Kyoto energypark

19. Transmission Line Connection to the Grid

19.0 TRANSMISSION LINE CONNECTION TO THE GRID

19.1 Existing Distribution Networks

Energy Australia own and manage the distribution lines within the vicinity of the Kyoto Energy Park sites. Energy Australia supply electricity in the Upper Hunter LGA to residential customers within the network. These include the 33kV,66kV and 132kV networks as shown in Figure 19.0. An increase in demand for electricity in NSW, the Newcastle and the Hunter Region has resulted from factors such as an a deficit in generation capacity, increase in new housing developments, increased coal production forecast for the Upper Hunter, and the associated energy demands within the local and regional community.

Within the Upper Hunter Region, Scone, Aberdeen, Muswellbrook, Moonan and Rouchel zone substations and Muswellbrook mine are all supplied by the Muswellbrook 132/33kV Sub-transmission Station (STS). The Glenbawn Hydro generator is also connected to this system.

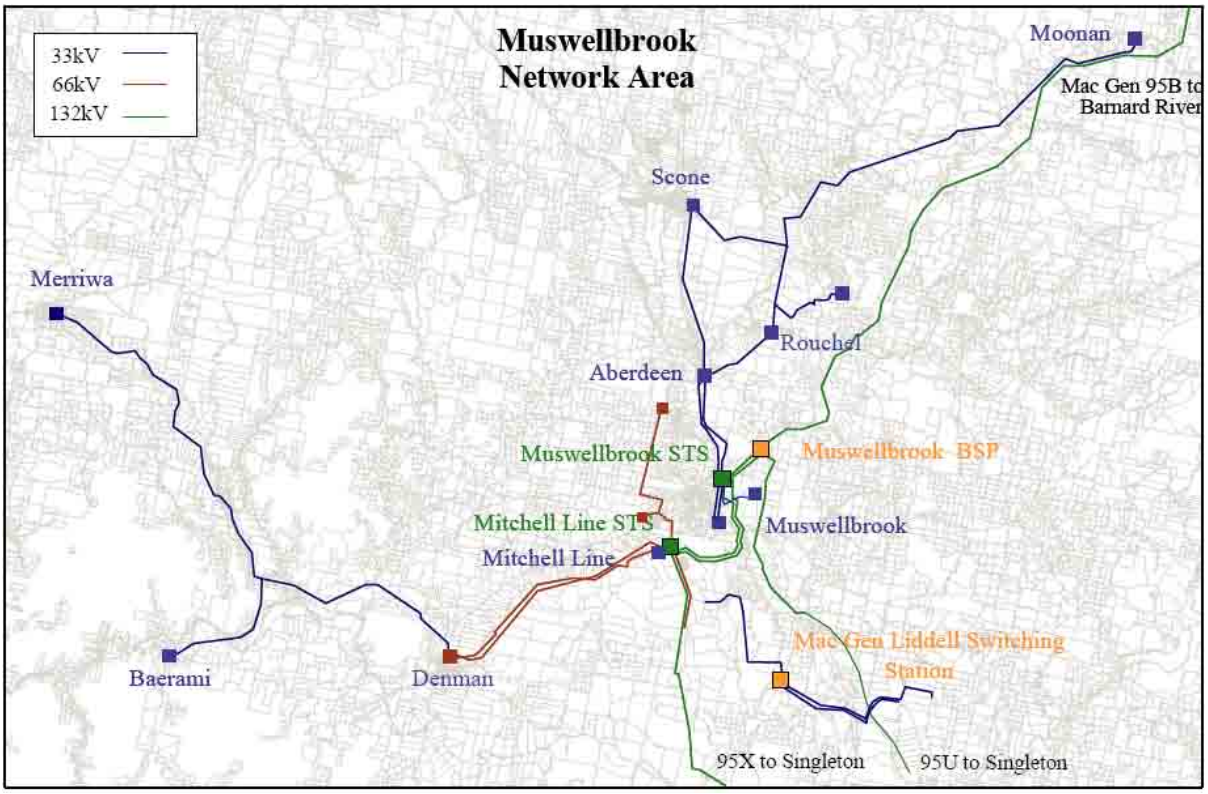


Figure 19.0 Existing Supply Network- Upper Hunter Area (Source: Energy Australia Oct 2007)

19.1.1 Transgrid

The local transmission network is owned, operated and maintained by Transgrid. There are two 330kV lines running from Muswellbrook and Liddell 330kV terminals which bypass the Scone township on the eastern side at a distance of approximately 30-35km. Transgrid were contacted by Econnect and Pamada to determine existing transmission line infrastructure in the region and potential for connection.

A 330kV connection would require the construction and commissioning of 330kV network infrastructure, which is prohibitively expensive for overall capacity of less than 200MW. The transmission line infrastructure is also larger with greater visual impact and community concerns related to landuse issues. Accordingly, the 330kV connection option has not been considered further in this report.

In addition there is a 132kV line that runs from Muswellbrook terminal station to an industrial site owned by Macquarie Generation near Barnard River. The Muswellbrook-Barnard River 132kV circuit crosses the main

road between Scone and Moonan approximately 30km northeast from Scone and is therefore very difficult to access from the proposed Kyoto Energy Park sites. This option was not considered further in this assessment.

19.1.2 Energy Australia

The local area is supplied from TransGrid Muswellbrook 330/132kV terminal station. The local sub-transmission and distribution systems are owned, operated and maintained by Energy Australia. The distribution assets located in the vicinity of the proposed site are limited to the Scone 33/11kV zone substation which is located on the south east part of the town. Scone zone substation is supplied from a Muswellbrook zone substation via two single 33kV circuits.

In addition there is a 66kV circuit that runs from Mitchell line – Dartbrook to supply two local mines sites at Dartbrook (Dartbrook Mine) and Kayuga (Kayuga Mine).

The existing sub-transmission and distribution system in the area consists of an integrated 11kV network servicing local properties.

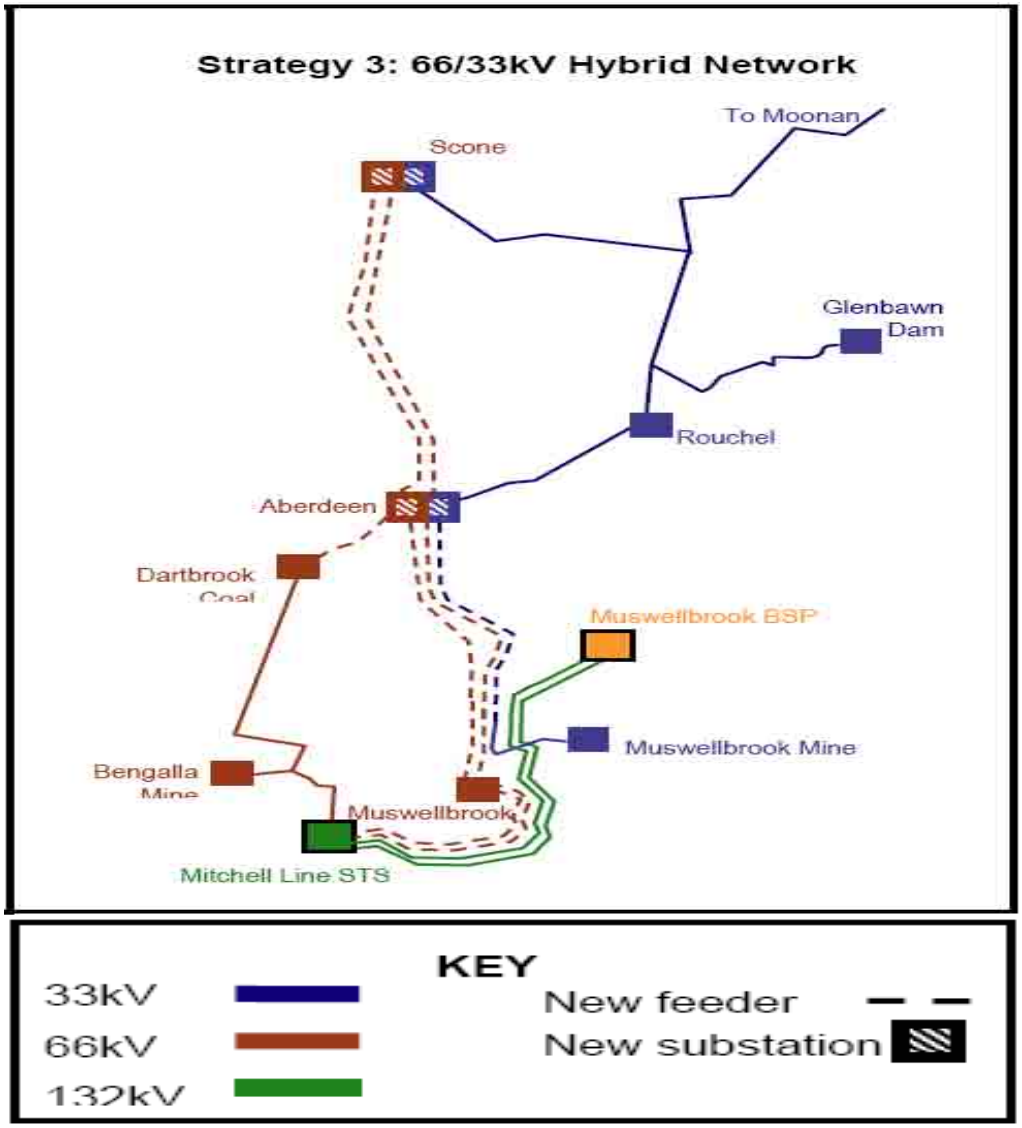


Figure 19.1 Energy Australia Upgrade to existing network (Energy Australia 2007)

Network Upgrade Scone Substation

In September 2007, Energy Australia officially announced a proposal to construct the new 66/33/11kV substation on the outskirts of Scone and an upgrade of the 33kV Scone and Aberdeen supply to 66kV (*see Energy Australia Community Newsletter March 2008 - Appendix P*). These works also included the installation of a replacement 66kV feeder from Kayuga to the new 66kV Scone substation (*see Energy Australia Community Newsletter March 2008 - Appendix P(i))*.

These works were allocated to replace worn and outdated zone substations and line infrastructure and to increase capacity and security in the region. These works were outlined in a paper released by Energy Australia entitled 'Development of New Scone 66/33/11kV Substation (to Address Capacity and Condition Issues in the Upper Hunter Area) dated 15th October 2007.

The new Scone 66/33/11kV substation was under construction at the time of writing this report.

The replacement of the Scone substation works are outlined as follows:

1) Extension of the existing 66kV 'Dartbrook' feeder to the new Scone zone substation (completed in 2009);
2) A new hybrid 66/33kV Scone substation (completed early 2009);
3) Upgrade existing 33kV feeder to a 66kV feeder from Muswellbrook to Scone (completed in 2012)

These works would be important if the Kyoto Energy Park was to connect into the new Scone STS as works under Item 3) above would need to be completed prior to connection i.e. in 2012.

19.2 Connection of the Kyoto Energy Park to the local Grid

19.2.1 Connection Options

An initial feasibility study into the existing electrical power system and connection options for the Kyoto Energy Park was undertaken by Econnect in December 2005. At the time Energy Australia advised that a number of network developments in the Upper Hunter region were planned in the next five years. These works were outlined in a paper released by Energy Australia entitled 'Development of New Scone 66/33/11kV Substation (to Address Capacity and Condition Issues in the Upper Hunter Area) dated 15th October 2007.

Econnect reviewed the original connection study in December 2007 to incorporate the latest project capacity (including solar photovoltaic plant and Energy Australia network developments, to assess their potential impact on the Kyoto project grid integration options. The report prepared by Econnect in December 2007 took into consideration a revised total capacity of up to 90MW of wind turbine generation capacity. The report was prepared assuming that augmentation of the Scone substation was completed by 2012.

19.2.3 Transmission constraints

Three (3) possible connection options were identified as feasible based on consultation with Energy Australia and a connection feasibility by Econnect. The Econnect report is attached as *Appendix L – Kyoto Wind Farm –Prefeasibility Study (Dec 2007).*

Further to this Pamada engaged Vemtec Utility and Infrastructure Services Pty Ltd to conduct a detailed Line Route Assessment. This report is attached as *Appendix M- Vemtec Pty Ltd – Kyoto Energy Park Scone Overhead Powerline Route Review (21 April 2008)*.

Existing network diagrams were supplied by Energy Australia and used to identify options for line routes from the Kyoto Energy Park site substation to the connection point on the grid.

The initial determination of a line route was governed by the following considerations:

- Utilise the ability to upgrade along existing local power lines where economically feasible and practical;
- Positioning of the proposed routes on cleared open land way from existing or proposed residential communities;

- Minimising options for easements over private land where feasible and providing other options;
- Maximising the utilisation of made or unmade road reserves (Crown Road or Electricity Easements);
- Minimise impact of the line route on existing remnant vegetation, either in road reserves or within private properties

Based on the previous information a full inspection of all line route options was undertaken by a Senior Vemtec staff and Pamada in November 2007. Four possible line route options were identified in the study with variations to divert lines around rural centres and residential zonings. Line route options were also selected to ensure no major access restrictions for private landholders or encroachments in to private property.

Further inspections were undertaken by individual environmental consultants (see Section 19.4). An assessment of the possible line route options were then made taking into account economic considerations, line losses over distribution distance, existing network and potential land-use constraints, and roadside vegetation. Furthermore variations to line route options were considered based on planning considerations such as private easements, visual impacts and physical constraints including vegetation and traffic restrictions.

19.2.4 Description of Preferred Transmission Line Routes

Four line route options were investigated by Vemtec and various specialist consultants. These four options are listed in Table 19.0. Based on studies undertaken and consultations two preferred options were identified as Option 2 (66kV to Scone STS) and Option 4 (132 kV to Muswellbrook STS). These two preferred options are illustrated in Figure 19.2.

Option 2 is the preferred option for a final Kyoto Energy Park capacity of less than 90MW, and Option 4 for a Kyoto Energy Park capacity greater than 90MW, as summarised in Section 19.8 Preferred Connection Option. Final option selection will also consider a detailed network flow study prior to construction to verify capacity.

Option 2 (66/33kV)

Option 2 involves the construction of a 66kV line infrastructure for connection to the new Scone STS located south east of the Scone township as shown in **Figure 19.2**. Option 2 would also require the construction of a 33kV line for connection of Middlebrook Station wind turbines to the proposed Mountain Station site substation along Bunnan Road. This option would require significant upgrading of existing 11kV line infrastructure (approximately 72% of works) located in rural road reserves.

Figure 19.4 - The proposed 66kV overhead line route commences at the Mt Moobi escarpment in close proximity to turbines 30 and 31. The route then follows the Crown road easement descending the Moobi escarpment until the intersection of Old Winters Road.

Two options exist for line routes east of Mt Moobi. Option 2A follows Old Winters Rd to the intersection of Yarrandi Rd and Moobi Rd. Option 2B could be considered across private land subject to a separate agreement reached between the subject landholders and the proponent. No potential restrictions to the existing land holders access was evident during inspection.

Figure 19.3 - Two options exist to bypass the rural town centre of Scone for connection to the Scone STS. Option 2A continues along Liverpool St and Kingdon St to the west of Scone bypassing the rural town centre. The route traverses the edge of the Scone Sports Complex and the Scone Sewage Treatment Works replacing existing line infrastructure in these zones. The route then utilises the existing transmission line easement to the south of the Scone Golf Course, but does not traverse it.

Option 2A bypasses built up areas of Scone and recreational areas, utilises the replacement of existing line infrastructure without restricting access to any of these zones. Option 2A does not traverse or encroach upon the Scone Golf Course as it bypasses it to the south.

Option2B is a secondary option traversing private land held by Invermein Pty Ltd. This option would completely bypass the rural centre and allow for a more direct route accessing the existing transmission line easement to the South. This option would be subject to approval by Invermein Pty Ltd for land sharing.

Option 2 would involve works in close proximity to natural waterways, which shall be undertaken in accordance with Energy Australia design standards as described in Section 19.7.2. Option 2 would also include replacement of the existing 11kV overhead line crossing the railway south of Scone. These works would be undertaken in accordance with Energy Australian standards and policies.

Option 4 (132/33kV)

Option 4 is the preferred option for a Kyoto Energy Park capacity in the order of 90MW or greater. This option would involve the construction of a 132kV line for connection to the existing Muswellbrook STS located on the New England highway just north of Muswellbrook (see **Figure 19.2**). This option bypasses rural centres of Scone and Muswellbrook towns. Option 4 would also require the construction of a 33kV line for connection of Middlebrook Station wind turbines to the proposed Mountain Station site substation along Bunnan Road. This option would require significant upgrading of existing 11kV line infrastructure (approximately 85% of works) located in rural road reserves.

Option 4 is utilises the existing rural road reserves and would mainly involve the replacement of existing 11kV line infrastructure along the route. The route follows the Bunnan, Yarrandi, Nandowra, Back Muswellbrook and Kayuga Roads for connection at the Muswellbrook STS point.

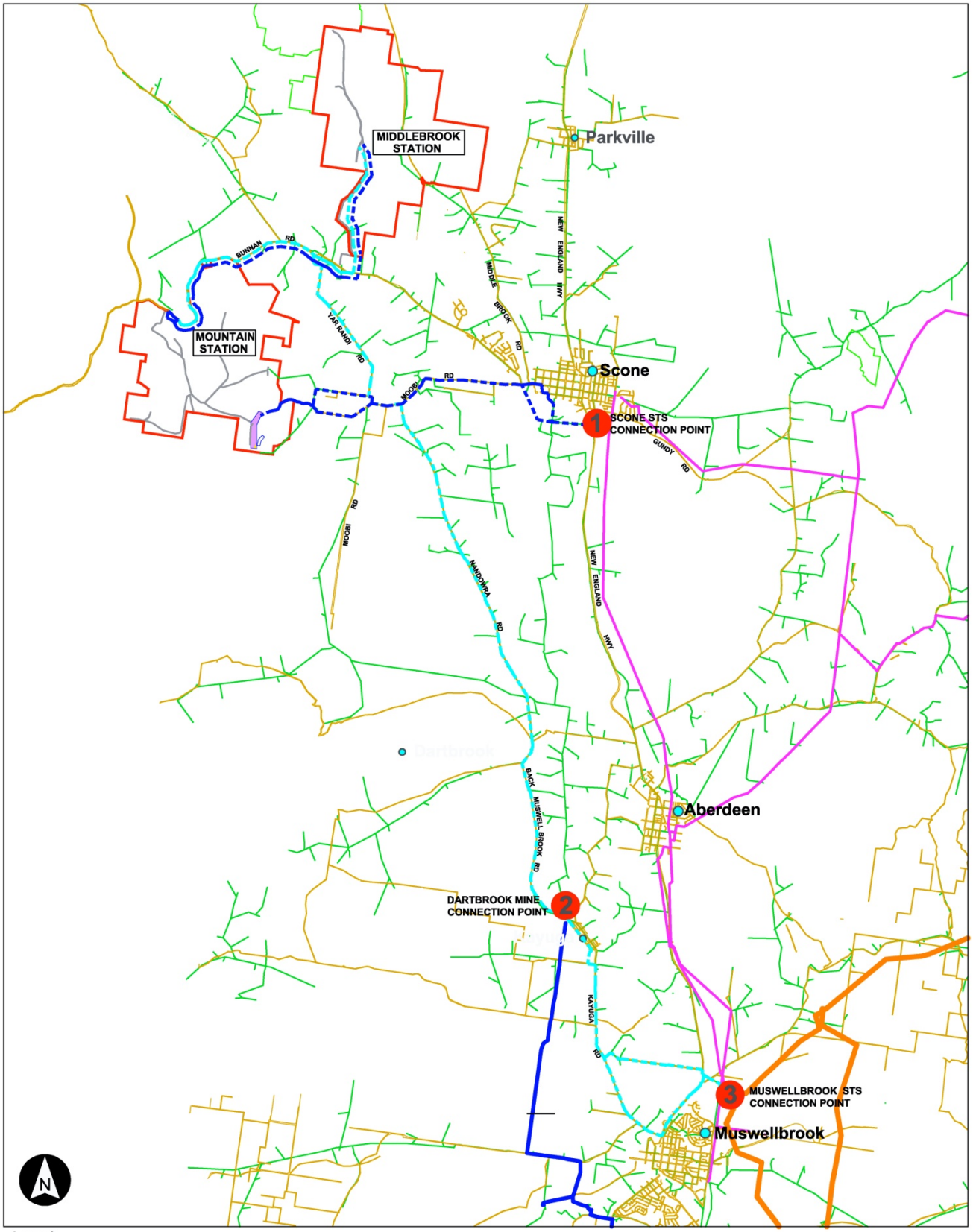
Figure 19.5 – Options exist for alternate routes (Options 4A and 4B) just north of Muswellbrook as illustrated in Figure 19.5. Option 4B is proposed as a more direct route which bypasses rural residential allotments along New England highway. Option 4B would be subject to land sharing agreement with the private landholder. No severance to land access would occur as a result of the proposal.

Option 4 would involve works in close proximity to natural waterways. These works would be undertaken in accordance with Energy Australia design standards as described in Section 19.7.2. Option 4 would also include replacement of the existing 11kV overhead line crossing the main railway north of Muswellbrook. These works would be undertaken in accordance with Energy Australian standards and policies.

Table19.0 Summary of Transmission Connection and Line Route Options

Line Route Options	Line Capacity (kV)	Route Length (km)	Connection Options	Grid Connection Owner	Capacity Constraints	Comments
Option 1	*66/33*kV*	*66kV = 18.6* *33kV = 8.5*	**Connection 1** Scone STS 66kV Terminal	Energy Australia	• Up to 60MW connection capacity until 2009 (Econnect). • Following the upgrade of the Scone- Mitchell Line 66kV feeders up to 90MW of capacity by 2012 (Econnect).	Not preferred option
Option 2 **(Figure 19.2/19.3/19.4)**	*66/33*kV*	*66kV = 12.6* *33kV = 8.5*	**Connection 1** Scone STS 66kV Terminal	Energy Australia	• As Above	**Preferred line route for Kyoto Energy Park capacity less than or equal to 90MW based on flow analysis.**
Option 3	*66/33*kV*	*66kV = 32.3* *33kV = 8.5*	**Connection 2** Tee Connection to Dartbrook Mine 66kV feeder.	Anglo Coal Pty Ltd	• Tee connection to the Dartbrook 66kV feeder will provide sufficient network capacity for up to 60MW (Econnect). • Additional capacity may be added but will require the re-construction of the existing Dartbrook-Mitchell line 66kV circuit. •	Not preferred option
Option 4 **(Figure 19.2/19.5)**	*132/33*kV*	*66kV = 41.6* *33kV = 8.5*	**Connection 3** Muswellbrook 132kV STS Terminal	Energy Australia	A connection to Muswellbrook 132kV terminal will provide the required capacity to connect in excess of 150MW of capacity	**Preferred line route option for Kyoto Energy Park capacity greater than 90MW**

** Includes provision for a 33,000V (33kV) interconnector between Mountain and Middlebrook Station sites.*



Legend:

- Major & Minor Rural Town Centres
- 1 Connection Point Option
- Minor road

Existing Transmission Network
- 11kV Line
- 33kV Line
- 66kV Line
- 132kV Line

Prefered Transmission Route Options
- Option 2 , 66kV Line
- Option 4 , 132kV Line

0 2.5 5.0
Kilometres

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Figure 19.2 - Preferred Transmission Route Options 2 and 4 (Overall)

pamada A4

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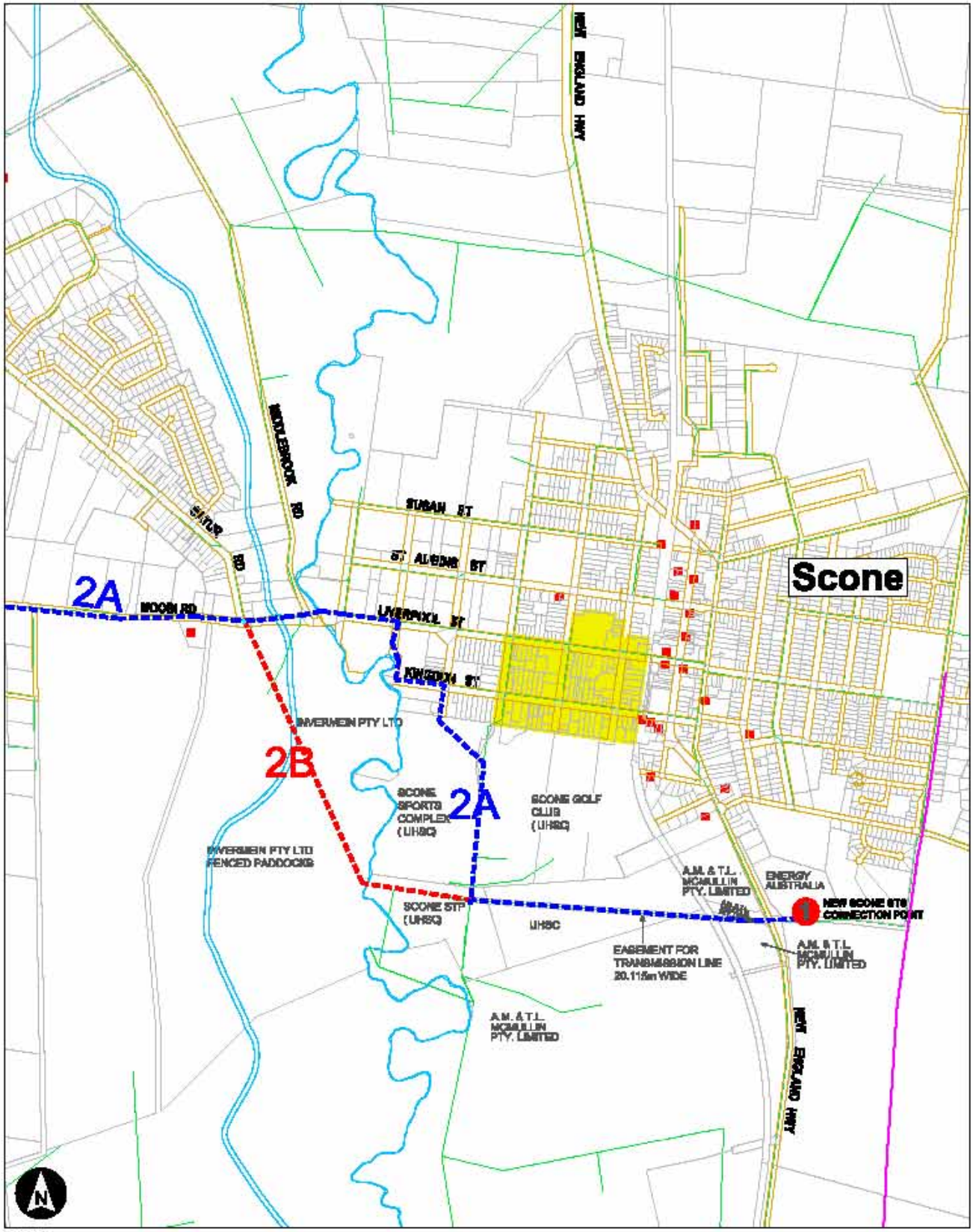

Legend:

Existing Line Route
- 11kV Line
- 33kV Line

Proposed Line Route Variations
- Option 2A 66kV
- Option 2B 66kV

Heritage Conservation Zone

Identified Heritage Item

1 Grid Connection Point

0 500 1000 Metres

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Figure 19.3 - Prefered Transmission Option 2 (Scone Detail)

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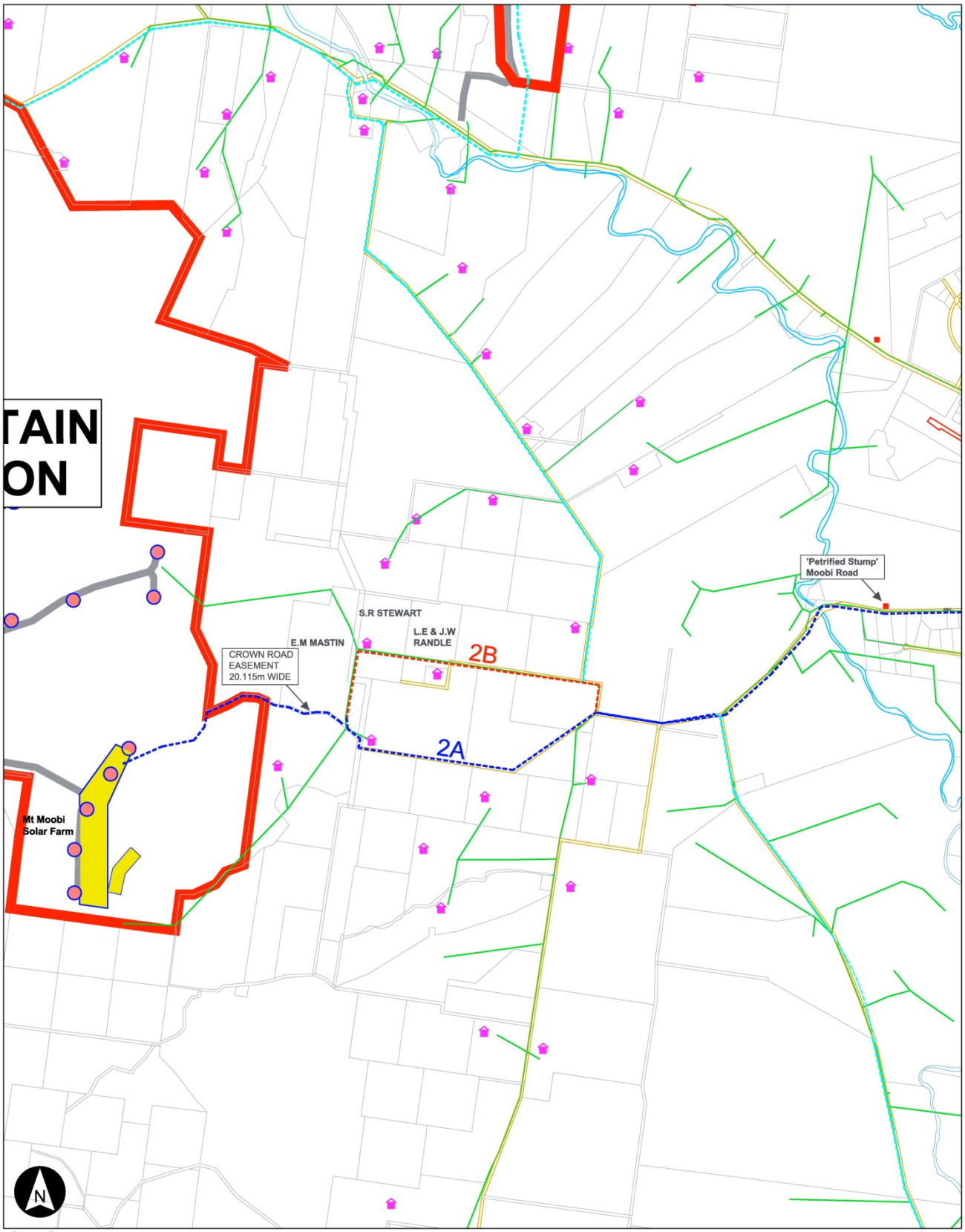

Legend:

Existing Line Route
11kV Line

Proposed Line Route Variations
Option 2A 66kV
Option 2B 66kV

Residence

0 1 2
Kilometres

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Figure 19.4 - Prefered Transmission Option 2 (Moobi Detail)

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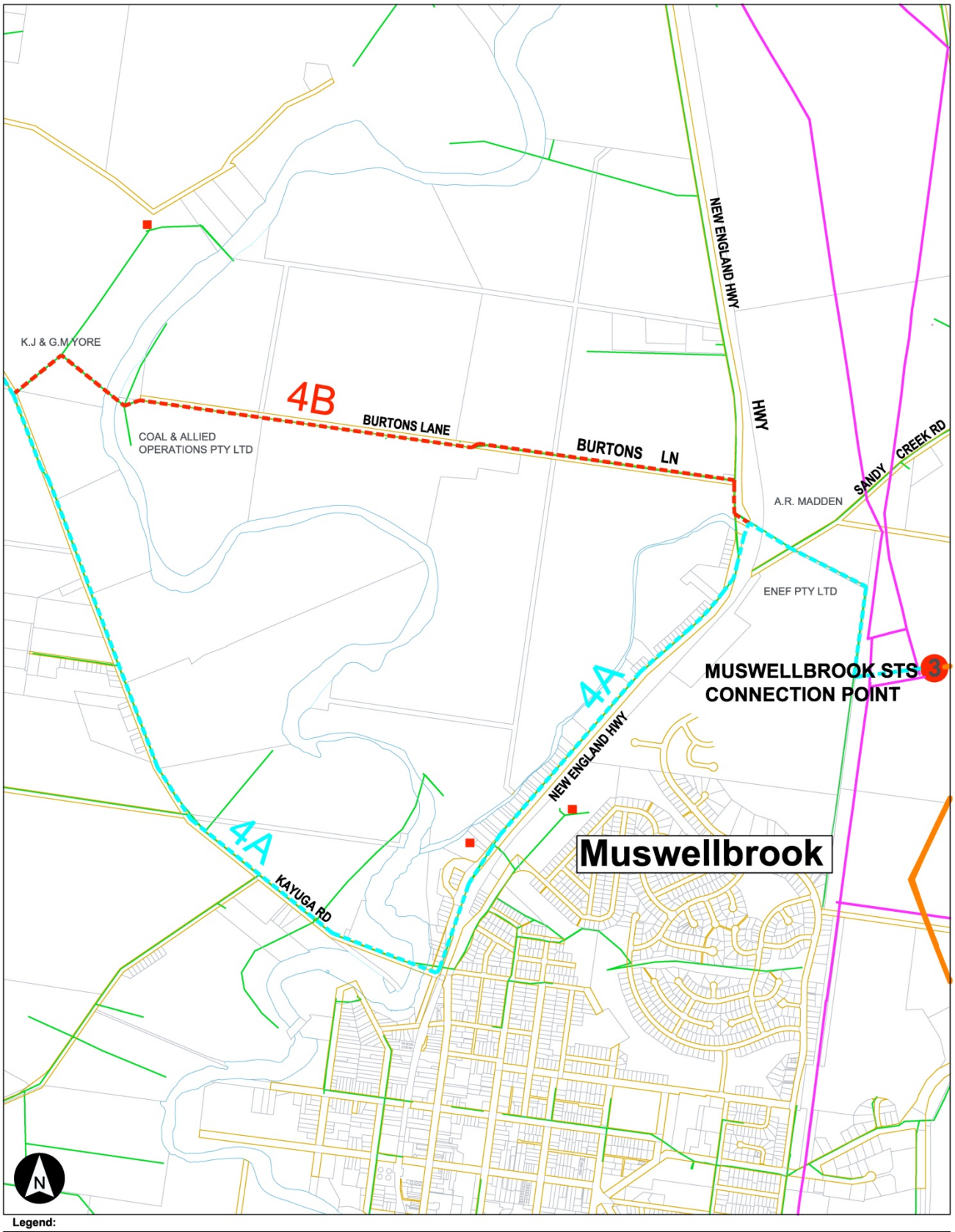

Legend:

Existing Line Route
- 11kV Line
- 33kV Line
- 132kV Line

Proposed Line Route Variations
- Option 4A 132kV
- Option 4B 132kV

- Identified Heritage Item
- 3 Grid Connection Point

0 500 1000
Metres

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Figure 19.5 - Prefered Transmission Option 4 (Muswellbrook Detail)

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19.3 Community Consultation

Pamada initially set up a Community Register to engage community and residents and gain feedback on the proposal. Ongoing community consultation including face to face meetings with residents, group meetings and general feedback has resulted in feedback over the proposed line route options for the Kyoto Energy Park.

Further information was gained during a Community Information Day was held at the Scone Equine Centre on Saturday 16th February 2008. Some 150 local people attended the day and 56 feedback forms were received based on various issues including overhead line route implications. Diagrams were displayed at the Day showing locations of proposed line routes for public comment. Some of the residents have expressed concern with line route locations mainly visual impacts and EMF implications for health. Consultants were available on the day to review comments from the public.

Comments received from the Community Day and ongoing discussion with individual members of the community were taken into account in the assessment. This generally translated into bypassing areas in residential zones, built up areas and houses located close to poles in road reserves. Many people were concerned that a tower type structure was being considered and potential health and visual impacts on the landscape from the pole infrastructure.

Visual mitigation factors have been summarised in Section 19.4.6. Further analysis of EMF implications have been addressed and summarised in Section 19.4.8.

19.4 Environmental Assessment of Proposed Transmission Line routes

Environmental and social assessments were undertaken for four line route options identified in the Vemtec report including:

- Flora and Fauna Surveys for line route options (Conacher Environmental Group)
- Aboriginal cultural assessment (Myall Coast Archaeology)
- European Heritage Impact (Myall Coast Archaeology)
- Soil Management (HDB Town Planning)
- Fire Risk (Conacher Travers)
- Visual impact assessment (Integral)
- Noise Compliance (Wilkinson Murray)
- Impacts of Electro Magnetic Fields – EMF (Vemtec)
- Landuse Issues (Vemtec/HDB Town Planning)
- Community Consultation (HDB Town Planning/Pamada/Key Insights)
- Government Consultation (HDB Town Planning/Pamada)
- Consultation with Utilities (Econnect/Vemtec/Pamada)

The findings and recommendations resulting from these investigations are summarised below and discussed in reports contained within relevant Appendices.

Recommendations for mitigation strategies have been included in the Statement of Commitments in Section 20.6.3 to this report.

19.4.1 Flora and Fauna Impact

Preferred Line route options predominantly follow existing roads and it is proposed that all transmission lines will be contained within road reserves and existing easements where possible. A full inspection of proposed transmission line route corridors was undertaken on separate occasions by:

1. Vemtec Pty Ltd – to identify remnant vegetation along line routes that would impact upon line route feasibility, and;
2. Conacher Environmental Group to determine if any threatened flora and fauna species were evident along route lines.

Vemtec identified small stands of remnant vegetation along Bunnan Road in the vicinity of the two sites. Selective trees may need to be removed as pole structures will be required on both sides of the road reserve

to allow for communication lines between the two sites. Minimising the impact on existing remnant vegetation, will be a high priority during line construction activities. It is anticipated that remnant vegetation may only have to be removed in circumstances where:

- no viable alternative can be determined (e.g. agreement can not be reached with private land owners to deviate around remnant vegetation);
- the vegetation species presently, or are likely in future, to infringe upon the required electrical clearances stipulated under appropriate electricity industry

No threatened species were observed by Conacher during there inspection of line routes. No significant environmental constraints were observed during line route studies. The remnant vegetation along proposed line routes consisted mainly of disturbed vegetation with scattered tree species such as Ironbark, White Box, Grey Gum, Forest Red Gum, Angophora and Callitris. Any vegetation removal would only require removal of occasional trees.

In the original Vemtec line route survey some remnant vegetation was noted along Bunnan Road in the vicinity of Mountain Station that may require removal during the upgrading of overhead lines. Following the Vemtec assessment Conacher surveyed the line routes and for ecological significance. Conacher noted that a negligible amount of the EEC, mostly isolated trees, may be required to be removed for the construction of the transmission line from the northern end of Mountain Station (66kV and 132kV) and southern end of Middlebrook Station (33kV) to the Bunnan road reserve. The selective removal of the EEC within adjacent properties as above has been included in the vegetation removal summarised in Section 8.2 of this report. A summary of the Conacher survey is provided in Appendix A Section 5.3.2.

It is therefore considered that the construction and operation of the transmission line routes required to connect the Kyoto Energy Park to the electricity grid will have a negligible impact on biodiversity, flora and fauna for all line routes.

19.4.2 Aboriginal Cultural Assessment

All line routes were inspected by the Myall Coast Archaeological for the presence of Aboriginal artefacts, objects, or any impacts on places of Aboriginal heritage significant. No places of Aboriginal significance were observed along external line routes by the consultant, or the presence of aboriginal artefacts or objects.

Line routes are mainly located along existing line routes and road reserves, and would require replacement of the existing wooden pole configurations with new concrete pole configurations. Final pole configuration (i.e. 66kV or 132kV) will depend on final capacity of the Kyoto Energy Park facilities.

If Aboriginal Objects or artefacts are discovered during pole excavation works or during ground disturbance, then all work shall cease and appropriate strategies for mitigation of impacts shall be developed in consultation with the Aboriginal Stakeholders and in accordance with the Act.

19.4.3 European Heritage Impact

Assessment methodology

The proposed line transmission infrastructure was assessed to determine firstly if any known items of heritage existed along any of the proposed line route options and potential impacts associated with the a) location of the transmission infrastructure in relation known items of heritage and b) if transmission construction works could potentially damage the known Item.

Myall Coast Archaeological Services initially investigated and surveyed four (4) possible line route options for connection of the Kyoto Energy Park to the electricity grid. Based on studies as discussed in this section Pamada are considering two (2) options for connection Option 2 and Option 4. The final option will be selected based upon the final design considerations as discussed in Section 19.8.

European Heritage Impact

Both preferred options for connection including Option 2 (66kV) and Option 4(132kV) involve replacement of existing distribution lines (11kV) along existing networks. The proposed upgrade works in the vicinity of the known items are likely to consist of changing the pole material and configuration from timber to concrete. Some poles will be replaced with new timber poles generally in areas closer to towns or in character with

existing residential zones with timber pole structures. The proposed changes are in line with best practice for electrical transmission purposes and generally replaced as required.

Pole Configuration and Heights

The existing network in the vicinity of the Kyoto Energy Park consists of 11kV timber poles, typically 11 to 12.5 metres high, with conductors arranged in a horizontal fashion (see Figure 19.6 below on the left). During upgrade works these poles would be replaced by concrete poles in similar arrangement to that shown in Figure 19.6 on the right. Concrete poles would be painted olive green to blend into the environment.

New concrete poles (66kV and 132kV arrangements) would be typically 18.5 to 26 m in overall height dependent on final line design considerations (pole application, numbers of conductors, spacing and strength of foundation material at pole base). The 11kV conductor arrangement would be replaced on these new poles at a distance of about 2.5m below the lowest high voltage conductor. Standard 66/132kV line and pole construction assemblies are provided in *Appendix M –Vemtec 21 April 2008.*

Figure 19.6 Photographs showing existing timber poles (left) and proposed replacement concrete poles (right) (Energy Australia 2007)

Line infrastructure works would require pole foundations to be excavated with an auger fitted to a truck or small excavator. Poles would then be concreted into place, prior to ‘stringing’ of overhead lines. The overall depth of pole excavation would be 2.5 – 3.5m depending on pole spacing, foundation strength, line tension and also pole application (e.g. terminal or intermediate pole).

Vibration would not be a concern as pole foundations would be excavated in compacted alluvial deposit typical of the Hunter alluvial sediments. Excavation in solid rock would generally not be required. If required it would be limited to routes accessing the site or within the sites, at considerable distance from any Heritage Items or other building structures.

In consideration of the above factors all identified Heritage Items were found to be at sufficient distance from any proposed line works for vibration to be considered an issue for further consideration.

Option 2 - 66kV connection to the new Scone STS

Preferred variations routes to the south of Scone township are shown in Figure 19.3 including Options 2A and 2B. These options bypass the Heritage Conservation Zone and most heritage items. Variations 2A and 2B were found to pass within relative proximity to four known items of local heritage (Listed on Schedule 3 of the Scone LEP). Three of the known items were found to be at sufficient distance to not have any impact. The fourth know item which passes a petrified stump located on the road verge on Moobi Road (see Figure 19.4).

The petrified stump is a protected by a cage as it is situated alongside Moobi Road as shown in Figure 19.7 below. The petrified stump is a geological item that is close to the road pavement and existing transmission line infrastructure.

Proposed works include replacing the existing pole and line infrastructure with a new 66kV line configuration. Any damage to this item is unlikely however measures would be adopted during construction to ensure this does not occur. It is recommended that the closest pole near the petrified stump be placed the maximum distance possible.

Figure 19.7 Petrified stump in cage, Moobi Road (Line Route Option 2)

Option 4 - 132kV connection to the Muswellbrook STS

Option 4 includes a connection to the existing Muswellbrook STS as shown in Figure 19.6. This route will require the replacement of existing 11kV distribution line with a new 132 kV pole configuration. The proposed route (with proposed variations) is illustrated in Figure 19.2 and 19.5. All routes have been assessed and are at sufficient distance from any heritage items to ensure there is no impact to these items.

European Heritage Recommendations

Myall Coast Archaeological made the following recommendations:

- The petrified stump is protected by a cage structure as it is located close to the road edge. Any damage to this item is unlikely however measures will be adopted in the CEMP to ensure this does not occur. It is recommended that the closest pole near the petrified stump be placed the maximum distance possible.
- Option 2B (Figure 19.3) or a combination of 2A and 2B would be the preferred option from a precautionary heritage approach.
- Option 4 (Figure 19.5) involving a 132kV line will replace existing distribution lines over the route and will have no impact on known items of European Heritage.

19.4.4 Soil Management

Depending upon specific land conditions and the time of year line construction activities are undertaken, there is a possibility that some areas along the line route may suffer from furrowing or pasture damage, arising from the passage of heavy vehicles and equipment, particularly across private easements.

Preventative and remedial measures can however be undertaken, to limit such impacts. These include, but are not limited to:

- reinstatement of affected areas;
- establishment of agreed access procedures with land owners, to minimise vehicle movements on the property and avoid sensitive or significant land areas etc.
- scheduling of the construction activities to times of dry weather conditions (i.e. summer)

19.4.5 Fire Risk

If the transmission line construction activities are conducted during periods of high fire risk, the passage of vehicles over paddocks and/or vegetated areas, could introduce a potential fire hazard. In order to mitigate or limit this risk, all construction crews will be required to carry suitable fire suppression equipment, when undertaking works during declared fire risk periods. The passage of vehicles and equipment could introduce a small risk of fuel/oil spillage during the works. Construction contractors will be required to carry appropriate oil spill containment kits.

19.4.6 Visual Impact

The visual impact of the transmission lines were addressed as part of the comprehensive Visual Impact Assessment (*Appendix B*) conducted by Integral Landscape Architecture and Visual Planning. Integral inspected line route options and visual impacts of existing infrastructure.

Visual impact assessment included recommendations for line routes and recommendations for mitigation of visual effect associated with pole structures. The final line route will be based mainly on final design capacity of the Kyoto Energy Park (see Table 19.0) with two (2) options available. Regardless of this, the lines will predominantly be located on road reserves replacing existing power poles. The installation of new, taller poles will occur and with the increased height comes increased visual effect.

The preferred line route options are 2 and 4. Following final route selection, a detailed visual evaluation will provide visual mitigation strategies, for the preferred line route option.

19.4.7 Noise Compliance

Noise impacts were assessed as a part of the comprehensive Noise Impact Assessment (*Appendix D*) undertaken by Wilkinson Murray Pty Ltd . Overhead powerlines would either replace existing lines or be constructed as new lines, for connection of the Kyoto Energy Park to the grid.

The noise assessment undertaken by Wilkinson Murray recommended that noise levels would be predicted to exceed criteria for a few days at residences within 200m of the line alignment. Transmission Line route Option 2 and 4 would be the most favourable route based on these noise criteria. These options bypass the least numbers of residencies in proximity to the line routes.

The assessment concludes that given the large distances from the Kyoto Energy Park to the residences, vibration from construction would not be perceptible.

19.4.8 Electro Magnetic Fields (EMF)

Vemtec Pty Ltd made an assessment of potential impacts of Electro-magnetic fields on household residencies in the vicinity of the proposed line route options.

In Australia, the determination of recommended maximum EMF exposure limits is governed by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) administered through the Australian Radiation Protection and Nuclear Safety Act 1998 and Regulations 1999 and by other regulatory instruments and public health organisations.

There are currently no specific Australian Standards regulating exposure to power line frequency EMF's. ARPANSA references the current standards as the "Interim guidelines on limits of exposure to 50/50 Hz electric and magnetic fields", as issued by the National Health and Medical Research Council (NHMRC).

In December 2006 ARPANSA introduced draft standards known currently as 'Radiation Protection Standard – Exposure Limits for Electric & Magnetic Fields - 0Hz to 3kHz". These standards are still in draft form but introduce a 'basic restriction' to ensure that there is no biological effect leading to adverse health outcomes as follows:

EMF Compliance

During the investigation stages of the project all transmission line routes were surveyed by Vemtec and Pamada for potential landuse restrictions. The Kyoto Energy Park proposes to utilise either 66kV or 132kV transmission lines for connection of the Kyoto Energy Park to the local electricity grid. These line routes are proposed to utilise existing alignments with upgrades, mainly in road reserves, while bypassing built-up areas with houses located adjacent to existing line infrastructure. Potential impacts of EMF on surrounding houses both present and future (based on landuse zonings) were considered along all line routes.

EMF's decay exponentially as a function of distance from their source. This means that the EMF arising from the transmission line network will diminish rapidly with distance from the line route. Figure 19.8 below, provides a typical cross section EMF profile of a 66kV and 132kV line operating at full current rating or Kyoto Energy Park capacity.

This graph shows that typical Magnetic Field strengths (mG), measured a metre from the ground at a distance from the line.

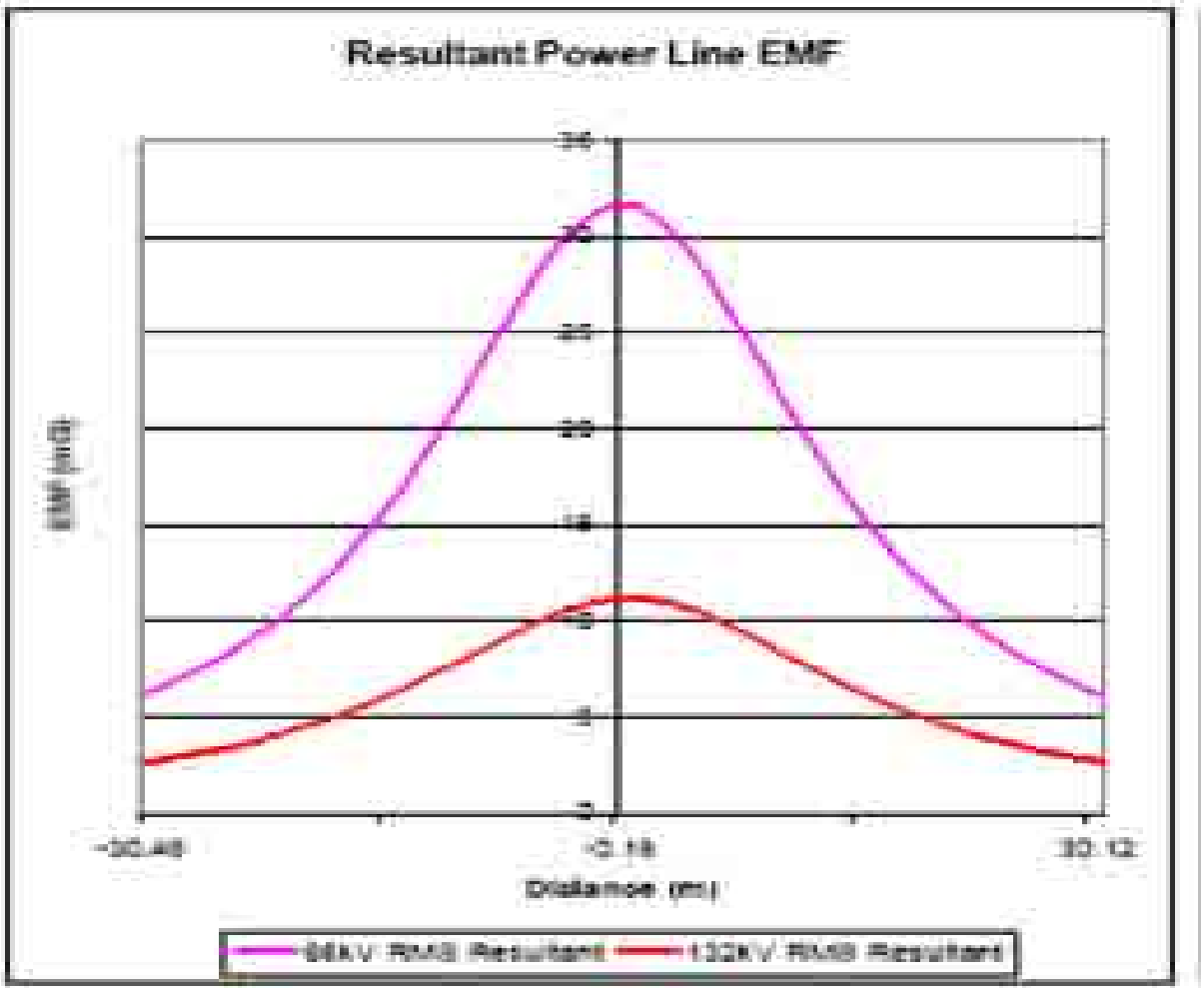


Figure 19.8 Typical 66,000 & 132,000 Volt Line EMF Profile (Vemtec 2008)

EMF compliance with both the NHMRC (current guidelines) and the ARPANSA (draft standards) are assessed in Table 19.1 below.

Thus it can be established that given the use of the standard construction design as per the drawings outlined in the Vemtec report entitled line configuration table (or similar) the EMF exposures will be managed at levels well below the currently accepted limits. No potential impacts from EMF were found in the assessment.

Table 19.1 – EMF Compliance with NHMRC and ARPANSA standards

Electro Magnetic Field (EMF) Compliance

Line Configuration	NHMRC Standard (Current)		ARPANSA (Draft 2006)	
	(General 24 hr Exposure) (mG)	EMF @30m (mG)	General Public 50HZ (micro Tesla)	EMF @30m (micro Tesla)
66kV Configuration	**1000**	**6**	**100**	0.624-3.16
132kV Configuration	**1000**	**2.5**	**100**	0.26-1.12

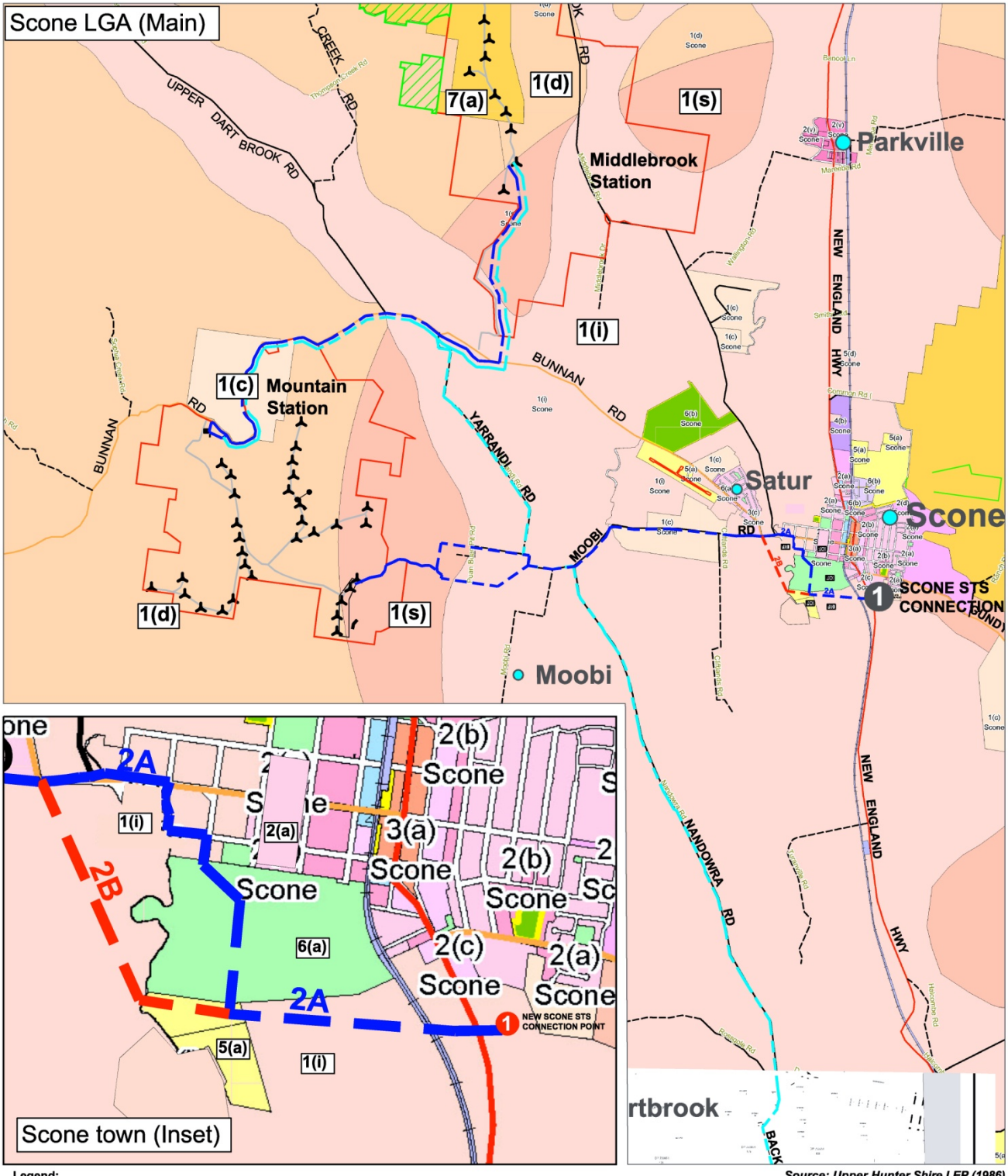
19.4.9 Landuse Impacts

No significant landuse issues or constraints were observed with the preferred line route options, however built up areas and rural centres and residential zones have been avoided where possible. Line routes are predominantly located in road reserves, road easements and transmission line easements. Some variations are proposed to utilise easements over private property to bypass built up areas in the vicinity of Scone (Option 2) and Muswellbrook (Option 4). Acceptance of these variations would be subject to negotiations with respective private landholders following receipt of approval for the overall project. These proposed variations to line routes over private land are represented as Option 2B, Scone (Figure 19.3), Option 2B, Moobi (Figure 19.4), and Option 4B, Muswellbrook (Figure 19.5).

Figure 19.9 below illustrates the landuse zonings for Transmission Option 2 within the Scone Local Government Area (LGA). As shown the route has been chosen to avoid main roads and built up areas while replacing existing distribution networks (11kV) mainly within existing road reserves.

Figure 19.10 below illustrates the proposed route for Option 4 (Dartbrook Mine/Muswellbrook STS Connection) north of Muswellbrook and within the Muswellbrook LGA. This proposed route would replace mainly replace existing distribution lines (11kV) as shown.

Figures 19.9 and 19.10 also highlight variations (represented as 2B,4B) for these routes. Figure 19.9 highlights transmission line option 2 in relation to local zonings of the Scone LEP 1986, being the current legislation. Figure 19.10 highlights transmission line option 4 in relation to local zonings of the draft Muswellbrook LEP 2008. It is important to note that the permissibility of transmission line networks against local zonings is not an issue as the proposed transmission line works would be permissible without consent under Division 5, Clause 41 of the Infrastructure SEPP as the Proponent meets the definition of an “electricity supply authority” and the works meet the definition of “development for the purpose of an electricity transmission or distribution network” (see Section 4.3.7).



Kyoto energypark

Figure 19.9 - Line Route Option 2 and 4 - Landuse zoning (Scone LGA)

pamada A4

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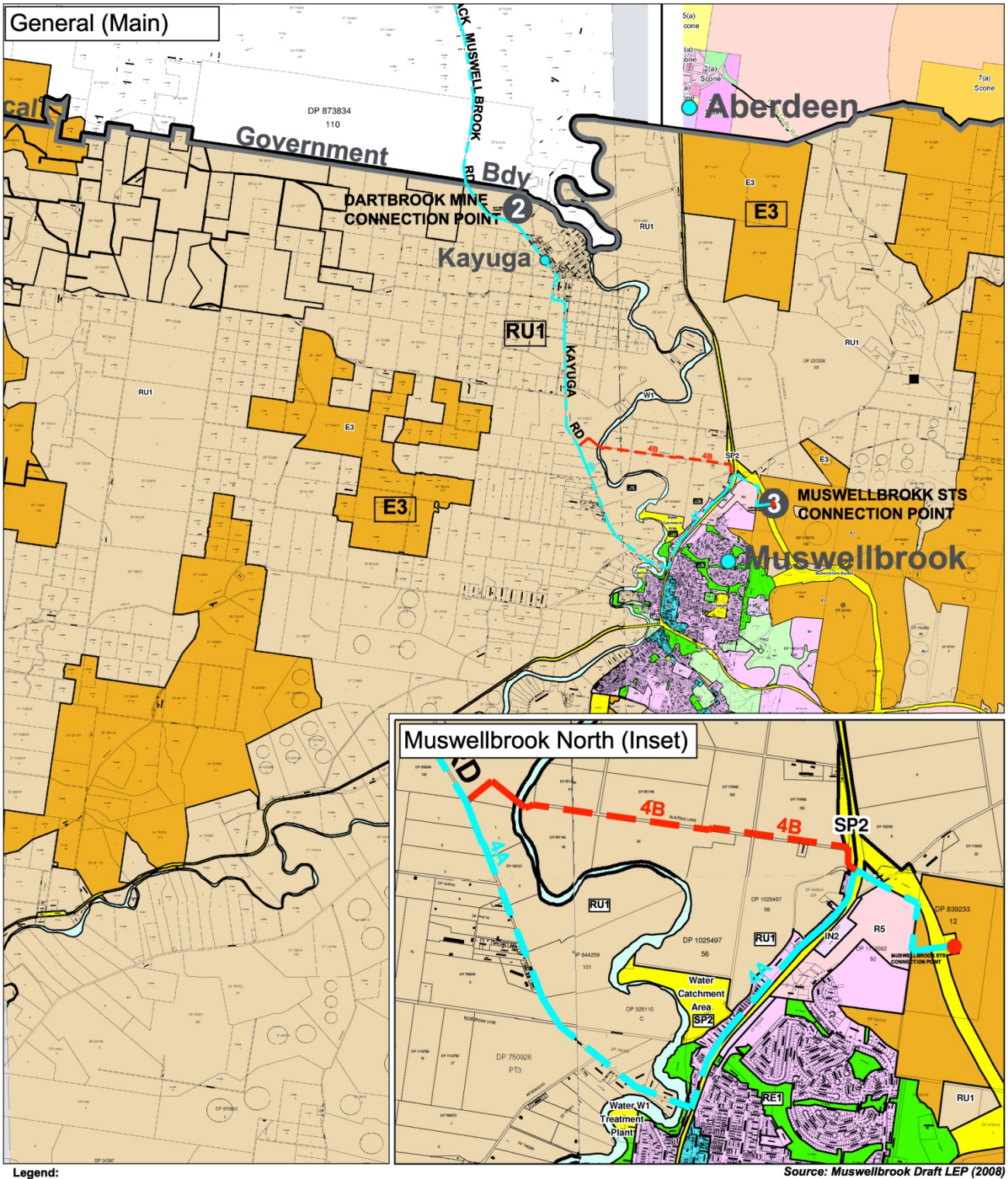

Kyoto energypark

Figure 19.10 - Line Route Options - Landuse zoning (Muswellbrook LGA)

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19.5 Government Consultation

Four options for connection were considered in the assessment. Energy Australia advised that the most favourable option was Option 2 (66kV connection to Scone STS) and Option 4 (132kV connection to Muswellbrook STS). The Upper Hunter Shire Council confirmed preference was for Option 3 and Option 4 as this route bypasses existing residential landuse zones and Scone.

19.6 Consultation with Energy Australia/Transgrid/NEMMCO

On 22 August 2007, Econnect lodged a Connection Inquiry (on behalf of Pamada) with Energy Australia for connection of approximately 90MW of renewable generator capacity (wind solar and mini-hydro) to the existing Energy Australia network. A response was received from Energy Australia on 13 December and 18 December 2007.

Ongoing consultation with Energy Australia has taken place since lodgement of the original Connection Enquiry. Energy Australia were supplied with the line route investigation undertaken by Vemtec into possible feeder routes from the Kyoto Energy Park to connection point. The Vemtec report included 3 possible connection options and 4 line route options. Pamada received comments back from Energy Australia on 30 July 2008.

A meeting was held with NEMMCO in August 2008 regarding connection options. NEMMCO indicated that they are currently undertaking a load stability analysis of the Upper Hunter network. NEMMCO also indicated that the 132kV connection may be the best option for the Kyoto Energy Park connection to reduce fault level potential with the 66kV connection.

In summary Energy Australia expressed reservations over connection to their 66kV network at any location with potential impacts associated with voltage regulation, stability, loading and protection. Energy Australia recommended that a detailed system analysis is undertaken at the time of system design for any connection. Energy Australia preference was for Option 4 (132kV). Second preference was for Option 2 (66kV) to Scone.

19.7 Final Transmission Design Considerations

19.7.1 Private Easements

Where possible, line routes shall follow existing roads, and be contained within the road reserve. The two preferred line routes options for electrical reticulation include provision for easements across private land. During final design of the line route affected landowners will be consulted on a broad range of issues.

Such issues may include:

- Agreement from the landowner to encroach upon or pass the land (i.e. create and easement for transmission);
- Subject to and agreement a preference for line route for example a land owner may prefer the line route to run adjacent to an existing fence line or property boundary;
- Current land use and future development plans for the property (if any);
- Seasonal access conditions or other relevant constraints, which may have a bearing on where and when line construction activities could be undertaken.

Assuming an agreement is reached between a land owner and Pamada for the line route to encroach upon, or pass through private property:

- An easement will be registered on land title documents in favour of the Line owner Easement widths shall normally be as specified in NS 143, or in any supporting documentation prepared justifying the need for departure from these standards. The width of an easement is defined by its function and the various tasks necessary to operate and maintain the asset it covers. It should also ensure that no unreasonable safety hazards are created for the owner of the land or the public generally. The principal determinant of easement width for overhead lines is safety clearances and conductor blowout distance.
  The typical easement widths as specified by Energy Australia are
  - 33,000 V (33kV) = 15/20metres
  - 66,000 V (66kV) = 20 metres

- 132,000 V (132kV) = 30 metres

This would generally represent the maximum width of easement for most cases of span lengths and specific terrain issues for the Kyoto Energy Park.

- The legal costs of establishing the easement on the Land Title will be borne by the developers. If a land owner wishes to obtain their own independent legal advice concerning the establishment of the easement, such costs will be borne by the land owner;
- Typically, the land owner is compensated for the establishment of an electricity easement. Common industry practice is to consider factors such as the market value of the area occupied by the easement, the number of poles and/or pole support "stays" on the property, and effects on existing land use

Easement widths given above are maximum widths but could be reduced based on pole spacing and function determined during final design of lines. Transmission easements have been located to minimise clearing of trees, and to reduce visibility from neighbouring houses. Clearance of vegetation surrounding line infrastructure would be undertaken in accordance with Energy Australia Standard NS179 Vegetation Safety Clearances (April 2002). Selective vegetation clearances would be required around poles (at 3m radius) and along lines as specified in Table 1 of NS179. Shrubs and other vegetation to a height of 3m would not be cut.

The preferred route for power reticulation to the connection point would be finalised taking into account commercial discussions with Energy Australia and final design phases during the connection agreement.

Figure 19.11 Typical Concrete Pole Configuration (Energy Australia 2008)

Transmission line Option 2 includes

19.7.2 Transmission Line Standards and Design

The existing transmission system in the area consists of an integrated 11kV network servicing local properties. Line works would involve replacing existing 11kV network along the final line route as required with a 66/11 or 132/11 kV pole arrangement. These poles would be designed to accommodate existing

communications lines as per Energy Australia standards. Pole arrangements interconnecting Middlebrook Station to Mountain station would consists of 66/33/11 kV pole arrangement. Separate poles may be used for communications only between Middlebrook and Mountain Station sites along Bunnan Road. The new transmission lines would be supported on either concrete or wooden pole structures, where possible replacing the existing 11kV wooden poles. Power pole heights would vary depending upon pole type, configuration and use. Pole would be spaced approximately 100 – 150 metres apart depending on terrain. Options for pole configuration have been fully described in *Appendix N Vemtec Pty Ltd – Kyoto Energy Park Scone Overhead Powerline Route Review*.

Concrete pole configurations are the preferred pole configuration for the area and will be used in preference to existing timber poles (see typical configuration Figure 19.9). Where a new line requires the upgrading of an existing line to some extent, the existing poles shall be used where suitable. If this results in a predominantly timber line, then any new poles shall normally also be timber, although concrete poles may be used where access or environmental conditions make it more appropriate.

It is proposed that all transmission line infrastructure works external to the site shall be dedicated to the network distributor (Energy Australia) for ongoing management and maintenance subject to final negotiation. Transmission line infrastructure internal to the site including the site substation would most likely be owned and maintained by the proponent. During decommissioning only internal transmission line infrastructure would be decommissioned and removed including all internal cabling, networks, and site substation.

All line works shall be in accordance with Energy Australia methodologies and standards including line work in close proximity to waterways and rail lines. Lines would be strung across waterways and would not interfere with the flows or hydraulic or geomorphic functions of the waterways. Final line and pole design shall take into account pole configurations around waterways and design parameters. All lines including pole design, material and configuration, upgrading of existing lines shall be undertaken in accordance with Energy Australia's standard NS 135. Vegetation clearing shall be in accordance with Energy Australia standard NS 179 Vegetation Clearing. Pole boring and pole erection shall be in accordance with NS 128. Pole positioning shall be in accordance with NS 167.

19.7.3 Line Construction Environmental Management Plan

A Line Construction Environmental Management Plan (LCMP) will be implemented for line construction works to minimise the impacts from line construction operations on the local community, surrounding properties and effected landowners. Planning and implementation of the construction activities associated with the new line will take into consideration the following issues:

- any seasonal or other land access restrictions likely to influence construction activities;
- logistics and materials storage considerations;
- the number and availability of accredited construction resources and contractors;
- minimising both the number and duration of disruptions to the power supplies of customers affected by the construction works;

During the construction of the line, it is proposed to inform affected land owners and the broader community, of key project planning and construction activities, by periodic correspondence and/or local media announcements.

19.8 Preferred Connection Option

The preferred connection option and associated line route has not been decided. Matters requiring resolution include:

- Final overall generation capacity of the Kyoto Energy Park. Final design capacity currently estimated between 93 to137 MW. A number of factors may impact on this final capacity including Aviation impacts on Middlebrook station, Wind Turbine Capacity (2.1-3 MW) and solar PV Plant size (3-10MW);
- Assessment of the impact of loads coming on line (eg new mines) on the overall network at time of Connection Application;
- Further studies to quantify the impact on the local network post network upgrade, steady state voltage and voltage fluctuations, a detailed fault analysis of the network for each option based on final capacity.

The preferred options for connection and Transmission Line route Options 2 (66kV) and 4(132kV). These options involve variations to bypass town subdivisions and the central township in general. The line routes predominantly follow road reserves, existing transmission easements and along existing lines but also allow for more direct routes through private and public land reserves. No discussion with directly affected landholders has been undertaken in this assessment.

The final recommendations for connection options are summarised below:

Table 19.2 Preferred Connection Option

Final Kyoto Energy Park Capacity	Preferred Option	Recommendations
Final capacity of Kyoto Energy Park <90MW	Line Route Option 2 (see Figure 19.2/19.3/19.4)	• Perform detailed power studies for Option 2 to quantify impact on the local network post network upgrade • Prepare and submit a Connection Application to Energy Australia for Option 2. • Discuss possible private easements with landholders for nominated variations. • Environmental mitigation measures will be formulated in a Line Construction Management Plan which will include recommendations, environmental management and mitigation procedures for electrical and line construction works.
Final capacity of Kyoto Energy Park >90MW	Line Route Option 4 (see Figure 19.2/19.5)	• Prepare and submit a connection application to Energy Australia for Option 4 providing additional capacity up to estimated 160MW • Discuss possible private easements with landholders for nominated variations. • Environmental mitigation measures will be formulated in a Line Construction Management Plan which will include recommendations, environmental management and mitigation procedures for electrical and line construction works.

19.9 Conclusion

Three (3) options for grid connection and four (4) associated line routes were initially following site inspections and analysis from consultants and Energy Australia. These initial options are summarised in Table 19.0.

Transmission route constraints were identified following extensive consultation with government departments including key stakeholders (Upper Hunter Shire Council, Energy Australia) and specific feedback obtained from Community consultation and environmental consultants.

All line routes were surveyed and assessed by individual environmental consultants. Recommendations for environmental considerations are summarised in Section 19.4. Recommendations from government departments and utilities are summarised in Section 19.5 and 19.6 respectively.
Design requirements for line and pole configurations are summarised in Section 19.7. Commitments in relation to line transmissions are made in Section 19.7.3 and Section 20.6.3 Draft Statement of Commitments.

Following this two preferred options for connection were identified for connection of the Kyoto Energy Park to the local grid. These two options are referred to as Option 2 (66kV connection to Scone) and Option 4 (132kV connection to Muswellbrook), see Section 19.8

Energy Australia are currently augmenting the local substation and distribution network in the Muswellbrook to Scone area. This work has been planned to replace outdated substations and lines and strengthen the existing network in the region. A summary of these works is provided in Section 19.1.2.

To fully understand the impact of the connection of the Kyoto Energy Park to the network and design solutions would require detailed evaluation and flow and safety analysis modelling of the Kyoto Energy Park and network integrity at the time of connection. Capability of the network capacity would be further assessed during the preparation of a Connection Application submitted to Energy Australia at the time of connection. As part of this application Energy Australia would undertake a load flow and protection analysis for the Energy Park at the time of connection.

Kyoto Energy Park Scone is wholly an Australian Enterprise. The Management is 100% Australian.
The funding of this proposal and report is 100% Australian.
An Australian Project

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