Cumulative Visual Impact Assessment

9.1 What is Cumulative Impact Assessment?

A cumulative landscape and visual impact may result from a wind farm being constructed in conjunction with other existing or proposed wind farm developments, and may be either associated or separate to it.

Separate wind farm developments may occur within the established viewshed of the proposed wind farm, or may be located within a regional context where visibility is dependent on a journey between each site or project viewshed.

'Direct' cumulative visual impacts may occur where two or more winds farms have been constructed within the same locality, and may be viewed from the same view location simultaneously.

'Indirect' cumulative visual impacts may occur where two or more wind farms have been constructed within the same locality, and may be viewed from the same view location but not within the same field of view (i.e. the viewer has to turn their head in order to view both wind farms).

'Sequential' cumulative visual impacts may arise as a result of multiple wind farms being observed at different locations during the course of a journey (e.g. from a vehicle travelling along a highway or from a network of local roads), which may form an impression of greater magnitude within the construct of short term memory.

The majority of wind farms within New South Wales, currently constructed, approved or under consideration by the DoP&I, are located within the general regional area of the New South Wales Southern Tablelands, including sites in the locality of Crookwell, Goulburn, and Yass. The distribution of proposed, approved and operating wind farms within New South Wales are illustrated in **Figure 19**, and the occurrence of wind farms surrounding the Crookwell 3 wind farm in **Figure 20**. These figures illustrate the location of wind farms known at the time this LVIA was prepared. The number and location of wind farms is likely to change as more wind farm projects are announced.



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Katoomba Leura fled Citif Woodstock Triangle Fig Edith TRIANGLE Warradero runkey Creek Aouni avin enolan Cave 102 Cowra Grenfell Warra rcrombie Caves Swelchield Shooters Hill umballdry Darbys Falls Morongla Greek Abencromb Wattamondai Wyang ala Burraga KANANGRA - BOYD BLUE BURRAGO S C A ethorpe Koorawatha NATIONAL Bimbi del. NATIONAL PARK Nattai Oak (177 Bigga Reids Flat BLUE Yerranderie o, yennautoenn Wirrima Godfrey Cree k Thuddungra beceve ri'bba ree 15 AL UNE Sweet Hill J. Bendick Murrell Snowy Mountain Lookout NATTAL Thirlm 16 + Alount Epai 4 OLYMPIC Buxton Maimuru o 6 Frogmore Taylor-s Fla NA 123 Millvale Young 3in da RANGE ^{hiands} 14 89 Hill Top 11 ' da Colo Vale Rugby Hanworth Womba Kingsvale Boorowa 9 CROOKWELL /17 Loughsi 12 Bowral Myrtleville 18.Jel RUFFIN WAY Harden-Murrumburrat Wallendbeer Moss Vale 13 Grabben 10 Kala 9 Barniste 3b 3a Fitzroy Fa Cootamundra Binr iona Indanoon inosd Wingell 7 . Marulan Tallong Daltor HUME 52 GOULBURN Kang Val Marulan South Gunning 8 laibane Yarra 10 ngra 2A Bowning B kham HWY 98 Cambewa 2 Jugic 80 YASS Boma Dak Mourt Bungonia MORTON 56 Komungla nverary Collector 20 Coolac Forest Yalwa - Coobs Mountains PARK Pettity RD 6 Murrumbateman Inveralochy Gundaroo 61 Barbolar2 Lak Bathurst Nangus Tome Tara Gundagai 5 ERRALONG Wandandian A Adjung bi 10 Vee Jaspei Black Pesk rioa Brungle + Alount Tianjara ower Boro MLP PARK KINGS 21 52 Mount Varn Bungendore sept 143 3 + Mount Cole Lak CANBERRA Tumut 46 18 Milton Mollyr Ulla Afount Liphtio Quèanbeyan TALLAGAND & Burril oskinstow Mongarloy + 4992 Braidwood (18) abourie Lake Misny-+ Ugh-Mou Mount Damain AUSTRALIAN Bawley Point Tharwa Batlow Brush Island

Figure 20 NSW Southern Tablelands Wind Farm Locations (as of June 2012)

Legend

- 1 Adjunblily Wind Farm
- 2 Birrema Wind Farm
- 3a Yass Wind Farm (Coppabella)
- 3b Yass Wind Farm (Marilba)
- 4 Rugby Wind Farm
- 5 Capital Wind Farm (I & II)
- 6 Woodlawn Wind Farm
- 7 Cullerin Wind Farm
- 8 Collector Wind Farm
- 9 Gunning Wind Farm
- 10 Gullen Range Wind Farm
- 11 Crookwell WInd Farm
- 12 Crookwell 2 WInd Farm
- 13 Crookwell 3 Wind Farm
- 14 Taralga Wind Farm 15 Paling Yards Wind Farm
- 16 Golspie Wind Farm
- 17 Rye Park Wind Farm 18 Bango Wind Farm

Proposed wind farm development

- Approved wind farm development
- Operational wind farm development

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9.2 Other wind farm developments in the regional area

The DoP&I website identifies 8 wind farm developments that are currently operational, approved or proposed within the same regional context as the Crookwell 3 wind farm which are identified in Figure 17 and Table 20.

| Wind Farm | Proponent or Owner | Status | Number of turbines |
|--------------|--------------------------------|---------------|-----------------------|
| Cullerin | Origin Energy | Operational | 15 |
| Capital 1 | Infigen Energy | Operational | 63 |
| Woodlawn | Infigen Energy | Operational | 23 |
| Taralga | RES Australia | Approved | 62 |
| Gunning | Acciona | Operational | 31 |
| Paling Yards | Union Fenosa Wind Australia | Proposal Only | Up to 60 |
| Rugby | Suzlon Energy and Windlab | Proposal Only | Up to 52 |
| Capital 2 | Infigen Energy | Approved | 41 |

 Table 20 - Regional Wind Farm Developments

9.3 Other wind farm developments in the local area

The DoP&I website identifies 3 wind farm developments that are currently existing or proposed within the same locality as the Crookwell 3 wind farm which are identified in **Table 21**.

| Wind Farm | Proponent | Status | Number of turbines |
|--------------|--------------------------------------|-------------|-----------------------|
| Crookwell 1 | Eraring Energy | Operational | 8 |
| Crookwell 2 | Crookwell Development | Approved | 46 |
| Gullen Range | Gullen Range Wind Farm Pty Ltd | Approved | 73 |

 Table 21 - Local Wind Farm Developments

GBD is not aware of any smaller wind farm developments that are currently lodged, or being assessed by the Goulburn Mulwaree or Upper Lachlan Shire Councils.

9.4 Other wind farm turbines that occur within the Crookwell 3 10km viewshed

A number of wind turbines within the constructed Crookwell 1, approved Crookwell 2 and approved Gullen Range wind farms would occur within the Crookwell 3 wind farm 10km viewshed. The extent and location of wind turbines within the Crookwell 3 viewshed are outlined in **Table 22**.

| Wind Farm | Approximate number of turbines within Crookwell 3 10km viewshed | Approximate distance between closest Crookwell 3 South wind turbine and other wind farm turbine | Approximate distance between closest Crookwell 3 East wind turbine and other wind farm turbine |
|--------------|---|--|---|
| Crookwell 1 | 8 | 6km | 7.6km |
| Crookwell 2 | 46 | 2.7km | 2.2km |
| Gullen Range | 22 | 8.5km | 16.5km |

Table 22 - Other wind farm turbines within Crookwell 3 10km viewshed

The location of other wind turbines within the Crookwell 3 wind farm 10km viewshed are illustrated

in Figure 17.

This LVIA has considered and assessed issues related to cumulative visual impact associated with multiple wind farm developments within the Crookwell 3 wind farm 10km viewshed.

The combined ZVI illustrates intervisibility between the existing Crookwell wind farm and approved Gullen Range and Crookwell 2 wind farms, together with the proposed Crookwell 3 wind farm development (refer **Figures 21** to **24**). The photomontages also illustrate the location of wind turbines associated with other wind farm developments within, and beyond, the Crookwell 3 wind farm 10km viewshed.

Overall the Crookwell 3 wind farm is not considered to significantly increase the magnitude of visual impact for the majority of residential view locations within the Crookwell 3 wind farm 10km viewshed. The potential for the occurrence of 'direct' and 'indirect' cumulative visual impact is







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Figure 21 ZVI Diagram 3 Cumulative Crookwell 3 and Crookwell 1

Legend



Figure 22 ZVI Diagram 4 Cumulative Crookwell 3 and Crookwell 2





Crookwell 2 ZVI - Tip of blade



•

Crookwell 3 and Crookwell 2 Cumulative ZVI - Tip of blade

- Residence within 3km of Crookwell 3 turbines
- Residence between 3km and 5km of Crookwell 3 turbines
- Residence between 5km and 10km of Crookwell 3 turbines
- Proposed Crookwell 3 East Turblne
- + Proposed Crookwell 3 South Turbine
- Approved Crookwell 2 Turbine
- Existing Crookwell Turbine
- Approved Gullen Range Turbine





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Figure 23 ZVI Diagram 5 Cumulative Crookwell 3 and Gullen Range

Legend



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3km

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Figure 24 ZVI Diagram 6 Cumulative Crookwell 1, 2, 3 and Gullen Range

mitigated to a degree by the screening or partial filtering of views toward approved and existing wind farms.

Potential 'sequential' views will occur along various sections of local roads, including the Goulburn Crookwell Road whilst travelling in north and southbound directions. Sequential views from local roads would be mitigated to some extent by undulating landform and tree cover alongside road corridors.

Electrical works

SECTION 10

10.1 On and offsite electrical works

The Crookwell 3 wind farm would include a range of electrical infrastructure to collect and distribute electricity generated by the wind turbines. Electrical works would include:

- Generator transformers; and
- Underground 33kV and control cables.

The majority of electrical connections between the wind turbines would be via underground cabling within the project boundary.

An underground or overhead connection would be required between the Crookwell 3 South and East site boundaries and the Crookwell 2 site boundary to reach the substation approved as part of the Crookwell 2 wind farm.

A formal visual assessment of a potential overhead electrical connection between the Crookwell 3 wind farm and approved Crookwell 2 wind farm has not been undertaken as part of this LVIA; however, the transmission line required for short distances to link the sites across road reserves would be similar in height and profile (or smaller) than the existing 66kV transmission line that runs north past the Crookwell 3 South site supplying power to the Crookwell township.

Subject to the determination of a detailed alignment, the potential overhead transmission line is unlikely to impact on a significant number of residential dwellings, but is likely to be exposed to a high number of motorists travelling along the Goulburn to Crookwell Road. A detailed landscape and visual assessment would also need to consider the impacts associated with the potential overhead transmission line crossing or following drainage lines, as well as the clearance of vegetated areas to accommodate the transmission line easement.

The proposed pole design for any potential overhead transmission line is anticipated to be a single tapered pole, including angle and intermediate poles; however, the final selected pole assembly may incorporate alternative arrangements for the location insulators and conductors.

A key consideration within the design process for any potential overhead transmission line would be to avoid residential dwellings and sensitive view locations wherever possible. **Table 23** provides a summary of typical mitigation measures which could be adopted to minimise potential visual impact if an overhead transmission line is required.

| Component | Potential Mitigation | Life Cycle Stage |
|--|---|---------------------------------------|
| General alignment | A careful and considered route selection process to avoid sensitive view locations and loss of existing vegetation where possible. | Planning, Construction and Operation. |
| Pole location | Wherever possible, select angle positions in strategic locations to minimise potential visual impact (e.g. avoiding, where possible, skyline views) and to provide a maximum setback from residential dwellings and road corridors. | Planning and Construction. |
| Pole design | Selection of suitable component materials with low reflective properties. | Construction and Operation. |
| Conductors | Selection of materials with low reflective properties. | Construction and Operation. |
| Insulators | Selection of materials with low reflective properties. | Construction and Operation. |
| Erosion control | Appropriate control and removal of spoil from construction areas. | Construction. |
| Construction materials and equipment storage areas | Selection of suitable storage areas for materials or plant with minimum visibility from residences and roads with screening where necessary. | Construction. |
| Landscape Treatments | Strategic tree or shrub planting between the view location and the transmission line. | Construction and Operation. |

| Table 23 – Transmission line mitigation measures | Table 23 – | Transmission | line mitigation | measures |
|--|------------|--------------|-----------------|----------|
|--|------------|--------------|-----------------|----------|

Photomontages

SECTION 11

11.1 Photomontages

The DGR's state that the Crookwell 3 EA must "include photomontages of the project taken from potentially affected residences (including approved but not yet developed dwellings or subdivisions with residential rights), settlements and significant public view points..."

Whilst any residence with a view toward the Crookwell 3 wind farm turbines may be potentially affected (with a resultant high, medium or low visual impact), it is not feasible or practical to prepare a photomontage for each and every residence within the Crookwell 3 10 km viewshed.

In order to provide a representative selection of photomontage, twenty one view locations (A to U) were selected, including non associated residential dwellings within 2 km of the Crookwell 3 wind turbines. Four of the photomontage view locations have been selected from surrounding road corridors including the Crookwell Goulburn Road and Woodhouselee Road. The twenty one photomontage locations are illustrated in **Figure 25**.

The photomontage locations were also selected to represent a range of distances between the viewpoint and wind turbines (between 830m and 5.6km) to illustrate the potential influence of distance on visibility and resultant visual impact.

The photomontages have been prepared with regard to the guidelines set out in the Scottish Natural Heritage (2006) Visual representation of windfarms: good practice guidance and British Landscape Institute Advice Note 01/11 (March 2011) Photography and photomontage in landscape and visual impact assessment.

Each photomontage was generated through the following steps:

- A digital terrain model (DTM) of the Crookwell 3 wind farm site was created from a terrain model of the surrounding area using digital contours;
- The site DTM was loaded in the Garrad Hassan 'WindFarmer' software package;
- The layout of the wind farm and 3 dimensional representation of the wind turbine was configured in GH WindFarmer;

- The location of each viewpoint (photo location) was configured in WindFarmer the sun position for each viewpoint was configured by using the time and date of the photographs from that viewpoint;
- The view from each photomontage location was then assessed in WindFarmer. This process requires accurate mapping of the terrain as modelled, with that as seen in the photographs. The photographs, taken from each photomontage location were loaded into WindFarmer and the visible turbines superimposed on the photographs;
- The photomontage were adjusted using Photoshop CS3 to compensate for fogging due to haze or distance, as well as screening by vegetation or obstacles; and
- The final image was converted to JPG format and imported and annotated as the final figure.

 Table 24 identifies the twenty one photomontage locations, property names (where relevant),

 corresponding reference number identified in the Residential View and Public View Location Matrices

 outlined in Table 16 and Table 17 and the status of each photomontage location.

| Photomontage Location (Refer Figure 25 for location details) | Figure Reference | Property name and View Location Matrix reference (R) – (Refer Tables 16 and 17) | Status: Residential (associated) Residential (non associated) Road corridor | Visual Impact (Refer Table 16 and 17 for details) |
|--|-----------------------|---|--|--|
| A | Figures 26 and 27 | 'Emohruo' , Dawson's Creek Road (R7) | Residential (non associated) | Crookwell 3 South: Moderate to High Crookwell 3 East: Low |
| В | Figures 28, 29 and 30 | 'Narangi' residence, south of Pejar Road (R8) | Residential (non associated) | Crookwell 3 South: High Crookwell 3 East: Low |
| С | Figures 31 and 32 | 'Wombat Hollow' residence, west of Crookwell Road | Residential (non associated) | Crookwell 3 South : High |

| Table 24 – Photomontage Deta | ils |
|------------------------------|-----|
|------------------------------|-----|

| Photomontage Location (Refer Figure 25 for location details) | Figure Reference | Property name and View Location Matrix reference (R) – (Refer Tables 16 and 17) (R19) | Status: Residential (associated) Residential (non associated) Road corridor | Visual Impact (Refer Table 16 and 17 for details) Crookwell 3 East: Low |
|--|---------------------------------|--|--|---|
| D | Figures 33 and 34 | Goulburn Crookwell Road travelling north west | Road corridor | Crookwell 3 South: Low Crookwell 3 East: Low |
| E | Figures 35, 36, 37 and 38 | Residence north of Crookwell Road (R13) | Residential (non associated) | Crookwell 3 South: Moderate Crookwell 3 East: Moderate |
| F | Figures 39 and 40 | Woodhouselee Road view north to north east | Road corridor | Crookwell 3 South: Low Crookwell 3 East: Low |
| G | Figures 41 and 42 | Woodhouselee, view north to east (in the vicinity of R59, R61 and R62) | Road corridor, Woodhouselee | Crookwell 3 South: Nil Crookwell 3 East: Low |
| н | Figures 43 and 44 | 'Valdarman Hill' residence view north east to east (R64) | Residential (non associated) | Crookwell 3 South: Nil Crookwell 3 East: High |
| I | Figures 45 and 46 | 'Little Vale' residence view south to south east (R66) | Residential (non associated) | Crookwell 3 South: Nil Crookwell 3 East: High |
| J | Figures 47 and 48 | South of 'Rosedale' residence view south to south west (R106) | Residential (non associated) | Crookwell 3 South: Nil Crookwell 3 East: |

| Photomontage Location (Refer Figure 25 for location details) | Figure Reference | Property name and View Location Matrix reference (R) – (Refer Tables 16 and 17) | Status: Residential (associated) Residential (non associated) Road corridor | Visual Impact (Refer Table 16 and 17 for details) Low |
|--|----------------------|---|--|--|
| К | Figures 49 and 50 | Woodhouselee Road (Meadowvale residence R68) | Residential (Crookwell 3 non associated) – associated with Crookwell 2. | Crookwell 3 South: Nil Crookwell 3 East: Low |
| L | Figures 51 and 52 | Crookwell Goulburn Road travelling south | Road corridor | Crookwell 3 South: Low Crookwell 3 East: Low |
| M | Figures 53 and 54 | Non residential – woolshed (R58a) | Non residential (non associated) | Crookwell 3 South: N/A Crookwell 3 East: N/A |
| N | Figures 55 and 56 | Residential dwelling 'Wallaroobie' (R61) | Residential (non associated) | Crookwell 3 South: Nil Crookwell 3 East: Moderate to High |
| 0 | Figures 57 and 58 | Residential dwelling, 'Cottonwood ' (R62) | Residential (non associated) | Crookwell 3 South: Nil Crookwell 3 East: Moderate to High |
| P | Figures 59 and 60 | Residential dwelling 'Windalee' (R65) | Residential (non associated) | Crookwell 3 South: Nil Crookwell 3 East: High |
| Q | Figures 61 and 62 | 'Little Vale' – access track between R66 | Residential (non associated) | Crookwell 3 South: Nil |

| Photomontage Location (Refer Figure 25 for location details) | Figure Reference | Property name and View Location Matrix reference (R) – (Refer Tables 16 and 17) and R67 | Status: Residential (associated) Residential (non associated) Road corridor | Visual Impact (Refer Table 16 and 17 for details) Crookwell 3 East: High |
|--|----------------------|--|--|--|
| R | Figures 63 and 64 | Residential dwelling 'Atholvale' (R69) | Residential (non associated) | Crookwell 3 South: Nil Crookwell 3 East: Moderate to High |
| S | Figures 65 and 66 | Residential dwelling 'Snowgums' (R70) | Residential (non associated) | Crookwell 3 South: Nil Crookwell 3 East: Low |
| Т | Figures 67 and 68 | Non residential - St James's Church, Woodhouselee. (R80a) | Non residential (non associated) | Crookwell 3 South: Nil Crookwell 3 East: Moderate |
| U | Figures 69 and 70 | 'Rainmore' – potential future residential dwelling (R117) | Potential future residential (non associated) | Crookwell 3 South: High Crookwell 3 East: Nil |

The horizontal and vertical field of view within the majority of the photomontages exceeds the parameters of normal human vision. However, in reality the eyes, head and body can all move and under normal conditions a person would sample a broad area of landscape within a panorama view. Rather than restricting the extent of each photomontage to a single photographic image or cropped image representing the static human field of view, a broader field of view has been presented to more fully illustrate the extent of the wind turbines.

Whilst a photomontage can provide an image that illustrates a very accurate representation of a wind turbine in relation to its proposed location and scale relative to the surrounding landscape, this LVIA

acknowledges that large scale objects in the landscape can appear smaller in photomontage than in real life and is partly due to the fact that a flat image does not allow the viewer to perceive any information relating to depth or distance.

The British Landscape Institute states that 'it is also important to recognise that two-dimensional photographic images and photomontages alone cannot capture or reflect the complexity underlying the visual experience and should therefore be considered an approximate of the three-dimensional visual experiences that an observer would receive in the field'.

Figure 25 -Photomontage Locations



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Photomontage Location A - 'Emohruo' non associated property (R5). Proposed view with turbine markers.

Distance to closest turbine 3km

Photo location coordinates: Easting 731131 Northing 6170317 (GDA94)

Proposed Crookwell 3 South turbine marker

Proposed Crookwell 3 East turbine marker

Approved Crookwell 2 turbine marker



- Proposed Crookwell 3 South Turbine
- Approved Crookwell 2 Turbine
- Existing Crookwell Turbine
- Approved Gullen Range Turblne



Figure 26 -Photomontage Sheet A1



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Photomontage Location A - 'Emohruo' non associated property (R5), existing view



Photomontage Location A - 'Emohruo' non associated property (R5), proposed view Distance to closest turbine 3km

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Photomontage Location B - 'Narangi' non associated residence (R8). Proposed view with turbine markers.

Distance to closest turbine 1.1km

Photo location coordinates: Easting 733871 Northing 6173230 (GDA 94)



Proposed Crookwell 3 East turbine marker

Approved Crookwell 2 turbine marker



- Photomontage Location
- Proposed Crookwell 3 East Turbine
- Proposed Crookwell 3 South Turbine
- Approved Crookwell 2 Turbine
- Existing Crookwell Turbine
- Approved Gullen Range Turblne



Figure 28 -Photomontage Sheet B1



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Photomontage Location B - 'Narangi' non associated property (R8), existing view (B2)



Photomontage Location B - 'Nerangi' non associated property (R8), proposed view (B2) Distance to closest turbine 1.1km

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Photomontage Location B - 'Narangi' non associated property (R8), existing view (B3)



Photomontage Location B - 'Narangi' non associated property (R8), proposed view (B3) Distance to closest turbine 1.1km

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Photomontage Location C - 'Wombat Hollow' non associated property (R19). Proposed view with turbine markers.

Distance to closest turbine 1.1km

Photo location coordinates: Easting 735653 Northing 6171832 (GDA 94)

Proposed Crookwell 3 South turbine marker

Approved Gullen Range turbine marker





Figure 31 -Photomontage Sheet C1



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Photomontage Location C - 'Wombat Hollow' non associated property, existing view



Photomontage Location C - 'Wombat Hollow' non associated property, proposed view Distance to closest turbine 1.1km

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Figure 32 -Photomontage Sheet C2

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Photomontage Location D - Goulburn to Crookwell Road (view from road corridor). Proposed view with turbine markers.

Distance to closest turbine 2.5km

Photo location coordinates: Easting 737265 Northing 6168509 (AusGeod 84)

Proposed Crookwell 3 South turbine marker

Approved Crookwell 2 turbine marker

Approved Gullen Range turbine marker

Existing Crookwell turbine marker



- Photomontage Location
- Proposed Crookwell 3 East Turbine
- Proposed Crookwell 3 South Turbine
- Approved Crookwell 2 Turbine
- Existing Crookwell Turbine
- Approved Gullen Range Turblne



Figure 33 -Photomontage Sheet D1



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Photomontage Location D - Goulburn to Crookwell Road (view from road corridor), existing view



Photomontage Location D - Goulburn to Crookwell Road (view from road corridor), proposed view Distance to closest turbine 2.5km

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Figure 34 -Photomontage Sheet D2

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