Bango Wind Farm Project

Transport Assessment

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1. Introduction

1.1 Project Background

Wind Prospect CWP Pty Ltd is a partnership between the Wind Prospect Group (WP) and Continental Wind Partners (CWP) and is a locally based wind farm development company with offices in Adelaide, Brisbane, Newcastle, and Melbourne. Wind Prospect CWP Pty Ltd proposes to develop a wind farm on rural land to the south of the town of Boorowa and the village of Rye Park, NSW. The proposed development is known as the Bango Wind Farm Project and would accommodate up to 122 wind turbines.

The proposed Project site is located across two Local Government Areas (LGAs): Yass Valley Council and Boorowa Council. The Project site is centred approximately 20 km north of Yass, 7 km south-east of Boorowa and 80 km west of Goulburn, NSW. The turbines extend over a 25 km span running generally north-west to south-east, starting near Boorowa Road – refer to *Appendix A: Proposed Wind Farm Layout*.

This assessment investigates transportation issues associated with wind farm component and equipment haulage. The report identifies a preferred transportation mode and haulage routes to various site access points. Prevailing transport constraints and impacts are identified and assessed. Appropriate site access locations from the public road network are also identified. The report will serve as a supporting background paper to the Project's environmental assessment (EA).

1.2 Director General's & Other Authority Requirements

Planning NSW's Director General's Requirements (DGRs) require the traffic and transport assessment to assess the construction and operational traffic impacts of the project including:

- Details of traffic volumes (both light and heavy vehicles) and transport routes during construction and operation;
- Assess the potential traffic impacts of the project on road network function (including intersection level of service) and road safety;
- Assess the capacity of the existing road network to accommodate the type and volume of traffic generated by the project (including over-size vehicles) during construction and operation, including full details of any required upgrades to roads, bridges, site access provisions (for safe access to the public road network) or other road features;
- Details of measures to mitigate and/or manage potential impacts, including construction traffic control, road dilapidation surveys and measures to control soil erosion and dust generated by traffic volumes;
- Details of access roads within the site including how these would connect to the existing public road network (ie. site access) and ongoing operational maintenance requirements for on-site roads; and
- Consideration of relevant Council traffic / road policies.

The project falls within two Local Government Areas (LGAs), namely Yass Valley Council and Boorowa Council. In addition to the above DGRs, these Councils have requested that the following issues be covered and/or included in the traffic and transport assessment:

Boorowa Council

- Concerns about the capability of local roads to handle increased construction traffic flows and that the local roads would require substantial upgrading, repairs and maintenance of the roads proposed to be used.
- Preparation of a Construction Environmental Management Plan (CEMP) to outline a construction schedule, hours of work, waste disposal, etc.
- Cumulative impacts of multiple wind farms proposed within the Boorowa LGA.

Yass Valley Council

- No additional issues or comments.

1.3 Assessment Scope & Methodology

The scope of the assessment included the following tasks:

- Review of project background information.
- Project discussions with Wind Prospect CWP project team.
- Discussions with relevant Councils and RMS.
- Site visits to the wind farm sites and surrounding road network, including preferred transportation routes.
- Spot traffic counts were undertaken at various locations to confirm counts obtained from RMS and Council sources.
- Traffic generation during construction and operational phases of the Project.
- Traffic distribution onto the surrounding local and regional road network.
- Assessment of transport impacts on the surrounding road network including site access, road safety, road capacity and road conditions.
- Discussion of mitigation measures to address potential transport impacts identified.
- Preparation of this Transport Assessment Report to be used as part of the Project's Environmental Assessment (EA).

1.4 Report Structure

The remainder of this assessment report is presented as follows:

Chapter 2 provides an overall project description as well as general details of the wind farm equipment specifications and components.

Chapter 3 describes the potential transport modes as well as existing transport conditions including transport routes and site access locations.

Chapter 4 assesses the transportation impacts during the construction and operation phases of the Project.

Chapter 5 discusses mitigation measures to address potential transport impacts identified.

Chapter 6 provides a summary and conclusions to the assessment.

2. Project Details

2.1 Project Description

The proposed Bango Wind Farm Project would consist of up to 122 wind turbines with a rated capacity of at least 1.5 MW each. The approach to assessing impacts of the proposal will be based on greatest number (122 wind turbines) and largest turbine (ie. most impact) to ensure flexibility is retained post-consent to choose the most suitable wind turbine layout and technology available in the market at the time.

The wind turbines would be three bladed, multi-pitch, horizontal axis machines, with a maximum height of approximately 192 m, ie. from the base of the tower to blade tip when the blade is in the vertical position.

Turbines would be chiefly located on the higher altitude ridges within the site boundary, where they would be well spaced and positioned with a high regard for landscape amenity, existing land use, ecological conservation, and cultural heritage values, and in accordance with relevant legislation.

The Project comprises three ‘clusters’ of wind turbines as follows:

- Mt Buffalo Cluster: 58 turbines on eastern side of Project site;
- Kangiara Cluster: 34 turbines in central area of Project site; and
- Langs Creek Cluster: 30 turbines on north-western side of Project site.

Refer to Project site diagrams in *Appendix A: Proposed Wind Farm Layout*.

The subject wind farm would also consist of permanent and temporary ancillary structures and equipment, which would be positioned in accordance with site constraints. These would typically include:

- Access roads (internal site road network) connecting the public road network to the wind turbine locations and substations.
- Overhead and underground electrical cabling.
- Substations, typically comprising a main collector substation on site and a switching station near the point of connection.
- Underground electrical interconnection lines and control cables within each of the wind turbine clusters, connecting to the main collector substation.
- External overhead electrical interconnection lines (up to 132 kV single or double circuit) and associated communications cables between the main collector and switching substation to the transmission line;
- Permanent storage compounds, one per cluster.
- Up to six permanent wind monitoring masts.
- Mobile concrete batching plants and rock crushing compounds.
- Cleared areas to store construction materials and wind turbine components (construction laydown areas).
- Operations buildings.
- Construction site offices, associated facilities and site parking.

- Appropriate wind farm signage both during the construction and operational phases of the proposed development.
- Crane hardstand areas for the erection, assembly, commissioning, maintenance, recommissioning and decommissioning of the wind turbines.

The wind farm would connect to the nearby overhead transmission line network with the switching station compound to be located adjacent or close to the point of connection. The existing transmission lines within the Project area are the two 132 kV Yass-Cowra (circuits 999 and 973) power lines running through the centre of the site.

The project site is currently used as rural farm land and this would continue to be the case after construction. Once the wind farm is operational it would be monitored remotely, with maintenance staff undertaking regular services in line with the selected wind turbine.

The life span of a wind farm is usually 20 to 25 years, after which time there would be an option to either decommission the site, restoring the area to its previous land use with regard to consent conditions and lease requirements, or to upgrade the equipment and extend the wind farm's operational life.

2.2 Wind Farm Components

The model of wind turbine that will be used for the Project has not yet been resolved as final turbine selection will occur through a competitive tender process pending Development Consent. However, in terms of generation capacity, the wind turbines currently available in the market place that are under consideration for this Project will be at least 1.5 MW in capacity. By way of example the Suzlon S88, 2.1 MW machine (as installed at the Capital Wind Farm, east of Lake George, NSW) is typical of the type of wind turbine that could be used.

Consideration will also be given to the use of different turbine sizes and manufacturers across the site to better utilise the on-site wind resource profile. Under this circumstance, turbine dimensions would still fall within the permissible turbine sizes considered in the Environmental Assessment (EA).

The wind turbine components generally comprise a nacelle and gearbox assembly, hub, blades (three no.) and tower in three to five sections. Transport of blades would be typically undertaken one at a time with a length of up to 72 m. The nacelle and gearbox assembly are transported separately to limit transport weights. To facilitate transportation and ease of installation the tower support structure would be manufactured in three to five sections, depending on heights chosen.

The larger dimension wind turbine items such as the blades, nacelles and the larger diameter lower tower components may, when transported, exceed the road standard clearance restrictions and require special transportation permits. There is anticipated to be no issues for transporting the smaller sections of the smaller sized wind turbine components.

2.2.1 Turbine Rotor

Potentially, the turbines to be used for the Project would be three-bladed, semi-variable speed, pitch-regulated machines with rotor diameters between 74 m and 144 m and a swept area ranging from of 4,300 m^2 to 16,286 m^2. Typically turbines of this magnitude begin to generate energy at wind speeds in the order of 3.5 m/s to 4 m/s (approximately 13 km/h) and shut down (for safety reasons) in wind speeds greater than 25 m/s (90 km/h).

Wind turbine blades are typically made from glass fibre reinforced with epoxy or plastic attached to a steel hub, and include lightning rods for the entire length of the blade. The blades typically rotate at about 12 rpm at low wind speeds and up to 18 rpm at higher wind speeds.

2.2.2 Towers

The supporting structure is comprised of a reducing cylindrical tower made out of either a welded steel shell or a concrete steel hybrid, fitted with an internal ladder or lift. The largest tower height under consideration is 120 m with an approximate diameter at the base of 4.5 m and 3 m at the top. It is important to note that the maximum blade length suitable for this tower height is 72 m, which establishes the maximum proposed blade tip height of 192 m. Alternative tower heights between 80 m and 120 m are also under consideration however, this is not exhaustive since new models and certified designs are continually entering the market place. The tower will typically be manufactured and transported to site in three to five sections for on-site assembly.

2.2.3 Blade Tip

The blade tip will comprise the highest point of the wind turbine when in a vertical position. Given the turbines under consideration, a blade tip height of 192 m is considered to be the maximum. As new turbine models are regularly appearing on the market, blade tip height may vary by up to 5 m to accommodate potential changes to tower heights and blade lengths of new machines.

2.2.4 Nacelle

The nacelle is the housing constructed of steel and fibreglass that is mounted on top of the tower and can be 12 m long x 4.5 m high x 4.5 m wide. It encloses the gearbox, generator, transformers (model dependant), motors, brakes, electronic components, wiring and hydraulic and lubricating oil systems. Weather monitoring equipment located on top of the nacelle will provide data on wind speed and direction for the automatic operation of the wind turbine.

2.2.5 Footings

Three types of foundation for the wind turbines will be considered pending geotechnical investigation of the ground conditions at the Project site.

Slab (gravity) foundations would typically involve the excavation of approximately 750 m^3 (cubic metres) of ground material to a depth of approximately 2.5 m. Up to 200 m^3 would, if suitable, be used as backfill around the turbine base. Remaining excavation material will be used for the on-site road infrastructure, where necessary. A slab foundation would involve installation of shuttering and steel reinforcement, followed by the pouring of concrete.

If slab plus rock anchor foundations are required, the construction of the foundation for each machine would involve the excavation of approximately 570 m^3 of ground material to a depth of approximately 2.5 m (based on a 17.5 m diameter circular foundation). Slab plus rock anchor foundations require shuttering and steel reinforcement, drilling of rock anchor piles up to a depth of approximately 20 m, concrete pour, after which the rock anchors are stressed and secured once the concrete has cured sufficiently.

Detailed geotechnical surveys will be carried out during pre-construction work to determine the necessary foundation type per wind turbine. It is feasible that more than one type of foundation may be required for the Project, following the assessment of the individual wind turbine locations. New wind turbines are continually coming on to the market and it is possible that minor variations to these typical dimensions could occur prior to final wind turbine selection.

For this assessment, the use of slab (gravity) foundations has been assumed as a worst case. A typical foundation size of 25 m x 25 m is being considered as worst case for the layout, which reflects the largest known foundation impact based on currently available wind turbines. It is possible that larger foundations up to 30 m x 30 m could be used for the layout, but the resultant overall impact would be much less due to the fewer number of wind turbines and, therefore, foundations and hardstands required for the layout.

2.2.6 Crane Hardstand and Assembly Areas

Site access roads would have areas of hardstand (approximately 25 m by 60 m) adjacent to each wind turbine for use during component assembly and by cranes during installation. The clearing of native vegetation for the construction of access roads and hardstand areas will be avoided where possible.

The roads would be surfaced with local stone material to required load-bearing specifications. The nature and colour of surface stone would be selected to minimise visual impact prior to construction. The roads and hardstand areas would be maintained throughout the operational life of the Project and used principally for the periodic maintenance of the wind turbines.

2.2.7 Monitoring Masts

There is currently one temporary 60 m wind monitoring mast installed 5.8 km to the south east of the Project site, recording wind data for Project development and planning. It is expected that additional temporary masts will be installed in stages within the three clusters prior to the start of construction of the wind farm.

Up to six permanent wind monitoring masts, up to 120 m high, are proposed to be installed on-site. Locations for these masts are yet to be determined and will be influenced by the final wind turbine selection, but may include the locations of the existing temporary monitoring masts. These permanent masts will provide information for the performance monitoring of the wind turbines. The wind monitoring masts would be of a guyed, narrow lattice or tubular steel design.

Permanent met masts will require low voltage cable connection for power and also a communications cable to be laid. The trench required for this will be much smaller than for the cables between turbines. The connection would come directly from the closest turbine.

2.2.8 Operation Facilities Building

A facilities building will be constructed at the same location as the main collector substation. The general location has been chosen to minimise the length of overhead and underground transmission lines and to minimise the visibility of the facilities building and main collector substation. The building will house instrumentation, electrical and communications equipment, routine maintenance stores, a small work area and staff amenities. The facilities buildings will comply with all relevant building requirements.

2.3 Electrical Infrastructure

2.3.1 Main Collector Substation

The main collector substation will consist of a single 180 MVA transformer to step-up the voltage to 132 kV, together with ancillary equipment.

The main collector substation will occupy an area approximately 150 m by 150 m and will be surrounded by a 3 m high security fence. It will include an array of busbars, circuit breakers, isolators, various voltage and current transformers and a static compensator-capacitor as agreed with TransGrid.

Transportation of the transformers, which are typically 90 tonnes each, would be by road and would involve the direct loading onto a platform trailer.

2.3.2 Switching Station

Connecting to the high voltage grid will probably require a switching substation be constructed close to the point of connection with the existing transmission line. The switching station will occupy an area approximately 220 m by 160 m and will be surrounded by a 3 m high security fence. The ground surface within the enclosure will be covered partly with a layer of crushed rock and partly by concrete slabs. The approximate 3.5 ha area includes provision for a 20 m buffer of land surrounding the equipment required by TransGrid.

The switching station will most likely require a communications tower, which is expected to be up to 20 m in height depending on geographic conditions.

Construction access would be via Tangmangaroo Road off Lachlan Valley Way. Within the proposed switching station compound, an all weather access driveway incorporating provision for car parking would be constructed.

2.3.3 Overhead and Underground Cabling

The electrical cables from the wind turbine sites will comprise a mix of underground and overhead cabling and will connect directly to the main collector substation. The following summarises the required cabling:

- Approximately 61 km of up to 33 kV entrenched underground transmission lines and control cables;
- Approximately 9 km of up to 132 kV double circuit overhead transmission lines, some sections running in 2 or 3 parallel line configurations; and
- Establishment of a typical operation facilities building to house control and communications equipment.

The underground cable routes will generally be between the turbines and follow the route of the internal access roads. The final route will minimise vegetation clearing and avoid potential erosion and heritage sites, and will also depend on the ease of excavation, ground stability and cost. In some locations overhead line will be used to link clusters of turbines together and bring power back to the main collector substation.

Control cables will interconnect the wind turbine generators and the operation facilities building. Computerised controls within each wind turbine will automatically control start-up, speed of rotation and cut-out at high wind speeds and during faults. Recording systems will monitor wind conditions and energy output at each of the turbines. Remote monitoring and control of the Project will also be employed. Control cables will consist of optic fibre, twisted pair or multi-core cable and will be located underground within the groups of turbines.

The installation of buried earthing conductors and electrodes will also be required in the vicinity of the turbines, the facilities building and the sub-stations as required.

A single or double circuit 132 kV external transmission line will be constructed between the switching station and the transmission line for energy export into the grid. The 132 kV overhead transmission line will be up to 30 m in height comprising of two cross arms with insulators with an average span length of 250 m.

3. Existing Conditions

3.1 Transport Mode

The assessment of transportation of wind turbine components to site involves the separate consideration of the transport mode between:

- Australian ports for imports and other local manufacturing plants located in Australia to the Bango wind farm site;
- Transportation through the towns / villages along the transport routes; and
- Site access off the public road network to the internal road network of the Bango wind farm site.

The port of entry for imported wind turbine equipment and/or the location of manufacturing sites has not yet been resolved / confirmed. Therefore, this assessment evaluates all potential transport routes from all directions around NSW and beyond, if applicable.

Both rail and road transport modes have been considered for transporting the imported and locally manufactured wind turbine and sub-station transformer components.

Rail Transport

Rail as a transport option is potentially possible via the Main South Line and a decommissioned rail spur line to a railhead at Boorowa. This could be accessed from Port Kembla and other parts manufacturing sites in Australia. However, while specially designed flat bed cars and support systems are available to transport long loads of up to 40 m and the rail system can cope with heavy loads, the width of the blade container package or blade height and the size of the larger tower sections would not be able to be transported due to a lack of vertical and horizontal clearance within the electrified sections and at some en-route structures such as bridges.

Problems of scheduling rail services and restriction on track capacity may also affect delivery and would require negotiation and confirmation with rail operators.

The decommissioned rail spur line that connects Boorowa to the rail network would require extensive rehabilitation to all elements such as track, road / farm crossings, bridges and drainage structures before being suitable for service. The extent of work to re-commission this line for a wind farm project of this size is not considered to be economically feasible.

The problem also exists of handling and transporting wind turbine components from the rail hub to site, requiring road transport in any case. The extent of transportation handling, together with the other prohibitive issues described above, is such that it is not considered feasible to use rail transport.

Therefore, road transport is the only feasible option for transporting the larger wind turbine components and the heavy mass transformers. The use of rail is not considered to be feasible and as an option, rail transport has not been pursued any further.

Road Transport

All road routes to the Boorowa / Yass Valley areas are primarily by either National Routes or State Highways and, subject to statutory permit conditions, can accommodate the proposed wind turbine components generating over-mass and over-size vehicles.

A NSW Roads & Maritime Services (RMS) permit is required to be obtained for road access for over-mass and over-size vehicles along the major road network (National Routes or State Highways) from areas of component manufacture or import to the Boorowa / Yass Valley areas. The nominated transport contractor would be responsible for obtaining all necessary transport permits, arranging escort services and any other third party services as required by applicable regulations.

Transport of wind farm components manufactured elsewhere in Australia, would be by road via the national highway network, with the obvious permissible routes being via the Hume Highway from the south, east and north and potentially the Newell Highway and Lachlan Valley Way from the west and far north – refer to *Figure 3.1* below.

The road network has the flexibility to provide a single transportation mode from origin to the wind farm site without the need for additional loading and handling operations.

Air Transport

Due to the over-size nature of wind farm components and the potential difficulties associated with land transport, the option of air transport by helicopter has been considered. This type of transport has been used previously for wind farm projects in difficult-to-access locations.

Air transport is considered to be the most direct and efficient transport mode, often with a significant reduction in impacts to the community. However, air transport is costly and wind farm components need to be specifically designed for aerial transport, loading and unloading, which increases manufacturing costs.

In this case, while air transport has been considered as a transport option, it is unlikely to be practicable with respect to the economic feasibility of this Project.

3.2 Road Transport Routes

3.2.1 Wind Farm Site Access Locations

There are proposed to be four site access points off the public road network serving all the wind turbine locations and some other ancillary facilities as well as one other site access point serving substation construction and components only – refer to *Figure 3.2* below and *Appendix A: Proposed Wind Farm Layout*. An internal site road network would allow access within the wind farm site linking the public road network with the wind turbine locations.

The site accesses are proposed to be located as follows:

- Lachlan Valley Way access, approximately 30.7 km north of Hume Highway or approximately 12.4 km south of Boorowa town (50 km/h urban speed zone). Road network access would be directly off Lachlan Valley Way. This site access is proposed to serve the Kangiara cluster of up to 34 wind turbines.
- Wargeila Road access, approximately 26.4 km north of Yass Valley Way or approximately 7.4 km south of Rye Park-Dalton Road. Road network access would be via Yass Valley Way and then north along Wargeila Road. This site access is proposed to serve the majority of the Mt Buffalo cluster of up to 53 wind turbines.
- Hopefield Lane access, approximately 5.4 km east of Boorowa town (Long Street). Road network access would be via Lachlan Valley Way, around Boorowa town, east

along Boorowa Road and then south along Hopefield Lane. This site access is proposed to serve the Langs Creek cluster of up to 30 wind turbines.

- Rye Park-Dalton Road access, approximately 850 m south of Rye Park village (50 km/h urban speed zone). Road network access would be via Yass Valley Way, north along Wargeila Road and then north along Rye Park-Dalton Road. This site access is proposed to serve a small portion of the Mt Buffalo cluster of up to 5 wind turbines.
- Tangmangaroo Road access (substation / switching station construction and components only), approximately 8.8 km north-east of Lachlan Valley Way. Road network access would be via Lachlan Valley Way and then north-east along Tangmangaroo Road.

3.2.2 Major Road Network Route Options

Road transport routes are required to access the above proposed main site access locations. There are a number of potential transport routes that were identified and assessed. The assessment took into account not only the site access locations but also potential road transport options from all travel directions. Effectively, transport from the various directions would travel along the following major State Road or highway routes before travelling along the necessary local road network:

- East, north-east, south and west – via Hume Highway, Lachlan Valley Way and Yass Valley Way (these routes would include over-size vehicle transport)
- North – via Cowra and Lachlan Valley Way (standard vehicle transport only)

The above major road network provides a relatively high standard of road infrastructure, generally suitable for transport by heavy and over-size vehicles. These routes, as a minimum, have relatively wide carriageways and road formations, pavement linemarking, and controlled access to side roads. In general, they have 100 km/h speed limits.

With respect to the local road network, the road conditions along Wargeila Road, Tangmangaroo Road, Rye Park Road, Rye Park-Dalton Road and Hopefield Lane are considered to be conducive to the transportation of wind turbine components and construction materials with some relatively minor road upgrades.

In order to minimise road upgrade works, transport routes are likely to focus on the shortest routes to the proposed site access points from the major road network. Therefore, the major and local road networks would provide transport routes to the wind farm project site access locations as shown following in *Figure 3.1* and *Figure 3.2*.

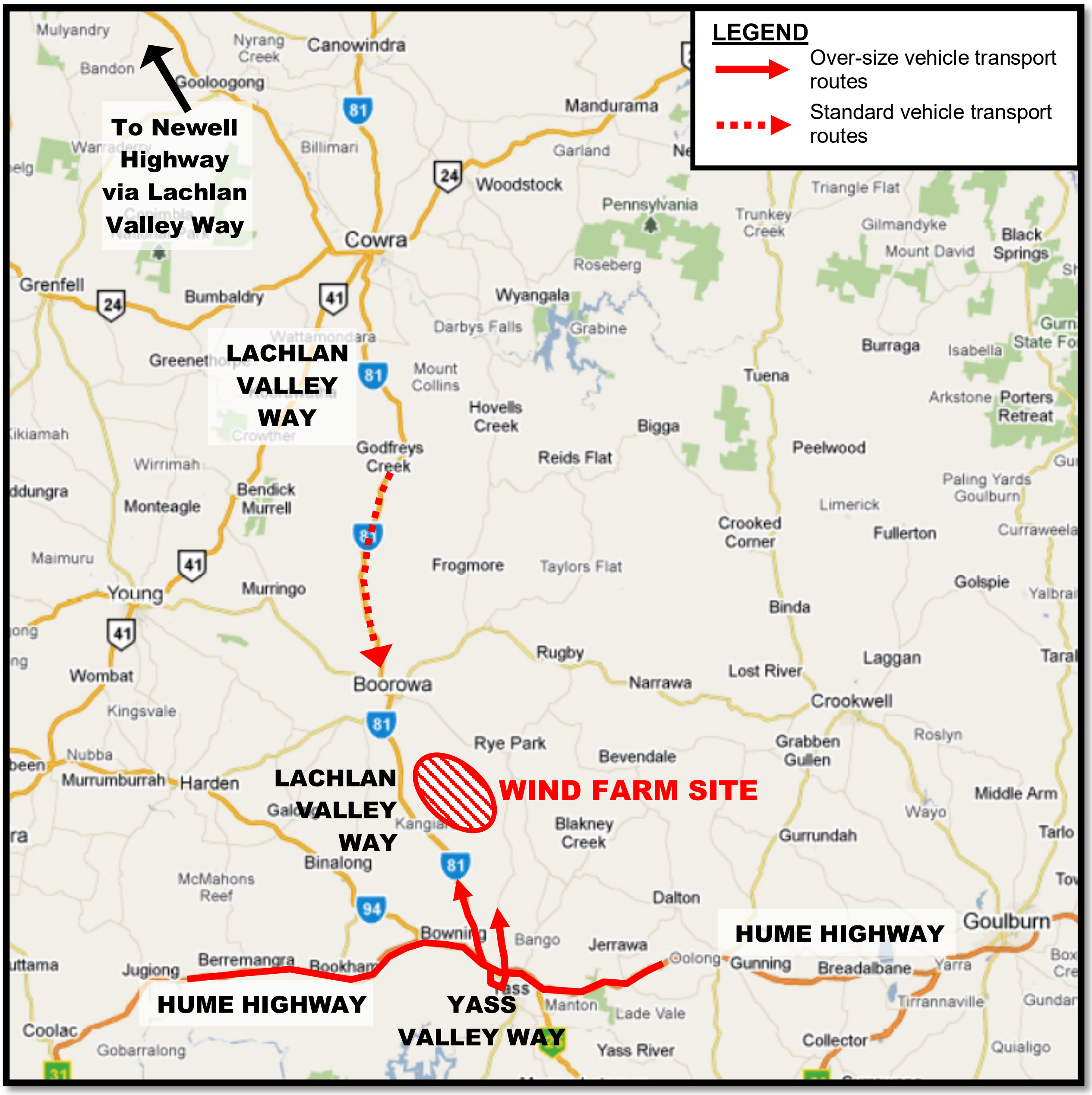


Figure 3.1: Regional Major Road Network & Transport Routes

Site access locations and transportation routes along the local area road network for light vehicles, heavy vehicles and over-size transportation vehicles are shown in *Figure 3.2* following.

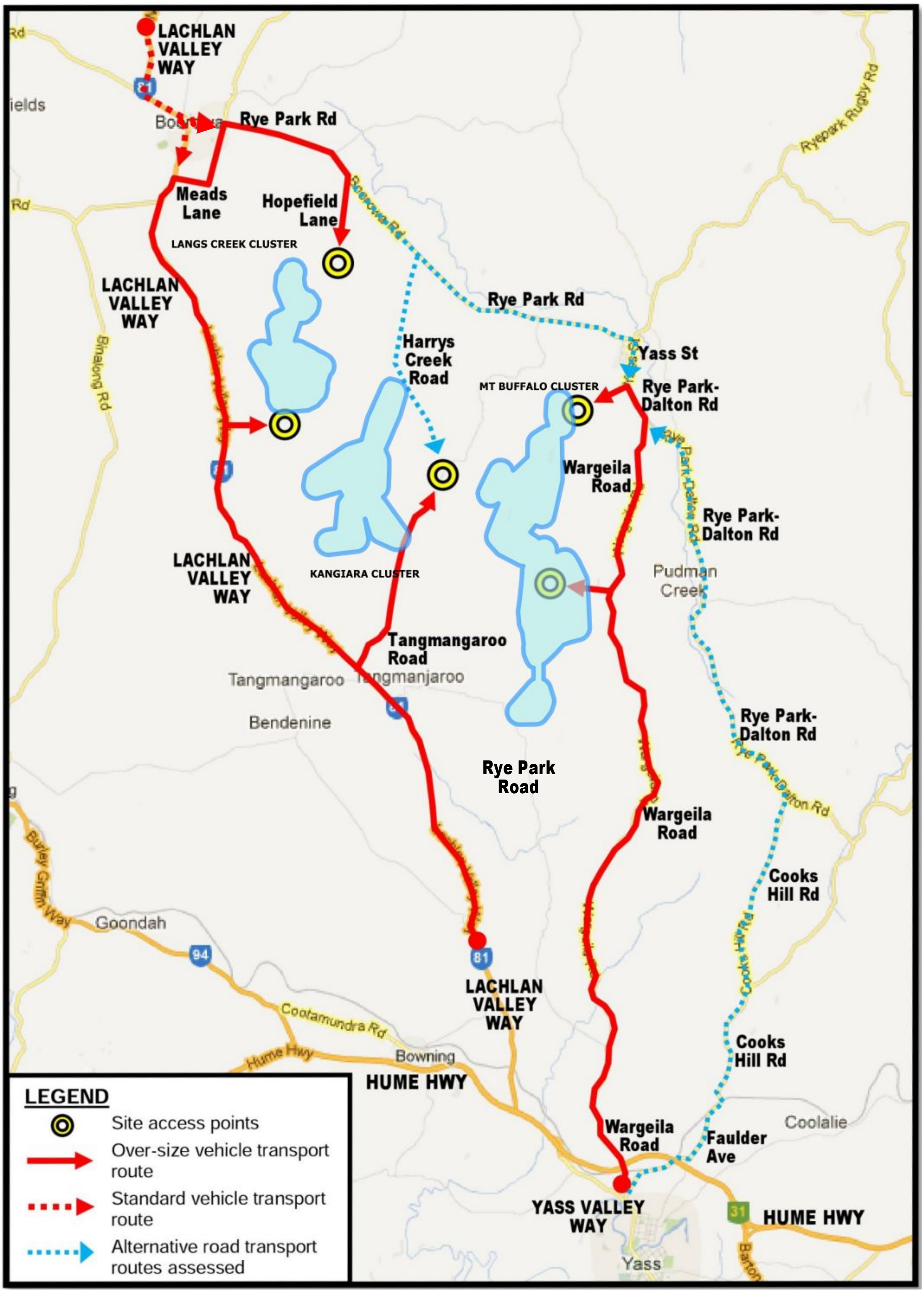


Figure 3.2: Transportation Routes to Wind Farm Site Access Points

3.2.3 Transport Along Lachlan Valley Way

The major road network transport route from Hume Highway to the Tangmangaroo Road, Lachlan Valley Way and Hopefield Lane access points is initially via Lachlan Valley Way. Lachlan Valley Way is a State Road (MR 81) running from Hume Highway in the south to Newell Highway near Forbes in the north. Boorowa is approximately 44 km north of the Hume Highway.

Lachlan Valley Way intersects the Hume Highway at a channelised 'seagull' intersection. Lachlan Valley Way generally has a 9 m wide pavement formation incorporating two travel lanes and shoulder areas with centreline and edgeline pavement markings. There are miscellaneous sections of the route that are missing pavement marking due to pavement patching and ongoing road maintenance works.

The pavement conditions are generally above average although there are some sections that show significant wear. The poorer sections have various pavement failures with patching works. Some of these sections are being targeted with upgrade works.

The general road environment can be described as rolling terrain with some sharper curves and crests requiring 75 km/h and 85 km/h advisory speeds on curves within the background 100 km/h speed zone. However, the alignment is not prohibitive to over-size and heavy transport.

Traffic volumes along Lachlan Valley Way (approximately 15 km north of Hume Highway at the Boorowa River bridge crossing) were 1,766 vehicles per day (vpd) in 2006[1]. These volumes almost double in Boorowa town (Marsden Street south of Pudman Street) to some 3,400 vpd in 2006[2]. From spot counts undertaken during site visits and site observations along Lachlan Valley Way, it is estimated that daily traffic volumes are currently of the same order as those recorded in 2006.

The following road characteristics are noted, which would need to be considered by the transport contractor:

- From the Hume Highway to the rail bridge overpass (approximately 1.7 km north of the highway intersection), the road has acceptable pavement conditions with no edgeline, soft shoulders and a narrower pavement formation (7 m to 8 m).
- The rail bridge overpass has overhead power lines and a relatively sharp crest to negotiate.
- Approximately 4.2 km north of the highway intersection, there is a section of average road conditions for approximately 500 m to the Walls Junction Road intersection.
- From approximately 10.0 km to 12.2 km north of the highway intersection, there is a section of lesser standard road with average pavement conditions, no edgeline, soft shoulders and a narrower pavement formation (7 to 8 m).
- The Boorowa River crossing at approximately 14.9 km north of the highway intersection is narrower than the approaches with no shoulder areas.
- Tangmangaroo Road junction at approximately 19.4 km north of the highway.
- Lachlan Valley Way site access, approximately 30.7 km north of the highway.

1 RMS counting station no.94.511
2 RMS counting station no.94.273

- The Langs Creek Bridge crossing at approximately 36.9 km north of the highway intersection is slightly narrower than the road approaches.

Refer to *Section 5.4* for typical examples of upgrade works and other risk mitigation measures along over-size transport routes.

3.2.4 Transport Along Tangmangaroo Road

Tangmangaroo Road is an unclassified local road connecting various properties in the area. It runs from Lachlan Valley Way in the south and continues for a distance of approximately 18 km to Rye Park Road in the north. At Lachlan Valley Way it forms the stem of an uncontrolled T-junction.

Tangmangaroo Road varies in condition and standard along its length. The southern section between Lachlan Valley Way north for a distance of approximately 2.5 km is relatively open with a 6 m to 7 m wide unsealed pavement formation and no linemarking. In this section, the pavement conditions generally appear to be relatively stable.

North of approximately 2.5 km from Lachlan Valley Way, the carriageway width narrows to average 4 m to 5 m with some localised widening and narrowings. The unsealed surface is of a lesser standard with more rutting and potholes evident. Also, this northern section has significant roadside vegetation / trees, which would require pruning / removal to allow over-size vehicle transport.

The general alignment is largely straight with larger radius curves on a relatively flat terrain with some gentle undulations. There are a number of minor sags due to causeways, which may require road amendments to accommodate over-size and heavy transport.

Traffic volumes along Tangmangaroo Road were recorded as 30 vpd in June 2002[3]. Site observations and spot counts during site visits confirmed that volumes in 2013 have not increased to any extent and are currently no more than 50 vpd.

The following road characteristics are noted along Tangmangaroo Road (north of Lachlan Valley Way to the proposed Tangmangaroo Road access points near the Harrys Creek Road junction), which would need to be considered by the transport contractor:

- Approximately 0.4 km north of Lachlan Valley Way, there is a sag / dip in the road caused by a culvert crossing, which may need to be checked for scraping (bottoming-out) and structural adequacy from heavier loads.
- Approximately 2.3 km north of Lachlan Valley Way, the road width narrows to approximately 4 m to 5 m as it enters a woodland area with significant sections of roadside vegetation.
- Approximately 2.4 km north of Lachlan Valley Way, there is a sag / dip in the road caused by a culvert crossing, which would need to be checked for scraping (bottoming-out) and structural adequacy from heavier loads. At this location and on approaches, there is also overhanging tree foliage, which may require some pruning to allow over-size vehicle transport.
- Approximately 4.3 km north of Lachlan Valley Way, there is a single traffic lane causeway approximately 4 m wide. This would need to be checked for structural adequacy from heavier loads and may require temporary widening and approach upgrades for wider loads.

3 Yass Valley Way counts June 2002

- Between approximately 5.2 km to 5.9 km north of Lachlan Valley Way, the road environment is slightly more open with less roadside trees and a carriageway width of between 4 m to 5 m.
- Approximately 6.1 km north of Lachlan Valley Way, there is a significant sag / dip in the road caused by a small culvert crossing, which would need to be checked for scraping (bottoming-out) and structural adequacy from heavier loads. Local widening and upgrade works are likely to be required. At this location and on approaches, there is also overhanging tree foliage, which may require some pruning to allow over-size vehicle transport.
- Approximately 6.3 km north of Lachlan Valley Way, there is a section of narrower carriageway (up to 4 m wide) with significant overhanging tree foliage, which would require pruning / removal to allow over-size vehicle transport.
- Drews Lane junction at approximately 6.6 km north of Lachlan Valley Way.
- Approximately 6.9 km north of Lachlan Valley Way, there is a sag / dip in the road caused by a culvert crossing, which would need to be checked for scraping (bottoming-out) and structural adequacy from heavier loads. At this location and on approaches, there is also overhanging tree foliage, which may require some pruning to allow over-size vehicle transport.
- Approximately 7.4 km north of Lachlan Valley Way, there is a localised narrowing of the carriageway down to approximately 3 m, which would require widening past a large tree by the roadside and around a relatively sharp left curve.
- Approximately 7.9 km north of Lachlan Valley Way, there is a relatively sharp left curve and localised narrowing of the carriageway to less than 4 m, which would require widening. At this location and on approaches, there is also overhanging tree foliage, which may require some pruning to allow over-size vehicle transport.
- Tangmangaroo Road site access point at approximately 8.8 km north of Lachlan Valley Way.

Refer to *Section 5.4* for typical examples of upgrade works and other risk mitigation measures along over-size transport routes.

3.2.5 Transport Around Boorowa Town

Transport to the Hopefield Lane access off Rye Park Road is proposed to be diverted around Boorowa town's urban area. This is particularly so for the town centre due to pedestrian refuges and the Pudman Street roundabout restricting larger vehicle access in addition to the higher parking manoeuvres in the town centre. Several options were assessed including the Trucking Yards Road route to Court Street, the Market Street route and the Meads Lane / Long Street route, all to the east of the main town centre.

The Trucking Yards Road route is considered to be unsuitable due to sharp horizontal curves and a vertical sag curve along parts of its alignment. The Market Street route is potentially suitable although it would need to travel past residences and through a school zone on Brial Street. The preferred route is to turn east off Lachlan Valley Way into Meads Lane and continue to Long Street (also known as Cemetery Road at the southern end) where the route turns north. The route then continues north along Long Street where it turns into Rugby Road (MR 248) at the eastern edge of Boorowa town, and continues north-east along Rugby Road. This route was selected based on consultation undertaken in 2011 with the Mayor and General Manager of Boorowa Council to avoid heavy vehicle traffic impacts on the town's main street.

The Meads Lane / Long Street route is only partly sealed but in relatively good condition along the unsealed sections. The unsealed section starts approximately 300 m east of Lachlan Valley Way. While the route has a relatively narrow carriageway (less than 4 m wide), this is offset by the surrounding land use of paddocks and farms, which would have less impact from heavy vehicle movements in comparison to travelling through the residential areas of Boorowa.

The following road characteristics are noted along the Meads Lane / Long Street route, which would need to be considered by the transport contractor:

- Approximately 1 km east of Lachlan Valley Way, there is a sag and culvert across a small creek, which may require strengthening for larger transport.
- On the approach to Long Street (Cemetery Road), there are numerous large trees with overhanging foliage, which may require pruning to allow transport of larger vehicles. The route in this section also deteriorates somewhat with a poorer unsealed surface and a narrower formed carriageway. Some grading and formation works may be required.
- At the direction change from Meads Lane to Long Street (Cemetery Road), the curve is relatively sharp with a number of trees and fence posts on the inside of the curve. These obstacles may need to be removed to allow transport (swept path) of the longer blades in particular.
- Approximately 200 m north of Meads Lane, along Long Street (Cemetery Road), the road surface reverts to a sealed pavement.

The preferred transport route as well as other routes considered for over-size transportation vehicles around Boorowa town is shown in *Figure 3.3* below.

3.2.6 Transport Along Rye Park Road

Rye Park Road connects Boorowa in the west to the village of Rye Park in the east. Its length is approximately 19.3 km. Rye Park Road would provide access to Hopefield Lane, which has a wind farm site access point located off its southern end. Hopefield Lane runs to the south of Rye Park Road.

Rye Park Road varies in condition and standard along its length. The western section (up to approximately 2 km east of Harrys Creek Road) generally has a 6 m to 7 m wide pavement formation incorporating two travel lanes with a soft shoulder area. There are some narrower widths at bridge creek crossings. The road has centreline marking but no edgeline marking.

The eastern section has a generally wider pavement formation (7 m to 8 m) with both centreline and edgeline marking. The general road environment can be described as gentle rolling terrain with moderate to large radius horizontal curved alignments within the 100 km/h speed zone.

The pavement conditions are largely average to below average although there are some sections of better standard. There are sections of the route that have quite a rough pavement in patches due to pavement failures (eg. potholes, cracking) and associated pavement patching. These occur towards the western end of the road section. Patching is significant along soft shoulder areas where potholes and other pavement deficiencies are evident.

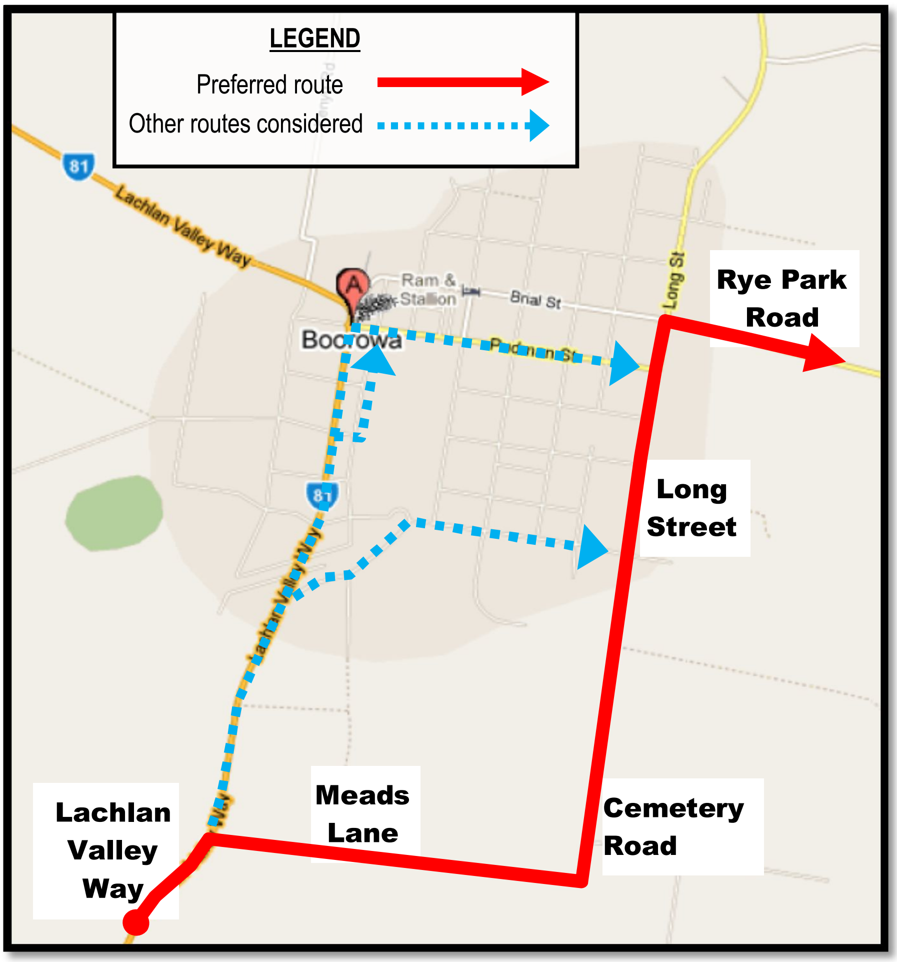


Figure 3.3: Over-Size Vehicle Transportation Route Around Boorowa Town

Traffic volumes are unavailable for Rye Park Road, but site observations / spot counts and the arrangement of the local road network would indicate that daily traffic volumes would be less than 500 vpd.

The following road characteristics are noted between Boorowa town and Hopefield Lane, which would need to be considered by the transport contractor (further characteristics are also noted east of Hopefield Lane to Rye Park village):

- Travelling east from Boorowa (from the intersection of Rugby Road and Long Street), particularly after approximately 1.2 km, there are some below average pavement conditions with soft shoulder areas, significant pavement patching and potholes. Sections may need strengthening for larger transport.
- Approximately 2.4 km east of Boorowa, there is overhanging tree foliage, which may require some minor pruning to allow over-size vehicle transport.
- Approximately 2.7 km east of Boorowa, there is overhanging tree foliage, which may require some minor pruning to allow over-size vehicle transport.
- Hopefield Lane at approximately 5.4 km east of Boorowa.

Refer to *Section 5.4* for typical examples of upgrade works and other risk mitigation measures along over-size transport routes.

3.2.7 Transport Along Hopefield Lane

Hopefield Lane is an unclassified local road providing access to a small number of properties to the south of Rye Park Road. It intersects with Rye Park Road at a 'Give Way' controlled T-junction. Sight distance along Rye Park Road is adequate with approximately 300 m to both the east and the west.

Hopefield Lane varies in condition and standard along its length. It generally has a 5 to 6 m wide unsealed pavement formation with localised narrowing down to approximately 4 m in sections. There is no linemarking provided.

The general road environment is across gentle rolling terrain with a number of sharper curves and crests. The condition of the unsealed road pavement surface is generally good although there are some locations with relatively poor surfacing (potholes and rutting), which may require some basic upgrading works, eg. surface grading.

Traffic volumes are unavailable for Hopefield Lane, but site observations during site visits, as well as the minimal number of local traffic generators, indicate that daily traffic volumes would be less than 100 vpd.

In general, the Hopefield Lane route alignment and road environment are considered to be conducive for the transport of wind farm components without significant road upgrade works. The following road characteristics are noted along Hopefield Lane (south of Rye Park Road to a line of nine silos and a property gate at approximately 5.4 km), which would need to be considered by the transport contractor:

- The intersection at Rye Park Road would likely need some widening work to allow adequate swept path for longer vehicles entering Hopefield Lane from Rye Park Road (eastbound).
- Approximately 1.2 km to 1.3 km south of Rye Park Road, there is overhanging tree foliage, which may require some pruning to allow over-size vehicle transport.
- Approximately 1.9 km south of Rye Park Road, some local power lines cross the road corridor. These would require checking for height clearance and possible raising to allow over-size vehicle transport.
- Approximately 2.6 km south of Rye Park Road, there is a sharp crest alignment with a central guide post to guide opposing traffic to the left side of the carriageway. The crest alignment would need to be checked for vehicle scraping.
- Approximately 3.5 km south of Rye Park Road, the 'Hopefield' property access creates a significant carriageway narrowing. Any widening would need to be undertaken to the left (east) of a large tree at the property access.
- Approximately 4.2 km south of Rye Park Road, there is a property access with cattle grid, which creates a carriageway narrowing.
- South of approximately 3.0 km (near the 'Glenmore' property), the road width narrows to approximately 4 m. The unsealed pavement is of a lesser standard from this point south and may require some upgrading.
- There are numerous small culverts (up to 10 locations) running under the road along the route, which would need to be checked for structural adequacy from heavier loads.

Refer to Section 5.4 for typical examples of upgrade works and other risk mitigation measures along over-size transport routes.

3.2.8 Transport Along Yass Valley Way

The major road network transport route from Hume Highway to the Wargeila Road and Rye Park-Dalton Road access points is initially via Yass Valley Way. Yass Valley Way is classified as a minor arterial route and is the main road which links Yass, Hume Highway and Barton Highway. The road is about 18 km long connecting to Hume Highway at both ends with an interchange at Barton Highway. Yass town is approximately 5 km east of the western Hume Highway interchange.

At its western end, Yass Valley Way connects with the Hume Highway at a grade-separated interchange, which also serves a highway service centre. For the relatively short length between the highway and Yass town, Yass Valley Way generally has a 9 m wide pavement formation incorporating two travel lanes and shoulder areas with centreline and edgeline pavement markings.

The pavement conditions are generally above average although there are some sections that are showing signs of wear. The general road environment can be described as gently rolling terrain within a 100 km/h speed zone reducing to 70 km/h on the approach to the Yass urban area.

Traffic volumes along Yass Valley Way range from approximately 2,960 vehicles per day (vpd) on approach to Yass town (east of Black Range Road)[4] to almost 8,000 vpd at the Yass River bridge crossing in the town centre area[5]. From spot counts undertaken during site visits and site observations along Yass Valley Way, it is estimated that daily traffic volumes on the town outskirts are currently of the same order as those recorded in 2006.

Along Yass Valley Way, between the Hume Highway interchange and the western end of Yass town, the following road characteristics are noted, which would need to be considered by the transport contractor:

- For Hume Highway southbound traffic entering the interchange, the exit ramp has street light poles on the inside of the left curved alignment, which would need to be checked for adequacy of transport by longer loads.
- At the service centre roundabout, the centre island has some minor signage that may need to be adjusted / relocated to allow transport by longer loads.

3.2.9 Transport Along Wargeila Road

Wargeila Road is an unclassified local road running north off Yass Valley Way (west of Yass town) to Rye Park-Dalton Road, south of Rye Park village. At Yass Valley Way, it forms the stem of a priority controlled (‘Give Way’) T-junction approximately 3 km west of Yass town centre and 3 km east of the Yass Hume Highway interchange.

In general, Wargeila Road varies in condition and standard between its southern section (Yass Valley Way to Laverstock Road: approximately 6.4 km in length) and its northern section. The southern section is sealed with a 6 m to 7 m wide pavement formation while the northern section is partially sealed / unsealed with a narrower and varying road width. The pavement conditions generally appear to be relatively stable in both sealed and unsealed sections.

The general alignment is relatively gentle horizontal curves with some smaller radius curves

4 Yass Valley Council counts (April 2009)
5 RMS counting station no.94.361 (2006)

on a gently undulating terrain. There are a number of minor sags due to causeways, which may require road amendments to accommodate over-size and heavy transport.

Traffic volumes along Wargeila Road range from approximately 350 vpd at the southern Yass Valley Way end to approximately 50 vpd at the end of the sealed section of road[6]. Site observations and spot counts during site visits confirmed these volumes to be of a similar order in 2013.

The following road characteristics are noted along Wargeila Road (north from Yass Valley Way), which would need to be considered by the transport contractor:

- Approximately 1.0 km north of Yass Valley Way, the bridge over the railway crossing results in a narrowing of the road formation to approximately 5 m wide. Structural adequacy of the bridge would need to be confirmed for heavier loads.
- Approximately 1.2 km north of Yass Valley Way, the newer bridge over Hume Highway appears adequate with its width matching the approach road widths.
- Approximately 1.7 km north of Yass Valley Way, there is overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 2.1 km north of Yass Valley Way, there is overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 2.2 km north of Yass Valley Way, overhead powerlines cross the road and height adequacy would need to be checked to allow over-size vehicle transport.
- Approximately 2.6 km north of Yass Valley Way, there is overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Between approximately 3.1 km to 3.7 km north of Yass Valley Way, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Between approximately 4.1 km to 4.4 km north of Yass Valley Way, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Zouch Road at approximately 4.9 km north of Yass Valley Way.
- Between approximately 5.6 km to 5.9 km north of Yass Valley Way, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Between approximately 6.1 km to 6.3 km north of Yass Valley Way, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Laverstock Road junction at approximately 6.4 km north of Yass Valley Way. Wargeila Road continues with a right-turn.
- From the Laverstock Road junction north to approximately 1.0 km, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 1.3 km north of the Laverstock Road junction, there is a new culvert with a narrow road width of approximately 5 m. Strength adequacy would need to be confirmed for heavier and over-size vehicle transport.

6 Yass Valley Way counts March 2006 & January 2009

- Between approximately 1.3 km to 1.5 km north of the Laverstock Road junction, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 1.7 km north of the Laverstock Road junction, overhead powerlines cross the road and height adequacy would need to be checked to allow over-size vehicle transport.
- Approximately 2.0 km north of the Laverstock Road junction, there is overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 2.3 km north of the Laverstock Road junction, there is a narrow (approximately 4 m wide) single-lane bridge that would require upgrade. Appears structurally deficient with poor pavement condition.
- Between approximately 2.7 km to 4.9 km north of the Laverstock Road junction, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 3.2 km north of the Laverstock Road junction, overhead powerlines cross the road and height adequacy would need to be checked to allow over-size vehicle transport.
- Approximately 4.1 km north of the Laverstock Road junction, overhead powerlines cross the road and height adequacy would need to be checked to allow over-size vehicle transport.
- Approximately 5.1 km north of the Laverstock Road junction, a larger culvert structure would need to be checked for strength adequacy to allow over-size vehicle transport.
- Between approximately 5.3 km to 5.7 km north of the Laverstock Road junction, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Davis Lane at approximately 7.3 km north of the Laverstock Road junction.
- Between approximately 7.9 km to 13.1 km north of the Laverstock Road junction, there is denser intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 8.3 km north of the Laverstock Road junction, sealed pavement ends but road width is maintained at approximately 6 m.
- From approximately 8.5 km to 10.5 km north of the Laverstock Road junction, the road width narrows to approximately 5 m wide and the unsealed road surface deteriorates with increased potholes and rutting.
- Approximately 10.1 km north of the Laverstock Road junction, a larger culvert structure would need to be checked for strength adequacy to allow over-size vehicle transport.
- Approximately 12.2 km north of the Laverstock Road junction, the road width narrows to between 3 m to 4 m, before widening back to between 4 m to 5 m at approximately 12.3 km.
- Between approximately 13.2 km to 13.6 km north of the Laverstock Road junction, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 13.5 km north of the Laverstock Road junction, a relatively tight right curve would need widening upgrade works.

- Approximately 13.6 km north of the Laverstock Road junction, road widening upgrade works would be required past a large tree on the western side of the road.
- Approximately 13.8 km north of the Laverstock Road junction, there is overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 14.1 km north of the Laverstock Road junction, there is overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 14.4 km north of the Laverstock Road junction, overhead powerlines cross the road and height adequacy would need to be checked to allow over-size vehicle transport.
- Approximately 15.0 km north of the Laverstock Road junction, the road conditions improve with a wider formation and better unsealed surface.
- Approximately 15.5 km north of the Laverstock Road junction, sealed road surface starts and the road width increases to approximately 6 m to 7 m. Yass Valley Council / Boorowa Council boundary.
- Approximately 17.7 km north of the Laverstock Road junction, the road conditions improve with a wider road formation (up to 7 m).
- The proposed Wargeila Road site access to the Eastern cluster of wind turbines at approximately 19.9 km north of the Laverstock Road junction.
- Approximately 20.7 km north of the Laverstock Road junction, there is overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 21.1 km north of the Laverstock Road junction, a causeway structure and sag would need to be checked for strength adequacy to allow over-size vehicle transport.
- Approximately 21.2 km north of the Laverstock Road junction, sealed pavement ends but road width is maintained at approximately 6 m to 7 m.
- Approximately 21.4 km north of the Laverstock Road junction, there is overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 21.6 km north of the Laverstock Road junction, there is overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 21.7 km north of the Laverstock Road junction, overhead powerlines cross the road and height adequacy would need to be checked to allow over-size vehicle transport.
- Approximately 21.8 km north of the Laverstock Road junction, the road conditions deteriorate with a narrower road formation (approximately 5 m) and poor pavement conditions including rutting and potholes.
- Between approximately 21.8 km to 23.0 km north of the Laverstock Road junction, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Between approximately 23.2 km to 23.5 km north of the Laverstock Road junction, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Between approximately 23.5 km to 26.5 km north of the Laverstock Road junction, there is denser intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.

- Approximately 24.4 km north of the Laverstock Road junction, a relatively tight left curve with a large tree on the inside of the curve may need widening upgrade works.
- Approximately 26.2 km north of the Laverstock Road junction, sealed road surface starts and the road conditions improve markedly with a wider road formation.
- Rye Park-Dalton Road T-junction at approximately 27.3 km north of the Laverstock Road junction. Wargeila Road has a 'Give Way' control.

Refer to *Section 5.4* for typical examples of upgrade works and other risk mitigation measures along over-size transport routes.

3.2.10 Transport Along Rye Park-Dalton Road

Rye Park-Dalton Road is a local collector road running from Rye Park village in the north to Dalton village to the south-east. At Wargeila Road, it forms the priority leg of a T-junction approximately 2.4 km south of the Rye Park urban area.

In general, Rye Park-Dalton Road is of a consistently above average condition and standard along its length. It has an approximate 7 m wide road formation with centreline and edgeline markings. The shoulder area width varies. The pavement conditions are generally above average apart from occasional rutting / potholes.

The general alignment for the subject section is relatively gentle (larger radius) horizontal curves on a relatively flat terrain with some gentle undulations.

Traffic volumes are unavailable for Rye Park-Dalton Road, but site observations / spot counts and the arrangement of the local road network would indicate that daily traffic volumes would be less than 500 vpd.

The following road characteristics are noted along Rye Park-Dalton Road (north of Wargeila Road to Hillview Lane where the access point for the small North-East cluster of wind turbines is proposed), which would need to be considered by the transport contractor:

- Between the Wargeila Road junction north to approximately 0.5 km, there is intermittent overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 0.7 km north of the Wargeila Road junction, there is overhanging tree foliage, which may need to be pruned to allow over-size vehicle transport.
- Approximately 0.8 km north of the Wargeila Road junction, there is a short section of poorer road pavement conditions.
- Hillview Lane and the proposed wind farm site access point at approximately 1.5 km north of the Wargeila Road junction.

Refer to Section 5.4 for typical examples of upgrade works and other risk mitigation measures along over-size transport routes.

3.2.11 Alternative Transport Routes Assessed

Rye Park Village Route

Transport via the Rye Park village area was considered initially and assessed. The route along Rye Park Road (east from Hopefield Lane) is considered to be generally conducive to over-size vehicle transport. However, a transport route via Rye Park village has been disregarded from further assessment due to the following characteristics and issues:

- There is no viable bypass route of Rye Park village available. The back streets (eg. Cook Street, Bank Street) are all narrow, tree-lined streets with tight turning paths that longer vehicles would not be able to negotiate without significant upgrade works and impact to the local community. Moreover, relocation of powerlines and widening of junctions would be required along any bypass route.
- Transport via Yass Street (main street of Rye Park) to link Rye Park / Boorowa road (in the west) with Rye Park-Dalton Road (in the south) is problematic due to numerous (approximately 15) overhead powerlines crossing the route as well as the public land use along the main street, eg. public hall, post office, school, church, etc. Some overhanging tree foliage adds to the above issues.

A transport route via Rye Park village along Yass Street may be a possible contingent, alternative transport route. Refer to *Figure 3.2* previously.

Faulder Avenue / Cooks Hill Road / Rye Park-Dalton Road Route

Transport via the Faulder Avenue / Cooks Hill Road / Rye Park-Dalton Road route generally follows the Wargeila Road route north from Yass Valley Way to Rye Park. An initial assessment indicated that this route is considered to be conducive to heavy vehicle and over-size vehicle transport. However, due to its additional length from Yass Valley Way to the Wargeila Road site access point (44.7 km versus 26.4 km via Wargeila Road) and less traffic volumes along Wargeila Road (resulting in less traffic impacts), it has been disregarded as a primary transport route.

A transport route via the Faulder Avenue / Cooks Hill Road / Rye Park-Dalton Road route may be a possible contingent, alternative transport route between Yass Valley Way and the site access points off Wargeila Road and Hillview Lane (off Rye Park-Dalton Road). Refer to *Figure 3.2* previously.

Harrys Creek Road

Transport to the Tangmangaroo Road site access (substation infrastructure only) was considered initially via the north along Harrys Creek Road off the southern side of Rye Park Road. The route along Rye Park Road (east from Hopefield Lane) is considered to be generally conducive to over-size vehicle transport.

However, due to its additional length from Lachlan Valley Way to the Tangmangaroo Road site access point (approximately 50 km versus 8.8 km via Tangmangaroo Road) and less impacts on Boorowa town, it has been disregarded as a viable transport route. Refer to *Figure 3.2* previously.

3.3 Site Access Issues

With respect to each major site access, the following pertinent issues have been identified.

Lachlan Valley Way site access

The site access directly off Lachlan Valley Way is located approximately 30.7 km north of Hume Highway or approximately 12.4 km south of Boorowa town (50 km/h urban speed zone). This site access is proposed to serve the Central cluster of up to 36 wind turbines.

The proposed location of the site access is off the eastern side of Lachlan Valley Way. Available sight distance is limited to approximately 230 m to the peak of the crest alignment to the south and approximately 160 m to the curved alignment to the north.

The approximate 160 m available sight distance to the north is marginal with respect to the minimum required stopping sight distance (SSD) for cars and is sub-standard for trucks, which require almost 200 m within a 100 km/h speed zone[7].

Consequently, suitable traffic management will be required to adequately warn southbound traffic along Lachlan Valley Way of turning vehicles, particularly heavy vehicles, and provide safe access into and out of the wind farm site at this location.

The site access location would require some widening works to facilitate the swept paths of longer vehicles required for wind turbine component transport.

Tangmangaroo Road site access

The site access off the western side of Tangmangaroo Road is located approximately 8.8 km north-east of Lachlan Valley Way. This site access is proposed to serve substation construction and components only.

Due to a combination of a narrow road width, roadside vegetation and road alignment, available sight distance is restricted to less than 100 m to / from the proposed site access point. While this restriction in sight distance is less than what would normally be required for a road with a 100 km/h speed limit, it is not considered to be critical for the following reasons:

- The road at this location is unsealed and traffic speeds are likely to be well below 100 km/h due to pavement conditions and the general road environment; and
- Traffic volumes are very low (< 100 vpd) and consist predominantly of local rural traffic familiar with the conditions and likely to be well informed of the proposed wind farm construction activities.

The site access location would require some widening works to facilitate the swept paths of longer vehicles required for wind turbine component transport.

Hopefield Lane site access

Hopefield Lane is located approximately 5.4 km east of Boorowa town (Long Street). This site access off the southern side of Rye Park Road is proposed to serve the North-Western cluster of up to 30 wind turbines.

The site access is essentially at the southern end of Hopefield Lane adjacent to a gated property access. There is significant sight distance available in all directions at this location.

At the Hopefield Lane junction with Rye Park Road, there is approximately 250 m sight distance available to the east and at least 300 m sight distance available to the west, both of which are adequate for the 100 km/h speed zone along Rye Park Road.

While the Hopefield Lane junction with Rye Park Road is relatively wide, it may require some widening works to facilitate the swept paths of longer vehicles required for wind turbine component transport.

Wargeila Road site access

The site access off the western side of Wargeila Road is located approximately 26.4 km north of Yass Valley Way or approximately 7.4 km south of Rye Park-Dalton Road. This site access is proposed to serve the Eastern cluster of up to 59 wind turbines.

7 *Tables 8.3(a)* and *8.3(b)* in Austroads "*Rural Road Design: A Guide to the Geometric Design of Rural Roads*", 2003

From the proposed site access point, available sight distance is restricted to approximately 220 m to the north and approximately 250 m to the south along Wargeila Road. The available sight distance is considered to be adequate for the road environment, being a local road with very low traffic volumes (less than 50 vpd).

The site access location may require some widening works to facilitate the swept paths of longer vehicles required for wind turbine component transport.

Rye Park-Dalton Road site access

The site access off the western side of Rye Park-Dalton Road (Hillview Lane) is located approximately 850 m south of Rye Park village (50 km/h urban speed zone). This site access is proposed to serve the small North-Eastern cluster of up to 5 wind turbines.

At the Hillview Lane junction with Rye Park-Dalton Road, available sight distance is restricted to approximately 180 m to the north, which is adequate with respect to the minimum required stopping sight distance (SSD) for cars but is sub-standard for trucks, which require almost 200 m within a 100 km/h speed zone[8]. Available sight distance to the south is at least 300 m, which is adequate.

Consequently, suitable traffic management will be required to adequately warn southbound traffic along Rye Park-Dalton Road of turning vehicles, particularly heavy vehicles, from Hillview Lane and provide safe access into and out of the site access at this location.

The Hillview Lane junction may require some widening works to facilitate the swept paths of longer vehicles required for wind turbine component transport.

3.4 Existing Traffic Flows

Existing traffic volumes were obtained from RMS data or from Councils (where available). RMS data is generally in the form of average annual daily traffic (AADT) and has been adjusted to represent vehicle volumes.

RMS data is predominantly based on traffic volumes from 2006 counts for two-way flows. However, site traffic count surveys (one-hour counts during peak travel periods and half-hour spot counts) and observations were undertaken along the most critical road sections to confirm that current 2013 traffic flows were of the same order as those recorded in previous years.

Existing traffic volumes in vehicles per day (vpd) and vehicles per (peak) hour (vph) for the surrounding road network are shown in *Table 3.1* below.

Table 3.1: Existing Traffic Volumes

Road Section	Vehicles Per Day (vpd)	Vehicles Per Hour (vph) *	Traffic Volume Source
Lachlan Valley Way – 15 km north of Hume Highway at the Boorowa River bridge crossing	1,766	200	RMS counting station 94.511 (2006)

8 *Tables 8.3(a)* and *8.3(b)* in Austroads "*Rural Road Design: A Guide to the Geometric Design of Rural Roads*", 2003

Road Section		Vehicles Per Day (vpd)	Vehicles Per Hour (vph) *	Traffic Volume Source
Lachlan Valley Way – Marsden Street south of Pudman Street, Boorowa		3,400	350	RMS counting station 94.273 (2006)
Lachlan Valley Way – at Cowra Shire boundary		994	100	RMS counting station 94.222 (2006)
Yass Valley Way – east of Black Range Road		2,961	300	Yass Valley Way Council counts (April 2009)
Rye Park Road		< 500	50	On-site observations and spot counts
Rye Park-Dalton Road		< 500	50	On-site observations and spot counts
Wargeila Road	southern end	353	40	Yass Valley Way Council counts, on-site observations and spot counts
	end of seal	49	10	
Tangmangaroo Road		< 50	10	Yass Valley Way Council counts, on - site observations and spot counts
Hopefield Lane		< 50	10	On-site observations and spot counts

* Peak hourly traffic flows have been estimated to be between 10% and 15% of daily traffic flows for the more heavily trafficked roads.

4. Impact Assessment

In general, construction of the wind farm would include the following activities:

- Transport of construction machinery and labour to the Project site.
- On-site civil works for internal access roads, crane pads, lay-down areas, wind turbine footings and cable trenching.
- Road upgrade works (as required) to the public road network to allow over-size and over-mass transportation.
- Transport of wind turbine infrastructure to the Project site.
- Installation of wind turbines on site using cranes.
- Construction of electrical substations.
- Construction of site control room and operations and maintenance facilities.
- Construction of electrical transmission lines.
- Restoration and revegetation of disturbed areas.

In general, construction would be limited to the following times:

- Monday to Friday, 7:00 am to 6:00 pm;
- Saturday, 8:00 am to 1:00 pm; and
- No construction on Sundays or public holidays.

4.1 Construction Vehicle Types

The type of construction vehicles proposed to access the Project site depends on the equipment and/or personnel being transported and their function on the site. Access to construction site offices and facilities buildings would generally be available for conventional two-wheel drive vehicles. Access to individual wind turbine locations may be restricted to four-wheel drive or multiple wheel drive vehicles depending on the internal road network conditions.

Due to the size and weight of the wind turbine components it is expected that many of the delivery vehicles would be 'over-size' (width and/or length), 'over-mass' or both. These vehicles would be regarded as restricted access vehicles (RAVs) and will require special RMS operating permits to allow them to travel on public roads.

'Over-mass' loads would be carried on trailers, or combinations of trailers, with sufficient axle groups to ensure compliance with point load and overall load limits for the road surface. As a point of reference, the heaviest load based on an assessment of current turbine specifications from a variety of turbine manufacturers is 125 tonnes (comprising the entire nacelle / gearbox configuration in one unit). Such loads are typically carried on trailers with 10-plus axles, with each axle having up to 8 tyres. Allowing for the weight of the trailers themselves, typical axle weights under such configurations are in the range of 12 to 13 tonnes, or less than 2 tonnes per tyre. This is less than a typical semi-trailer with 11 tonnes per axle but only 4 tyres per axle, resulting in 2.75 tonnes per tyre.

Over-size vehicles therefore incur less loading stress on the road surface, especially when run under escort with limited speed, than normal heavy vehicle traffic. Furthermore, both ‘over-size’ and ’over-mass’ vehicles feature trailers with steering on some or all rear axles. This technology ensures improved manoeuvrability, minimises stress on the equipment and the load, and reduces or eliminates tyre scrubbing and the associated stresses on the road surface when cornering.

The fleet of vehicles engaged to deliver oversize components would typically consist of:

- Extendable blade trailers of standard semi-trailer width (2.5 m) with the ability to extend to 45 m with up to 4 rear axles, some or all of which will be steerable;
- Heavy duty low loaders, with up to 10-plus rear axles and with each axle having 8 or more tyres to spread the load of the heavier WTG components. These low loaders may have the ability to carry loads up to 30 m in length, and may widen up to 5 m to reduce pressures on the road surface. Depending on the extendable length of these trailers, some of the rear axles may be self-steering;
- Dolly / jinker arrangements to carry loads longer than 30 m, where permitted to do so by permits and the WTG supplier. The rear axle groups on the jinker arrangements are steerable; and
- A variety of high power prime movers, typically rated 130 to 200 tonnes gross combination mass (GCM), as required depending on the total combination weight, ie. WTG load + trailer + prime mover.

Refer to *Figure 4.1* following for typical transport vehicles that are used for wind farm component delivery.

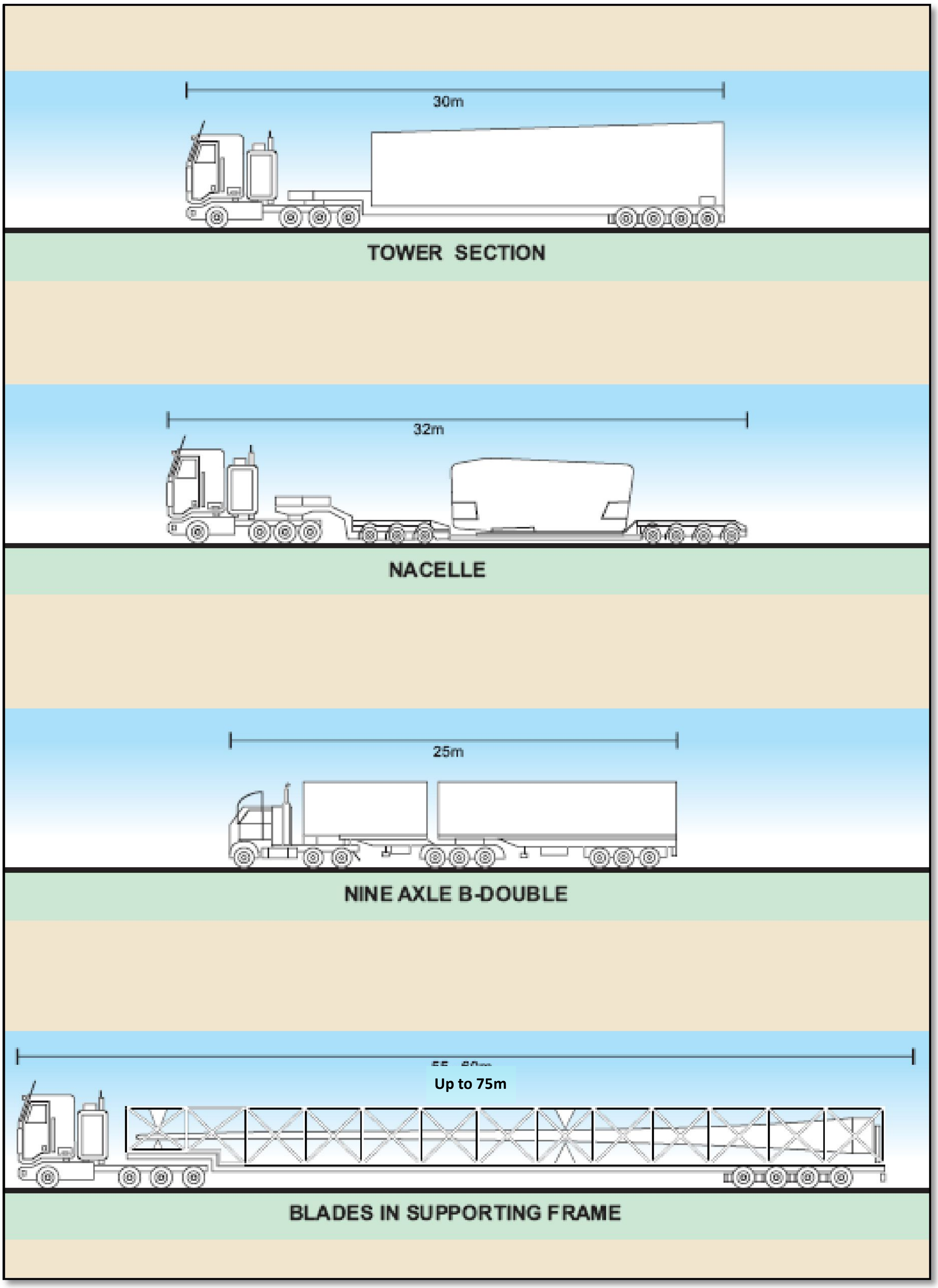
Over-size vehicles are those over 19 metres in length, 2.5 metres in width and/or 4.3 metres in height and their operating permits would require one or more escort vehicles to accompany them. Over-mass vehicles are those with a gross mass greater than 42.5 tonnes.

As mentioned previously, each wind turbine generator comprises a nacelle (approximately 75 tonnes), hub (approximately 25 tonnes), three blades (approximately 7 tonnes each and up to 72 m long) and three to five tower sections (approximately 50 tonnes each).

The components would typically be carried on specially designed trailers with axles that extend up to 4.2 metres in total width to carry the hubs and nacelles. The blades, which may be up to 72 m long, are carried on specialised trailers which have steerable rear axles allowing negotiation of relatively small radius curves provided that the inside of the curve is clear of obstacles.

The standard design vehicle for swept path adequacy in the provision of intersections and the design of parking and turning areas would generally be (as a minimum) the Austroads single unit truck / bus of 12.2 m length. However, provision would be made, where possible, to allow for a ‘B-double’ swept path, which requires a wider area allowing for manoeuvring by semi trailers and over-size vehicles.

The design of access roads and junctions would need to allow for widths of up to 4.5 metres and weights complying with NSW Roads and Maritime Services (RMS) maximum loading.



Source: *Aurecon 2011*

Figure 4.1: Typical Transport Vehicles

4.2 Construction Phase Traffic Generation

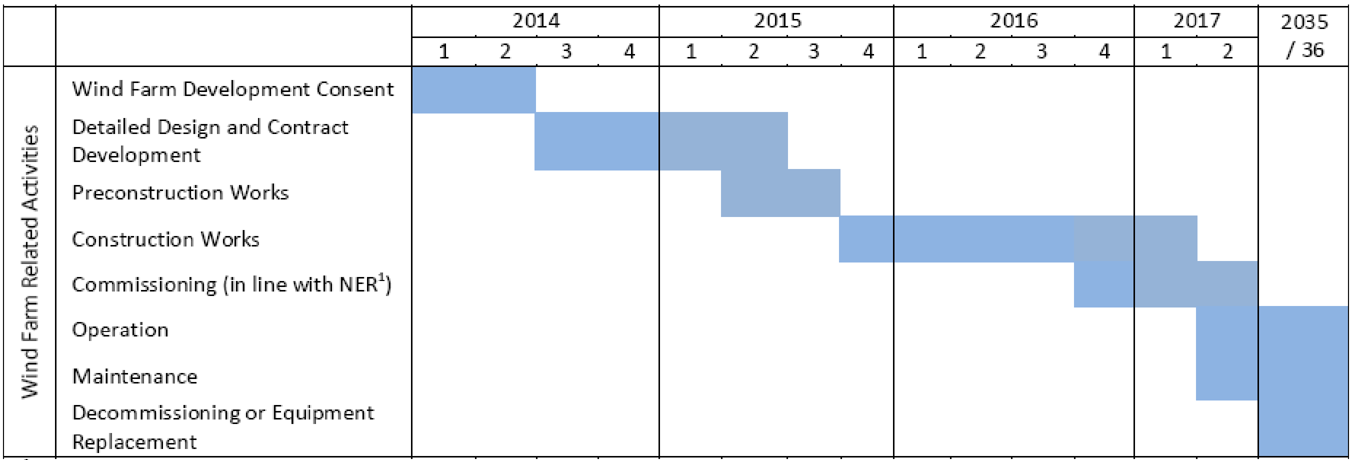
During the construction phase, which is expected to extend over eighteen (18) months, several tasks would generate traffic. These are categorised as follows:

- Wind farm component delivery
- Construction material delivery
- Construction staff transport

Traffic-generating tasks include:

- Initial site set-up and access construction during the pre-construction period;
- Construction staff movements between the site and the local centres;
- Wind farm component deliveries (including over-size transport);
- Concrete material deliveries and other general deliveries during construction works;
- Operational staff movements during operation and maintenance; and
- Decommissioning and reinstatement construction activities.

These tasks are proposed to occur over the following general Project timeline shown in *Figure 4.2* below. It is anticipated that due to the number of wind turbines proposed the Project could be constructed in stages over a period of 18 to 30 months. Within this timeframe it is anticipated that activities will occur within all Clusters of the Project.



[1] *National Electricity Rules*

Figure 4.2: Anticipated Project Timeline

4.2.1 *Transport of Wind Farm Components*

The transport of the various wind farm components would generate traffic as shown in *Table 4.1* below.

Table 4.1: Wind Farm Component Transportation

Wind farm Component	Characteristics	Traffic Generation
Nacelle	Weight is up to 125 tonnes, one per wind turbine: single load with installed drive trains.	Traffic generation for 1 wind turbine: 1 over-size (mass) vehicle Traffic generation for 122 wind turbines: 122 over-size vehicles
Blades	Three blades per wind turbine: up to 72 m long, single blade per vehicle.	Traffic generation for 1 wind turbine: 3 over-size (length) vehicles Traffic generation for 122 wind turbines: 366 over-size vehicles
Hub	Typical weight is approximately 40 tonnes, one per wind turbine in single load. Sometimes the hub 'capping', which is a lightweight fibreglass piece, is stacked into groups of 3 and sent in a single load to site.	Traffic generation for 1 wind turbine: 1 low-loader vehicle Traffic generation for 122 wind turbines: 122 low-loader vehicles
Tower	Typically three to five sections, each weighing between 20 and 65 tonnes depending on the section and measuring between approximately 20 m to 25 m long. An additional section for insert into the foundation weighs 10 tonnes and is typically 4 m in diameter and 5 m long. Typically 3 to 4 sections per tower, plus the foundation ring. Tower sections range from 15 m (lower sections) up to 30 m (top section).	Traffic generation for 1 wind turbine: 5 low-loader (over-mass) vehicles + 1 semi-trailer truck Traffic generation for 122 wind turbines: 610 low-loader (over-mass) vehicles + 122 semi-trailer trucks
Additional Materials	Typically for each wind turbine, additional miscellaneous equipment to be delivered to the site would require approximately one container (semi-trailer) truck.	Traffic generation for 1 wind turbine: 1 semi-trailer truck Traffic generation for 122 wind turbines: 122 semi-trailer trucks
Sub-station Transformers	The collector substation transformers would have a typical weight of up to 90 tonnes. Transportation of up to five transformers would be by road and would involve direct loading onto a platform trailer.	Traffic generation: 5 over-size (mass) vehicle + 10 semi-trailers of support equipment.
Switching Station	Semi-trailer for transportation of switching station components at the point of connection.	Traffic generation: 10 semi-trailers of components and associated equipment.

Wind farm Component	Characteristics	Traffic Generation
Overhead Transmission Lines	Semi-trailer for transportation of power poles, conductors, wires and other materials.	Traffic generation: dependant on final details of pole numbers, spacing and location but assume a minimum 20 semi-trailers of poles and associated transmission line equipment.
Site Cranes	Assume four cranes (2 main cranes and 2 tailing cranes) moving between wind turbine sites. These would travel to the preferred site access point at the start of construction and then leave at the end.	Traffic generation: 4 over-size (mass) vehicle + 12 semi-trailers of support equipment.

As a worst case, based on delivery of a total of three whole wind turbines per week and working on a six-day week, some five oversize loads per day would be generated. With the addition of a maximum of two semi-trailer loads of other equipment / components in the one day, it is assumed that the delivery of wind farm components would generate a maximum 14 trips per day, inclusive of 10 oversize vehicle trips per day.

With respect to traffic distribution of wind farm component transport, this would largely depend on the origin of component manufacture. A reasonable scenario is for WTG cargo to be imported to Port Kembla because there is no local manufacturing capability in Australia for these components. Therefore, the Hume Highway route from the north would be most likely used for transport of blades, nacelles and hubs.

All tower sections are likely to come along the Hume Highway route from the south if sourced from KPE (Portland) or RPG (Adelaide or Dandenong), KPE and RPG being the two recognised manufacturers of WTG towers Australia.

Switching station equipment and some overhead transmission line equipment would also arrive via Lachlan Valley Way and Tangmangaroo Road.

4.2.2 *Transport of Construction Materials*

The major construction materials to be transported include gravel/road base for construction of site access roads, constituent materials for the on-site concrete batch plant, steel reinforcement deliveries for foundation construction, steel strands and cabling for the transmission lines, and other miscellaneous materials deliveries for site offices and the like. Construction material delivery would typically generate the following traffic generation.

Concrete

Assuming the use of slab (gravity) foundations, each tower would require approximately 640 m^3 of reinforced concrete. Concrete would be delivered to the wind turbine bases via the internal site road network from on-site batching plants proposed to be located at or near the Lachlan Valley Way, Wargeila Road and Hopefield Lane site access locations. From there, they would travel along the internal site road network to access each wind turbine location (except for the five wind turbines that are accessed off Rye Park-Dalton Road and which are assumed would be served via the Wargeila Road site access).

At 6 m^3 per load, some 107 truck loads or 214 truck movements per foundation site would be required during a single day pour. All these movements would be within the site (ie. between batch plants and wind turbine locations) and not be required to travel along the external public road network.

As a contingency, in the unlikely event that on-site concrete batching plants are unable to provide the available concrete, pre-mixed concrete would need to be sourced from local businesses in nearby centres, eg. Goulburn, Canberra, Cowra, etc. This would result in the daily peak traffic generation of 107 truckloads of pre-mixed concrete along each of the relevant access routes at any one time during the construction period. It is reiterated that it is the Project intent to use on-site concrete batching plants and that the use of pre-mixed concrete sourced from off-site is unlikely. Therefore, the delivery of constituent materials to on-site concrete batching plants has been used in the assessment of transport impacts.

Cement for foundations will be sourced by the civil construction company awarded to undertake the Project. This may be sourced locally or from alternative suppliers.

Gravel and sand will be sourced locally and as close to the Project site where it is practicable to do so, including recycling material excavated from foundations and earthworks where possible. There is one operating quarry for unprocessed construction materials within the Project site located east of Tangmangaroo Road between the Kangiara Cluster and the Mt Buffalo Cluster. Additional operating and disused quarries are located within the locality of the Project site and these may be further utilised (subject to obtaining the necessary permits). In addition, several landowners have expressed interest in allowing gravel extraction from their properties, which would require the necessary extraction permits prior to use.

Delivery of constituent materials (eg. cement, sand, aggregate, water) for the on-site batching plants is assumed to average 50 truck loads per week resulting in 100 truck movements per week. This would be reduced if suitable local material such as aggregate and sand is able to be sourced on-site. In addition, it is assumed that some ten truck loads per week (or 20 truck movements per week) would be required to deliver steel reinforcement material.

Concrete material and foundation deliveries are assumed to be split to the main site access locations according to the number of wind turbines they would serve from surrounding areas via the relevant access routes. However, as a peak at any one time during the construction period, this would result in 100 truck movements of concrete materials and 20 truck movements of steel reinforcement per week along each of the relevant access routes.

The above truck movements would reduce by approximately 25% if mono-pile foundations were able to be used and generally reduced if a combination of foundation designs (combined slab plus rock anchor design) is implemented.

Gravel/road base

Road base material will be required for construction of access roads to wind turbine sites and the substations. Part of the road base requirement may be sourced from material extracted from wind turbine footings with the remainder sourced on-site (subject to permissions) or imported to the Project site. Where additional material is required, local supplies of the same geological type could be sourced from nearby quarries, local landowner gravel supplies or external aggregate suppliers.

It is anticipated that some road upgrade works (mainly widening on the inside of some tighter curves) may be required along Wargeila Road, Tangmangaroo Road and Hopefield Lane as a minimum. In addition, the on-site road network and hardstand areas for cranes are proposed to be constructed using a compacted road base or similar.

The construction of the on-site access road network and hardstand areas would result in an estimated 83 km length of road construction, as follows:

- Mt Buffalo Cluster: approximately 38 km of new on-site access roads required;
- Kangiara Cluster: approximately 29 km of new on-site access roads required; and
- Langs Creek Cluster: approximately 16 km of new on-site access roads required.

Assuming a 6.0 m wide road formation and 250 mm depth of material, approximately 124,500 m^3 of material would be required. It is assumed that approximately half of this material could be sourced on-site from foundation excavations or on-site borrow pits (some 64,500 m^3) while the remainder (approximately 60,000 m^3) would need to be sourced from external (off-site) locations[9]. Transport of off-site material to site during the construction period is assumed to be split between the access routes according to the number of wind turbines they would serve as follows:

- Lachlan Valley Way: 36 wind turbines of a total of 125 wind turbines = 29%
- Wargeila Road: 54 wind turbines of a total of 125 = 43%
- Hopefield Lane: 30 wind turbines of a total of 125 = 24%
- Rye Park-Dalton Road / Hillview Lane: 5 wind turbines of a total of 125 = 4%

Assuming the use of 'truck'n'dog' vehicles with an average 25 m^3 capacity, some 2,400 truck loads over the course of the project and a peak of 400 truck loads per month (over an initial 6-month construction period: say, months 2 to 7) would be required. In summary, based on the sourcing splits above, the following average truck loads and two-way movements would eventuate:

- Wargeila Road access route – 188 truck loads or 376 two-way truck movements per month (94 two-way truck movements per week) reducing to 32 two-way truck movements per month (8 two-way truck movements per week) along the Rye Park-Dalton Road access route
- Lachlan Valley Way access route – 212 truck loads or 424 two-way truck movements per month (106 two-way truck movements per week) reducing to 192 two-way truck movements per month (48 two-way truck movements per week) along the Boorowa town bypass and Rye Park Road access routes

Inter-turbine cabling

It is anticipated that approximately 100 cable drums of 700 m capacity for inter-turbine cabling would be required for the Project. These would be transported by semi-trailer with two drums per load. The resulting traffic generation would be some 50 truck loads over the course of the project. It is anticipated that during peak periods when cabling is required, some 20 truck loads per month (five truck loads or 10 two-way truck movements per week) would deliver these materials to site.

As a peak, at any one time during the construction period, cable deliveries are assumed to be five truck loads or 10 two-way truck movements per week along each of the access

9 This figure would be clarified by the construction environmental management plan (CEMP).

routes.

Water

Water requirements will be met by sourcing water from within the locality as long as a zero share licence can be obtained under the current water sharing plan. Where available, groundwater will be purchased from involved or adjacent landowner properties who hold groundwater licences and have unused allocations. The use of regulated surface water allocations from the nearby Wyangala Dam may also be an option. This source is controlled by State Water and its use would be subject to further discussions post consent.

If water cannot be sourced locally, then it will be brought to site by external water suppliers under contract to the Project. It is estimated that in the order of 15.0 megalitres (ML) of water would be required to produce the quantity of concrete required for gravity footings and as such can be considered the maximum amount of water required for use in concrete batching. By way of comparison, it is estimated that only 11.0 ML of water would be required if standard rock anchors were used for all footings.

In addition, it is estimated that a further 45.9 ML of water would be required for road construction and dust suppression activities. This would provide sufficient volume for all new and upgraded on-site access road construction and dust suppression activities, including those associated with the 33 km of unsealed arterial road.

As a worst case, transport of off-site water to site is estimated be an average of some 64 truck loads per week (or 128 two-way truck movements per week) throughout the construction period.

Water deliveries are assumed to be split to the main site access locations according to the number of wind turbines they would serve from surrounding areas via the relevant access routes. This would result in the following average truck movements:

- Wargeila Road access route – 31 truck loads or 62 two-way truck movements per week reducing to 6 two-way truck movements per week along the Rye Park-Dalton Road access route
- Lachlan Valley Way access route – 33 truck loads or 66 two-way truck movements per week reducing to 32 two-way truck movements per week along the Boorowa town bypass and Rye Park Road access routes

The above water transport would be reduced by approximately a quarter if standard rock anchor foundations are able to be used, and generally reduced if a combination of foundation designs (combined slab plus rock anchor design) is implemented.

Other miscellaneous deliveries

Other miscellaneous deliveries include general construction materials and equipment as well as site office operations equipment. It is estimated that some 20 delivery loads per week (or 40 two-way vehicle movements per week) would be required throughout the construction period.

These miscellaneous deliveries are all assumed to be sourced from nearby centres such as Yass, Canberra and Goulburn and would be transported to the main site access locations according to the number of wind turbines they would serve from surrounding areas via the relevant access routes. This would result in the following average truck movements:

- Wargeila Road access route – 9 truck loads or 18 two-way truck movements per week reducing to 2 two-way truck movements per week along the Rye Park-Dalton Road access route
- Lachlan Valley Way access route – 11 truck loads or 22 two-way truck movements per week reducing to 10 two-way truck movements per week along the Boorowa town bypass and Rye Park Road access routes

Given the scale of the Project, it is anticipated that there would be no need for waste material to be exported from the site during construction. Top soil cleared from surfaces during the construction phase would be used for remediation, and rock excavated for turbine footing preparations would be used for road base, back fill for foundations and/or erosion control purposes, as far as practicable.

4.2.3 Construction Staff Traffic

For the majority (10 months) of the 18 month construction period, it is anticipated that construction staff numbers would be up to approximately 60 staff. During peak construction periods, it is anticipated that construction staff numbers would increase up to 100 staff for an approximate eight month period coinciding with the turbine installation phase.

Assuming there would be some shared journey-to-work trips by construction staff (resulting from car pooling and similar initiatives), an average of 1.25 persons/car has been adopted for traffic generation purposes. During general staffing periods, traffic generation would be some 48 light vehicles (cars) or 96 light vehicle trips/day. During peak staffing periods, traffic generation would be some 80 light vehicles (cars) or 160 light vehicle trips/day along the surrounding road network.

It is assumed that construction staff trip distribution would be split equally between the north and west (Cowra to Wagga Wagga areas), south (Canberra and Yass areas) and east (Goulburn area), resulting in a maximum 48 construction staff vehicle movements per day (80 construction staff vehicle movements per day during peak staffing periods) along each of the relevant access routes depending on where peak construction activity was occurring.

4.2.4 Total Traffic Generation

The above sections provide the basis for estimating the average total traffic generation over the construction period. Traffic generation used in this transport assessment ranges from a moderate (average) scenario, that would apply for the great majority of the 18 month construction period, to a conservative (high) scenario, which assumes that peak construction staff numbers would coincide with other peak traffic generating activities such as large single-day concrete pours and access road construction, as well as delivery of wind turbine components.

While the conservative (high) scenario could potentially occur, it is more likely that peak access road construction activities would be undertaken during the earlier stages of the construction program and not necessarily coincide with peak construction staff numbers and other peak construction activities such as concrete foundation pours. Nonetheless, this conservative overlap of activities has been adopted to consider a ‘worst-case’ scenario as well as the more applicable and relevant moderate (average) scenario.

Typically, the conservative (high) traffic generation scenario would apply for only some four months out of the total 18 month construction period. This four month period would coincide with construction of WTG foundations and delivery of WTG components. It should be noted that it would not necessarily be a continuous four months.

For the remaining 14 months, a moderate (average) traffic generation scenario has been assumed, although realistically there would be at least one month at either end of the construction period where a low traffic generation period would apply, eg. during pre-construction tasks and pre-commissioning.

Traffic generation for both moderate and conservative (in brackets) scenarios is shown in *Table 4.2* below and has been classified into daily movement trips (ie. two-way trips), shown as vehicles per day (vpd) and peak hour trips (where applicable), shown as vehicles per hour (vph).

Table 4.2: Project Traffic Generation (Trips per Day)

Traffic Generating Activity		Lachlan Valley Way	T'mangaroo Road	Rye Park Rd / Hopefield Ln	Yass Valley Way / Wargeila Road	Rye Park-Dalton Rd
Construction staff (light vehicles only)	vpd	48 (80)	20 (30)	48 (80)	48 (80)	48 (80)
	vph	24 (40)	10 (15)	24 (40)	24 (40)	24 (40)
Wind farm component delivery (heavy and over-size vehicles)	vpd	0 (14)	0 (10)	0 (14)	0 (14)	0 (14)
	vph	0 (4)	0 (4)	0 (4)	0 (4)	0 (4)
Concrete batch plant material delivery (heavy vehicles)	vpd	20 (20)	-	20 (20)	20 (20)	-
	vph	4 (4)	-	4 (4)	4 (4)	-
Delivery of steel reinforcement (heavy vehicles)	vpd	2 (4)	2 (2)	2 (4)	2 (4)	2 (4)
	vph	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)
Gravel / road base deliveries (heavy vehicles)	vpd	12 (22)	4 (8)	8 (10)	12 (20)	2 (4)
	vph	2 (4)	2 (2)	2 (4)	2 (4)	2 (2)
Inter-turbine cabling delivery (heavy vehicles)	vpd	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)
	vph	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)
Water deliveries (heavy vehicles)	vpd	8 (14)	4 (6)	6 (8)	8 (14)	4 (6)
	vph	3 (3)	3 (3)	3 (3)	3 (3)	3 (3)
Other miscellaneous construction deliveries (heavy vehicles)	vpd	4 (4)	2 (2)	2 (2)	4 (4)	2 (2)
	vph	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)
TOTAL Light vehicles	**vpd**	**48 (80)**	**20 (30)**	**48 (80)**	**48 (80)**	**48 (80)**
	vph	**24 (40)**	**10 (15)**	**24 (40)**	**24 (40)**	**24 (40)**
Heavy vehicles	**vpd**	**48 (80)**	**14 (30)**	**40 (60)**	**48 (78)**	**12 (32)**
	vph	**13 (19)**	**9 (13)**	**13 (19)**	**13 (19)**	**9 (13)**

4.3 Effect of Construction Phase Traffic Generation

4.3.1 Road Capacity

In order to assess the potential impacts on road capacity, the traffic generation of heavy vehicles and the staff traffic generation (refer to *Table 4.2* above) have been added to existing daily and peak hour traffic flows to obtain future traffic flows (for both moderate and conservative traffic generation scenarios) along the affected road network.

Future traffic volumes in vehicles per day and vehicles per hour for roads along the proposed access routes are shown in *Table 4.3* following. The traffic volumes are broken up into light vehicles (LV) and heavy vehicles (HV) with the heavy vehicle proportion assumed to be between 10% and 15% of the total traffic volume. The figures in brackets are for the conservative (high) traffic generation scenario.

Table 4.3: Future Traffic Volumes

Traffic Scenario		Lachlan Valley Way	T'mangaroo Road	Rye Park Road	Hopefield Lane	Yass Valley Way	Wargeila Road	Rye Park-Dalton Rd
Daily Traffic – vehicles per day								
Existing traffic[1]	LV	1,600	40	450	40	2,700	320	450
	HV	200	5	50	5	300	40	50
Wind farm traffic generation	LV	48 (80)	20 (30)	48 (80)	48 (80)	48 (80)	48 (80)	48 (80)
	HV	48 (80)	14 (30)	40 (60)	40 (60)	48 (78)	48 (78)	12 (32)
Combined future traffic	LV	1,648 (1,680)	60 (70)	498 (530)	88 (120)	2,748 (2,780)	368 (400)	498 (530)
	HV	248 (280)	19 (35)	90 (110)	45 (65)	348 (378)	88 (118)	62 (82)
Hourly (Peak) Traffic – vehicles per hour								
Existing traffic[1]	LV	180	5	50	5	300	35	50
	HV	20	1	5	1	30	5	5
Wind farm traffic generation	LV	24 (40)	10 (15)	24 (40)	24 (40)	24 (40)	24 (40)	24 (40)
	HV	13 (19)	9 (13)	13 (19)	13 (19)	13 (19)	13 (19)	9 (13)
Combined future traffic	LV	204 (220)	15 (20)	74 (90)	29 (45)	324 (340)	59 (75)	74 (90)
	HV	33 (39)	10 (14)	18 (24)	14 (20)	43 (49)	18 (24)	14 (18)

1. Existing traffic derived from *Table 3.1*. HV % assumed to be between 10% and 15% of total traffic volume.

Road capacity can be expressed and qualified along a section of the rural road network as its 'level of service' (LoS). Typically, the LoS is based on road capacity analysis as described in Austroads' "*Guide to Traffic Engineering Practice, Part 2 – Roadway Capacity*". Road capacity can be expressed in total vehicles per day and/or vehicles per hour.

The level of service descriptions are as follows:

LOS A: Free flow conditions, high degree of freedom for drivers to select desired speed and manoeuvre within traffic stream. Individual drivers are virtually unaffected by the presence of others in the 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, but restricted freedom for drivers to select desired speed and manoeuvre within traffic stream.

LOS D: Approaching unstable flow, severely restricted freedom for drivers to select desired speed and manoeuvre within traffic stream. Small increases in flow generally cause operational problems.

LOS E: Traffic volumes close to capacity, virtually no freedom to select desired speed or manoeuvre within traffic stream. Unstable flow and minor disturbances and/or small increases in flow would cause operational break-downs.

LOS F: Forced flow conditions where the amount of traffic approaching a point exceeds that which can pass it. Flow break-down occurs resulting in queuing and delays.

Road capacity for two-lane, two-way sections of a rural road network is largely based on a combination of design speed, travel lane and shoulder width, sight distance restrictions, traffic composition, directional traffic splits and terrain[10]. This provides a basic level of service and associated service flow rate under prevailing road and traffic conditions. For the minor unsealed roads, service flow rates are not applicable as they have significant variations in standards of formed lanes and carriageways.

Based on their road and traffic characteristics, the levels of service and flow rates for the affected sections of the rural road network along the relevant transport routes are shown in *Table 4.4* following.

Table 4.4: Rural Road Network Service Flow Rates

Road Section	Level of Service (LoS)				
	A	B	C	D	E
Lachlan Valley Way	240 vph 2,400 vpd	470 vph 4,800 vpd	765 vph 7,900 vpd	1,260 vph 13,500 vpd	2,250 vph 22,900 vpd
Tangmangaroo Road	not applicable	not applicable	not applicable	not applicable	not applicable
Rye Park Road	105 vph 1,050 vpd	260 vph 2,850 vpd	480 vph 5,250 vpd	730 vph 7,800 vpd	1,440 vph 13,800 vpd
Hopefield Lane	not applicable	not applicable	not applicable	not applicable	not applicable
Yass Valley Way	240 vph 2,400 vpd	470 vph 4,800 vpd	765 vph 7,900 vpd	1,260 vph 13,500 vpd	2,250 vph 22,900 vpd
Wargeila Road (sealed section at southern end)	85 vph 850 vpd	210 vph 2,250 vpd	390 vph 4,250 vpd	590 vph 6,300 vpd	1,160 vph 12,200 vpd
Rye Park-Dalton Road	105 vph 1,050 vpd	260 vph 2,850 vpd	480 vph 5,250 vpd	730 vph 7,800 vpd	1,440 vph 13,800 vpd

10 Austroads "*Guide to Traffic Engineering Practice: Part 2 – Roadway Capacity*", Section 3

Based on the above service flow rates and the existing and additional wind farm generated construction traffic volumes (conservative scenario peak volumes used as a worst case scenario) of the rural roads along both access routes, 'before and after' levels of service can be expected as shown in *Table 4.5* following.

Table 4.5: Rural Road Network – Existing and Future Levels of Service

Road Section	Existing LoS	Future LoS
Lachlan Valley Way	A	A / B
Rye Park Road	A	A / B
Yass Valley Way	B	B
Wargeila Road	A	A / B
Rye Park-Dalton Road	A	A

From the above table, it can be seen that the majority of the road network under consideration has significant spare capacity and is operating at high levels of service (A or B). It is clearly evident that operating conditions (levels of service) along the road network would change insignificantly from existing conditions, even after the addition of the conservative scenario (maximum peak) wind farm generated construction traffic.

For Tangmangaroo Road, Hopefield Lane and the northern section of Wargeila Road, which are all minor unsealed roads, service flow rates are not applicable as the roads do not have formed lanes and carriageways. However, these sections of the road network would be operating at a high level of service with significant spare capacity, due to their very low existing traffic volumes (less than 50 vpd). While the addition of construction-related traffic generation temporarily increases traffic volumes along these minor roads during the construction period, their ample spare capacity allows the volumes to be readily absorbed.

In summary, the addition of heavy vehicles and construction staff traffic during peak construction periods would not significantly change the levels of service nor significantly affect road network operations and intersection performance pertaining to capacity issues. The temporary increase in traffic volumes due to construction-related activities is able to be readily absorbed by the subject road network with appropriate road infrastructure upgrades and construction traffic management.

4.3.2 Site Access and Road Safety

Construction traffic is proposed to access the various wind turbine sites via an internal site road network off five main site access points (described previously in *Section 3.2.1*). The Lachlan Valley Way and Rye Park-Dalton Road (Hillview Lane) site access locations have been identified as having sight distance issues onto the public road network and thus, suitable temporary traffic control during the construction period (conforming to RMS' "*Traffic Control at Worksites Manual*" and relevant Australian Standards) may be required to warn road users of turning truck traffic and other construction-related vehicle movements. Traffic management (eg. 'stop-go' traffic control) during peak activities such as concrete pours for example, may also be required at the Tangmangaroo Road site access location due to sight restrictions in both directions.

Suitable on-site manoeuvring areas would be available so that larger vehicles are able to safely manoeuvre into the site off the public road network, around the site and out of the site onto the public road network. The location and layout of all site access junctions with the public road network would be confirmed with the relevant road authorities taking into account set back of property boundaries and swept path turn radii for over-size (length) loads.

It is envisaged that for the over-size and over-mass vehicles to be used for wind farm component delivery, escort vehicles, transport restrictions and appropriate traffic management would be adopted to ensure safe passage from the public road network onto the site. These issues would be resolved in detail by the by the selected transport contractor when seeking approvals from relevant road authorities.

All vehicles would enter and exit the site to/from the public road network in a forward direction only. All vehicles generated by construction staff would be accommodated within on-site parking areas.

To ensure adequate road safety is maintained, a comprehensive Construction Traffic Management Plan (CTMP) would be prepared in conjunction with the chosen transport contractor and relevant road authorities. The CTMP would detail appropriate construction traffic controls and management measures and all aspects would be implemented in co-ordination with the Councils and RMS. It is acknowledged that on occasions local traffic will be inconvenienced. However, the management measures within the CTMP would endeavour to mitigate any impacts. The CTMP would include, but not be limited to, provisions for:

- Scheduling of transport deliveries, particularly outside of school bus route hours, ie. 7:00 to 9:00 am and 3:00 to 4:30 pm;
- Undertaking community consultation before and during all transport and haulage activities, including contact details to ensure community concerns are logged and addressed;
- Clear communication of road closures (if required);
- Letterbox drop along affected routes;
- Minimising disruption to local vehicles by ensuring average and maximum wait times due to project traffic along local roads are stipulated by the chosen transport contractor (typically an average maximum of 3 minutes wait time);
- Upgrading road infrastructure including designing and implementing temporary modifications to intersections and roadside furniture as appropriate;
- Managing transport operations including provision of warning and guidance signage, traffic control devices, temporary construction speed zones and other temporary traffic control measures;
- Preparation of a 'Transport Code of Conduct' for all staff and contractors detailing designated transport routes, road behavioural requirements, speed limits and local climatic conditions that may affect road safety, eg. snow / ice, fog, etc.;
- Procedure to monitor traffic impacts and respond to impacts rapidly; and
- Reinstatement of pre-existing road conditions after construction phase is complete.

4.3.3 *Internal Access Roads*

The construction and maintenance of the wind farm would require the construction of an internal site road network to reach each of the wind turbine locations and the substation. In some cases the site road network works would involve upgrading existing access tracks and in others constructing new ones. Route selection for the access roads has been determined taking into consideration topography, drainage and potential erosion impacts – refer to *Appendix A: Proposed Wind Farm Layout*.

The internal site road network would consist of private roads and will not be accessible to the public. Access would be controlled by locked gates. The internal site access roads would generally be 6.0 m wide with regular passing bays and turning heads to accommodate construction vehicles and the crane required to assemble the wind turbines. Hardstand areas would be required around each turbine site for the safe operation of large cranes. These areas would also provide turning opportunities for delivery vehicles.

The roads would be an all-weather graded surface. Ongoing operational maintenance of on-site roads would be undertaken by the wind farm operator.

4.3.4 *Road Condition Maintenance*

There are a number of public road works that would be required to enable transport of components and materials to the wind farm sites. These have been identified in general previously in this assessment but would be confirmed and resolved in detail by the selected transport contractor when seeking approvals from relevant road authorities.

The permit system requires transport contractors to state the registration details of the trucks/ trailers used for each load, so the link between permissions and equipment is very tight.

Trucks being used for all escorted loads are given an inspection by the escort at the start of every trip, while other trucks are required to meet regulated maintenance requirements and these procedures are regularly audited to ensure compliance. Under these operating procedures, there would be no further actions required by local Councils to ensure that trucks are fit for purpose. Notwithstanding, the transport contractor would be expected to comply with any additional requirements from any party (ie. Councils, RMS, etc.), if requested to do so.

A thorough dilapidation survey would be undertaken on all public access roads prior to construction starting. This would provide the basis for identifying any road damage and subsequent restoration works after the construction period is complete. Regular inspection regimes undertaken in consultation between local Councils and the proponent would be developed. Any damage resulting from construction traffic, except that resulting from normal wear and tear, would be repaired to pre-existing conditions

4.4 Operational Phase Traffic Generation

Traffic generation during operations would be relatively minor. There is proposed to be 15 operational / maintenance staff, likely to be based in the local area, servicing the wind turbines. Aspects of the Project operation to be dealt with by on-site staff would include safety management, environmental condition monitoring, landowner management, routine servicing, malfunction rectification and site visits. Other remote monitoring functions would typically include turbine performance assessment, wind farm reporting, remote re-setting and maintenance co-ordination.

It is understood operational traffic would consist of 4WD-type service vehicles travelling between individual wind turbine sites along the internal road network after gaining access off the public road network from either of the two site access locations. It is envisaged that with journey-to-work and home trips, this would amount to a maximum of approximately 30 trips per day, which would readily be absorbed into the spare capacity of the existing road network.

There is the possibility that the operational wind farm may attract tourist traffic along the roads surrounding the sites. However, it is considered that this would not significantly increase traffic volumes or cause any unfavourable impacts.

4.5 Effect of Operation Phase Traffic Generation

Based on the relatively minor traffic generation during operations described above, traffic and road network impacts would be negligible. The current road network has significant spare capacity and is used by 4WD-type vehicles, which are proposed to be used for servicing the various sites.

All vehicles generated by operations staff would be accommodated within on-site parking areas.

4.6 Cumulative Impacts

At present there are two nearby major developments or projects (both wind farms) that may potentially result in cumulative impacts to the subject wind farm project. The Rye Park and Rugby wind farm projects are at different stages of the design and development process and thus their timing for construction and operation is unclear at this stage.

Both the Rye Park and Rugby wind farm projects propose to use the major and minor road network in the surrounding area, some of which is similar to the transport routes proposed for the Bango wind farm project, eg. Lachlan Valley Way, Rye Park-Dalton Road. This has the potential to exacerbate any traffic and transport impacts.

Once progression of these two wind farm projects is confirmed and other possible major developments in the surrounding area are determined, and also when the construction dates / timetables are finalised for the Bango wind farm project, the cumulative impact of these would need to be considered with respect to transport and traffic operations. Possible mitigation measures may include scheduling of construction activities and deliveries to minimise road transport movements, region-wide traffic management and/or shared road upgrades, for example.

5. Mitigation Measures

5.1 General Management of Potential Impacts

The management of potential impacts caused by the proposed wind farm project would cover the construction, operation and decommissioning phases of the Project. With respect to the potential traffic impacts during the decommissioning phase, these essentially mirror the construction phase impacts, although would occur over a shorter time period.

For management of potential impacts during the construction phase, the following general measures would need to be undertaken:

- Engage a licensed and experienced transport contractor with experience in transporting similar wind farm component loads. The contractor would be responsible for obtaining all required approvals and permits from the RMS and local Councils and for complying with conditions specified in the approvals. Transport contractors would also conduct any dilapidation surveys and arrange for detailed pavement and infrastructure inspections (eg. bridge loading adequacy) to ensure all access routes are suitable prior to carrying out the transport tasks.
- Develop a Construction Traffic Management Plan (CTMP) in conjunction with the transport contractor and relevant road authorities and implement all aspects of the CTMP in co-ordination with the local Councils and RMS. Refer to previous *Section 4.3.2* for typical details to be included in the CTMP.
- Undertake road infrastructure upgrade works to allow over-size transport along the proposed transport routes to access the site. Details of specific upgrade works follow in *Section 5.3* below.
- There are some locations along the over-size transport routes (eg. Wargeila Road access route) where road alignments and/or narrow carriageway widths would require over-size vehicles to use the full carriageway width. This would require traffic management in the form of temporary, short-term full road closures ('rolling' road closures as vehicles pass critical locations) aided by escort vehicles.
- Prepare road dilapidation reports covering pavement, drainage and bridge structures in consultation with RMS and the local Councils for all of the proposed transport routes before and after construction. Regular inspection regimes undertaken in consultation between local Councils and the proponent would be developed. Any damage resulting from construction traffic, except that resulting from normal wear and tear, would be repaired to pre-existing conditions.
- Consider establishing a 'car pool' initiative for construction staff from nearby centres to minimise construction staff trips.
- For decommissioning, similar general measures would be necessary as those detailed for construction. However, the CTMP for decommissioning would need to be revised to address traffic operation and volume changes in the future years during the decommissioning phase.

For management of potential impacts during the operations phase, the following general measures would need to be undertaken:

- Establish a procedure to ensure the ongoing maintenance of the internal on-site access roads during the operation phase. This maintenance would include sedimentation and erosion control structures, where necessary.

5.2 Road Authority Approvals

The use of licensed and experienced contractors for transporting wind farm equipment is essential to ensure the minimisation of any impacts on the road network and traffic operations. There are a number of transport contractors who are experienced in the specialised transport of over-mass and over-size loads. These contractors operate closely with road authorities and are able to arrange all required permits for undertaking the transport tasks. They would also carry out detailed transport route assessments and confirm the requirement for any road infrastructure upgrades and/or bridge strengthening works.

In obtaining approval and permits for over-size transport, the following documents are pertinent:

- NSW RTA "*Operating Conditions: Specific permits for oversize and overmass vehicles and loads*" Version 2, August 2008
- NSW RTA "*Road Transport (General) Act 2005: General Class 1 Oversize (Load-Carrying Vehicle) Notice 2007 under Division 3 of Part 2 of the Road Transport (Mass, Loading and Access) Regulation 2005*" August 2007
- NSW RTA "*Road Transport (General) Act 2005: General Class 1 Oversize (Special Purpose Vehicle) Notice 2007 under Division 3 of Part 2 of the Road Transport (Mass, Loading and Access) Regulation 2005*" August 2007

Consultation with the NSW RMS regarding their requirements for transporting over-size and/or over-mass loads resulted in the following pertinent issues:

- Generally, the wider and longer over-size transport would require two pilot vehicles and contact with NSW Police for further guidance (pilot vehicles).
- Over-size permits are required to be 'specific' permits for each vehicle if they would be travelling along designated roads or locations. Additional and specific over-size permits may be required for loads with greater dimensions than covered by a General Class 1 Oversize Notice.
- A specific permit:
  - prescribes the travel conditions that apply to a particular vehicle;
  - identifies the vehicle to which the permit applies; and
  - identifies the registered operator of the vehicle.
- The permit may also specify conditions to secure payment for:
  - damage caused to roads, bridges or other property by the over-size vehicle;
  - road work that must be conducted before the vehicle can travel on a particular route; or
  - costs incurred by the RMS to evaluate the proposed route or provide any special escort services.
- An over-mass permit will be required for each nacelle component.

- An over-size (length) permit will be required for each blade component. The requirement for over-mass permits for blade components will depend on the type of vehicle used to transport them. However, preliminary assessment indicates that over-mass permits may not be required for blade components.
- Transport of blade components will most likely utilise a rear-end steering system on a trailer or low loader.
- An over-mass permit will be required for each tower component.
- An over-mass permit will be required for the sub-station transformer unit.
- An over-mass permit will be required for each crane.
- Night transport is generally available along the major road network (between 1 am and sunrise or 6 am, whichever is earlier).
- Transport through the any urban areas must generally occur during daylight periods. It is recommended that if the transport routes pass through any school zones or adjacent to any schools, transport also be restricted to outside school drop-off and pick-up times (8:00 am to 9:30 am and 2:30 pm to 4:00 pm) to prevent conflicts with these activities.
- As part of the transport permit process, the RMS and local Councils are likely to require a detailed sufficiency assessment of all bridges and other structures along the transport route to identify and specify strengthening requirements, if any. This may apply to a number of bridge / causeway crossings along Lachlan Valley Way and Wargeila Road.

5.3 Potential Road Infrastructure Upgrades

As well as the construction of an internal on-site road network that links up the various wind turbine sites and associated wind farm infrastructure, road upgrade works are likely to be required at a number of locations to accommodate the increased heavy vehicle volumes and over-size transport vehicles. The latter issue would be confirmed by a licensed transport contractor as part of their transport route assessment based on specific vehicles to be used.

The potential road infrastructure upgrades that may be required and/or would need to be considered by the chosen transport contractor include the following (refer to *Section 5.4* below for typical examples of upgrade works and other risk mitigation measures along over-size transport routes).

Lachlan Valley Way

- Possible adjustment of overhead power lines at rail bridge overpass (approximately 1.7 km north of Hume Highway intersection).

Tangmangaroo Road

- At approximately 0.4 km, 2.4 km, 6.1 km and 6.9 km north of Lachlan Valley Way, there are sags / dips in the road caused by culvert crossings, which may need to be checked for scraping (bottoming-out) and structural adequacy from heavier loads.
- Approximately 4.3 km north of Lachlan Valley Way, there is a single traffic lane causeway approximately 4 m wide, which would need to be checked for structural adequacy from heavier loads and may require temporary widening and approach upgrades for wider loads.

- Approximately 6.3 km north of Lachlan Valley Way, there is a section of narrower carriageway (up to 4 m wide), which may require widening works to allow over-size vehicle transport.
- Approximately 7.4 km north of Lachlan Valley Way, there is a localised narrowing of the carriageway down to approximately 3 m, which would require widening past a large tree and around a relatively sharp left curve.
- Approximately 7.9 km north of Lachlan Valley Way, there is a relatively sharp left curve and localised narrowing of the carriageway, which would require widening.
- At various locations, tree foliage pruning / roadside vegetation removal may be required to allow over-size vehicle transport.

Meads Lane / Long Street (Boorowa town bypass route)

- Approximately 1 km east of Lachlan Valley Way, there is a sag and culvert across a small creek, which may require strengthening for larger transport.
- On the approach to Long Street (Cemetery Road), there are numerous large trees with overhanging foliage, which may require pruning to allow transport of larger vehicles. The route in this section also deteriorates and some grading and formation widening works may be required.
- At the direction change from Meads Lane to Long Street (Cemetery Road), a number of trees and fence posts on the inside of the curve may need to be removed to allow transport (swept path) of the longer blades in particular.

Rye Park Road

- Approximately 1.2 km east from Boorowa (from the intersection of Rugby Road and Long Street), there are some below average pavement conditions and some sections may need upgrading / strengthening for larger transport.
- At two locations, tree foliage pruning may be required to allow over-size vehicle transport.

Hopefield Lane

- The intersection at Rye Park Road would likely need some widening work to allow adequate swept path for longer vehicles entering Hopefield Lane from Rye Park Road.
- Approximately 1.2 km to 1.3 km south of Rye Park Road, there is overhanging tree foliage, which may require some pruning to allow over-size vehicle transport.
- Approximately 1.9 km south of Rye Park Road, some local power lines cross the road corridor and these would require checking for height clearance and possible raising to allow over-size vehicle transport.
- Approximately 2.6 km south of Rye Park Road, there is a sharp crest alignment, which would need to be checked for vehicle scraping.
- Approximately 3.5 km south of Rye Park Road, the ‘Hopefield’ property access creates a significant carriageway narrowing. Possible widening works would need to be undertaken to the left (east) of a large tree at the property access.
- Approximately 4.2 km south of Rye Park Road, widening may be required where there is a property access with cattle grid, which creates a carriageway narrowing.

- South of approximately 3.0 km (near the 'Glenmore' property), the road width narrows and the unsealed pavement is of a lesser standard, which may require some upgrading.
- There are numerous small culverts (up to 10 locations) running under the road along the route, which would need to be checked for structural adequacy from heavier loads.

Yass Valley Way

- For Hume Highway southbound traffic entering the interchange, the exit ramp has street light poles on the inside of the left curved alignment, which would need to be checked for adequacy of transport by longer loads.
- At the service centre roundabout, the centre island has some minor signage that may need to be adjusted / relocated to allow transport by longer loads.

Wargeila Road

- Approximately 1.0 km north of Yass Valley Way, the bridge over the railway crossing results in a narrowing of the road formation to approximately 5 m wide. Structural adequacy of the bridge would need to be confirmed for heavier loads.
- Approximately 2.3 km north of the Laverstock Road junction, there is a narrow (approximately 4 m wide) single-lane bridge that is likely to require upgrade.
- From approximately 8.5 km to 10.5 km north of the Laverstock Road junction, road upgrading may be required due to the narrow road width and poor unsealed road surface.
- Approximately 13.5 km north of the Laverstock Road junction, a relatively tight right curve would need widening upgrade works.
- Approximately 13.6 km north of the Laverstock Road junction, road widening upgrade works would be required past a large tree on the western side of the road.
- Approximately 21.8 km north of the Laverstock Road junction, road upgrading may be required due to the narrow road width and poor road surface.
- Approximately 24.4 km north of the Laverstock Road junction, a relatively tight left curve may need widening upgrade works.
- At approximately 2.2 km north of Yass Valley Way, and 1.7 km, 3.2 km, 4.1 km, 14.4 km and 21.7 km north of the Laverstock Road junction, overhead powerlines cross the road and height adequacy would need to be checked to allow over-size vehicle transport.
- At approximately 1.3 km, 5.1 km, 10.1 km and 21.1 km north of the Laverstock Road junction, there are culverts where strength adequacy would need to be confirmed for heavier and over-size vehicle transport.
- There is significant overhanging tree foliage along the route, especially north of the Laverstock Road junction, which may need to be pruned to allow over-size vehicle transport.

Rye Park-Dalton Road

- At two locations, tree foliage pruning may be required to allow over-size vehicle transport.

5.4 Typical Transport Route Upgrade & Risk Mitigation Measures

Full structural road upgrades are not normally required for the routes intended to provide wind farm access. Exceptions include where access is via an under-rated bridge or where there are obstructions that overhang the road or limit the width of the vehicle / load that can pass. Mitigation strategies typically comprise the following.

Road Surface

As a general rule, ground clearances as low as 300 mm should be considered for over-mass trailers. Depending on the details of the transport equipment to be used, road camber, rise, fall and undulations may require review. Placing limits on vehicle speed ensures that even with heavy loads, the stresses on the road surface can be minimised. Whilst a sealed road surface is ideal, the vehicles are designed to and capable of travelling on unsealed surfaces such as those found on wind farm sites during construction – see *Figure 5.1* below. Therefore, temporary surfaces of crushed rock or similar material are normally adequate, on the basis that any such surface is properly drained to prevent loaded vehicles becoming bogged. There is not anticipated to be any significant impacts to road safety and/or traffic operations as a result of this type of road surfacing measure.

Figure 5.1: Typical unsealed access road within wind farm site

Road width

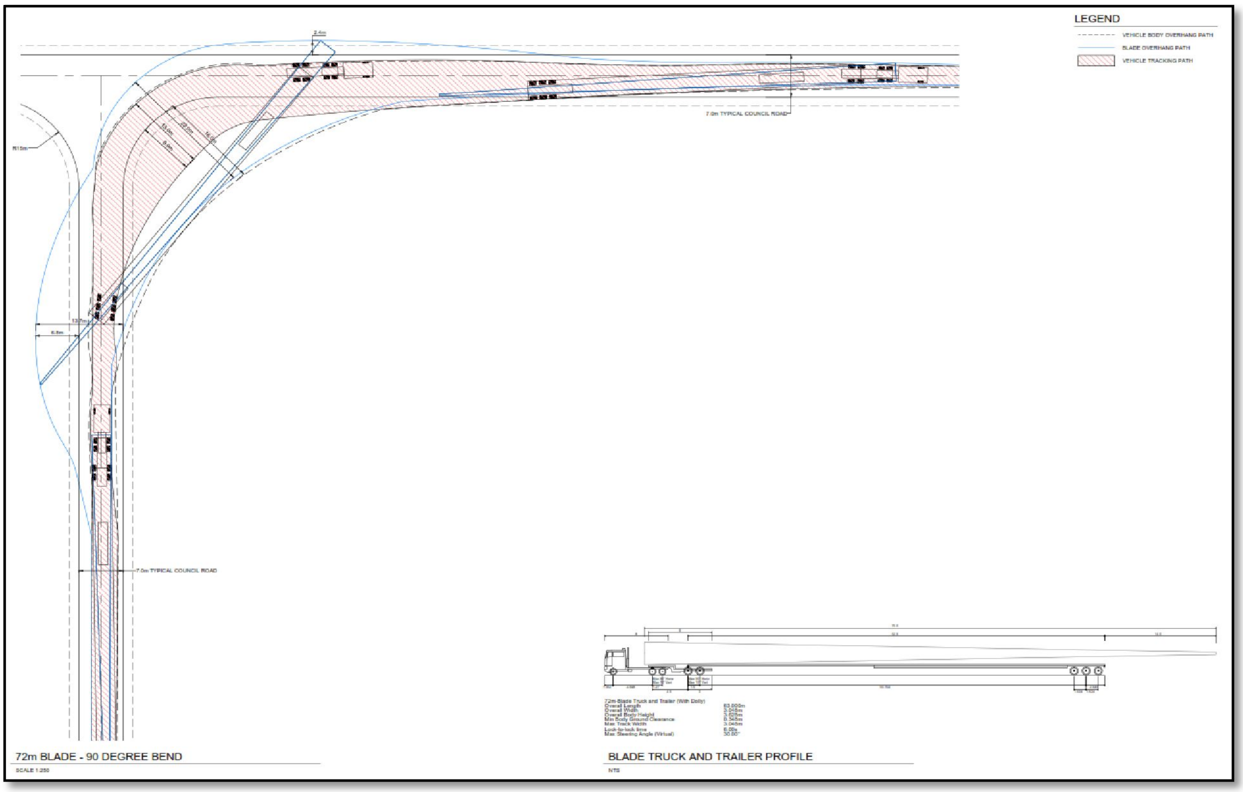
Larger WTG loads require a road width of up to 5 m, which is sometimes more than the width of minor roads that service remote wind farm sites. Consideration needs to be given to ensure adequate road width for over-size transport, although it is not normal to increase the width of a sealed surface if it already exists at less than 5 m. Where the road width is restricted (be it sealed or unsealed), the common approach is to clear sufficient vegetation from the sides of the road to allow shoulders of crushed rock to be laid. The level of the surface of any such preparation needs to match the edge of the existing road, to prevent tyre damage (and in the case of sealed roads, the break-up of the edge of the sealed section) when the vehicle is required to run wide for corners or to move over for on-coming traffic – see *Figure 5.2* below for increased unsealed road width.

Figure 5.2: Typical unsealed increase in width of (public) road

Intersection Layouts

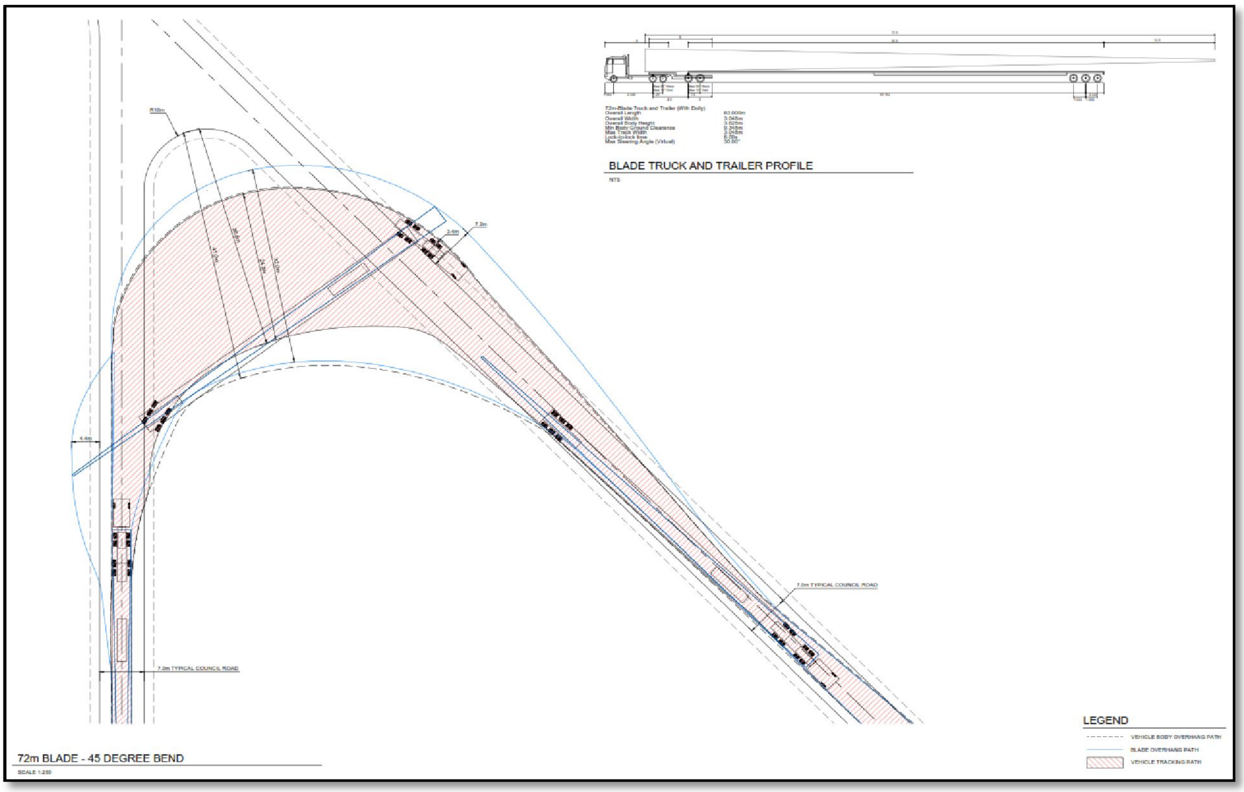
Swept path analysis is generally undertaken once the WTG has been determined for the project, to ensure that any obstacles such as ditches, signage or traffic furniture can be identified and remedied ahead of time – refer to *Figures 5.3* to *5.5* below (sourced from ICubed Consulting drawings). Where further road modifications are required to allow for 'cutting in' of vehicle rear wheels, crushed rock in-fill is normally sufficient on the basis that the vehicles are travelling slowly enough on the curves / turns to ensure minimum road stresses. Where temporary or crushed rock road surfaces are used, a regime of regular maintenance should be employed when over-size / over-mass vehicles are travelling to / from the wind farm site.

Once construction is complete, any temporary modifications can be removed and/or reinstated to ensure the intended swept path and traffic control devices of the road for typical usage are maintained, ie. to maintain safe operations. This could include reinstatement of temporary infill areas and relocation of road furniture, signage, etc.



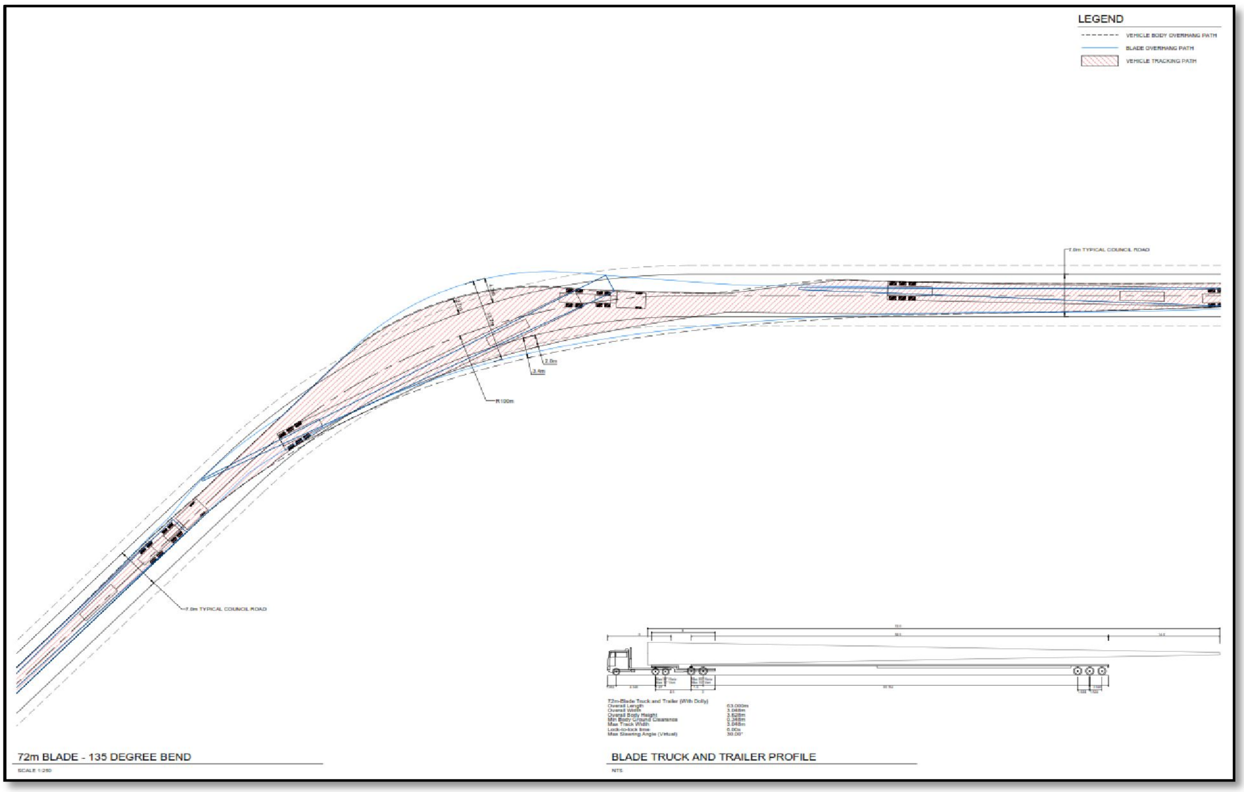
Source: *ICubed Consulting*

Figure 5.3: Swept path (90 degree bend) for 72 m blade truck & trailer



Source: *ICubed Consulting*

Figure 5.4: Swept path (45 degree bend) for 72 m blade truck & trailer



Source: *ICubed Consulting*

Figure 5.5: Swept path (135 degree bend) for 72 m blade truck & trailer

Overhead obstacles

Over-size vehicles can travel with a combined total height of 5.2 m without the need for an overhead pilot. Any obstructions or height risks such as low bridges (see *Figure 5.6* below), overhead power lines, hanging wires or tree branches would be identified. Where there is a bridge risk, detailed calculations would be done to ensure the loads as specified by the selected WTG manufacturer do not present any risk of a bridge strike. If this is possible, alternative route(s) should be sought. Overhanging wires can be provided with additional temporary support if required, whereas any overhanging tree branches would be cut back or restrained away from the path of the vehicle.

Bridges and culverts

In the event that there are bridges and/ or culverts which are deemed not strong or wide enough (typically less than 5 m travel path width) to support WTG transport equipment, the options are as follows:

- Build a temporary diversion with a structure to provide the necessary support, whilst leaving the original structure in place.
- Reinforce the existing structure by means of steel plates / girders as required to provide the necessary support. Reinforcement can be provided either below the structure, or as additional support on top of the existing road surface.
- As a last resort, if other options are not feasible or practicable, consideration may be given to the replacement of the bridge / culvert with a structurally suitable permanent upgrade to support the projected wind farm component loads.

The selection of any of the above options is dependent on a full technical assessment from a qualified structural engineer which typically occurs during the detailed design phase of the project, once the dimensions and loads are known.

Figure 5.6: Identification of bridge underpass height risk

6. Summary & Conclusions

The following pertinent issues summarise the transport impact assessment for the proposed Bango Wind Farm project:

- The wind farm would consist of up to 122 wind turbines in three clusters to be located on rural land centred approximately 20 km north of Yass, 7 km south-east of Boorowa and 80 km west of Goulburn, NSW.
- Road transport is the preferred method of transport. Rail is not feasible due to larger wind farm components not being able to be accommodated by the rail system, lack of vertical and horizontal clearance in some sections, double handling, problems of scheduling rail services and potential restriction on track capacity.
- The preferred transport route for over-size vehicles is via Hume Highway and either Lachlan Valley Way or Yass Valley Way to the site access locations. The Hopefield Lane site access would require transport around Boorowa town and via Rye Park Road. The Wargeila Road and Hillview Lane site accesses would require transport via Wargeila Road and Rye Park-Dalton Road.
- The minor road network of Tangmangaroo Road, Rye Park Road, Wargeila Road and Rye Park-Dalton Road all have significant spare capacity along the road network.
- There are proposed to be four site access points off the public road network (Lachlan Valley Way, Hopefield Lane, Wargeila Road and Hillview Lane) serving wind turbine locations and some other ancillary facilities as well as one other site access point (off Tangmangaroo Road) serving substation / switching station construction and components only.
- All wind turbine locations and ancillary infrastructure would be able to be accessed from the major site access points via the internal road network.
- In addition to the major site access locations, there would be minor and limited construction access required to the substation / switching station site and the external transmission line route via Tangmangaroo Road.
- During the construction phase, several tasks would generate traffic including wind farm component delivery, construction material delivery, concrete pours and construction staff transport. For the majority of the construction period, maximum daily traffic generation would be 48 light vehicle trips and up to 48 heavy vehicle trips per day.
- Traffic generation would typically be split to the main site access locations according to the number of wind turbines they would serve from surrounding areas via the relevant access routes.
- During peak construction activities, all affected roads on the road network would maintain their levels of service and adequately absorb construction-generated traffic.
- It is proposed that during peak traffic generation activities such as concrete pours and for over-size vehicles to be used for wind farm component delivery, escort vehicles and appropriate traffic management would be adopted to ensure safe passage from the public road network onto the site.
- Traffic generation during operations would be minimal resulting in a maximum of approximately 30 trips per day. Consequently, traffic and road network impacts would be negligible during the operational phase.

- For the potential over-size transport routes, road infrastructure upgrades are likely to be required at a number of locations along Lachlan Valley Way (minor), Tangmangaroo Road (moderate), Meads Lane / Long Street (moderate), Rye Park Road (minor), Hopefield Lane (moderate), Yass Valley Way (minor), Wargeila Road (significant) and Rye Park-Dalton Road (minor) to accommodate the increased heavy vehicle volumes and/or over-size transport vehicles.
- Along the over-size transport routes via the minor road network, where vehicles may require the use of the full carriageway width, traffic management would be required in the form of temporary, short-term full road closures ('rolling' road closures as vehicles pass critical locations) aided by escort vehicles.
- A Construction Traffic Management Plan (CTMP) would be prepared in conjunction with the transport contractor and relevant road authorities and all aspects would be implemented in co-ordination with the local Councils and RMS. The CTMP would typically address:
  - Scheduling of transport deliveries, particularly outside of school bus route hours;
  - Community consultation and issue logging;
  - Clear communication of road closures (if required);
  - Letterbox drop along affected routes;
  - Minimising disruption to local vehicles by ensuring average and maximum wait times due to project traffic along local roads;
  - Road infrastructure upgrade requirements;
  - Traffic management of transport operations;
  - Preparation of a 'Transport Code of Conduct' for all staff and contractors;
  - Procedure to monitor traffic impacts and respond to impacts rapidly; and
  - Reinstatement of pre-existing road conditions after construction is complete.
- The use of licensed and experienced contractors for transporting wind farm components would ensure a minimisation of transport impacts. They would arrange required over-size vehicle permits, carry out a detailed transport route assessment and confirm the requirement for any road / bridge infrastructure upgrades.

This Transport Assessment has addressed Planning NSW's Director General's Requirements (DGRs), for the construction and operational impacts of the project as follows:

- Details of light and heavy vehicle traffic volumes during construction and operation – refer to *Section 4.2* (specifically *Tables 4.2* and *4.3*) and *Section 4.4*.
- Details of transport routes during construction and operation – refer to *Section 3.2*.
- Assess potential impacts on road network function (including intersection level of service) and road safety – refer to *Section 4.3.1* and *Section 4.3.2*.
- Assess the capacity of the existing road network to accommodate the type and volume of traffic generated by the project (including over-size vehicles) during construction (refer to *Section 4.3.1*) and operation (refer to *Section 4.5*), including full details of any required upgrades to roads, bridges, site access provisions (for safe access to the public road network) or other road features (refer to *Section 5.3*).
- Details of measures to mitigate and/or manage potential impacts – refer to *Section 5*, particularly *Section 5.3*.

- Details of internal site access roads and connections to the existing public road network, including ongoing operational maintenance for on-site roads – refer to *Section 3.3*, *Section 4.3.2* and *Section 4.3.3*.
- Consideration of relevant Council traffic / road policies – refer to *Section 1.2* (consultation with relevant Councils)
- Any cumulative impacts from other proposed and approved developments in the surrounding area – refer to *Section 4.6*.

In conclusion, it is considered the proposed Bango Wind Farm Project would not create any significant adverse impacts with respect to transport issues such as traffic operations, road capacity on the surrounding road network, site access and road safety. The management of heavy vehicle movements during construction would be appropriately covered by a CTMP to be prepared prior to construction starts, while the use of a specialised and licensed transport contractor would ensure that the transport of over-size wind turbine components would be carried out in an appropriate manner.

Appendix A

Proposed Wind Farm Layout