be provided to the Department of Defence.

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7.13.2 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC98	Creation of hazard	Minimise risk	Liaise with CASA and determine the appropriate number, location and type of aircraft warning beacons to be fitted on wind turbines prior to the commencement of construction	Construction	X	X		
SOC99	Creation of hazard	Minimise risk	Notify all relevant authorities (CASA, AirServices, Department of Defence) of the final position of all wind turbines	Construction	X	X		

7.14 FIRE AND BUSHFIRE IMPACTS

7.14.1 Assessment

Wind farm site

Background

The bushfire danger period for NSW runs from 1 October to 31 March each year, however it can vary subject to local conditions (RFS 2008). The region is generally characterised by a persistently hot, dry climate (DECC 2003).

Issues considered relevant to the Proposal and bushfire impacts include:

- Activities such as hot welding in fire-danger periods
- Potential for infrastructure to start or influence a fire
- Access to the site and fire-fighting strategies onsite.

The NSW Rural Bushfire Service Planning for Bushfire Protection (2006) identifies a number of vegetation formations and their associated fuel tonnes per hectare. Vegetation within the wind farm site is classed as Acacia sub-formation (tall shrublands) within the Arid shrublands class. The Acacia sub-formation is described as shrubs, usually taller than two metres, dominated by various Acacia species and other large shrubs. This formation may also have an abundant hummock grass (spinifex) ground cover (RFS 2006). The fuel per hectare for this formation is nine tonnes, which is considered comparatively low (with other vegetation formations having fuel loads of up 25 tonnes per hectare).

The vegetation located across the wind farm site is discontinuous and fragmented. Additionally, there is no apparent understorey vegetation that would facilitate the advancement of a fire, should one occur. The nearest residential dwelling to the wind farm site is located approximately 1.5 kilometres to the south west of the stage one site area and has limited vegetation around it. The Umberumberka Reservoir is located between the dwelling and the wind farm site.

The elevated position of the wind turbines within the wind farm site may increase the frequency of lightning strike at the site. Extensive die back in the vegetation onsite, including ground cover and tree canopy, has created a fuel load in many areas. The steep topography and absence of water bodies may also assist the rate of spread of wildfires. There is one rural fire service station located at Silverton, with additional NSW Fire Brigade trucks located within the township of Broken Hill.

Impact assessment – construction

Throughout the construction and decommissioning phases of the Proposal, a number of flammable materials and ignition sources would be utilised onsite. These would include substances such fuels and oils and construction machinery. In addition, there is a risk that construction workers may inadvertently discard cigarette butts. The nature of the vegetation over the construction site would also impact on the potential for wildfires to spread. It is considered that the vegetation located on the wind farm site is not conducive to the spread of wildfires due to the sparse nature of the understorey as well as the generally fragmented nature of the vegetation communities. In addition, the potential fuel tonne per hectare as described by RFS (2006) is considered to be low.

Impact assessment – operation

The site would include electrical equipment along with petrochemicals and as a result there is potential for the wind turbines, substation, control building and transmission lines to start or influence the spread of fire onsite. Zilkha Renewable Energy (2002) reports that records from a leading insurer show that fires due to equipment failure are very rare in modern wind turbine designs. In 15 years and with over 12,000 insured turbines, the insurer has had only one case of third-party damage from fire caused by a turbine.

Recent incidents include a fire in a turbine at an Iowa wind farm in October 2007. The fire caused major damage to one turbine with two of the blades detached during the fire. During high temperatures, a turbine fire at Lake Bonney Stage 2 wind farm in South Australia February 2006 was reported. Turbines automatically shut down if ambient temperatures exceed the safe operating range, or if components overheat. The fire was speculated to be caused by an electrical fault. The fire was controlled at the site.

While the likelihood is low, electrical failure can produce a fire within a turbine tower. In the event of a turbine igniting onsite, the generally low fuel levels in the surrounding area and sparse nature of the vegetation would reduce the intensity of wildfire and likelihood of spread. In addition, shutdown mechanisms would be installed in the wind turbines and remote alarming and maintenance procedures would also be used to minimise risks. The RFS and NSW Fire Brigade would be involved in any fire-fighting response. The RFS have stated that due to the hazardous materials stored on wind farm sites (hydrocarbons within turbines and the substation), the local RFS would only ever act in a support capacity to the NSW Fire Brigade in the event of an infrastructure-related fire onsite. The RFS and NSW Fire Brigade would be consulted regarding safety, communication, site access and response protocols in the event of a fire originating in the wind farm infrastructure, and also in the event of an external wildfire threatening the wind farm.

Lightning rods are installed in turbines to ground lightning strikes in order to minimise risk of damage to the turbines and risk of igniting a wildfire. Relatively minor damage to turbines may occur from lightning strike. The risk of turbine ignition is considered to be low, based on the low likelihood of electrical failure or overheating and a range of factors mitigating the fire hazard.

The transformer in the substation facility would contain transformer oil for the purpose of cooling and insulation. The facility would be bunded with a capacity exceeding the volume of the transformer oil to contain the oil in the event of a major leak or fire. The facility would be regularly inspected and maintained to ensure leaks do not present a fire hazard, and to ensure the bunded area is clear (including removing any rainwater). Transformer oil would be changed regularly at appropriate intervals by qualified staff to minimise the potential for fire caused by contaminated oil. The oil would be removed from the site and disposed of appropriately.

The substation would be surrounded by a gravel and concrete area free of vegetation to prevent the spread of fire from the substation and reduce the impact of bushfire on the structure. The substation area would also be surrounded by a security fence as a safety precaution to prevent trespassers and stock ingress. An asset protection zone would be maintained around the control room and substation buildings, compliant with the RFS *Planning for Bushfire Protection* guidelines. Workplace health and safety protocols would be developed to minimise the risk of fire for workers during construction and during maintenance in the control room and amenities.

Transmission line route (site to Broken Hill, site to Red Cliffs)

Background

As described in RFS (2006), vegetation occurring along the proposed transmission line route between the wind farm site and Broken Hill is the chenopod sub-formation within the Arid shrublands class. This sub-formation is described as being dominated by low shrubs, usually less than 1.5 metres tall, including saltbushes, bluebushes and copperburrs. Ground cover made up of perennial tussock grass (never hummock grass), RFS (2006). RFS (2006) describe the potential fuel from this formation as being nine tonnes per hectare. The potential impacts associated with the construction and operation of the power line is manageable with the implementation of appropriate mitigation measures.

The area of the proposed transmission line from Broken Hill to Buronga and Red Cliffs is characterised by scattered vegetation communities and generally flat topography. The vegetation, particularly in the southern portion of the proposed transmission line, has a thicker and more continuous understorey than the vegetation on the wind farm site. The land on which the proposed transmission line would be constructed is primarily farming and grazing land, which may help reduce the risk of bushfire within these areas by managing the fuel levels.

Impact assessment – construction

It is considered that the characteristics of the vegetation along the transmission line route between Broken Hill, Buronga and Red Cliffs, particularly in the southern portion, is more conducive to the spread of potential wildfires than within the turbine envelope. Ignition sources could relate to broken lines and lightning strike.

The Rural Fire Service would be consulted in regard to the adequacy of bushfire prevention procedures to be implemented onsite during construction, operation and decommissioning. These procedures would in particular cover hot-work procedures and response measures to control any incident.

Impact assessment – operation

Electrical transmission lines would be underground across the turbine site to the substation, where possible. Overhead lines would then be constructed from the onsite substation to link the Proposal to the NSW grid at the Broken Hill substation. The vegetation along the easement from the wind farm site to Broken Hill is generally made up of chenopod shrublands, mature height of two metres and scattered areas (less than 5 per cent) of mulga and prickly wattle that have mature heights of up to five metres. The overhead lines have been routed to avoid the scattered areas of mulga and prickly wattle where possible, reducing the need for clearing and eliminating ongoing fire risks from tree growth and in the event of a line breakage. Cable routes would be periodically inspected to monitor regrowth.

Overhead transmission lines would also be constructed from the substation at Broken Hill to Red Cliffs. As previously discussed, the nature of the vegetation observed along the proposed transmission line route is considered more conducive to wildfire than the vegetation observed at the wind farm site. Additionally, the proposed transmission line would cross properties that are currently being used for farming and grazing, with the presence of these property owners assisting in the early detection of any fires.

7.14.2 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area-Stage 1	Site area-Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC100	Increase risk of fire ignition or spread	Minimise risk	Consult with the Rural Fire Service (RFS) and NSW Fire Brigade (NSWFB) in regard to the adequacy of bushfire prevention measures to be implemented on site during construction, operation and decommissioning. These measures would in particular cover hot-work procedures, asset protection zones, safety, communication, site access and response protocols in the event of a fire originating in the wind farm infrastructure, or in the event of an external wildfire threatening the wind farm or nearby properties	Construction Operation Decommissioning	X	X		
SOC101	Increase risk of fire ignition or spread	Minimise risk	Hold appropriate fire fighting equipment on site and train an appropriate number of site personnel in its use. Determine the equipment and level of training in consultation with the local RFS	Construction Operation Decommissioning	X	X		
SOC102	Increase risk of fire ignition or spread	Minimise risk	Handle and store flammable materials and ignition sources brought onto the site as per manufacturer's instructions	Construction Operation	X	X	X	X
SOC103	Increase risk of fire ignition or spread	Minimise risk	Maintain asset protection zones, based on the RFS Planning for Bushfire Protection, around the control room, substations and in electricity transmission easements Develop workplace health and safety protocols to minimise the risk of fire to workers	Construction Operation Decommissioning	X	X	X	X
SOC104	Increase risk of fire ignition or spread	Minimise risk	Bund substation facilities with a capacity sufficient to contain the volume of transformer oil in the event of a major leak or fire. Maintain bunds to ensure leaks do not present a fire hazard, and to ensure the bunded area is clear (including removing any rainwater)	Construction Operation	X	X		
SOC105	Increase risk of fire ignition or spread	Minimise risk	Surround substations with a gravel and concrete area free of vegetation to prevent the spread of fire from the substation and reduce the impact of bushfire on the structure	Construction Operation	X	X		

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC106	Increase risk of fire ignition or spread	Minimise risk	Hold fire extinguishers on site in all control buildings, substation buildings and facilities buildings	Construction Operation	X	X		
SOC107	Increase risk of fire ignition or spread	Minimise risk	Periodically inspect overhead transmission easements to monitor regrowth of encroaching vegetation	Operation	X	X	X	X

7.15 ELECTROMAGNETIC FIELDS (EMFS)

7.15.1 Assessment

Wind farm site

Background

Electromagnetic fields (having both electric and magnetic components) are generated by operational electrical equipment, including transmission lines, substations and wind turbines. Transmission lines and electrical devices, including substations and wind turbines, generate 50Hz electric and magnetic fields within their vicinity.

The Australian Radiation Protection and Nuclear Safety Agency (APANSA) was formed in 1998 as a Federal Government agency charged with responsibility of protecting the health and safety of people and the environment, from the harmful effects of ionising and non-ionising radiation. ARPANSA is currently developing guidelines on exposure limits to EMFs but in the meantime they still refer to the National Health and Medical Research Council Interim Guidelines. The National Health and Medical Research Council Interim Guidelines on Limits of Exposure to 50/60Hz Electric and Magnetic Fields recommended limit for 24 hour exposure is 1000mG for magnetic fields and 5kV/m for continuous public exposure to electrical fields.

Electric fields can be reduced both by shielding and with distance from operating electrical equipment. Magnetic fields are reduced more effectively with distance. Underground cables used in the on site reticulation (22-66kV) will contain three core conductors in trefoil arrangement to cancel out the effect of magnetic fields from adjacent conductors

Impact assessment – construction

No impact mitigation is considered to be required.

Impact assessment – operation

EMFs would occur during the operational phase of the wind farm. Due to the type and configuration of the wind farm infrastructure proposed, the electromagnetic fields would vary in different locations. Transmission lines connecting turbines to the onsite electrical substation may be overhead or underground. There would be a need for the construction of overhead transmission lines from the substation located on the wind farm site to the TransGrid substation in Broken Hill. It is also proposed that overhead transmission lines be constructed between the wind farm site and Red Cliffs substation in Victoria.

Few landholders have the potential to be directly affected by EMFs produced by the turbines and the transmission line to Broken Hill, due to the extremely low density of settlement in this area, (a detailed discussion regarding impacts is presented below) and the rapid reduction of EMF with distance from turbines and power lines. The same applies to the larger number of landholders, likely in excess of 20, on the transmission line between Site and Red Cliffs substation.

Proximity to receivers (including residences, places of work and recreation) is the key constraint with regard to managing the impact of EMFs. Any off-site electricity lines will be located and designed in accordance with the Principals of Prudent Avoidance which essentially means taking appropriate precautions at modest cost without undue inconvenience to avert possible risk. Therefore electricity cables will be located away from residences, where practical, to minimise magnetic fields from any off-site transmission lines.

The United Kingdom National Grid Company has conducted a survey of suburban substations to determine the level of EMFs produced. Measurements were taken at 0.5 metres above ground level within one metre of enclosures. The results revealed mean magnetic flux densities of about 19mG, halving at an average distance of 1.3 metres and becoming indistinguishable from the background due to other domestic sources within five metres (HPA 2004).

Fencing around the substation and the location of the substation and control buildings would ensure that the EMF exposure to receivers including the public and property owners and workers are well below the 1,000mG levels determined for public health.

A report investigated the expected magnetic field for 1,650kW proposed wind turbines for Windrush Energy in 2004 (Iravani *et al.* 2004). The study was based on research and measurements of an existing wind turbine. The measured flux density at the door of the existing turbine was 0.4mG and the typical value around the wind turbine was 0.04mG. The acceptable level is 833mG. The results determined that no measurable magnetic field would be expected at distance of eight metres from the 1,650kW wind turbine.

The report concluded:

> *It is our strong belief that the magnetic fields produced by the generation and export of electricity from the Windrush wind turbine does not pose a threat to public health.*

The turbines proposed for the Silverton site would be much larger, however receivers are few, as discussed below. As such, the low risk of health impacts is considered to be highly manageable.

The areas proposed for the installation of wind farm site infrastructure would have limited public access. Access to these areas by the general public would be restricted, with periodic access by appropriately trained and qualified maintenance staff only. Property owners accessing the sites would have no reason to spend extended periods near the infrastructure, which is not located near frequent use areas such as sheds, yards and residences. Should property owners require access to control buildings or other wind farm infrastructure, they would be accompanied by an appropriately trained and qualified maintenance staff member.

Wind farms present an opportunity for tourist and educational use. Although it does not form part of this Proposal, there is a potential for the Silverton Wind Farm to be used in the future as a renewable energy educational facility. Again, extended exposure is not anticipated from tours, however appropriate safeguards could be put into place prior to the operation of any tours to ensure the opportunity for human exposure to EMFs is minimised and within recommended guidelines.

Microwave Communications

Microwave communication links are likely to provide communications and control system telemetry for wind farm and substation operations. Microwave communication is a commonly used method of communication/data transfer and is implemented by a wide variety of telecommunications companies, emergency services, transmission network services providers within Australia and the world. These communication links produce electromagnetic energy (EME's) by using low frequency radio waves.

Microwave signals travel in a narrow beam from the antenna and dispersion of microwave energy outside this path is minimal or insignificant. Microwave communication antennae's transmit and receive low power signals. Based on current research findings, it is not expected that any harmful effects would result from exposure to microwave links. (Hahash, 1989).

All links installed will be regulated and licensed by Australian Communications and Media Authority (ACMA) and will operate within safety standards recommended by the World Health Organisation (WHO) and required by ACMA

Transmission line route (site to Broken Hill)

Background

Underground transmission lines connecting turbines to the onsite substation would be up to 66kV. From the substation, the voltage would be stepped up and electricity produced by the wind farm would be fed into 220kV overhead transmission lines connecting the Stage 1 substation to the TransGrid substation near Broken Hill.

The magnetic fields associated with a transmission line at any moment in time depend on a range of factors, including the amount of power flowing in the line and the distance of the measurement point from the conductors. Typical levels of magnetic field under a 220kV high-voltage transmission line range from 5 to 50mG at a distance of 30 metres from the centre of the easement. The strength of the field falls away rapidly with increased distance. High-voltage lines can produce magnetic fields of up to 80mG. These figures are far less than the 1,000mG limit recommended for 24-hour exposure (National Health and Medical Research Council Interim Guidelines on Limits of Exposure to 50/60Hz electric and magnetic fields).

Electric fields from power lines diminish rapidly with distance from the source. Their levels are extremely low, with levels of 0.07V/m and 0.01V/m recorded at 30m and 60m from a 115kV power line (Hafemeister, 1996), and are significantly less than the 5kV/m (5000V/m) NHMRC interim guideline for continuous exposure. At the voltage (33kV) proposed in this project, the effects are negligible.

In reality the proposed transmission line between the wind farm and the existing Broken Hill substation does not pass closer than 1km to any residences and therefore impact from EMF's is considered negligible.

In a 33kV transmission line, the load may be 'unbalanced' (greater at one end than the other) and located closer to the ground than in a 132kV line and, as such, receivers may be exposed to larger EMFs than with the higher voltage lines (pers. comm. Mr Colin Hackney, Country Energy 2006). Where practical, 33kV lines would be underground, maximising the shielding effect to minimise EMF exposure.

Impacts are not anticipated as a consequence of the low exposure rates in combination with the low likelihood that people or stock would be within range of high exposure levels for extended periods.

Impact assessment – construction

No impact mitigation is considered to be required.

Impact assessment – operation

Few landholders have the potential to be directly affected by EMFs produced by the transmission line from the wind farm site to Broken Hill, due to the low density of settlement in this area and the rapid reduction of EMF with distance from transmission lines.

Transmission line route (site to Red Cliffs)

Background

The background for EMFs has been described above. In addition, there is a larger number of landholders, likely in excess of 20, associated with the transmission line between to the site and Red Cliffs substation.

Impact assessment – construction

No impact mitigation is considered to be required.

Impact assessment – operation

Few landholders have the potential to be directly affected by EMFs produced by the transmission line from Broken Hill to Red Cliffs, due to the low density of settlement in this area and the rapid reduction of EMF with distance from transmission lines. There is only one known residence within 200m of the proposed route and consultation with the landowner will occur before the route alignment will be finalised. It is expected that adequate separation between the power line and the residence will be incorporated into the design.

Therefore impacts from EMF's are not anticipated as a consequence of the low exposure rates in combination with the low likelihood that people or stock would be within range of high exposure levels for extended periods.

7.15.2 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC108	Exposure from EMFs	Minimise exposure	Adhere to standard industry approaches and policies with respect to EMF through maintenance of adequate easements around transmission lines	Operation			X	X

7.16 COMMUNICATION IMPACTS

7.16.1 Approach

A study of the potential telecommunication impacts of the proposed Silverton Wind Farm was undertaken by the Proponent. The methodology for the telecommunication impact assessment is described below.

- Identify licence holders within a 25 kilometre radius of the proposed wind farm site and point-to-point links in the vicinity of the site, using information provided on the Australian Communications and Media Authority (ACMA)RADCOM database
- Provide written notification of the Proposal to, and seek comments from, each licence holder identified via the ACMA RADCOM database within a 25 kilometre radius of the site
- Record and review all responses received to identify any issues raised by licence holders
- Discuss issues raised with relevant licence holder with the aim to resolve or identify mitigation measures
- Carry out an assessment of the 'Fresnel zone' associated with each fixed point-to-point communications link crossing the site
- Determine appropriate exclusion zones for proposed turbine layout based on Fresnel zone calculations and advice from licence holders
- Confirm that all turbines (including blades) are located outside the exclusion zone
- Determine appropriate additional mitigation measures that may be required.

A copy of the full telecommunication impact assessment is presented in Appendix 9.

7.16.2 Assessment

Wind farm site

Background

Electromagnetic Interference (EMI) has the potential to cause degradation or total loss of signal strength and may cause poor TV reception and/or 'ghosting' effects. EMI can also result in a coverage reduction of mobile phone, radio and aircraft navigation communications. URS (2004) identified three principal mechanisms by which wind turbines may cause EMI as discussed below.

- **Reflection or scattering:** If a signal sent between a transmitter and receiver becomes obstructed by an object located within the path of a signal, reflection and/or scattering may occur. Should a rotating blade of a wind turbine receive a primary transmitted signal, a scattered time-delayed (or out of phase) signal may be produced and transmitted to the receiver. This may result in a signal that would be distorted in relation to the primary signal.
- **Diffraction:** Diffraction can occur when an object is located in the path of a signal wave front. This object can both reflect and absorb the signal.
- **Near field effects:** Wind turbines may cause interference to radio signals due to the electromagnetic fields emitted by the generator and the switching components within the turbine nacelle. However, as a result of advances in technology and compliance with the Electromagnetic Emission Standard EN 61000-6-4 (AS/NZ 4251.2:1999) *Emission standard for industrial environments*, the wind turbines proposed would not cause active EMI due to near field effects.

Factors such as placement of the wind turbine in relation to the signal path/s, the signal frequency, the characteristics/composition of the wind turbines rotor blades, the receiver characteristics and the propagation characteristics of the radio wave in the local atmospheric conditions would affect the level of EMI produced by a wind turbine. While the site proposed for the development of the wind farm is a remote area, communications links and broadcast networks are present in the surrounding region.

Television and radio broadcast services

The ACMA RADCOM database lists the following broadcasters under postcode 2880, which includes the Silverton area.

- Television broadcasting: Broken Hill TV1: ABC, BKN, SBS and SCN. Remote Central and Eastern Australia TV1: ABC, IMP, SBS. Remote Central and Eastern Australia TV2: QQQ
- Radio broadcasting: Broken Hill RA1: 2ABCFM, 2BH, 2DRY, 2HIL, 2JJJ, 2NB. Central Zone RA2: 8KIN, Remote Commercial Radio Service Central Zone RA1: 8SAT. Remote commercial Radio Service North East Zone RA1: 4BRZ, 4RBL
- Rocky Hill, Broken Hill (31 57 10, 141 26 20) licence number 1158320 is the nearest TV transmission source for the locality of the proposed wind farm. It is located approximately 28 kilometres southeast of the proposed wind farm site

Mobile phone services

Mobile phone services operational in the Silverton/Broken Hill area include CDMA, GSM, 3G and Next G. High-frequency communications links used for mobile transmission networks are discussed in Radio Communication Services. The extent and range of the existing local mobile phone coverage provided by the three mobile phone service providers are presented in the telecommunications report, Appendix 9.

Radio communication services

According to the ACMA RADCOM database, the area in the vicinity of the proposed wind farm is classified as a Remote Density Area. Very few licence holders operate radio communications services and/or mobile communication systems within a 25 kilometre radius of the proposed wind farm.

Contact was made with the organisations identified as operating radio communication licences, including fixed link communications, within 25 kilometres of the wind farm wind monitoring mast (-31 47 57.31827, 141 14 56.83686). Each was asked to provide independent comments/advice on the possibility of the wind farm development interfering with their communications links.

Aircraft navigation systems

Broken Hill Certified Aerodrome is the closest major aerodrome to the wind farm site. CASA advised that the Obstacle Limitation Surfaces reach a distance of 15 kilometres from the field. The aerodrome is approximately 6 kilometres south of Broken Hill CBD and 29 kilometres southeast of the wind farm site. There are three private airstrips located approximately 15 kilometres from the proposed wind farm site (refer to Figure 7.14). A figure outlining the location of the Broken Hill Certified Aerodrome as well as the other smaller landing strips in relation to the proposed wind farm site is presented within the Telecommunications report, Appendix 9.

Impact assessment – construction

The siting of the wind turbines during construction has the potential to impact any microwave links crossing the proposed turbine site. Where the potential exists for interference to line-of-sight links, an obstruction analysis can be undertaken to ensure that no part of a wind turbine assembly would enter the Fresnel zone of the microwave link. The maximum extent of the Fresnel zone occurs at the midpoint along the path of the microwave link.

One point-to-point communications link was identified as crossing the site boundary. This was listed on the ACMA database as 'Rural Fires North Barrier Trig Point 95 kilometres N of Broken Hill', Site ID 34929 transmitting to 'NSW State Emergency Service Site Ambulance Site THACKARINGA'.

An obstruction analysis was carried out which determined that the maximum extent of the second Fresnel zone at the midpoint of the link to be 189 metres. Conservatively, provided the wind turbines do not encroach within a distance of approximately 200 metres on either side of the above link, interference is unlikely to be observed.

Impact assessment – operation

Operational impacts may affect television and radio broadcast services, mobile phone services, radio communication services and aircraft navigation systems. These are discussed separately below.

Television and radio broadcast services

Television Interference (TVI) is dependent on a range of factors including environmental factors (topography, direct signal strength, transmitter type and receiver type) and wind farm design factors (turbine elevation, rotor size and orientation, speed of rotation, blade material and pitch). TVI caused by the operation of wind turbines is characterised by video distortion, while the audio component of the signal is not affected (URS 2004). There is also a degree of uncertainty regarding predicted levels of interference resulting from the variability of local conditions and the characteristics of antennas used in particular installations.

The level of TVI can be influenced by:

- Where a receiver is located relative to the TV transmitter and the wind farm
- The frequency of the transmitted television signal
- Whether there are any other tall structures in the vicinity of the receiver
- The direction of the rotor blades and blade material
- The nature and quality of the receiving aerial.

Generally, the potential for interference at receiver locations increases with distance of the receivers from the transmitter. Signal strength decreases with increasing distance from the source. As such, a wind farm in an area of already poor signal strength may potentially have a greater impact on reception than the same wind farm in an area of relatively strong signal strength. In addition, reception in the vicinity of the wind farm can vary with the degree of topographic obstruction of the signal.

The wind turbine interference zone is the zone of interference for a single wind turbine, and is primarily an elongated zone extending from the turbine structure in the direction away from the transmitter and a zone of shorter but wider extent on the transmitter side. The zone of potential interference for a wind farm is the resultant total of the effects from individual turbines. The International Telecommunications Union Recommendation ITU-R BT.805 states that impacts beyond five kilometres are unlikely. In addition, interference may extend beyond five kilometres where the receiver location is shielded from the direct signal, but in direct line-of-sight to the turbine. The form of interference, if experienced, would depend on the relative positions of the wind farm, the transmitting station and the receiver. As discussed, television interference can take the form of either a 'ghost' image that pulsates horizontally at the 'blade pass' frequency or a fluctuation in picture brightness, also at the blade pass frequency.

There are approximately 26 houses within a five kilometre radius of the proposed wind farm. The location of the wind farm with respect to Rocky Hill, Broken Hill communications is presented in the telecommunications report, Appendix 9. Assessment of the likely impact on specific house locations is difficult prior to the actual operation of the proposed wind farm. Once the wind farm is operational, it is possible that television reception could be affected at some of these locations unless some form of mitigation is introduced. As previously stated, the International Telecommunications Union Recommendation ITU-R BT.805 states that impacts beyond five kilometres are unlikely. The majority of the 26 houses are located close to five kilometres from the wind farm.

Some houses in the area may have satellite pay TV service antenna installations. Unless a particular subscriber's antenna reception direction and elevation is aligned with a turbine, no impacts on TV reception are likely.

In addition to the direct effects of the operational turbines, the level of radio broadcast interference experienced can also be influenced by:

- Abnormal weather conditions
- Multi-path distortion
- Overloading
- Electrical interference from household appliances.

Country Energy responded on 22 January 2008 and advised that they do not envisage any interference or disruption to their communications services as a result of the Proposal. A copy of this correspondence is presented in Appendix 9.

One point-to-point communications link was identified as crossing the site boundary and listed on the ACMA database as 'Rural Fires North Barrier Trig Point 95km N of Broken Hill', Site ID 34929 transmitting to 'NSW State Emergency Service Site Ambulance Site THACKARINGA'. A subsequent obstruction analysis was carried out which determined that the maximum extent of the second Fresnel zone at the midpoint of the link was 189 metres. Conservatively, provided the wind turbines do not encroach within a distance of approximately 200 metres either side of the above link, interference is unlikely to be observed.

Mitigation measures for potential television and radio impacts are described in the mitigation measures section.

Mobile phone services

A mobile phone network consists of a system of adjoining zones called 'cells', which can vary in size with a radius of two to ten kilometres. Each cell has its own base station that sends and receives radio signals throughout its specified zone. Mobile phone antennas need to be mounted clear of surrounding obstructions such as buildings to reduce 'dead spots' and allow the base station to effectively cover its intended cells.

No GSM/CDMA mobile services are registered at sites in the close vicinity of the wind farm. As such, the potential impacts to mobile service coverage as a result of the operation of the proposed wind farm are considered negligible.

Radio communication services

Fixed link radio transmissions have a point-to-point transmission path typically between two elevated topographical features. The transmission path may become compromised if a wind farm is located within the direct line-of-sight or what is known as the Fresnel zone around the line-of-sight between the sending and receiving antennas.

The potential impact zone would vary with the distance between the transmitter and receiver, frequency of transmission and the location of any particular point along its path. Communications are only likely to be affected if a wind farm is in the line-of-sight between two sending and receiving antennas or within a zone of the line-of-sight of these antennas.

Where the potential exists for interference to line-of-sight links, an obstruction analysis can be undertaken to ensure that no part of a wind turbine assembly would enter the Fresnel zone of the microwave link. The maximum extent of the Fresnel zone occurs at the midpoint along the path of the microwave link.

Two-way mobile: No significant impact from the wind farm on base coverage beyond normal mobile operational performance is anticipated. This assessment is based on the geographic separation between the base antennas and the turbine structures. However a mobile unit communicating with a base station when the mobile is located within metres of the wind turbine structures may experience some very local performance change, however moving a short distance from the turbine would restore performance to normal.

CB radio: CB radios are not individually licensed and are subject to class licensing only. Therefore no records of location or operators of CB radios exist, and the channels are shared without any right of protection from interference. Impacts to CB radio users as result of the construction of the wind farm are anticipated to be minor. There may be very local effects to portable or mobile units in the immediate vicinity of the turbines that could be avoided by a small location change of the unit.

Aircraft navigation systems

Details of correspondence between the Proponent, CASA, Broken Hill City Council, Airservices Australia and the Department of Defence is provided in Section 7.13.

Mitigation strategies are available to address any loss of signal quality, due to the operational wind farm.

Transmission line route (site to Broken Hill, site to Red Cliffs)

Background

Both transmission line corridors would require the construction of towers that can potentially impact on microwave links located within the area.

Impact assessment – construction

Siting of transmission towers along the transmission line route may have a potential impact on microwave links within the area. Siting of the towers would consider any microwave links that may cross the proposed transmission line route.

When commissioning the transmission lines appropriate procedures would be in place to ensure continuity of electricity supply to customers during the commissioning of the wind farm. Sections of the Broken Hill and Red Cliffs substations may need to be de-energised to allow safe installation of switchgear and the new power line/s from the wind farm, however this would not involve reduction of power supply to customers.

Impact assessment – operation

There are no expected operational impacts to EMI's during operation of the transmission line route.

7.16.3 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC109	Deterioration of signal strength	No deterioration of signal strength	Locate wind turbines to avoid microwave link paths that cross site	Construction	X	X		
SOC110	Deterioration of signal strength	No deterioration of signal strength	Ensure adequate television reception is maintained for neighbouring residences as follows: – Assess pre-existing television signal strength at residences within 5km of the site, prior to construction – In the event that after construction television interference (TVI) is experienced by existing receivers within 5km of the site, investigate the source and nature of the interference – Where investigations determine that the interference is cause by the wind farm, establish appropriate mitigation measures at each of the affected receivers in consultation and agreement with the landowners	Operation	X	X		

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8. ASSESSMENT OF ADDITIONAL ISSUES

Beyond the key issues identified by the Department of Planning in the Director-General's Requirements, additional areas of impact were identified using a risk analysis model. This model considers the nature of the potential impact (is it temporary, reversible, likely to generate indirect impacts), the receiving environment (sensitivity to impact, recovery response time) and the likelihood of the impact occurring.

Table 8.1Risk analysis of remaining issues

Discussed in this Section:	Impact area		Nature of impact	Sensitivity of receiving environment	Likelihood of occurrence	RISK RATING
Section 8.1	Community wellbeing	Wind farm	3	4	3	36
		Transmission	2	2	3	12
Section 8.2	Lifestyle values	Wind farm	3	4	3	36
		Transmission	2	2	3	12
Section 8.3	Tourism	Wind farm	3	4	3	36
		Transmission	2	2	2	8
Section 8.4	Film and art	Wind farm	2	3	4	24
		Transmission	2	2	2	8
Section 8.5	Health and safety	Wind farm	5	2	2	20
		Transmission	5	2	2	20
Section 8.6.1	Climate	Wind farm	1	1	5	5
		Transmission	1	1	5	5
Section 8.6.2	Air quality	Wind farm	2	2	5	20
		Transmission	2	2	5	20
Section 8.6.3	Soils	Wind farm	3	4	4	48
		Transmission	3	4	4	48
Section 8.7	Resource	Wind farm	4	2	5	40
		Transmission	4	2	5	40
Section 8.8	Cumulative	Wind farm	4	3	4	48
		Transmission	3	2	4	48

Note: The risk rating has been calculated as a factor of the anticipated nature of the impact and sensitivity of the receiving environment:

1 = low nature of anticipated impact/sensitivity/likelihood of occurrence

5 = high nature of anticipated impact/sensitivity/likelihood of occurrence

Risk ratings are then portrayed from least to greatest: green, yellow, orange, red.

8.1 COMMUNITY WELLBEING

8.1.1 Assessment

Background

The local communities in the direct vicinity of the wind farm site include Silverton and Broken Hill. Data published on the Bureau of Statistics website for the 2006 census indicated that there are a total of 89 usual residents in Silverton with a total of 28 families. In addition, 2006 census data also indicated a total of 19,361 usual residences with a total of 5,102 families for Broken Hill. The community comprises families that have been in the area for several generations and newer residents attracted by work opportunities or lifestyle choices.

A number of properties are located along the proposed transmission line to Buronga and Red Cliffs. Although most of the route is sparsely settled, two major towns, Wentworth and Buronga, are located at the southern end of the proposed route. The majority of the properties located along the proposed route are farmers and grazers, although a short section of the route would place it adjacent to more dense residential areas.

The investigation of community wellbeing in this EA centres on indicators of community wellbeing and predicting the community's response to the Proposal.

Community and individual wellbeing centres on the individual's experience of keys issues such as employment, economic resources and health. It may also be affected by contextual factors that include family and social networks, neighbourhood amenity and access to services on the basis of proximity and affordability (Newton 2006). Broken Hill City Council prepared a Social Plan for 2005 to 2010 in which a number of community needs affecting wellbeing were identified, including:

- New employment opportunities
- A safe, healthy and sustainable living environment
- Access to similar services and opportunities available to larger communities
- Access to computer technology
- Maintenance of exiting services and infrastructure
- A secure and safe water supply
- Regular and affordable transportation
- A positive outlook on the future of the city.

The Social and Community Plan outlined a range of needs for targeted groups including young people and women from culturally or linguistically diverse backgrounds, Aboriginal and Torres Straight Islanders.

Another measure of 'community' is the willingness of individuals to be involved in volunteer organisations such as the Bush Fire Brigade, Meals on Wheels, the Country Women's Association, farmers' associations, local sports and recreation clubs. These groups are well represented in the region. Broken Hill has an extensive range of sporting facilities including lawn bowling clubs, golf clubs, indoor cricket, speedway, racecourse, greyhound track, basketball stadium, heated swimming pool, squash and tennis facilities and a large number of ovals used for cricket, football, soccer, softball and hockey (BHMP 2007 to 2012). These organisations are based on shared goals and largely maintained by volunteers. The additional element of people who have long associations with the area can strengthen the fabric of the local community.

Warren et al. (2005) observed that the move from centralised power generation to decentralised use of renewable sources raises novel and challenging issues social engagement. Their study of wind farms in Scotland and Ireland investigated the nature of community views about wind farms.

The study found that aesthetic perceptions (whether positive or negative) are the strongest single influence on individuals' attitudes towards wind farms and that proximity to wind farms is not a reliable indicator of perception in the long term. Surveys showed that people with anti-wind farm views perceived turbines as noisier and more intrusive than those in favour of wind turbines, regardless of the actual recorded levels (Krohn and Damborg 1999, cited in Warren et al. 2005). The study observed that opposition arises in part from exaggerated perceptions of wind farms that living near a wind farm dispels (Elliott 1994; Redlinger et al. 2002; SEDD 2002; Braunholtz 2003; SEI 2003a, cited in Warren et al. 2005). More positive feelings about wind farms were recorded closer to the wind farm site than further away (Warren et al. 2005).

Warren et al. (2005) state that a consistent picture of public attitudes to wind power is emerging from surveys and case studies in Europe. Large majorities are strongly in favour of wind farms, their opinions formed by personal experience in contrast to a minority in opposition whose opinions are formed not by experience but by misinformation and prejudice. This does not discount the real issues associated with community impacts, those being landscape aesthetics and the speed, scale and uncoordinated nature of the wind farm developments (Warren et al. 2005).

Public attitudes are critically influenced by the nature of the planning and development process; the more open and participatory, the greater the level of public support (Birnie et al. 1999; Khan 2003, cited in Warren et al. 2005). To address the requirement to involve the community in planning of the Proposal, an open house forum was held at the Silverton Municipal Chambers on Wednesday 26 November 2007 (documented in Section 6.2). Visual impact was considered to be the biggest concern by respondents. Potential for adverse noise impacts was the other main issue the community associated with the Proposal. The clean renewable energy that would be generated from the wind farm was considered the most likeable aspect of wind farms, however the same number of respondents indicated that there was nothing they liked about wind farms. Perceived visual impacts, noise and the potential impacts to the site were the three main dislikes that the community associated with wind farms. General issues that were raised by the community included the economic benefits for the Proponent, the level of community input, the general planning process and the perception that rural people's lives were being disregarded by those people living in cities.

Impact assessment

With regard to specific wellbeing indicators, the construction of the wind farm would have a positive impact for many members of the community in terms of employment opportunities (construction work, services required by construction contractors, tourism potential), accessibility (upgrading of certain access roads) and services (improved electricity supply). A community fund also forms part of the Proposal and may be used to address specific community needs, and direct benefits have been offered to Silverton residents through the provision of solar energy equipment to residents. However, the construction of wind farms can be an emotive issue for many. Benefits would not be equally distributed among the community and some businesses may be affected due to the loss of visual aesthetic and to construction traffic (discussed in detail in Section 7 under Visual impacts, Traffic impacts and Economic impacts).

It is recommended that, to address the potential for the Proposal to adversely affect community wellbeing, the Social and Community Plan priority actions be used as a guide when considering mitigation measures.

The construction of the wind farm would generate a level of community disruption. In addition to physical impacts (such as noise, traffic and dust, considered in more detail in Sections 7.3, 7.6 and 8.6.2) the construction phase marks the beginning of a Proposal that people have strong views about. Adverse impacts may arise for a number of reasons:

- The development represents a large outside force over which the individual feels they have little control
- The development process takes the power of consent out of the hands of local representatives, being decided at the state (and sometimes federal) level
- The development is of a nature which is highly visible, relatively novel and may not be avoidable during day-to-day activities.

The development is of a nature that focuses monetary benefits on a relatively small number of directly involved stakeholders.

Impact assessment – operation

The Proposal is not anticipated to impact community wellbeing in ways additional to those issues discussed above during the operational phase. No mitigation measures are considered to be required. It is assumed that measures adopted during the construction phase would continue through the life of the project.

8.1.2 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area-Stage 1	Site area-Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC111	Community division	Provide accurate information	Disseminate accessible and independent information on wind farm impacts including benefits	Construction Operation	X	X	X	X
SOC112	Community division	Provide broad community benefit	Establish Community Fund as outlined in the Environmental Assessment	Operation	X	X		

8.2 LIFESTYLE IMPACTS

8.2.1 Assessment

Wind farm site

Background

In the area of the proposed wind farm, there are four landholders grazing sheep and harvesting goats (feral).

Silverton, the nearest town, is a small regional town that caters primarily for tourists and is the home of a number of artists. The nearest major town is Broken Hill located approximately 25 kilometres southeast of the wind farm site. Historically, Broken Hill and Silverton were mining townships, however with the decline in mining activities, tourism has also become the main industry in Broken Hill. Residents around the wind farm site, including some residents of Silverton, regularly commute along the Silverton Road to access services (and in many cases employment opportunities) in Broken Hill.

There is also a bushwalking club based in Broken Hill that is known to frequent the area for bushwalking, particularly in the western parts of the Barrier Ranges.

Impact assessment – construction

Visual impacts, noise, the generation of dust from vehicles and the increased traffic flow during construction and decommissioning may impact on the lifestyle values of those living adjacent to the wind farm site (including Silverton) and along main haulage routes, during the construction and decommissioning phases of the wind farm.

Due to the distance between the nearest resident and the proposed infrastructure, construction noise (excluding traffic noise, discussed separately) is not expected to impact on residents. Visual impact would be present. Response to this impact would be subjective; to many the installation of large-scale renewable energy infrastructure may be an attraction.

A number of the haulage routes would require construction equipment to travel along sections of unsealed public access roads. In periods of dry weather, the use of these roads may result in the generation of dust, potentially affecting the general community. It is considered that impacts would attenuate rapidly with distance from these sites. One of the proposed haulage routes to access the western portion of the site requires traffic to travel through Silverton. Residences and businesses within Silverton would experience increased traffic flow as a result of the Proposal, with associated safety, noise and dust impacts. Traffic delays could also be expected. It was noted in discussions with members of the local community that some Silverton residents travel to work in Broken Hill each day. Due to the layout of Broken Hill, appropriately designed haulage routes would have a low impact on lifestyle values within Broken Hill.

While construction and decommissioning impacts would be temporary, they would occur over an extended period (three to five years). Some areas would be subject to impact for this entire time (the Silverton Road between Daydream Mine Road and Broken Hill) while work at other areas, such as at discrete points along the transmission route, would be relatively short. All works would be regulated by occupational health and safety, noise and pollution restrictions, set out by the EPA. Due to the low population density, this is not expected to generate an unacceptable level of impact, however mitigation for affected receivers would be required.

The construction phase of the Proposal has the potential to impact the bushwalking activities that may occur in the area. As the construction phase 1 is scheduled to last for approximately 18 months and the overall project expected to take three to five years, this impact to bush walkers would be temporary.

Impact assessment – operation

The operation of the wind farm would impact on lifestyle values. While the operational wind farm would not preclude nearby residential or recreational land uses, the perceived visual, noise, health and land value impacts may adversely affect the section of the community seeking the quiet, rural and outback character of the area. These impacts are expected to attenuate with distance from the site. Time can also lessen the perceived adverse impacts of a wind farm, as actual experience replaces initial exaggerated perceptions (cited in Warren *et al.* 2005).

Specialist reports have quantified and evaluated the visual and noise impacts of the Proposal (refer to appendices for full reports, Appendix 1 and 2, respectively). Health impacts have been evaluated in Section 8.5. On the basis of these assessments, the impact on the lifestyle values of the site is expected to be manageable by specifically managing these impact areas. No additional mitigation measures are considered to be required.

Transmission line route (site to Broken Hill, site to Red Cliffs)

Background

There are a number of landholders that would be potentially impacted by the proposed transmission line corridor between the wind farm site and Broken Hill. The Proponent has been in consultation with these landholders throughout the planning process with the objective of designing the least intrusive corridor.

At present there is an existing transmission line that connects Broken Hill, Buronga and Red Cliffs. There are a large number of private properties located along this easement, which would be duplicated to develop the transmission required for the Proposal. The northern properties located within the unincorporated lands are administered by NSW Department of Lands, with the properties located in the south within the Wentworth Shire LGA on land zoned 1 (a) General Rural. Separate approval would be sought for the transmission infrastructure within Victoria.

The current land use for the majority of the properties located along the proposed transmission line corridor is rural farming and grazing.

Impact assessment – construction

A new transmission line would be installed between the site and Broken Hill, requiring pole footing excavation and access arrangements. Between Broken Hill and Red Cliffs, it is proposed that the additional transmission lines be installed adjacent to the existing line.

The construction of the transmission lines is unlikely to impact on the affected property owner's ability to use their land for the purposes of farming and grazing. Other areas affecting lifestyle values relate to specific visual, noise and traffic impacts, discussed in separately in Sections 7.2, 7.3 and 7.6. Mitigation measures have been developed under these sections to ensure that impacts are managed.

Impact assessment – operation

No additional impacts apply to the operational phase of the proposed transmission line corridor.

8.2.2 Mitigation measures

The impacts described above are considered manageable with the adoption and implementation of appropriate safeguards. Visual, noise, traffic, tourism, health and safety and air quality impacts are evaluated in more detail and mitigation measures stipulated in Sections 7.2, 7.3, 7.6, 8.3, 8.5 and 8.6.2. No additional mitigation measures are considered necessary.

8.3 TOURISM IMPACTS

8.3.1 Assessment

Wind farm site

Background

Most relevant to tourism impacts is the wind farm envelope's proximity to Silverton, an historic township where tourism is the dominant industry. Tourism for the Silverton/Broken Hill area is a large and diverse industry. A large number of tourists visit the Silverton/Broken Hill area every year. Tourism NSW reported that 418,000 domestic overnight travellers visited outback NSW, of which it is expected that 75 per cent (313,500) visited Broken Hill during the year ending June 2006 (Tourism NSW 2007).

TNS consultants prepared a Pilot Visitor Destination Report for Tourism Research Australia in October 2006 (TNS 2006). The objective of this report was to develop a comprehensive understanding of the profile, travel behaviours and satisfaction of visitors to Broken Hill region. The key findings from the Visitor Destination Report are presented below:

- 95 per cent of visitors stay overnight
- 76 per cent of visitors visit for holiday and leisure purposes
- The nature/outback type experience is a key draw card for visitation
- The towns most likely to be visited included Silverton, Cobar, Wilcannia and Peterborough.

The report also indicated that the five primary reasons for tourists to visit Broken Hill include:

- To visit Broken Hill
- To experience the scenery
- There's a variety of things to do and see
- To experience the wide open spaces
- To explore the history and heritage.

There are a number of different tourist activities on offer in the Silverton/Broken Hill area including:

- Historic Silverton (the town of Silverton)
- Visiting heritage building and sites
- Visiting art galleries and museums
- Visiting the sculpture park
- Visiting the Living Desert Reserve
- General sightseeing (including the Mundi Mundi Lookout).

Eldee Station, to the north-west of the proposed wind farm site, runs tours of historic sites and geological phenomenon within the wind farm site area. They also capitalise on nature-based tourism, providing accommodation and recreational activities.

Impact assessment – construction

A renewable energy Proposal of this nature is likely to create interest among the local and wider community and represents a potential tourist attraction for the Silverton/Broken Hill area. The number and type of visitors to the Silverton/Broken Hill region may be impacted by the operation of the wind farm. It is anticipated that there is potential for an increase in tourists that wish to view an operational wind farm and recognised that the infrastructure may also dampen a section of the tourist market, specifically nature-based tourism.

There are a number of businesses located in Silverton and its surrounds that cater for tourists visiting the area that may be directly affected by changes in tourist numbers.

The primary factors responsible for potential impact on the tourist industry during the construction phase relate to construction traffic. During the construction of the wind farm, access would be gained mainly by the Daydream Mine Road via Silverton Road but also potentially for a number of turbines via Silverton. A preliminary assessment has indicated that 26 of the 120 wind turbines in Stage 1 may need to be constructed via Silverton township. Impacts are likely to include loss of visual aesthetic, increased traffic and associated noise, dust and pavement deterioration. These have been discussed previously in separate sections of this EA (Sections 7.3 and 7.6).

The key impact area, determined by accessibility to the wind farm site, is the Silverton Road, the primary access to Silverton from Broken Hill. The increase in traffic movements associated with construction and decommissioning works may impact on tourist traffic accessing both Silverton and the Daydream Mine. The traffic impact study has indicated that the potential impact of construction traffic is expected to be manageable with the implementation of measures to address safety; however there may be delays to tourist traffic as a result of these safety measures. The construction work may affect the tourist's outback experience and even deter some visitors.

Countering this, there is an opportunity to promote the construction of the wind farm. A section of the tourism market would be attracted to viewing the construction and several safe vantages are present from the Silverton Road and Mundi Mundi Plains lookout. Educational tours are not part of this Proposal, however the Proponent is not averse to a third party organising such tours as a commercial activity.

Camel tours may be disrupted by the construction activity on Silverton Road. They currently cross this road to access the Silverton Common. Short and longer duration tours take in the plains surrounding Silverton. Safety issues arise at crossing points and an increase in large and heavy vehicles may scare the camels, however these issues are considered manageable in consultation with the operators of this facility.

The construction of the wind farm has the potential to attract tourists. The renewable energy industry is in its relative infancy within Australia, and there is a potential fascination with the construction of renewable technology such as wind farms. Through the community consultation process undertaken as part of this environmental assessment, a number of members of the community have indicated an interest in the Proposal and that they would like to witness the construction of the infrastructure.

The visual impacts, specifically related to the operational turbines, may have a negative or positive impact on tourism numbers and experiences. As discussed above, visual impacts have been described in greater detail in Section 7.2. It is also considered that, with adequate promotion, the operation of the wind farm would have a positive effect on tourism numbers visiting the area.

Transmission line route (site to Red Cliffs)

Background

The Silverton Road connects Broken Hill and Silverton and will therefore experience increased traffic during the development of the wind farm which may impact tourism values of the area.

The Silver City Highway is a major arterial road linking Broken Hill to Mildura and Victoria and will therefore similarly experience increased traffic. There are two towns located along the Silver City Highway between Broken Hill and Mildura: Wentworth and Buronga. Both of these towns are located at the southern end of the Silver City Highway. The Silver City Highway provides an access route for tourists travelling north to Broken Hill and beyond and south to Mildura and into western Victoria.

Impact assessment – construction

The traffic impact study indicated that the Silverton Road and Silver City Highway have adequate carrying capacity to accommodate the expected increase in traffic flow as a result of the Proposal, without presenting a major impact to users of the highway.

Adverse impacts to tourism would largely be managed by specific mitigation of impacts discussed separately in this EA (visual, noise, traffic, air quality) however several additional measures are recommended (see following table).

Impact assessment – operation

It is considered that the operation of the transmission line between the site, Broken Hill, Buronga and Red Cliffs would not impact tourism adversely.

8.3.2 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC113	Affect on local activities	Minimise disruption	Co-ordinate construction activities with local events	Construction	X	X	X	X
SOC114	Affect on local activities	Minimise disruption	Provide wind farm promotional information to the local visitor information centres	Construction Operation	X	X		
SOC115	Affect on local activities	Minimise disruption	Support educational and promotional tours targeting the construction and operation of the wind farm, subject to safety concerns and the permission of landholders permission being addressed	Construction Operation	X	X		
SOC116	Affect on local activities	Minimise disruption	Work with the Silverton Village Committee and involved landholders to allow for the development of the wind farm as a tourist attraction, if this option is desirable to these parties	Operation	X	X		

8.4 FILM AND ART IMPACTS

8.4.1 Assessment

Wind farm site

Information in this section is drawn from the Landscape and Visual Assessment completed by URS, as well as additional desktop research.

The landscape of far west New South Wales has appeared in a number of feature films and commercials, and is promoted to the local and international film industry as a unique combination of landscape and infrastructure elements. Information provided by representatives from Film Broken Hill indicates that the landscape character of the area (vastness, city and townships) is a draw card for the film industry (pers com D. Haskard, Manger Film Broken Hill, February 2008). The far west film industry has an estimated annual value to the economy in excess of $400,000 (pers com D.Haskard, Manger Film Broken Hill, February 2008).

Areas utilised previously and promoted to the film industry within approximately 120 kilometre radius of Broken Hill are described below.

- Silverton township and surrounding areas
- Mundi Mundi Plains (Mundi Mundi and Belmont Stations)
- Mundi Mundi Lookout (including to the north for approximately 20 kilometres)
- Mundi Mundi Ranges (including south of the lookout for approximately 10 kilometres and north for approximately 20 kilometres)
- Cockburn (on the SA/NSW border)
- Townships and roadhouses: Little Topar, old Quandong, Coomba, Packsaddle, White Cliffs, Milparinka, Tibooburra, Pooncarie, Menindee and Wilcannia
- National Parks: Sturt, Kinchega, Paroo Darling, Mungo.

Features films filmed in the area include Mad Max and Dirty Deeds (Film Broken Hill). In addition, representatives from the Film Broken Hill office indicated that a number of commercials and photographic shoots occur in the Silverton area sporadically throughout the year.

Film Broken Hill indicated that film revenue for 2007 was noted to be down 35 per cent on the corresponding period the previous year.

The Film Broken Hill website provides a gallery of images to illustrate the extensive and varied nature of available film locations around the region. The gallery includes images around Silverton as well as surrounding locations that would include views to a number of the wind turbines including:

- The road to the Daydream Mine
- The clay pan film location on the Mundi Mundi Plain
- The road to the Mundi Mundi Lookout
- The road to Eldee Station.

There is also a vibrant artist community/art industry within Silverton and Broken Hill. There are currently three commercial art galleries in Silverton as well as a several more located in Broken Hill. The region has also produced several well known Australian artists including Pro Hart and Jack Absalom.

A large amount of art work is produced and sold locally for the tourist market in a wide range of styles and mediums, from traditional oils through to modern contemporary and the surreal.

Many local landscape paintings respond to the natural scenery (gum trees, dry creek beds, desert dunes and hills, from broad visual perspectives to detail studies), however many of the artists, including those with galleries located in Silverton, also respond to the changing nature of the landscape and produce artwork that documents the built environment as well as elements of the surrounding industrial and mining landscape.

West Darling Arts was established in 1997 to support the development of the Arts in Broken Hill, Wentworth and Central Darling LGAs. The West Darling Arts website indicates that it operates under the auspices of Broken Hill City Council with additional support from the Central Darling and Wentworth Shire Councils and the NSW Ministry of the Arts. A representative of West Darling Arts indicated that although the Barrier Ranges offered a unique opportunity for local artists, it wasn't considered one of the top five most popular areas in which to paint in the area (pers com J. Giddey, Regional Arts Development Officer, West Darling Arts, 2008). West Darling Arts indicated that the five predominant areas used by artists in Broken Hill/Silverton were as follows:

- Menindee
- Tibooburra
- South Australia
- The Pinnacles
- Mutawinjii.

Impact assessment – construction

It is considered that potential visual, traffic and noise impacts likely to occur during the construction phase of the Proposal may impact on both the film industry and the local artist community. These impacts may be perceived to adversely affect the attractiveness of the area for films, television, photo shoots and to artists who seek out the wide open landscapes for their naturalness and visual amenity.

Section 7.2 of this EA addresses visual impacts in detail. These are associated primarily with the operational phase of the Proposal, however construction traffic and infrastructure may generate additional impacts that lessen the appeal of the area in the short term for filming and other artistic exercises.

Section 7.6 of this EA addresses traffic impacts in detail. The Proposal would increase traffic along the Silverton Road, which is the main road between Silverton and Broken Hill. This may impact on the number of people visiting Silverton and its art galleries. Safety would be addressed as part of a dedicated Traffic Management Plan, however the perceived impacts associated with high volumes of traffic may be a deterrent for some visitors.

There is also a potential for construction noise to impact on filming activities. Noise modelling results (refer to Section 7.3 of this EA) have indicated that all potential receivers in the close vicinity of the proposed turbine site would be in compliance with relevant noise criteria. Although there is a potential for construction noise to impact on filming during the construction phase, this impact is considered manageable, primarily as the construction phase of the Proposal is temporary in nature.

Dust generation as a result of construction activities of heavy vehicles may also have the potential to impact on the film and art industry. It is considered that there is a potential for dust generation to occur during the construction phase. Appropriate mitigation measures have been described in Section 8.6.2.

Impact assessment – operation

The LVIA (summarised in Section 7.2 and presented in full, Appendix 1) concluded that the operation of the wind farm, based on 598 turbines, would have a medium impact on the landscape character and medium visual impact on people travelling through and residing in areas surrounding the proposed wind farm. Based on this assessment, there is also potential for the wind farm to impact both the film and artist industries within Broken Hill and Silverton. While operational noise can be managed to comply with relevant guidelines (as discussed in Section 7.3 and present in full, Appendix 2), this compliance is based on human receivers and therefore some disparity may be expected in the sound levels recorded by filming crews.

The production of a feature film involves a large number of issues including the identification and selection of suitable filming locations. The identification of a suitable film location would consider a number of limitations including access and availability of services and communications.

The modern suite of post-production editing technology provides the opportunity to enhance or remove features in both film and digital formats, and is a common and widespread practice employed in many areas of both film and photography. It would therefore be possible, if required, to edit undesired visual or audio elements. For example, individual or groups of turbines could be removed from film or photographic images; noise generated from the wind farm could be dubbed out. It is acknowledged that this additional work would lead to a likely additional cost to production. In addition, the noise impact assessment presented in Appendix 2 identifies indicative noise levels at a range of locations surrounding the wind farm. This information could be used by prospective filming projects to assess the likely impact, if any, prior to film site selection. This would allow the operational noise impact to be managed in advance of filming.

There is potential for artists to be impacted by the visual impact of operational wind turbines. It is considered that should a turbine be within a landscape that the artist wishes to paint, digital software technology would be able to remove any turbines from a photograph taken for reference, leaving a natural landscape to paint. In addition, it is noted that the area encompassing the proposed turbine site is not one of the more popular areas to paint, as indicated by West Darling Arts. Notwithstanding this, it is acknowledged that artists do paint landscapes within the Barrier Ranges. It is considered that the proposed turbine site would only impact on an artist wishing to paint larger scale areas. It is considered that the wind farm is unlikely to impact smaller scale potential art sites such as trees and shrubs.

Transmission line route (site to Broken Hill)

Background

The transmission line from the substation to Broken Hill is similarly situated within a sparsely developed landscape.

Impact assessment – construction

No additional impact is anticipated from the development of the transmission line between the substation and Broken Hill.

Impact assessment – operation

No additional impact is anticipated from the operation of the transmission line between the substation and Broken Hill.

Transmission line route (site to Red Cliffs)

Background

The transmission line corridor proposed to be constructed between Broken Hill, Buronga and Red Cliffs substations is planned to run adjacent to the current existing power line. This line would traverse over 300km covering a diverse range of landscapes. Farming infrastructure and small townships are features of this landscape. While no specific filming locations or artist draw points are known at this time, this potential exists and, similar to the Barrier Ranges, it could be suggested that the landscape provides unique opportunities for these endeavours.

Impact assessment – construction

The construction of the transmission line between Broken Hill, Buronga and Red Cliffs substations is unlikely to impact the film and art industries. The likely access points to the proposed transmission line would originate from the Silver City Highway, which is capable of accommodating an increased traffic load, as discussed in Section 7.6. The proposed location of the transmission line is adjacent to an existing line and primarily within farming and grazing land. It is therefore unlikely to have a large impact on the visual amenity of the area. Further visual assessment is presented in Section 7.2.

Impact assessment – operation

As the proposed transmission line is planned to run adjacent to the existing power line, it is considered that impacts as a result of the operation of the power line would be negligible.

8.4.2 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC117	Affect on film and art activities	Minimise disruption	Liaise with Film Broken Hill and West Darlings Arts to ensure that these parties are informed regarding the construction activities and timing to minimise the potential for inconvenience caused to filming and art endeavours during construction	Construction	X	X	X	X

8.5 HEALTH AND SAFETY

8.5.1 Assessment

Wind farm site

Background

There are a number of hazards associated with the construction, operation and decommissioning of wind farms and associated infrastructure, including construction activities, construction noise, traffic, shadow flicker and the stability of turbines. These issues are discussed below. Operational noise impacts, traffic impacts and electromagnetic fields are discussed separately in Sections 7.3, 7.6 and 7.15 respectively.

Hazards inherent with wind farm construction activities relate to the size and movement of infrastructure (large rotating blades at great height), high-voltage electricity and high wind speeds. The risks are similar to working on other large infrastructure, such as tall buildings and transmission lines. No member of the public has been killed by a wind farm. Fourteen people have been killed worldwide, most during construction-related activities, since the early 1970s (SEDA 2004). Industry practice has improved over this time and many dangerous activities have been eliminated or had their risk reduced; for example, climbing (SEDA 2004). Employee safety is managed through the application of standard workplace practices, such as restraints, fall arrest systems, protective clothing and procedures that enable infrastructure to remain stationary during specific activities. Emergency response protocols and equipment and reminders of the requirement for workers to take responsibility for their safety are able to address a large component of potential risks.

The stability of turbines is an issue often raised during community consultation. Due to the size of component parts, objects are not likely to fall far from the turbine. Three hundred metres has been suggested as the upper buffer distance required to ensure no buildings or populated areas are within range (SEDA 2004). SEDA (2004) also notes that this would always be less than the buffer required to meet visual and noise criteria.

Modern wind turbines are extremely safe and reliable, with a history of independent certification and compliance of over 25 years. Wind turbines supplied by the leading global manufacturers (including those identified in Table 3.1) are designed and built to high industry standards, such as the International Electrotechnical Commission (IEC). Type Certification of particular wind turbine models is provided by independent certification authorities that specialise in wind turbines such as Det Norske Veritas (DMV), Germanischer (GL) and TUV Rheinland (TUV). The Type Certification process establishes the safety and reliability of the design and the validity of its supporting calculations, including the assumptions and inputs on which the certificates are based.

The wind turbine foundations are designed to meet the requirements and loads for the particular wind turbine model, as well as the site specific geotechnical, seismic and climatic conditions. The design and construction of the wind turbine foundations would be in accordance with the Australian Standard for concrete structures (AS3600).

> *"Wind energy is one of the safest energy technologies. It is a matter of record that no member of the public has ever been injured during the normal operation of a wind turbine, with over 25 years operating experience and with more than 70,000 machines installed around the world"*
>
> (British Wind Energy Association 2007)

Construction works to complete all stages of the Proposal would take place over a three- to five-year period, utilising main and local roads. Considering traffic flow to and from the site along Silverton Road, 250 construction vehicle movements per day are expected during peak times. Potential traffic impact identification and mitigation has been assessed in the Traffic and Transport Impact Study (Section 7.6). Access routes have been selected which, with the implementation of recommended safeguards, would minimise risks to workers, the public and stock during the construction phase.

There would also be a large amount of construction machinery onsite during the construction phase. This machinery would include heavy trucks, low loaders, excavators, large cranes and light vehicles. In addition, construction activities including blasting and welding also carry an increased risk.

Impact assessment – operation

The hazards associated with the operational phase of the wind farm and associated transmission lines are considered to be low. Standard 4WD vehicles would be used during maintenance visits. Procedures would be put in place to ensure a safe working environment is maintained. All maintenance staff would be appropriately trained to undertake their specific tasks.

Transmission line route (site to Broken Hill, site to Red Cliffs)

Background

Similar risks are present in the construction and maintenance of transmission lines. Working at height, high-voltage electricity, wind and adjacent traffic management are issues that must be managed.

Impact assessment – construction

The construction of the transmission lines would be completed by appropriately qualified contractors. These contractors would have appropriate training for the installation of transmission lines.

Hazards and associated risks that construction staff would be exposed to as a result of the Proposal are considered manageable through the implementation of a site occupational health and safety plan. In addition, all construction works would be undertaken by appropriately trained and licensed contractors, qualified to undertake the specific works.

Impact assessment – operation

It is considered that the potential operational impacts are similar to those associated with the wind farm site as described above.

8.5.2 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC118	Safety of persons and stock	Minimise risks	Prepare and implement an appropriate Health and Safety Plan covering all phases of the project. This plan would identify hazards associated with construction works, and prepare appropriate safeguards, protocols and responses including emergency response protocols	Construction Operation Decommissioning	X	X	X	X
SOC119	Safety of persons and stock	Minimise risks	Induct all site workers on their first day of employment at the site. The induction would include a detailed briefing on health and safety	Construction Occupation Decommissioning	X	X	X	X
SOC120	Safety of persons and stock	Minimise risks	Ensure all contractors selected for construction are appropriately qualified and trained	Construction Decommissioning	X	X	X	X
SOC121	Safety of persons and stock	Minimise risks	Install appropriate site fencing and/or signage where there is a risk to the safety of construction workers or the general public	Construction Decommissioning	X	X	X	X
SOC122	Safety of persons and stock	Minimise risks	Undertake detailed geotechnical investigations (such as core samples) in the area of the proposed turbines to determine ground stability and soundness of the strata taking into account the potential for any mine shafts	Construction	X	X		
SOC123	Safety of persons and stock	Minimise risks	Establish a turbine maintenance program in accordance with industry standards	Operation	X	X		

8.6 PHYSICAL IMPACTS

8.6.1 Assessment – Climate

Wind farm site

Background

Data was obtained from the Bureau of Meteorology weather station at Umberumberka Reservoir (latitude 31.82ºS longitude 141.21ºE). A review of this data indicated that the general climatic conditions at the site may be expected to be hot, dry and windy, conditions that may be conducive to dust generation.

Impact assessment – construction

Vehicle emissions and the manufacture of many components of the development would contribute to greenhouse gases in the atmosphere, a known contributor to global warming. On balance however, over the life of the Proposal (in excess of 30 years), the production of emission-free electricity is considered a strong justification for this impact.

Impact assessment – operation

The local climate may be affected to a minor degree by the increase in turbulence caused by the operational wind turbines. Modelling and experimentation on real wind turbines has shown that the mixing effect of thermal layers has very little effect on temperature (Baidya, et al. 2004). Recordings taken below wind turbines and averaged over a 24-hour period were observed to be greater than existing ground level wind speeds by approximately 0.6 metres per second and raise temperatures by approximately 0.7oC (Baidya, et al. 2004). The turbines proposed are larger than those used during the modelling experiment. Larger blades may be expected to produce greater mixing of the thermal layers, however, being located at a greater height, on ground impacts are still considered negligible.

Wind speed impacts have been suggested as being confined to a distance from each turbine equivalent to ten times the vertical height of the turbine (SEDA 2002). For the turbines considered (maximum of 155 metres from the ground to blade-tip), an effect up to 1.32 kilometres from each turbine may be noted (attenuating with distance from the turbines). As the local topography is undulating, the horizontal distance from each turbine may be less than this amount in actuality.

The turbines would turn slowly in low wind conditions and faster with increasing wind speeds; hence they would amplify rather than counter natural wind conditions. The anticipated change in wind speed and temperature at ground level is not considered large enough to impact vegetation or be in conflict with the continued grazing use of the land. This impact would be ongoing but negligible.

The Proposal would make a positive contribution to the reduction in greenhouse gas emissions by providing an alternative to electricity sourced from fossil fuels. This constitutes the primary environmental benefit of the Proposal, as discussed in Section 4 of this document.

For each megawatt-hour of electricity consumed in the NSW electricity pool, approximately 1,000 kilograms of greenhouse gases are emitted, primarily from coal-fired power stations. The Silverton Wind Farm would represent a renewable method of electricity generation to meet increasing demand of non-greenhouse gas producing electricity generation. Therefore every megawatt-hour of electricity generated by the wind farm could prevent approximately one megawatt-hour of electricity being generated at a coal-fired power station.

Reduction in greenhouse gas emission directly contributes to combating the adverse impacts associated with climate change including:

- The increase in extreme weather events
- Increased demand for water and associated impacts on natural systems
- Economic impacts associated with changing land capability.

Adverse impacts noted specifically for Australian agricultural communities include an increase in floods, droughts and forest fires. As a consequence of reduced local production capacity in conjunction with increased production in positively affected northern hemisphere countries, the economic impact of climate change is particularly relevant to agricultural economies (AGO 2003) including the region for the proposed transmission line.

No adverse climate change impacts related to the operational phase of the wind farm would result. Impacts to air quality have been considered in Section 8.6.2.

Transmission line route (site to Broken Hill, site to Red Cliffs)

Background

The area for the proposed transmission line between the site, Broken Hill, Buronga and Red Cliffs would likely see a broad range of climatic characteristics due to the distance of 300 kilometres. For the purpose of this report, the following data was obtained from the weather station located at the Wentworth post office, (latitude 34.11° S and longitude 141.92° E). The data obtained from the Bureau of Meteorology suggests, similar to the Umberumberka data, the weather may be expected to be hot, dry and windy – conditions conducive to dust generation. The climatic conditions are not too dissimilar between the two weather stations and climatic conditions along the transmission line route are expected to be similar to that described.

Impact assessment – construction

Potential impacts have been described above under the wind farm site impacts.

Impact assessment – operation

It is considered that there would be no impacts to the local climate as a result of the operation of the transmission lines.

8.6.2 Assessment – Air quality

Wind farm site

Background

The site is bounded to all sides by undeveloped land with the closest township, Silverton, approximately five kilometres to the southwest.

Particularly during periods of low rainfall, large areas of bare ground may be created through intensive grazing or fire. There are also a large number of feral goats within the turbine envelope, further increasing the pressure on native vegetation. This may increase erosion with resultant increases in dust levels.

The State of the Environment (SoE) supplementary report (2007) for the Broken Hill LGA notes that the two traditional air quality problems are dust and smoke from slow combustion heaters. Dust may be a factor on the wind farm site. It is located in a windy ridge system facing the Mundi Mundi Plains. There is evidence that strong winds deposit soil from the plains in the ridge system and localised dust storms occur. Smoke problems are more likely to be experienced in urban areas, not onsite or in the immediate vicinity. There are no heavy polluting industries and therefore no monitoring of air quality is currently being undertaken in the vicinity of works.

Receivers which may be considered sensitive to air quality impacts during and following the development of the Silverton Wind Farm include residences (particularly in the town of Silverton) and tourists.

Impact assessment – construction

Dust and emissions are likely to be generated during clearing, excavation, blasting (if required), concrete batching, rock crushing (if required), road works and during the transport of infrastructure and materials to the site. It is considered that any impacts likely to occur would be greatest during the construction and decommissioning phases, both temporary phases, likely to last 18 months to five years.

In addition, the works area would not be static for this period; it would move as infrastructure is progressively installed and therefore the impact would not be experienced continuously at any one place during these phases. The exception to this may be along Silverton Road, a preferred haulage route for much of the development.

Impact assessment – operation

The operation of the wind farm would require minimal traffic on roads/tracks that would have been upgraded to accommodate heavy loads during the construction phase. Additionally, none of the wind farm infrastructure would generate emissions that would impact air quality. Therefore negligible air quality impacts are anticipated to be generated during the operational phase of the wind farm.

Transmission line route (site to Broken Hill, site to Red Cliffs)

Background

The proposed transmission line route would encompass properties within the Western CMA and Lower Murray-Darling CMA. These areas are predominately farming and grazing properties with the average property size of 17,400 hectares (LMD CAP 2006). As such there would be a low number of receivers and it is considered that the potential impact to air quality at these receivers would be low.

Impact assessment – construction

As discussed above, there are only a limited number of receivers that may be impacted as a result of the construction of the transmission line. In addition, the relatively continual nature of the vegetation along the proposed easement is likely to lead to a reduction in the amount of dust generated as a result of the construction works.

The distance between the proposed activities and the receivers as well as the potential for mitigation suggest that air quality impacts during construction and decommissioning would not be high. The impacts of the Proposal during the construction and decommissioning phases are considered manageable with regard to air quality. Mitigation strategies that would be employed during these phases to manage the potential for adverse air quality impacts are presented below.

Impact assessment – operation

The transmission infrastructure would not generate emissions that would impact air quality. Therefore no air quality impacts are anticipated to be generated by the operational transmission lines.

8.6.3 Assessment – Soils

Wind farm site

Background

The Barrier Ranges are a block of metamorphic and deformed sedimentary rocks that form a series of northeast and northwest trending ridges rising up to 300 metres above the surrounding plains (NSW DECC 2004). The Broken Hill Land Systems Series Sheet SH54-15 indicates that the proposed wind farm site is located on two specific land systems: the Umberumberka Land System and the Barrier Land System. A brief description of these two land systems, adapted from Broken Hill Land Systems Series Sheet SH54-15, is provided below.

- Umberumberka Land System (Ub): rugged ranges displaying narrow incised drainage with a relief to 200 metres. Lithosols with some texture contrast soils
- Barrier Land System (Br): ranges displaying narrow incised drainage with relief to 80 metres. Lithosols with some red-texture contrast soils.

The topography of the wind farm site varies in elevation between about 180 m AHD and 460 m AHD. Slopes are generally gentle at less than about seven per cent (4°), however some steeper slope in excess of 15 per cent (9°) occurs particularly in the west of the site (Arup 2008).

Impact assessment – construction

The construction of the footings for the turbines as well as the access roads are considered to be the predominant potential impacts to soils of the wind farm site. The average rainfall for the area is 206.5mm. Information obtained from the Western CMA in relation to soils on both Belmont and Eldee Stations indicated that the general forms of erosion in those soils include:

- Scalding and sand drift
- Minor rilling and water sheeting
- Gully and sheet erosion.

It is considered that these forms of erosion are primarily as a result of grazing, drought and associated natural processes including wind and rainfall.

Soil compaction and soil erosion are likely to occur during excavation works, road works and the transport of machinery. There is also a risk of potential soil contamination from the use of chemicals including hydrocarbon fuels and toilet facilities during construction of the turbines.

Blasting may be required during the construction of the footings for the turbines as well as for sections of the access roads. The spoil from any excavation and blasting works would be stockpiled and reused wherever practicable. Excess spoil would be disposed off appropriately in accordance with any NSW Department of Lands requirements, or an appropriately licensed landfill.

Impacts are expected to be temporary during the construction period. As the construction would occur within a specific time and area, the potential for impact would be limited. Additionally, the application of mitigation measures would reduce the potential for cascading impacts (such as transport of sediment in drainage lines and resultant impacts offsite).

Impacts of the Proposal to the local soils and landforms are considered manageable.

Impact assessment – operation

The operation of the wind farm is likely to require minimal traffic, as discussed in Section 7.6. No other adverse soil impacts are anticipated. There is potential for improved vegetation cover across the site, based on goat management to which the Proponent would commit. This would reduce soil loss across the site.

Transmission line route (site to Broken Hill)

Background

The proposed area between the site and Broken Hill is situated on the Umberumberka soil landscape. As detailed above, the Umberumberka soil landscape is characterised by rugged ranges displaying narrow incised drainage with a relief to 200 metres and lithosols with some texture-contrast soils (Broken Hill Land Systems Series Sheet SH 54–15).

Impact assessment – construction

There are no additional impacts or mitigation measures than those described above, for the wind farm site.

Impact assessment – operation

The operation of the transmission line is likely to require minimal traffic, as discussed in Section 7.6. No other adverse soil impacts are anticipated.

Transmission line route (Broken Hill to Red Cliffs)

Background

There are a number of landform classes located along the proposed transmission line route between Broken Hill and Red Cliffs. A brief description of the landform classes that the proposed transmission line easement would intersect in a general north–south direction is presented in Table 8.2. This information has been adapted from the following landform series sheets:

- Broken Hill Land Systems Series Sheet SH 54–15
- Menindee Land Systems Series Sheet SI 54–3
- Ana Branch Land Systems Series Sheet SI 54–7
- Mildura Land Systems Series Sheet SI 54–11

Table 8.2 General landform descriptions along the proposed transmission line route

Landform class	Description
Nine Mile (Nm)	Lower ridges, slopes and minor drainage plains of the Barrier Range, relief to 30m with red texture-contrast soils and areas of solonized brown soils and lithosols
Nuntherungie (Nn)	Undulating plains, relief to 15m. Contour bands of deep stone-free red clays alternating with bare stony red desert loams. Small areas of loose yellowish-brown calcareous loams and clay loams. Drainage tracts with deep loamy sand
Katatlpa (Kt)	Gently undulating plains, relief to 10m. Stony surfaces with red desert loams, bands of stone-free red clays in gilgai depressions. Less stony areas of loose, highly gypsic, yellowish-brown calcareous loams and clay loams. Drainage tracts of deep loamy alluvium
Kars (Kz)	Extensive sand plain with isolated low, sandy rises and drainage depressions, relief to 2m. Calcareous red earths and solonised brown soils
Fowlers (Fl)	Narrow flood plains, moderately scalded back plains with sandy loam surfaced reddish-brown texture-contrast soils and crusty brown clays; channels with fine sand and silt
Oakvale (Ok)	Stony plains with relief to 3m, deep-red desert loams and red clays in gilgai depressions and alluvial flats with brown self-mulching cracking clays
Trelega (Te)	Level to slightly undulating sand plains and swales of loamy solonised brown soils; aligned low dunes and low rises of deep-brownish sands and calcareous red earths; relief to 3m
Bulgamurra (Bm)	Slightly undulating sand plains with areas of aligned sand dunes; relief to 7m. Sand plains of calcareous loamy sand and sandy red and brown soils. Dunes of deep red sands. Isolated depressions of grey clays, usually fringed by black box
Overnewton (Ov)	Extensive, slightly undulating sand plain with isolated sandy hummocks and depressions with relief to 5m. Sand plains of calcareous loams and sandy loams
Mandleman (Mn)	Dune fields of parabolic and unaligned dunes merging into slightly undulating sand plains; relief to 10m. Dunes and swales of deep sandy red earths and isolated flats of solonised brown soils
Popiltah (Pt)	Small ephemeral reniform-shaped lakes to 2km diametre with lunettes, associated feeder channels and isolated box depressions; lunette relief to 10m, with grey cracking clays and brown texture-contrast soils in lakes, channels and swamps. Lunettes consist of deeply cemented sands and red texture-contrast soils.
Scotia (Sc)	Broad to narrow swales with long, aligned dunes and relief to 7m. Earthy sands, loamy texture-contrast soils and solonised brown soils in swales; siliceous red to brownish sands on dunes with isolated flats of brown texture-contrast soils
Ennisvale (Ez)	Extensive, gently undulating swales with aligned dunes and isolated flats with relief to 7m. Sandy solonised brown soils and red texture-contrast soils; dunes of deep brownish sands
Birdwood (Bw)	Small relict lakes and lunettes with extensive associated sand plains and isolated dunes with relief to 10m. Basin floors are highly saline, gypseous or calcareous grey clays

Landform class	Description
Hatfield	Extensive, slightly undulating sand plains with isolated small depressions with relief to 10m. Sand plains of solonised brown soils and sandy red and brown texture-contrast soils. Depressions of grey clays rimmed by scalded red texture-contrast soils
Ana Branch	Ana Branch frontage and broad flood plains with associated channels, billabongs, swamps, lunettes and plains. Channels are incised to 10m. Self-mulching cracking grey clays with areas of scalded red and brown texture-contrast soils; lunettes and rises of deep sands
Menilta (Mt)	Very gently undulating, partly scalded sand plains with areas of aligned dunes and isolated depressions and relief to 10m. Sand plains of sandy loam to sandy solonised brown soils or texture-contrast soils. Dunes of deeper sand soils
Arumpo (Ap)	Parallel east–west trending dunes of deep red earths and relief to 10m. Narrow swales of calcareous red earths
Darling (Dl)	Darling River frontage and broad flood plain with associated billabongs, swamps, back channels, levees and sandhills. Channels incised to 15m. Grey self mulching to silty clays, calcareous loamy sand to deep sandy red soils on levees and sand hills

The topography of the Murray-Darling Basin, in which the proposed transmission line is located, is characterised by dune fields, sand plains and undulating plains (NSW DECC 2004). The topography of the route is generally flat and there are numerous lakes, rivers and swamps located in the vicinity of the proposed transmission line (NSW DECC 2004).

Impact assessment – construction

There are no additional impacts or mitigation measures than those described above, for the wind farm site.

Impact assessment – operation

The operation of the transmission line is likely to require minimal traffic, as discussed in Section 7.6. No other adverse soil impacts are anticipated.

8.6.4 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC124	Soil	Minimise impact	Avoid compaction of soil resulting from vehicle access and laying of materials, particularly during saturated soil conditions, and remediated as necessary	Construction	X	X	X	X
SOC125	Air quality	Minimise impact	Undertake ongoing dust suppression throughout the construction phase	Construction	X	X	X	X
SOC126	Soil	Minimise impact	Monitor and maintain tracks to ensure landform stability is maintained, in accordance with erosion and sediment control plans	Operation	X	X	X	X

8.7 RESOURCE IMPACTS

8.7.1 Assessment

Wind farm site

Background

Life cycle analysis (LCA) is based on careful accounting of energy and material flows associated with a system or process. This approach covers the whole project life cycle, from the extraction of raw materials to the disposal of materials at the completion of projects. LCA is particularly relevant for renewable technologies, where it is often argued that the energy used to produce the technology is not 'paid back' during the lifetime of the technology (Schleisner 2000). LCA estimates of energy and emissions based on the total life cycle of materials used for a project, i.e. the total amount of energy consumed in procuring, processing, working up, transporting and disposing of the respective materials (Schleisner 2000).

In Schleisner's (2000) analysis of two wind farms in Denmark, the energy 'payback' time was modelled to be approximately three months. That is, in this time, the energy produced by the wind farm had 'paid back' the energy consumed in producing, installing and decommissioning that wind farm. It was found that 94 per cent of the materials used for construction of a wind turbine could be recycled (Schleisner 2000). Additionally, the value of the materials able to be sold for reuse can be used to offset the cost of decommissioning the wind farm and rehabilitating disturbed areas to pre-existing or better condition.

A life-cycle assessment has been conducted by Vestas for a Vestas V90-3.0 MW wind turbine, the maximum size turbine being considered for the Silverton Proposal. Vestas divided the life cycle into four phases: production, transportation, operation and disposal. This assessment looked only at the turbines and did not consider associated infrastructure such as transmission lines, substation and control buildings.

The study identified that the greatest consumption of energy and resources occurred during the production phase. Raw materials required include iron ore for the construction of steel components and their casings as well as crude oil to make the epoxy materials used in blade construction. These resources are limited and considered non-renewable. In contrast, energy consumption during the transportation, operation and disposal phases was relatively minor.

Early in the operational phase (based on a 20 to 30 year life span and taking into account the maintenance required over this period) the costs of construction and decommissioning are offset by the operational capacity of the turbines. Disposal encompasses the fuels required to dismantle and transport the turbines as well as the disposal of materials.

Using a functional unit of 1kWh as a basis for comparison, Vestas provide the following comparisons between phases of the 3MW wind turbine life cycle and CO2 emissions between other energy producing power stations (and Table 8.3).

Table 8.3 Energy consumed during the life cycle of a Vestas V90-3MW

A Vestas V90-3MW turbine is expected to generate 157,800MWh during a 20-year lifetime, repaying energy required to produce the turbine in approximately 6.6 months. Energy required to produce, transport, operate and dispose of the turbine has been converted to megawatt-hours to facilitate comparison with total energy produced.

Phase	Onshore Vestas V90-3 MW
Production phase	7,795.00 MWh
Transport phase	74.00 MWh
Operation phase	14.00 MWh
Disposal phase	*-3,572.00 MWh
Total	4,311 MWh

** The negative figure indicates the value of the material for reuse or recycling.*

Table 8.4 Comparison of CO2 emissions produced per kilowatt-hour

Using energy output (kWh) to compare emissions, the wind turbine produces a small fraction of the CO2 emissions of coal or gas-fired power stations.

Generation method	CO2 produced
Onshore Vestas V90-3 MW turbine	8 grams per kWh
Gas-fired power station	467 grams per kWh
Coal-fired power station	826 grams per kWh

Hence, by comparison to major electricity-generating methods employed in Australia, wind farms rate favourably based on:

- CO2 emissions generated per kilowatt-hour of energy produced
- Potential to reuse and recycle component parts
- Energy payback time in comparison to the life span of the Proposal.

Impact assessment – construction

The construction of the proposed wind farm, including associated infrastructure, would require the use of various resources, such as concrete and other masonry products (footing, slabs, hardstand areas, building elements), materials associated with the operation of machinery, and motor vehicles (fuels and lubricants) and other construction materials (metals, glass, plastics). Water use is considered separately in Section 7.5. These materials are not currently depleted or restricted in supply; however, increasing scarcity and environmental impacts are becoming apparent from the use of fossil fuels, mineral resources and other non-renewable resources. The Proposal is unlikely to place significant pressure on the availability of local or regional resources.

Sand and aggregate would be required for concrete batching. Without having completed the detailed design, it is expected that sand and aggregate would be sourced from excavation of footings where possible, or from existing approved sand and gravel pits within the local area. Local contractors are confident that the quantities required would easily be sourced locally. Concrete waste would be crushed and reused as aggregate where possible. No sand, soil, rock or other materials would be mined onsite for use in the Proposal.

Solid waste is one of the major pollutants caused by construction. Solid waste would be generated from a number of construction activities including:

- Limited vegetation clearing
- Material from packaging
- Building materials
- Scrap metals
- Effluent
- Plastic and masonry products.

Hazardous wastes would be present onsite. These include sanitary wastes, hydrocarbons, fertilisers and herbicides. Some of these would represent flammable materials and biohazards. During decommissioning it is likely that similar wastes would be generated.

A key strategy of construction and decommissioning works would be to avoid and minimise waste from the construction site, reuse and recycle waste where possible and dispose appropriately of waste that cannot be managed in any other way. This is the application of the Waste Hierarchy that states:

- Strategies which try to avoid products becoming waste are generally preferable to
- Strategies which seek to find a use for waste, which are in turn generally preferable to
- Strategies for disposal, which should be used as a last resort.

Impact assessment – operation

Resources required during the operational phase include fuel for construction and maintenance vehicles, lubricants for oil changes in the turbines and replacement parts if required that may consist of metal and plastic based products. The discussion and safeguards above apply equally to this phase, although resource requirements and wastes are anticipated to be much lower. All wastes would be removed by contractors and maintenance staff. No local garbage service would be required.

Transmission line route (site to Broken Hill, site to Red Cliffs)

Background

It is understood that the transmission line would be built from materials including steel, concrete and copper. These three resources are not currently in short supply and would be readily accessible for use in construction and operation of transmission infrastructure. It is noted that these resources have embedded energy associated with their extraction and manufacture. There may be potential to recycle and reuse some of the metals used, if the transmission lines are decommissioned.

Impact assessment – construction

Potential impacts are considered to be similar to those discussed for the construction of the wind farm site, above.

Impact assessment – operation

Potential impacts are considered to be similar to those discussed for the operation of the wind farm site, above.

8.7.2 Mitigation measures

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC127	Waste generation	Minimise waste and maximise recycling of materials	Reduce, reuse or recycle wastes whenever possible. Provide separate recyclable materials receptacles near site offices (e.g. for glass, plastics and aluminium)	Construction Operation	X	X	X	X
SOC128	Waste generation	Appropriate disposal of waste	Dispose of packaging materials and general construction wastes with Council's approval, at Council operated waste disposal centres	Construction Operation	X	X	X	X
SOC129	Waste generation	Appropriate disposal of waste	Provide toilet facilities for onsite workers and dispose of sullage from contractor's pump out toilet facilities at the local sewage treatment plants or other suitable facility agreed to by Council	Construction Operation	X	X	X	X
SOC130	Waste generation	Minimise waste and maximise recycling of materials	Use excavated material in road base construction, as aggregate for footings and construction pads where possible. Dispose of surplus material in appropriate locations on site	Construction Operation	X	X		

8.8 CUMULATIVE IMPACTS

Existing environment

For this EA, cumulative impacts consider the potential cumulative impact associated with the proposed development and other major developments in the area. Further, it is considered that there may be a perceived cumulative impact due to the staged nature of the Proposal. This overall impact has been assessed for each environmental factor in Sections 7 and 8.

According to the register of major projects on the NSW Department of Planning's website, there are two major projects currently subject to a Part 3A assessment in the far west region. The first project is for an underground mine proposed to be located within Broken Hill. The second is for the construction of six structures in the Menindee lakes system to improve operational flexibility to generate evaporative water savings. The potential cumulative impacts of these two proposed developments are considered within the following section.

Ecological impacts

The foremost concerns with regard to cumulative ecological impacts are related to fauna movement corridors (particularly flight paths and migration routes) during the operational phase. The biodiversity assessment, summarised in Section 7.4 of this EA, has considered potential movement corridors for native fauna in the locality and in the broader region.

On its own, Stage 1 works are not anticipated to affect use of these routes, which occur outside the proposed site boundaries. The additional infrastructure proposed for Stage 2 has not been comprehensively assessed in terms of biodiversity impact. Results to date indicate that Stage 2 development would not affect established migration routes of movement corridors, however, the increased breadth of the total development would be expected to result in additional collisions for birds and bats and to affect habitat utilisation by resident larger-ranging fauna.

The sparseness of vegetation in areas that would be developed and the relatively discrete nature of the development footprint reduce the level of direct impact to habitat (for flora and fauna). Sensitive vegetation communities (specifically porcupine grass/red mallee/gum coolibah/hummock grassland/low sparse woodland on metamorphic ranges on the Barrier Range, Broken Hill Complex Bioregion) are able to be mapped and largely avoided.

Indirect impacts to habitat that may come as a consequence of soil disturbance, such as sedimentation of waterways, can have cascading effects that impact areas at great distance from the site through a number of impact pathways. Sections 7.5 and 8.6.3 have described the hydrology and soil parametres of the site and impacts specific to this Proposal. Mitigation of these cumulative impacts is best undertaken on a case-by-case basis through rigorous implementation of erosion and sediment controls to address all soil-disturbing and dust-generating activities at each stage of construction. No measures additional to those described in Sections 7.5 and 8.6.3 are considered to be required.

Traffic and transport

There are two other proposals currently being assessed under Part 3A of the EP&A Act in the far west region as defined by the NSW DoP. One of these proposals relates to a proposed underground mine located in Broken Hill and the other is an infrastructure project on the Menindee Lake. At present, these two proposals are in the planning phase and have not been approved. It is considered that there is a potential cumulative impact to road users within Broken Hill and to lesser extent the Silver City Highway. As discussed in Section7.6, there would be an increase in traffic along the Silverton Road and through parts of Broken Hill resulting from the construction phase of the proposed wind farm. There may also be an increase in traffic particularly in Broken Hill as a result of the other two proposals in the area. The construction phase of the proposed wind farm is considered a temporary impact and with the adoption of the mitigation measures outlined in Section 7.6 this impact is considered manageable.

No additional mitigation measures to those described in Section 7.6 are considered necessary.

Economic

The potential for positive cumulative economic effects of the Proposal is very real during construction. The Proponent has identified that local labour and skills would be sought as preference when undergoing the construction of the wind farm. There would also be an ongoing employment need during the operating life of the proposed wind farm. Again, appropriate staff could be sourced and trained from willing local residents of both Silverton and Broken Hill. Liaison would continue with local economic development bodies to ensure this potential is maximised.

There may also be a cumulative impact associated with the Proposal competing for local resources should the other two major projects currently being assessed be approved. It is considered that local resources such as skilled labour may be stretched by the construction and operation of these large-scale infrastructure projects. Mitigation of this potential impact could be undertaken through training of the local labour force and liaison with relevant government authorities.

Greenhouse gas emissions and air quality impacts

As outlined in Section 4, each megawatt-hour of electricity generated by a renewable energy generator (eg the Silverton Wind Farm) would reduce coal-fired generation by approximately one megawatt-hour. For each megawatt-hour of electricity consumed in the NSW electricity pool, approximately 1,000 kilograms of greenhouse gases are currently emitted, primarily from coal-fired power stations. Therefore, every megawatt-hour of electricity generated by the wind farm would prevent one megawatt-hour of electricity being generated at a coal-fired power station, as well as preventing losses within the electricity transmission system.

The cumulative impact of additional alternate energy-generating facilities in NSW would have positive impacts for NSW in terms of provision of electricity to meet increasing demand as well as the reduction of coal-fired electricity generation with the associated environmental benefits (refer to Section 4.4.2 of this EA for detailed discussion).

9. STATEMENT OF COMMITMENTS

9.1 IMPLEMENTATION OF ENVIRONMENTAL MITIGATION MEASURES

The environmental impacts related to the Proposal would be managed by the Proponent's commitment to the Draft Statement of Commitments. These commitments include mitigation measures outlined in Chapter 7 of this EA. A complete list of these commitments is outlined in Section 9.2.

The implementation of mitigation measures would be by way of a Project Environmental Management Plan (PEMP), comprising a Construction Environmental Management Plan (CEMP) and an Operation Environmental Management Plan (OEMP). This process is illustrated in Figure 9.1. The PEMP would include performance indicators, timeframes, implementation and reporting responsibilities, communications protocols, a monitoring program, auditing and review arrangements, emergency responses, induction and training and complaint/dispute resolution procedures. The monitoring program would clearly identify any residual impacts after mitigation. AdaptFFive management would ensure that improvements were consolidated in the updated PEMP, CEMP and OEMP.

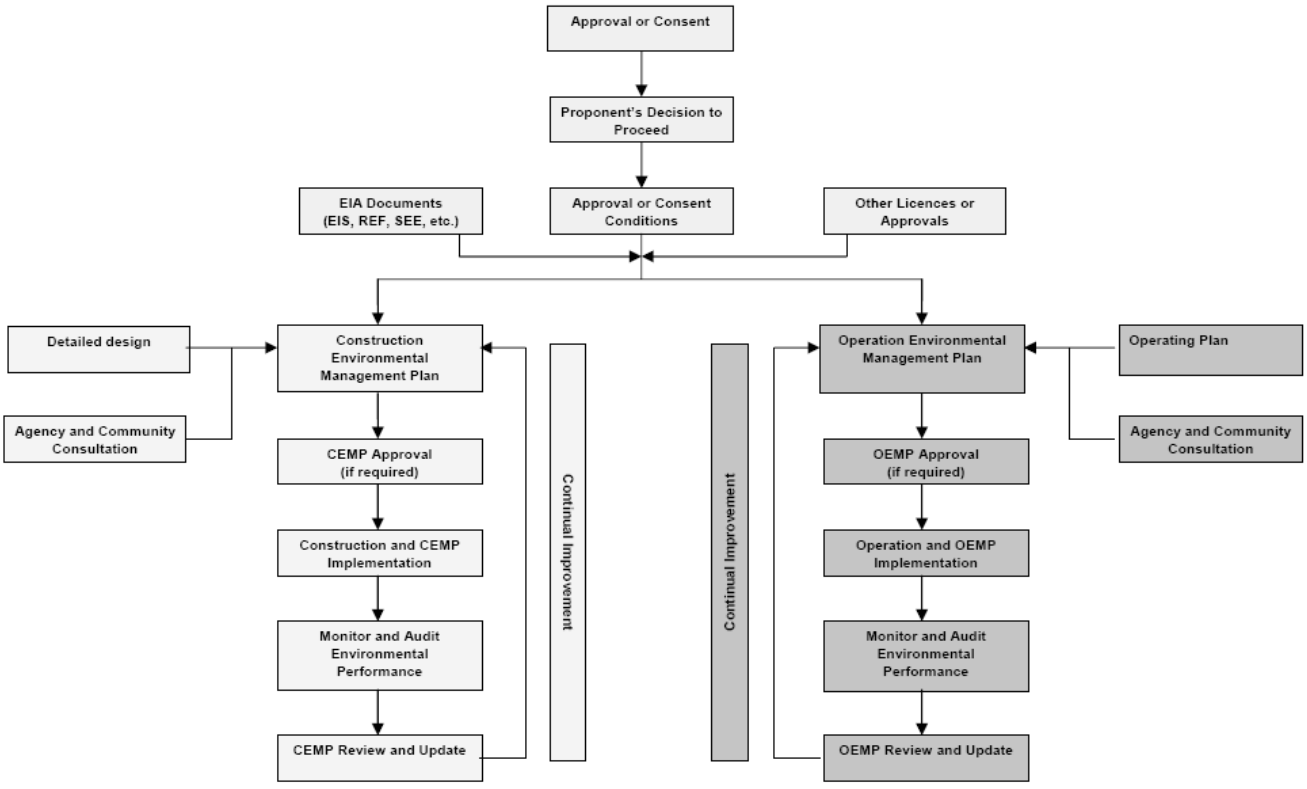

Figure 9.1 Post approval Project Environmental Management Plan (PEMP) process

Source: DIPNR 2004a

9.2 DRAFT STATEMENT OF COMMITMENTS

Under the Part 3A reforms, Proponents are required to provide a *Statement of Commitments* on how they propose to manage the project to minimise, and where possible avoid, impacts. Avoidance and mitigation measures have been developed for the design, construction, operation and decommissioning phases of the Proposal within this EA.

The commitments in this section have been developed into a comprehensive set of environmental impact avoidance and mitigation measures which incorporate:

- Specific recommendations contained in the specialist reports
- Additional measures identified during the preparation of this Environmental Assessment (in consultation with the community and government agencies).

This section summarises mitigation measures to which the Proponent would commit for all stages of the Proposal.

9.2.1 Visual

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC1	Visual Impact to nearby receivers	Minimise view of Infrastructure	Design and construct site control room and facilities buildings sympathetically with nature of locality	Construction	X	X		
SOC2	Visual Impact to nearby receivers	Minimise view of Infrastructure	Locate substations to minimise views from public roads and residences Locate transmission lines where practical to follow the corridor of existing transmission lines	Construction	X	X	X	X
SOC3	Visual Impact to nearby receivers	Minimise view of Infrastructure	Minimise activities that may require night time lighting, and if necessary use low lux (intensity) lighting designed to be mounted with the light projecting inwards to the site to minimise glare at night	Construction Operation	X	X		
SOC4	Visual Impact to nearby receivers	Minimise view of civil earth works	Rehabilitate any site access track not required during the operation of the wind farm at the completion of the construction phase	Construction	X	X		
SOC5	Visual Impact to nearby receivers	Minimise view of civil earth works	Use local materials wherever possible for access track construction	Construction	X	X	X	X
SOC6	Visual Impact to nearby receivers	Minimise view of civil earth works	Enforce protocols to control and minimise fugitive dust emissions	Construction	X	X	X	X
SOC7	Visual Impact to nearby receivers	Minimise view of civil earth works	Restrict the height of stockpiles to minimise visibility from outside the site	Construction	X	X		
SOC8	Visual Impact to nearby receivers	Minimise view of civil earth works	Minimise cut and fill for site tracks and stabilise disturbed ground as soon as possible after construction	Construction	X	X		
SOC9	Visual Impact to nearby receivers	Minimise view of civil earth works	Rehabilitate disturbed areas, as appropriate, in consultation with landholders	Construction Operation	X	X	X	X
SOC10	Visual Impact to nearby receivers	Minimise view of wind farm	Offer screening (planting of vegetation) to dwellings categorised as having a moderate or high visual impact	Construction Operation	X	X		

9.2.2 Noise

	Impact	Objective	Mitigation tasks	Project Phase	Site area– Stage 1	Site area– Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC11	Construction noise	Minimisation	Employ appropriate noise reduction strategies to ensure the recommendations of the NSW Environmental Noise Control Manual are met. Strategies may include the re-orientation machinery, re-scheduling of noisy activities, installation of temporary noise barriers, improved vehicle noise control, reduced work times and the use of 'quiet work practices' (such as reducing or relocating idling machinery)	Construction	X	X	X	X
SOC12	Construction noise	Minimisation	Use appropriate and effective exhaust mufflers and compressor silencers on machinery	Construction	X	X	X	X
SOC13	Construction noise	Minimisation	Respond to noise complaints in a timely manner	Construction	X	X	X	X
SOC14	Construction noise	Minimisation	Meet ANZECC guidelines for control of blasting impact at residences	Construction	X	X		
SOC15	Operational noise	Compliance	A final noise assessment will be completed prior to construction based on the final turbine layout and turbine selection to confirm noise criteria are likely to be met at identified residences	Construction	X	X		
SOC16	Operational noise	Minimisation	Implement an adaptive management approach if noise exceedences are identified during wind turbine operation	Operation	X	X		

9.2.3 Biodiversity

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC17	Loss of biodiversity value	Avoid or minimise impact	Design infrastructure layout to minimise clearing. Confine works wherever practical to cleared or sparsely vegetated areas	Construction	X	X	X	X
SOC18	Loss of biodiversity value	Avoid or minimise impact	Use existing clearings wherever practical for materials lay down, stockpiling and the deposition and retrieval of spoil	Construction Decommissioning	X	X	X	X
SOC19	Loss of biodiversity value	Avoid or minimise impact	Implement weed and sediment erosion controls to minimise onsite habitat degradation resulting from the proposed works	Construction Operation Decommissioning	X	X	X	X
SOC20	Loss of biodiversity value	Minimise impact	Undertake site stabilisation and rehabilitation on completion of works as required	Construction Decommissioning	X	X	X	X
SOC21	Loss of biodiversity value	Minimise impact	Minimise works where practical during and immediately following heavy rainfall events to protect soils and vegetation	Construction Decommissioning	X	X	X	X
SOC22	Loss of biodiversity value	Minimise impact	Store excavated topsoil, subsoil and weathered rock on site and replace in a manner that approximates the original ground profile	Construction	X	X	X	X
SOC23	Loss of biodiversity value	Minimise impact	Replace at least 20 centimetres of cement-free fill as the top layer where cement is included in cable trench backfill	Construction	X	X		
SOC24	Loss of biodiversity value	Minimise impact	Source imported materials such as sand and gravel from sites which do not show evidence of noxious weeds or Phytophthora infection	Construction	X	X	X	X
SOC25	Loss of biodiversity value	Minimise impact	Undertake post-construction weed monitoring after the first significant rainfall event to ensure that no weed infestations have resulted from the works	Construction Decommissioning	X	X	X	X

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC26	Loss of biodiversity value	Minimise impact	Procure an appropriately qualified ecologist to assist in locating tracks, cabling routes and other infrastructure in the vicinity of the Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland identified on site	Construction	X	X	X	X
SOC27	Loss of biodiversity value	Minimise impact	Make contractors and staff aware of the threatened species that may occur within the site, by disseminating information during 'toolbox' talks, to minimise impacts should any become present	Construction Operation Decommissioning	X	X	X	X
SOC28	Loss of biodiversity value	Minimise impact	Minimise track width through Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland where practical. Strategies would include avoiding routes that require extensive cut and fill, and maximising the use of single lane access tracks Establish clear demarcation (including signage) of the Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland to minimise work and access within this community	Construction	X	X	X	X
SOC29	Loss of biodiversity value	Minimise impact	Prepare and implement recovery plan for the Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland vegetation community which occurs onsite and the threatened reptile fauna which rely on it. This plan would aim to achieve a net gain within this ecological community	Operation	X	X		
SOC30	Loss of biodiversity value	Minimise impact	Prepare and implement a goat management plan across vegetation in the stage one area with a particular focus on porcupine grass/red mallee/gum coolibah/hummock grassland	Operation	X	X		
SOC31	Loss of biodiversity value	Avoid or minimise impact	Carry out further field work to ground validate the extent and condition of vegetation of conservation significance and threatened fauna in the stage 2 site area and stage 2 transmission corridor	Construction		X		X
SOC32	Loss of biodiversity value	Avoid or minimise impact	Carry out additional evaluation of the potential for impact on all flora and fauna species listed as threatened with potential to occur within the stage 2	Construction		X		X

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
			site area and stage 2 transmission corridor					
SOC33	Loss of biodiversity value	Avoid or minimise impact	Peg or otherwise delineate the boundaries of EECs in good condition and flora species listed as threatened which are in the vicinity of proposed works to minimise direct and indirect impacts in these areas	Construction Decommissioning	X	X	X	X
SOC34	Loss of biodiversity value	Avoid or minimise impact	Design transmission lines to minimise EEC impact. Strategies may include ensuring that the height of the transmission structure over EECs is sufficient to allow minimal impact on these communities, and making use of the existing cleared transmission easement to reduce the clearing required for the new line	Construction			X	X
SOC35	Loss of biodiversity value	Minimise impact	Establish a Vegetation Management Plan to ensure that the ongoing maintenance of the transmission easement has minimal impact on the integrity of any EEC vegetation within the easement	Operation			X	X
SOC36	Loss of biodiversity value	Minimise impact	Maintain access tracks to minimise ongoing erosion and sedimentation impacts	Operation	X	X	X	X
SOC37	Loss of biodiversity value	Minimise impact	Confine maintenance access to existing tracks, hardstand or heavily disturbed areas	Operation	X	X	X	X
SOC38	Loss of biodiversity value	Minimise impact	Design site substations to ensure that the transformers are adequately bunded against any spill	Construction	X	X		
SOC39	Loss of biodiversity value	Minimise impact	Discuss options to reduce grazing pressures on EEC identified to be in good condition with existing landholders	Operation	X	X	X	X
SOC40	Loss of biodiversity value	Avoid or minimise impact	Avoid significant clusters of rocks and boulders where these provide shelter to threatened fauna. Where rocks and boulders cannot be avoided, they should be placed directly adjacent to the works area to preserve the availability of refuge	Construction	X	X		

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC41	Loss of biodiversity value	Avoid or minimise impact	Avoid standing dead trees and woody debris where practical. Where they require removal to allow for the tracks and hardstand areas, they should be placed adjacent to the impact areas, to retain these refuges in the immediate area	Construction	X	X		
SOC42	Loss of biodiversity value	Avoid or minimise impact	Open trenches required for the installation of cabling for the minimal period practical. Check trenches at first light and remove any trapped fauna	Construction	X	X		
SOC43	Loss of biodiversity value	Avoid or minimise impact	Apply a buffer to mature hollow-bearing trees where practical to minimise indirect impacts (such as noise and dust)	Construction	X	X		
SOC44	Loss of biodiversity value	Avoid or minimise impact	Apply an appropriate buffer (50m) to identified Tawny Rock Dragon habitat to ensure that it is not adversely affected	Construction	X	X		
SOC45	Loss of biodiversity value	Avoid or minimise impact	Design power poles to minimise perching and roosting opportunities where practical Design power poles and overhead powerlines to reduce impacts to birds (for example by using flags or marker balls, large wire size, wire insulation, wire and conductor spacing) in areas of elevated risk of bird strike	Construction	X	X	X	X
SOC46	Loss of biodiversity value	Avoid or minimise impact	Design and implement an adaptive management monitoring program to document bird and bat mortalities, remove carcasses and assess the effectiveness of controls. If the results of assessment demonstrate that further mitigation is required, undertake further turbine ridge habitat modification and enhancement of off-site habitats	Operation	X	X		
SOC47	Loss of biodiversity value	Avoid or minimise impact	Undertake an appropriate fauna assessment, pertinent to applicable legislation at the time of decommissioning	Decommissioning	X	X	X	X

9.2.4 Hydrology

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC48	Deterioration of water quality	Minimise risk	Consult with Country Water on the scope of all further work to be undertaken in relation to the legislative requirements associated with the works in the Umberumberka Creek Special Area Undertake detailed geotechnical investigations to ensure that the project would have no material adverse effect on groundwater/aquifers Identify important springs and other water sources through consultation with leaseholders	Construction	X	X		
SOC49	Deterioration of water quality	Minimise risk	Establish a Sediment/Erosion Control Plan including the following provisions: – Install sediment traps wherever there is potential for sediment to collect and enter waterways – Bund stockpiles generated as a result of construction activities with silt fencing, (hay bales or similar) to reduce the potential for runoff from these areas – Establish soil and water management practices guided by the Best Practice guidelines contained within Soils and Construction Vol. 1 (Landcom 2004) – Ensure all vehicles onsite follow established access tracks and minimise onsite movements – Operate and maintain machinery in a manner that minimises risk of hydrocarbon spills	Construction Decommissioning	X	X	X	X
SOC50	Deterioration of water quality	Minimise risk	Prepare a Site Restoration Plan including protocols for restoration works such as: – Site preparation – Site stabilisation – Measures to encourage native vegetation recruitment – Monitoring	Construction Decommissioning	X	X	X	X
SOC51	Deterioration of water quality	Minimise risk	Carry out dust suppression as required through either watering or chemical means.	Construction Decommissioning	X	X	X	X

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC52	Deterioration of water quality	Minimise risk	Incorporate spill control procedures in the CEMP and OEMP including: – Identify persons responsible for implementing the plan if a spill of a dangerous or hazardous chemical/waste should occur – Locate Material Safety Data Sheets (MSDS) for all chemical inventories on site and readily available – Comply with manufacturers recommendations in relation to application and disposal where chemicals are used – Report any spill that occurs, to the Construction Manager regardless of size or type of spill – Notify the NSW EPA should the spill or hazard reach surface waters – Identify and bund chemical/fuel storage areas to prevent loss of any pollutants – Establish clearly defined works and refuelling areas – Store adequate hydrocarbon spill kits at the site and train site staff in their use	Construction Operation Decommissioning	X	X	X	X
SOC53	Deterioration of water quality	Minimise risk	Design water crossings to prevent impact on existing banks, water flow, animal passage and on the movement of substrate flows (sand moving through the channel). Strategies may include gabion baskets excavated to near ground level, which would facilitate heavy loads without trapping sand carried during high rainfall events	Construction	X	X	X	X
SOC54	Destruction of infrastructure	Minimise risk	Identify and mark out the underground pipe line that currently supplies water from the Umberumberka Reservoir. No excavation works would be undertaken within a specified (10m) buffer of the identified pipe line without the consent of Country Water.	Construction Decommissioning	X	X	X	X
SOC55	Deterioration of water quality	Minimise risk	Design of concrete batching plants would ensure concrete wash would not be subject to uncontrolled release. Areas of the batching plants would be bunded to contain peak rainfall events and remediated at the completion of the construction phase.	Construction	X	X		
SOC56	Deterioration of water quality	Minimise risk	Monitor and maintain all sediment and erosion controls implemented during the construction phase along the access tracks	Construction Operation Decommissioning	X	X	X	X

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC57	Deterioration of water quality	Minimise risk	Monitor bunded infrastructure to ensure that the amounts of oil could be fully contained in the event of a leak	Operation	X	X		
SOC58	Deterioration of water quality	Minimise risk	Maintain septic systems, if installed, to meet appropriate Australian Standards	Construction Operation Decommissioning	X	X		

9.2.5 Traffic and transport

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC59	Safety and asset protection	Minimise risk	Develop and implement a Traffic Management Plan (TMP) in consultation with roads authorities to facilitate appropriate management of potential traffic impacts. The TMP would include provisions for: – Scheduling of deliveries and managing timing of transport through Broken Hill to avoid peak hours (beginning/end of the school day), – Limiting the number of trips per day, – Undertaking community consultation before and during all haulage activities, – Designing and implementing temporary modifications to intersections and street furniture, – Installing required signage to direct traffic flows appropriately during haulage through Broken Hill – The erection of warning signs and/or advisory speed posting prior to isolated curves – Reinstating pre-existing conditions after temporary modifications to the roads and pavement along the route	Construction Operation Decommissioning	X	X	X	X
SOC60	Safety and asset protection	Minimise risk	Use a licensed haulage contractor with experience in transporting similar loads, responsible for obtaining all required approvals and permits from the RTA and Councils and for complying with conditions specified in those approvals	Construction	X	X	X	X

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC61	Safety and asset protection	Minimise risk	Adopt route-specific mitigation measures as appropriate based on guidance provided in the attached Traffic impact study.	Construction	X	X	X	X
SOC62	Safety and asset protection	Minimise risk	Establish procedures to ensure that soil is not carried onto the highway on the wheels of construction traffic.	Construction	X	X	X	X
SOC63	Safety and asset protection	Minimise risk	Provide a contact phone number to enable any issues or concerns to be rapidly identified and addressed, through appropriate procedures	Construction	X	X	X	X
SOC64	Safety and asset protection	Minimise risk	Prepare road dilapidation reports covering pavement and drainage structures in consultation with roads authorities for the route prior to the commencement of construction and after construction is complete. Repair any damage resulting from the construction traffic (except that resulting from normal wear and tear) as required during and after completion of construction at the Proponent's cost or, alternately, negotiate an alternative for road damage with the relevant roads authority.	Construction	X	X	X	X
SOC65	Safety and asset protection	Minimise risk	Assess the geometric layout of proposed intersections along the Silver City highway to ensure adequate turning paths are available to allow safe turning for construction vehicles. For any intersection determined to be unsuitable, identify mitigation strategies included intersection widening in consultation with the roads authority.	Construction	X	X	X	X
SOC66	Safety and asset protection	Minimise risk	Upgrade and seal the initial section of Daydream Mine Road and negotiate with roads authority to place a speed restriction on the road consistent with Silverton Road (90km/h).	Construction	X	X		
SOC67	Safety and asset protection	Minimise risk	To the extent that it will be extensively used for site access, upgrade and seal the initial section of Eldee Road and negotiate with roads authority to place a speed restriction on the road consistent with Silverton Road (90km/h).	Construction	X	X		
SOC68	Safety and asset protection	Provision of information	Provide information signage about the project at the Mundi Mundi lookout 5km west of Silverton and on the Silverton Road in the vicinity of Daydream Mine Road.	Construction	X	X		

9.2.6 Indigenous heritage

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC69	Loss of indigenous heritage items	Minimise impact	Develop in consultation with an archaeologist and the local Aboriginal Land Council a Cultural Heritage Management Protocol which documents the procedures to be followed for impact avoidance or mitigation in relation to indigenous heritage with reference to the recommended management strategies outlined in Table 22 of the archaeological report	Construction Operation Decommissioning	X	X	X	X
SOC70	Loss of indigenous heritage items	Minimise impact	Train specified personnel involved in the construction and operation phases of the project in procedures to avoid disturbance to any cultural heritage places and items	Construction Operation	X	X	X	X
SOC71	Loss of indigenous heritage items	Minimise impact	Conduct additional archaeological and heritage assessment in any areas which are proposed for impacts that have not been surveyed during the current assessment. Undertake field assessment in partnership with the local Aboriginal community. If Aboriginal objects are identified implement appropriate impact mitigation strategies	Construction	X	X	X	X
SOC72	Loss of indigenous heritage items	Minimise impact	Implement an active conservation strategy with regard to the two discrete object locales identified in Stage 1 to ensure that they are not inadvertently impacted during the construction, operation and decommissioning of the wind farm. (Note that these locales are either situated outside areas in which impacts are proposed or within areas in which a strategy of conservation, and hence impact avoidance, is expected to be highly feasible.)	Construction	X			
SOC73	Loss of indigenous heritage	Minimise impact	Conduct an adequate field survey and assessment of the Stage 2 area and formulate appropriate mitigation and management strategies	Construction		X		X

9.2.7 Non indigenous heritage

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC74	Loss of non indigenous heritage items	Minimise impact	Develop in consultation with an archaeologist a Cultural Heritage Management Protocol which documents the procedures to be followed for impact avoidance or mitigation in relation to non-indigenous heritage. A strategy of impact avoidance is entirely feasible for all of the recorded heritage items which warrant such an approach	Construction	X	X	X	X
SOC75	Loss of non indigenous heritage items	Minimise impact	Train personnel involved in the construction and management phases of the project in procedures to recognise and avoid disturbance to cultural heritage places and items	Construction	X	X	X	X
SOC76	Loss of non indigenous heritage items	Minimise impact	Conduct an additional heritage assessment in any areas which are proposed for impacts that have not been surveyed during the current assessment. The proposed impact areas would be subject to an appropriate level of field survey and assessment for the purposes of identifying non indigenous heritage sites	Construction		X		X
SOC77	Loss of non indigenous heritage items	Minimise impact	Subject any non indigenous heritage sites found in the proposed impact areas to a site significance assessment in order to form the basis for the development of appropriate mitigation and management strategies. This may involve the preparation of more detailed heritage assessments or heritage impact statements for sites if required. These would follow guidelines of the NSW Heritage Office publications 'Statements of Heritage Impact' and 'Assessing Heritage Significance'	Construction	X	X	X	X
SOC78	Loss of non indigenous heritage items	Minimise impact	Minimise impacts where practical to items assessed not to meet the criteria for heritage listing (e.g. SU32/HS1, SU54/HS1, SU141/HS1, SU141/HS2, SU143/HS1, SU190/HS1, SU191/HS3 & SU226/HS1)	Construction	X	X	X	X
SOC79	Loss of non indigenous heritage items	Minimise impact	Avoid impacts where practical to items assessed to meet the criteria for heritage listing (e.g. SU62/L1, SU90/L1, SU90/L2, SU90/L3, SU90/L4, SU92/HS1, SU93/HS1, SU94/HS2, SU191/L1, SU191/L2 and the Stone Ruins) and where avoidance is not feasible mitigate impacts in the form of archival recording and/or salvage excavation	Construction	X	X	X	X
SOC80	Loss of non indigenous heritage items	Minimise impact	Avoid impacts on individual recordings where practical in SU94, which contains a recording assessed to be of local significance and high research potential. Avoid or minimise impacts to the southeast of grid reference 526696e 6480400n	Construction	X			
SOC81	Loss of non indigenous heritage items	Minimise impact	Conserve infrastructure associated with the Umberumberka Reservoir (SU53/HS1, SU57 and SU58) where practical	Construction	X		X	

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC82	Loss of non indigenous heritage items	Minimise impact	Conserve Lake's Grave which is assessed to be of high local significance	Construction	X		X	
SOC83	Loss of non indigenous heritage items	Minimise impact	Avoid impacts at the zinc sintering works if practical or mitigate by archival recording and/or salvage excavation	Construction			X	
SOC84	Loss of non indigenous heritage items	Minimise impact	Keep all direct impacts associated with the transmission line at least 30 m off the permanent way of the Silverton tramway	Construction			X	X
SOC85	Loss of non indigenous heritage items	Minimise impact	Train specified personnel involved in the construction and operation phases of the project in procedures to avoid disturbance to any non-indigenous cultural heritage places and items	Construction Operation	X		X	

9.2.8 Economic

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC86	Affect on local community	Maximise positive impact of Proposal	Liaise with local industry representatives to maximise the use of local contractors and manufacturing facilities in the construction and decommissioning phases of the project	Construction	X	X	X	X
SOC87	Affect on local community	Maximise positive impact of Proposal	Liaise with the local visitor information centres to ensure that construction and decommissioning timing and haulage routes are known well in advance of works and to the extent practical coordinated with local events	Construction	X	X	X	X
SOC88	Affect on local community	Maximise positive impact of Proposal	Liaise with Broken Hill City Council and the Department of State and Regional Development to provide information to assist in attracting people to the local area to facilitate meeting the expected demand for human resources for both construction and operation of the Proposal	Construction Operation	X	X	X	X
SOC89	Affect on local community	Maximise positive impact of Proposal	Make available employment opportunities and training for the ongoing operation of the wind farm to local residents where reasonable	Operation	X	X		

9.2.9 Farming and grazing

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC90	Impact on current land use	Minimise impact	Develop protocols for construction traffic on access roads where stock may be grazing as part of the Traffic Management Plan	Construction Decommissioning	X	X	X	X
SOC91	Impact on current land use	Minimise impact	Restrict stock from works areas where there is a risk of stock injury	Construction Decommissioning	X	X	X	X
SOC92	Impact on current land use	Minimise impact	Ensure the Site Restoration Plan considers farming and grazing opportunities and impacts	Construction Decommissioning	X	X	X	X
SOC93	Impact on current land use	Minimise impact	Liaise with neighbouring landowners to provide information about the timing of construction activities	Construction Decommissioning	X	X	X	X
SOC94	Impact on current land use	Minimise impact	Provide a point of contact to all landholders adjacent to the infrastructure	Construction Operation Decommissioning	X	X	X	X
SOC95	Impact on current land use	Minimise impact	Surround switchyard and substation areas with a security fence as a safety precaution to prevent trespassers and stock ingress	Construction	X	X		

9.2.10 Mineral exploration

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC96	Conflict with mineral exploration	Minimise conflict	Liaise with current mineral lease holders, providing a final turbine and infrastructure layout, prior to the construction phase	Construction	X	X		
SOC97	Conflict with mineral exploration	Minimise conflict	Provide a point of contact to the current mineral lease holders	Construction Operation Decommissioning	X	X		

9.2.11 Aircraft hazard

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC98	Creation of hazard	Minimise risk	Liaise with CASA and determine the appropriate number, location and type of aircraft warning beacons to be fitted on wind turbines prior to the commencement of construction	Construction	X	X		
SOC99	Creation of hazard	Minimise risk	Notify all relevant authorities (CASA, AirServices, Department of Defence) of the final position of all wind turbines	Construction	X	X		

9.2.12 Fire and bushfire

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC100	Increase risk of fire ignition or spread	Minimise risk	Consult with the Rural Fire Service (RFS) and NSW Fire Brigade (NSWFB) in regard to the adequacy of bushfire prevention measures to be implemented on site during construction, operation and decommissioning. These measures would in particular cover hot-work procedures, asset protection zones, safety, communication, site access and response protocols in the event of a fire originating in the wind farm infrastructure, or in the event of an external wildfire threatening the wind farm or nearby properties	Construction Operation Decommissioning	X	X		
SOC101	Increase risk of fire ignition or spread	Minimise risk	Hold appropriate fire fighting equipment on site and train an appropriate number of site personnel in its use. Determine the equipment and level of training in consultation with the local RFS	Construction Operation Decommissioning	X	X		
SOC102	Increase risk of fire ignition or spread	Minimise risk	Handle and store flammable materials and ignition sources brought onto the site as per manufacturer's instructions	Construction Operation	X	X	X	X
SOC103	Increase risk of fire ignition or spread	Minimise risk	Maintain asset protection zones, based on the RFS Planning for Bushfire Protection, around the control room, substations and in electricity transmission easements Develop workplace health and safety protocols to minimise the risk of fire to workers	Construction Operation Decommissioning	X	X	X	X
SOC104	Increase risk of fire ignition or spread	Minimise risk	Bund substation facilities with a capacity sufficient to contain the volume of transformer oil in the event of a major leak or fire. Maintain bunds to ensure leaks do not present a fire hazard, and to ensure the bunded area is clear (including removing any rainwater)	Construction Operation	X	X		
SOC105	Increase risk of fire ignition or spread	Minimise risk	Surround substations with a gravel and concrete area free of vegetation to prevent the spread of fire from the substation and reduce the impact of bushfire on the structure	Construction Operation	X	X		

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC106	Increase risk of fire ignition or spread	Minimise risk	Hold fire extinguishers on site in all control buildings, substation buildings and facilities buildings	Construction Operation	X	X		
SOC107	Increase risk of fire ignition or spread	Minimise risk	Periodically inspect overhead transmission easements to monitor regrowth of encroaching vegetation	Operation	X	X	X	X

9.2.13 Electromagnetic fields

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC108	Exposure from EMFs	Minimise exposure	Adhere to standard industry approaches and policies with respect to EMF through maintenance of adequate easements around transmission lines	Operation			X	X

9.2.14 Communications

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC109	Deterioration of signal strength	No deterioration of signal strength	Locate wind turbines to avoid microwave link paths that cross site	Construction	X	X		
SOC110	Deterioration of signal strength	No deterioration of signal strength	Ensure adequate television reception is maintained for neighbouring residences as follows: Assess pre-existing television signal strength at residences within 5km of the site, prior to construction In the event that after construction television interference (TVI) is experienced by existing receivers within 5km of the site, investigate the source and nature of the interference Where investigations determine that the interference is cause by the wind farm, establish appropriate mitigation measures at each of the affected receivers in consultation and agreement with the landowners.	Operation	X	X		

9.2.15 Community wellbeing

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC111	Community division	Provide accurate information	Disseminate accessible and independent information on wind farm impacts including benefits	Construction Operation	X	X	X	X
SOC112	Community division	Provide broad community benefit	Establish Community Fund as outlined in the Environmental Assessment	Operation	X	X		

9.2.16 Tourism

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC113	Affect on local activities	Minimise disruption	Co-ordinate construction activities with local events	Construction	X	X	X	X
SOC114	Affect on local activities	Minimise disruption	Provide wind farm promotional information to the local visitor information centres	Construction Operation	X	X		
SOC115	Affect on local activities	Minimise disruption	Support educational and promotional tours targeting the construction and operation of the wind farm, subject to safety concerns and the permission of landholders permission being addressed	Construction Operation	X	X		
SOC116	Affect on local activities	Minimise disruption	Work with the Silverton Village Committee and involved landholders to allow for the development of the wind farm as a tourist attraction, if this option is desirable to these parties.	Operation	X	X		

9.2.17 Film and art

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC117	Affect on film and art activities	Minimise disruption	Liaise with Film Broken Hill and West Darlings Arts to ensure that these parties are informed regarding the construction activities and timing to minimise the potential for inconvenience caused to filming and art endeavours during construction	Construction	X	X	X	X

9.2.18 Health and safety

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC118	Safety of persons and stock	Minimise risks	Prepare and implement an appropriate Health and Safety Plan covering all phases of the project. This plan would identify hazards associated with construction works, and prepare appropriate safeguards, protocols and responses including emergency response protocols	Construction Operation Decommissioning	X	X	X	X
SOC119	Safety of persons and stock	Minimise risks	Induct all site workers on their first day of employment at the site. The induction would include a detailed briefing on health and safety	Construction Occupation Decommissioning	X	X	X	X
SOC120	Safety of persons and stock	Minimise risks	Ensure all contractors selected for construction are appropriately qualified and trained	Construction Decommissioning	X	X	X	X
SOC121	Safety of persons and stock	Minimise risks	Install appropriate site fencing and/or signage where there is a risk to the safety of construction workers or the general public	Construction Decommissioning	X	X	X	X
SOC122	Safety of persons and stock	Minimise risks	Undertake detailed geotechnical investigations (such as core samples) in the area of the proposed turbines to determine ground stability and soundness of the strata taking into account the potential for any mine shafts	Construction	X	X		
SOC123	Safety of persons and stock	Minimise risks	Establish a turbine maintenance program in accordance with industry standards	Operation	X	X		

9.2.19 Physical (Climate, air quality, soils)

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC124	Soil	Minimise impact	Avoid compaction of soil resulting from vehicle access and laying of materials, particularly during saturated soil conditions, and remediated as necessary	Construction	X	X	X	X
SOC125	Air quality	Minimise impact	Undertake ongoing dust suppression throughout the construction phase	Construction	X	X	X	X
SOC126	Soil	Minimise impact	Monitor and maintain tracks to ensure landform stability is maintained, in accordance with erosion and sediment control plans	Operation	X	X	X	X

9.2.20 Resource

	Impact	Objective	Mitigation tasks	Project Phase	Site area- Stage 1	Site area- Stage 2	Transmission line corridor – Broken Hill	Transmission line corridor – Red Cliffs
SOC127	Waste generation	Minimise waste and maximise recycling of materials	Reduce, reuse or recycle wastes whenever possible. Provide separate recyclable materials receptacles near site offices (e.g. for glass, plastics and aluminium)	Construction Operation	X	X	X	X
SOC128	Waste generation	Appropriate disposal of waste	Dispose of packaging materials and general construction wastes with Council's approval, at Council operated waste disposal centres	Construction Operation	X	X	X	X
SOC129	Waste generation	Appropriate disposal of waste	Provide toilet facilities for onsite workers and dispose of sullage from contractor's pump out toilet facilities at the local sewage treatment plants or other suitable facility agreed to by Counci	Construction Operation	X	X	X	X
SOC130	Waste generation	Minimise waste and maximise recycling of materials	Use excavated material in road base construction, as aggregate for footings and construction pads where possible. Dispose of surplus material in appropriate locations on site	Construction Operation	X	X		

9.3 MONITORING AND ADAPTIVE MANAGEMENT

Monitoring and adaptive management mechanisms will be in place to reduce the operational impacts of the Proposal, should unforeseen impacts result. The Proposal has a degree of flexibility to address unforeseen impacts. Specific management responses will be determined by the nature and extent of impacts, but could include adjustments to the turbines and associated infrastructure or to offsite areas; for example, to install visual screening offsite or habitat enhancement away from turbine locations.

The CEMP and OEMP will employ adaptive management in response to monitoring results and other inputs. Due to the level of detail and site specific investigation required, monitoring programs will not be designed prior to project consent. However, an indicative program is outlined below to assess the impact of the operational Proposal on birds and bats.

9.3.1 Example: bird and bat impact monitoring

Monitoring methods and data standards for dead bird searches, indirect disturbance impact assessment and habitat avoidance studies will be based on protocols in the Interim Standards for Assessing the Risks to Birds from Wind Farms in Australia (Brett Lane and Associates 2005).

In the case of bird and bat mortality, threshold mortality rates for threatened or sensitive bird and bat species would be determined for three monitoring periods (first six months, first two years, ongoing). The thresholds will trigger a management response, which will vary depending on the nature and extent of the impact.

The OEMP will contain details of a three-tiered monitoring program for bird and bat mortalities and habitat utilisation impacts:

1. First six months of operation

- An intensive period of monitoring required because birds and bats are in the process of habituating to the new development, and sensitive species may experience higher levels of mortality during this period
- During this period all turbine sites will be surveyed to determine variation in impact over the study area. Surveys may include monthly dead bird searches, bird utilisation surveys, observation of avoidance/diversion behaviour and targeted surveys for species of concern (such as raptors)
- Reporting will examine the impacts on potentially vulnerable species (such as threatened species, waterbirds and raptors)

2. First two years of operation

- Monitoring to assess mortality rates and trends over several seasons and longer term changes to local species abundance, habitat use patterns and possibly breeding success, directed by the results of previous monitoring
- The surveys may be limited to representative or higher risk turbine sites, based on the results of previous monitoring.
- Reporting will examine the impacts on potentially vulnerable species (such as threatened species, waterbirds and raptors)

3. Ongoing monitoring

- Mortality inspection and reporting to be continued for the life of the wind farm, at intervals determined by the results of previous monitoring. The inspection regime may be linked to turbine inspection and maintenance cycles. Mortalities of any significant species will be reported to DECC.

10. CONCLUSION

This EA has assessed the likely environmental impacts that may result from the proposed Silverton Wind Farm; a Proposal incorporating up to 598 turbines and capable of generating more than 1,000MW of greenhouse gas emission-free electricity.

The Proposal has incorporated the environmental constraints identified in an iterative manner throughout the project design to arrive at the most appropriate site layout. It has also incorporated measures to proactively address identified environmental risks throughout the construction, operation and decommissioning of the project. All measures to which the Proponent would commit are detailed in the draft Statement of Commitments summarised in Section 9.2.

This EA considers the key issues of the Proposal relating to visual impact, noise, biodiversity, communications, traffic and transport, heritage impact and a range of issues relating to the local community, including wellbeing, lifestyle values and tourism. These impacts must be considered in balance with the public benefits of the Proposal.

Benefits of the Proposal have been identified at the global, regional and local scale. These include (based on a 598 turbine layout):

- Production of approximately 3,500,000MWh of renewable electricity per annum, sufficient for the average consumption of around 437,500 homes
- Reduction in greenhouse gas emissions of approximately 3.5 million tonnes of carbon dioxide (equivalent) per annum, the equivalent of taking 700,000 cars off our roads
- Savings in water consumption of approximately 4,600 million litres per annum of potable water (this is the amount of water required to produce the same amount of electricity from coal-fired power stations)
- Annual savings in pollution from coal-fired power stations of up to 18,760 tonnes of sulphur dioxide, 8,365 tonnes of nitrogen oxides and 535,000 kilograms of particulates
- Provision of local jobs and injection of up to $701 million into the regional Australian economy
- Improved security of electricity supply through diversification.

The success of the Proposal in mitigating environmental impacts is underpinned by the development and implementation of the Project Environmental Management Plan and its associated Construction and Operation Environmental Management Plans.

The Proponent is committed to ensuring the measures developed in this Proposal are best practice and is committed to working to ensure the best possible result is achieved for the Silverton Wind Farm site. This not only has immediate benefits for the site and locality that would house the project, it would set a high standard for the development of wind energy resources in the state and the country.

On balance the local and global environmental, economic and social benefits of the Proposal are considered to outweigh residual adverse impacts identified on or near the site.

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11. GLOSSARY AND ACRONYMS

AADT	Annual Average Daily Traffic
ABARE	Australia Bureau of Resource Economics
ACMA	Australian Communications and Media Authority
AGO	Australian Greenhouse Office
AHD	Australian Heritage Database
AHIMS	Aboriginal Heritage Information Management System
APANSA	Australian Radiation Protection and Nuclear Safety Agency
APZ	Asset Protection Zones
AusWEA	Australian Wind Energy Association
BHLALC	Broken Hill Local Aboriginal Land Council
CASA	Civil Aviation Safety Authority
CEMP	Construction Environmental Management Plan
CFMEU	Construction, Forestry, Mining and Energy Union
CMA	Catchment Management Authority
DACR	Defence (Areas Control) Regulations
DECC	NSW Department of Environment and Climate Change, formerly the Department of Environment and Conservation
DEUS	Department of Energy, Utilities and Sustainability
DGRs	NSW Department of Planning's Director-Generals Requirements. The Environmental Assessment report must address issues as directed in the DGRs
DoL	Department of Lands
DoP	NSW Department of Planning
DPI	Department of Primary Industries
EA	Environmental Assessment report, format dictated by the NSW Department of Planning's Director-Generals Requirements
EEC	Endangered Ecological Community
EMF	Electromagnetic fields
EMI	Electromagnetic Interference
EMP	Environment Management Plan
EPA	Environmental Protection Agency
EP & A Act	Environmental Planning and Assessment Act 1979 (NSW)
EPBC	Environment Protection and Biodiversity Conservation
ESC	Effective Survey Coverage (referred to in Aboriginal Archaeology survey methods and results)
ESD	Ecologically Sustainable Development
EWEA	European Wind Energy Association
IBRA bioregions	Interim Biogeographic Regionalisation for Australia
ILO	International Labour Organisation
INP	Industrial Noise Policy
LALC	Local Aboriginal Land Council
LCA	Life Cycle Analysis
LEP	Local Environmental Plan
LGA	Local Government Area
LSALT	Lower Safe Altitude
LVIA	Landscape and Visual Impact Assessment
MRET	Mandatory Renewable Energy Target
MSDS	Material Safety Data Sheets

MW	Megawatts
MWh	Megawatt hours
MVA	Megavolt Ampere
NEM	National Electricity Market
NPI	National Pollutant Inventory
OEMP	Operational Environmental Management Plan
OLS	Obstacle Limitation Surfaces
PEMP	Project Environmental Management Plan
PFM	Planning Focus Meeting
Proponent	Silverton Wind Farm Developments Pty Ltd
PVP	Property Vegetation Plans
REP	Regional Environmental Plan
RFS	Rural Fire Service
RNE	Register of the National Estate
RRP	Regional Reference Price
RTA	Roads and Traffic Authority
SEDA	Sustainable Energy Development Authority
SEPP	State Environmental Planning Policy
SOC	Statement of Commitments
SHI	State Heritage Inventory
SHR	State Heritage Register
SOE	State of the Environment
TMP	Traffic Management Plan
TVI	Television Interference

12. ASSESSMENT PERSONNEL

This report was prepared by nghenvironmental. Specific sections were drawn from consultants' reports or from the Proponent, as detailed in Table 12.1

Table 12.1 Preparation of this document

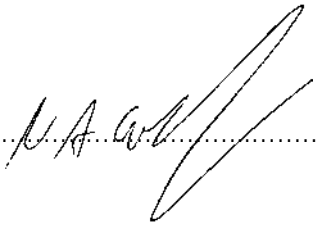
Section		Author
1	Executive summary	nghenvironmental
2	Introduction	nghenvironmental
3	Description of the Proposal	Silverton Wind Farm Developments
4	Project justification	Silverton Wind Farm Developments
5	Planning context	nghenvironmental
6	Consultation	nghenvironmental
7	Assessment of key issues	
7.1	Scoping and prioritisation of issues	nghenvironmental
7.2	Visual impact	Green Bean Design, Landscape Architects
7.3	Operational and construction noise	Heggies Pty Ltd
7.4	Biodiversity	nghenvironmental
7.5	Indigenous heritage	NSW Archaeology
7.6	Air hazard impacts	Silverton Wind Farm Developments and nghenvironmental
7.7	Communication impacts	Silverton Wind Farm Developments
7.8	Electromagnetic fields (EMFs)	Silverton Wind Farm Developments
7.9	Land value impacts	Silverton Wind Farm Developments and nghenvironmental
7.10	Traffic and transport	Bega Duo Designs
7.11	Fire and bushfire impacts	nghenvironmental
7.12	Hydrology	nghenvironmental
7.13	Mineral exploration impacts	nghenvironmental
8	Assessment of additional issues	nghenvironmental
8.1	Economic impacts	SGS Economics
8.2	Community wellbeing	nghenvironmental
8.3	Lifestyle impacts	nghenvironmental
8.4	Tourism impacts	nghenvironmental
8.5	Agricultural impacts	nghenvironmental
8.6	Health and safety	nghenvironmental
8.6.1	Construction activities	nghenvironmental
8.6.2	Shadow flicker	Garrad Hassan
8.6.3	Stability of turbines	nghenvironmental
8.7	Non indigenous heritage	NSW Archaeology and nghenvironmental
8.8	Physical impacts	nghenvironmental
8.8.1	Climate	nghenvironmental
8.8.2	Air quality impacts	nghenvironmental
8.8.3	Soils and landforms	nghenvironmental

Section		Author
8.9	Resource impacts	nghenvironmental
8.5	Cumulative impacts	nghenvironmental
9	Environmental management	nghenvironmental
10	Conclusion	nghenvironmental

Nick Graham-Higgs, Tim Browne and Brooke Marshall of nghenvironmental constitute the document's primary authors. The information contained in this document is neither false nor misleading. All information is considered by the authors to be correct at the time of writing.

Nicholas Graham-Higgs

nghenvironmental (Director)



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Tim Browne

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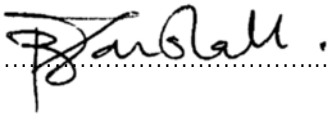

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Authors	Experience
Nicholas Graham-Higgs *Bachelor of Applied Science*	Nick has worked as an environmental planning consultant since 1992, specialising in environmental impact assessment and natural resource management. His work demands an in-depth knowledge of current planning and environmental legislation coupled with a comprehensive understanding of development-related impacts, especially those relating to the development of sustainable power generation facilities, including hydro and wind generated electricity. Nicholas has acquired his knowledge in this field over the last 17 years, during which he has worked with a number of land management organisations within and outside Australia. Much of the work undertaken has been within sensitive areas, including major works for infrastructure development: the augmentation of water supplies at Perisher Range and Adaminaby, the development of mini-hydro plants at Jounama, Khancoban and Geehi and environmental assessment for a wind farm on the Snowy Plains, near Kosciuszko National Park.
Tim Browne *Bachelor of Science* *Masters Science pending (Environmental Management)*	Tim completed a Bachelor of Science (in earth and environmental studies) at the University of Technology, Sydney. He is currently completing a post graduate Master of Environmental Management. Tim has consulting experience in environmental impact assessment, contaminated land investigation and remediation, as well as experience within the mining industry of Western Australia. Tim has recently prepared and assisted in the preparation of environmental impact assessments and biodiversity and management documents for clients such as Country Energy, RTA and Epuron Pty Ltd. These projects have given Tim a detailed understanding of the local and regional environments of south-eastern NSW, complimenting his knowledge of greater metropolitan Sydney and northern NSW. A recent example of this work was the preparation of an options study for a proposed electricity cabling route over 42 kilometres from Bega to Eden. Tim also assists RTA in providing environmental planning advice and services to facilitate the planning and construction of road works in southern NSW. Tim has had field experience in environmental impact assessments, biodiversity assessments including terrestrial fauna and flora and fauna surveys and contaminated site investigations. Tim is also an active member of the Environment Institute of Australia and New Zealand and The Geological Society of Australia.
Brooke Marshall *Bachelor of Natural Resources (Hons)*	Since joining nghenvironmental in 2004, Brooke has prepared impact assessment reports relating to residential developments, road construction, water supply infrastructure, telecommunications infrastructure, river modification, wind farms and prescribed burning activities. These reports have included threatened flora and fauna species assessments requiring research, fieldwork and GIS components. Brooke has prepared DAs under Parts 3A, 4 and 5 of the EP&A Act, as well as Environmental Management Plans, Rehabilitation Plans and Community Consultation Plans associated with these proposals. Brooke has prepared strategic reports considering natural values for local government (Snowy River Shire and Bega Valley Shire) and has worked on Species Impact Statements and EPBC Referrals. Brooke's work has been focussed on the South Coast, Southern Tablelands and Snowy Mountains regions of NSW, including sensitive sub-alpine areas. Brooke is currently focusing on environmental impact assessment, biodiversity assessments and wildlife management issues.

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14. ATTACHMENTS