

Director – Energy Assessments,
Development Assessment,
Department of Planning and Environment,
4 Parramatta Square,
12 Darcy Street, Parramatta NSW 2150

6 October 2023

Dear Sir/Madam,

**SUBMISSION IN RESPONSE TO THE ENVIRONMENTAL IMPACT STATEMENT OF THE
HUMELINK PROJECT -SSI-36656827**

ETAA - ELECTRICITY TRANSMISSION ASSESSMENT AND ADVICE
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**Document Supporting HumeLink EIS Submission by Mary-Jane and Nanette Betts - Transgrid
Property Holding YG-010. Address: 473 and 475 Black Range Road, Bowning NSW 2582**

INTRODUCTION

I am an Electrical Engineer with post graduate qualifications in Environmental Engineering Management. I have had 40 years' experience in the NSW power industry with the Electricity Commission of NSW and its successors, retiring from Transgrid in 2010. Until 2010, I was Group Manager/Environmental Approvals and Compliance in the Transgrid Capital Program Delivery Business Unit. My experience at senior management levels included High Voltage design and construction, and environmental approvals (including seeking legal opinions) of substations, transmission lines, power station switchyards and telecommunication facilities. More detail on my experience is set out at section 1.2.

I have been engaged by the Betts to provide my expert view on the impacts of the proposed HumeLink transmission line and its interactions with the approved rebuild of the 132kV transmission line on their property. I have also been asked to comment on a suggested modified HumeLink alignment through the Property.

My report addresses the following:

1. Current operations on the property and impact of the HumeLink transmission line
2. The specific (and unassessed by Transgrid) impact of the crossover between the HumeLink and the existing (but approved to be rebuilt) 132kV transmission line and the cumulative impact on the property of the HumeLink and the proposed Transgrid 132kV rebuild
3. Identification of an alternative route with lesser impacts

The views I have expressed in my report are my own. They are based on my detailed knowledge of the site, on my technical and environmental expertise as outlined above, through ongoing and in-depth discussions with the Betts, and in consultation with colleagues at ETAA regarding certain highly technical aspects of my assessments.

In my opinion:

- The HumeLink route through the Betts property traverses difficult terrain, making access for construction and maintenance difficult. An alternative, more accessible route is available.
- The Betts property is unusually constrained with close to 30% of the land dedicated to environmental conservation. The HumeLink route bisects the conservation land and also passes directly over a number of key use areas (helipad and tank for irrigation system) on the agricultural portion of the property.
- The crossover of the HumeLink and the 132kV line (which will sterilise a significant area of land) is proposed directly over the sheep yards.
- When the approved 132kV transmission line upgrade proceeds the cumulative impacts on the property will be substantial and to my knowledge have not been considered by Transgrid.
- Having regard to the significant impacts I have described in my report, I have concluded that Betts' preferred route is superior to Transgrid's route and have so advised. The Bett's modified route is technically feasible, would be simpler to construct and provides a lesser adverse environmental and economic impact on the Betts and their Property.

CURRENT OPERATIONS ON THE PROPERTY AND IMPACT OF THE HUMELINK

1.1 Current operations and proposed HumeLink

The Betts have provided me with details of their current operations, their plans for an ecolodge and the ecological and cultural heritage values of the property. This is set out in Appendix A.

I set out below three images of the property provided by the Betts. The first is the 10 June 2022 proposed HumeLink route through the property. The second is the current 17 April 2023 HumeLink route. The third is a hand drawn map which depicts key features on the Property and the HumeLink transmission line.

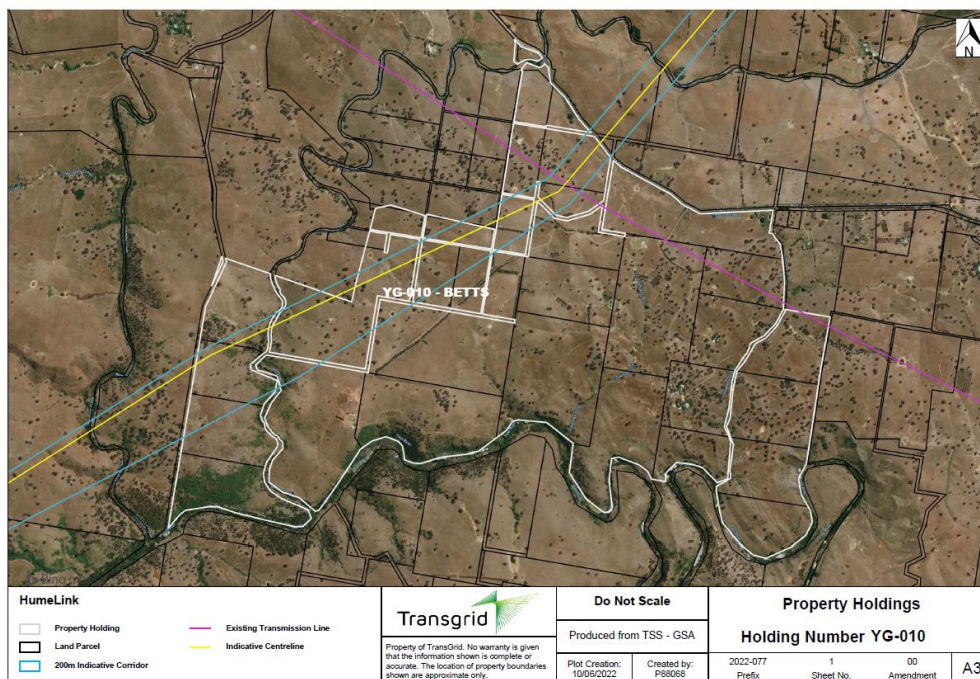


Figure 1: Original HumeLink route 10/06/22

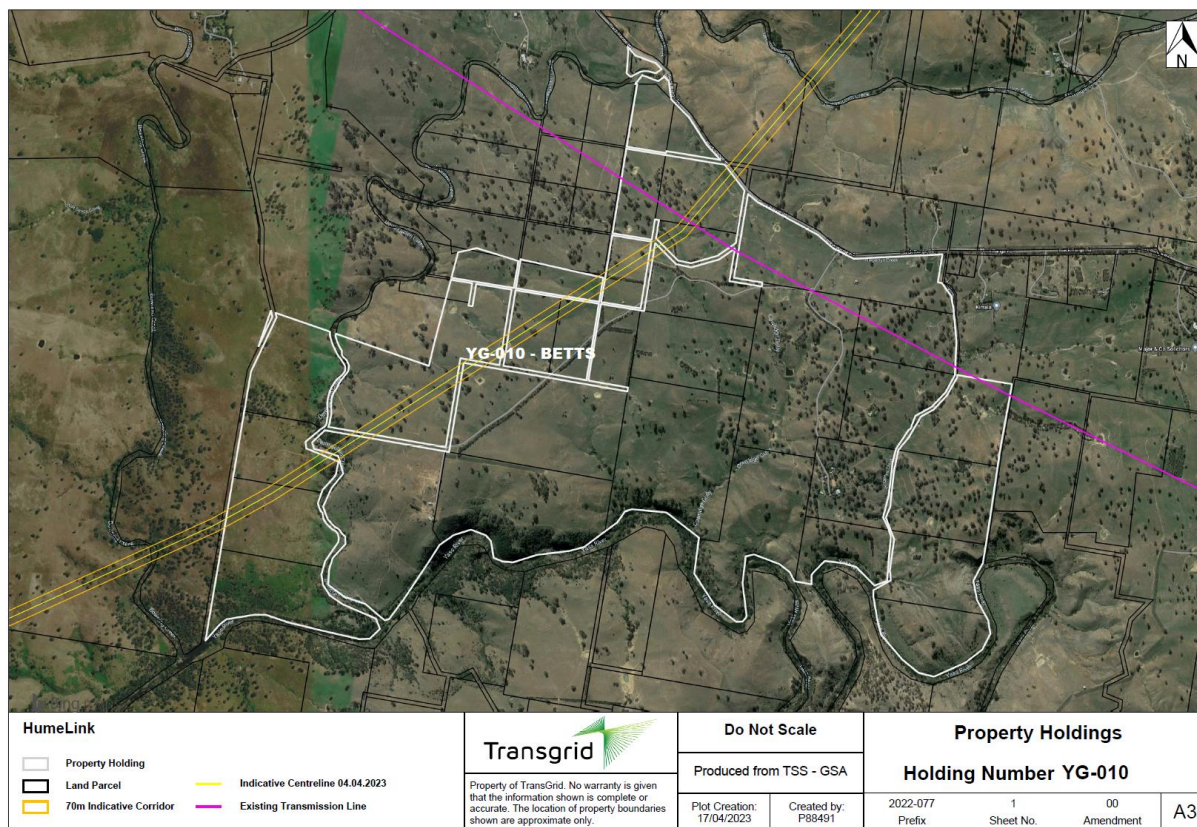


Figure 2: Current 17 April 2023 route.

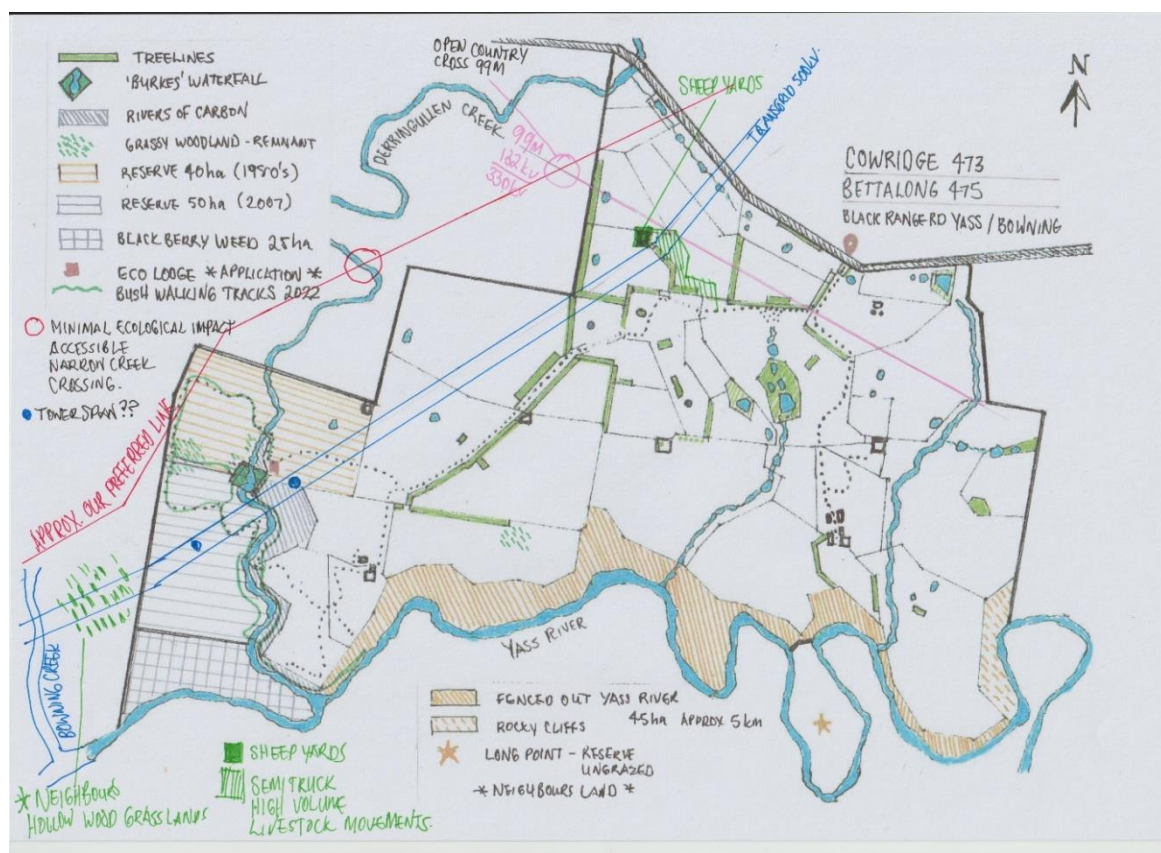


Figure 3: Current route and key features of the Property

Having regard to the three maps provided above and the information in Appendix A, I note that:

- The indicative centre line of the route has moved to the south between June 2022 and April 2023 (compare Figure 1 and Figure 2) and both routes have “bends” on the property.
- I understand that the Tower locations and construction details have not been subject to detailed design and the Betts have only been told indicative information: typically towers may be approximately 75m high, located between 300 to 450m apart. The Betts have been informed that there will be 8 towers on the property. By its nature, the routes and other assets shown are indicative only. I am advised by the Betts that since Transgrid has not yet entered the site for surveys and other investigations that Transgrid’s plans are largely based on aerial surveys and desk top studies.
- Figure 3 (and Figure 8 below) provide a comparison between Transgrid’s proposed HumeLink route and the Betts’ preferred alternative route. They show items that affect Transgrid’s route, such as sheepyards, semitrailer livestock transport, large capacity water tank, dams, helipad, and environmental conservation areas.
- In total, about 110ha has been set aside for environmental protection along Derringullen Creek, with 50ha set aside along the entire length of the Yass River on their property. A total of 175ha, restricted grazing to zero grazing conservation land. This amounts to almost 30% of the 609ha area of their property holding.
- The paddocks are serviced for irrigation and stock use by a complex system of underground pipelines connecting large dams and transferred by a solar pump to large concrete tanks, then gravity fed to 28 cement troughs servicing all paddock. The HumeLink route traverses over/directly adjacent to (depending on which route is proposed) the 120kl concrete tank depicted in the image in Appendix A.
- Aerial spraying with a helicopter is used to control weeds. The helipad is situated close to the tank so that herbicide concentrate can be safely mixed for aerial helicopter spraying for the control of blackberries and other noxious weeds on the property holding.
- The Betts have long standing plans to develop an ecolodge on their property adjacent to Derringullen Falls. A picture of Derringullen Falls is at Appendix A.
- The topographical map (in Figure 8 below) demonstrates that the crossing of Derringullen Creek (immediately below the waterfall) is in the steepest terrain on the property.
- There is an existing 132kV line running in a SE/NW over section of the Property (see line in pink on the map above), known as “99M”. (The approved rebuild of this line is discussed in section 2 below)
- The HumeLink and the 132kv line cross at a high activity area – ie the sheepyards (semi truck livestock loading). At that location there is also a slight change in direction for that route. To support the change in direction, a tension tower will be required. The structural requirements and footing for a tension tower are more extensive than for a standard suspension tower. A tension tower in that location will further impede the higher ground semi-truck access and high volume of livestock movements. As can be seen from the topographical map (Figure 8), at the NE edge of the sheep yards and access the ground levels drop off (I understand to mostly ground rock escarpment).
- Due to topographical constraints, it also appears likely that a wide span will be required from the HumeLink tension tower at the sheep yards to cross Black Range Road and reach the next tower location to the NE.

1.2 My experience in project management assessing impacts of construction of electricity infrastructure

As identified above, I have had 40 years’ experience in the NSW power industry with the Electricity Commission of NSW and its successors, retiring from Transgrid in 2010. Until 2010, I was Group Manager/Environmental Approvals and Compliance in the Transgrid Capital Program Delivery Business

Unit. The expertise of my project team in developing the *Power for Penrith Project*, consisting of the establishment of Regentville 330kV Substation and Associated 132kV lines, was recognized by Engineers Australia. Under my direction, Transgrid's entry in 1998 Engineering Excellence Awards won the category of "Engineering for Regional Communities". The facility was developed in the environmentally sensitive Mulgoa Valley and was the subject of extensive-political and media attention.

Since retirement, I have on occasion assisted communities affected by transmission infrastructure. In that regard, I have initiated an advisory group of former colleagues, *Electricity Transmission Assessments and Advice* (ETAA).

Directly related to the subject of this submission, my Group carried out the conceptual design and successfully prepared an environmental assessment to accompany a Part 4 application to Upper Lachlan Shire Council for the development of the nearby Bannaby 500/330kV Substation. This substation will be the terminal of the future HumeLink double circuit 500kV transmission line. It also presently serves as the termination hub of 500kV transmission lines from Mt Piper and Bayswater Power Stations and lines from Marulan, Yass and Sydney West 330kV Substations. It will also accommodate a future double circuit 500kV line to complete the Sydney 500kV Ring, which has AEMO committed status and is strategically necessary to progress the NSW Government's Renewable Energy Zone policy.

ETAA has also recently advised:

- Merriwa and Cassilis landowners affected by the transmission infrastructure associated with the Central West Orana Renewable Energy Zone. The proponent, Transgrid, was influenced to make a major change to the transmission line routes, and the project is now being managed by EnergyCo.
- landowners affected by the HumeLink 500kV transmission line where it connects to the abovementioned Bannaby 500kV Substation. The relevant issues are similar, but less extensive, to those on the Betts' property.

I am therefore totally familiar with the various associated issues in the Betts' holding, such as indigenous heritage, visual amenity, erosion control matters, transmission line connections, the continuation of important agricultural community access across the holding and future transmission access to the Snowy and southern NSW wind farms.

1.3 Conclusion

In my opinion the HumeLink will significantly adversely impact operations on the Betts property and its substantial ecological values.

- The safe use of the helipad and the use of the complex irrigation system are threatened by Transgrid's plans, including an apparent tension tower associated with a change of direction of the HumeLink line.

Discussions with the helicopter pilot and reference to the document "A Site Owners Guide to Helicopters" reveal that the proximity of a 75m high tower and associated conductors would limit the approach direction of the helicopter to the water tank to be largely from the east. Any other direction would constrain the approach, effectively reducing the size of the landing area. This is so that the pilot can avoid any trees, structures, or conductors within 100m in any direction and at the same time adjusting for wind direction and strength.

- The 75m towers and transmission lines will dominate the environment. The proposed route across Derringullen Falls will be extremely obvious and inappropriate in the area.
- The crossing of the HumeLink and the existing 132kV line combined with the change in direction of the HumeLink (and associated tension tower) will effectively sterilise a large area of land currently used for sheepyards, lambing paddock and sheep camps.

- The vegetation clearance requirements for the Humelink will require a loss of a large portion of the established trees on the property, including tree lines planted to provide seasonal protection for lambing paddocks and green habitat corridors.

CUMULATIVE IMPACT: HUMELINK AND TRANSGRID 132KV REBUILD

2.1 99M 132kV Line Rebuild

Transgrid proposes to rebuild the existing 99M single circuit 132kV (which cross the property – see pink line in Figures 1,2,3 and 8) to a double circuit 132kV line. According to the Transgrid web site, the 99M line rebuild from Yass to the Coppabella Wind Farm was the subject of a Review of Environmental Factors and addendums, approved on 12 August 2021, with work to commence in early 2022.

I have reviewed the REF prepared for the works and note that 99M work is a rebuild, NOT an upgrade. The line is being completely rebuilt across Betts' property. The REF Decision Statement indicates that all existing wooden pole transmission structures will be replaced with new steel or concrete pole transmission structures up to 40m in height (approximately 20m higher than existing) and construction zones of 40m x 40m will be required at each structure.

On 8 August 2020, Transgrid advised the Betts of the 99M line rebuild and approval process. Construction was anticipated to commence in quarter 3 to quarter 4 but they have not heard or received any further information on the 99M line since this original letter 2020. Apart from the Review of Environmental Factors addendum approvals, there is no mention on the current Transgrid web site regarding any 99M postponement, construction delay or cancellation.

In the Review of Environmental Factors Submissions Report, the towers for the rebuilt line would be reduced in height from 40m to 30m, following visual amenity community concerns of the project. (Sectional Elevation in Figure 4 below).

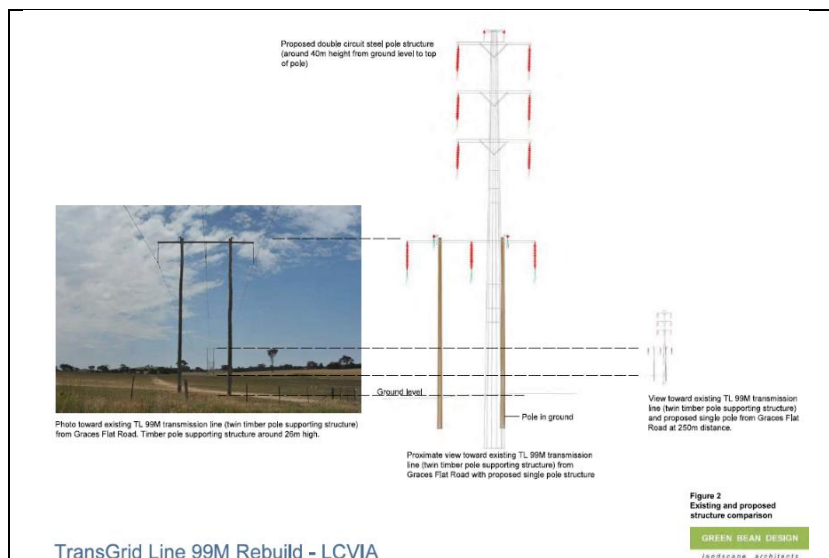


Figure 4 Sectional Elevation of Old vs New Towers - Betts 99M Rebuild Impact. Height now 30m from 40m.

An image from the REF depicting the proposed new line is below

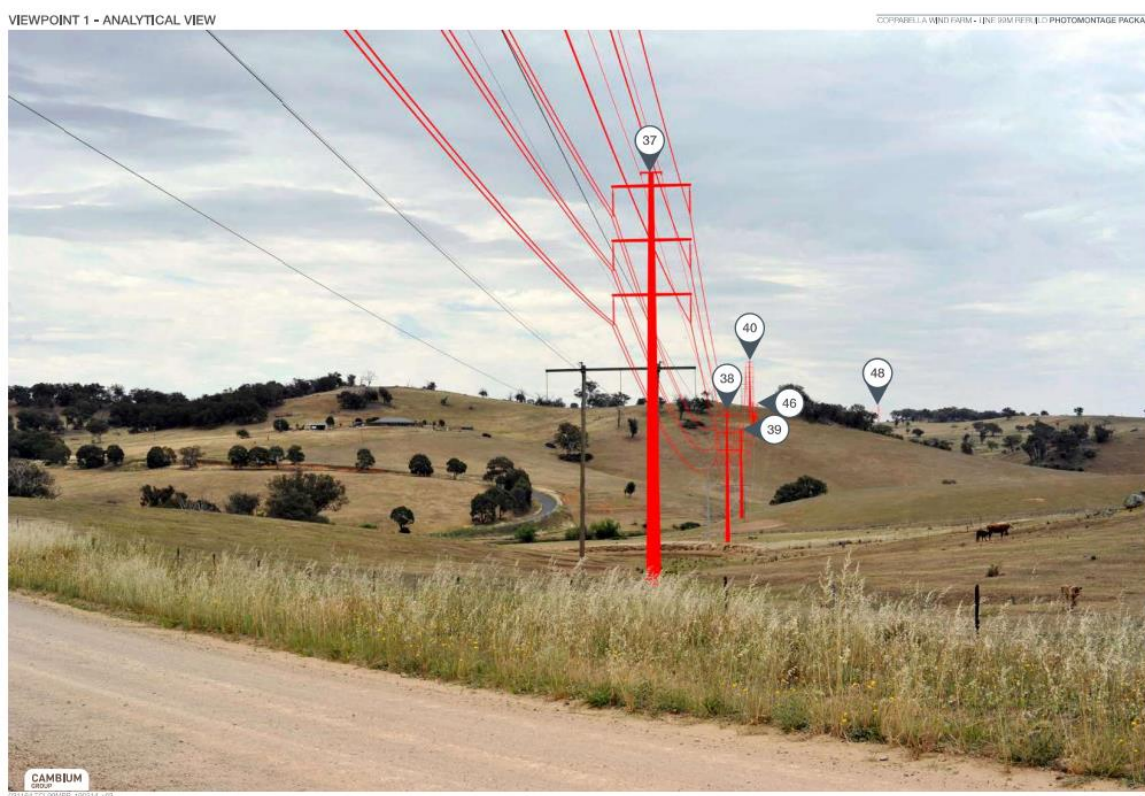


Figure 5: Extract from REF depicting proposed new 132kV double circuit

An understanding of the interaction between the HumeLink and the planned rebuild of the 99M is critical to identifying the impact of the HumeLink on the Betts.

2.2 Cross over HumeLink and rebuilt 99M

In the specific case of the HumeLink double circuit 500kV line crossing the 132kV double (rebuilt single) circuit 99M line on the Betts' property:

- A 132kV line is insulated for a large margin above its operating voltage e.g. switching and lightning surges. Hence, the voltage induced by a 500kV fault lasting a tenth of a second or less can be quite big before it becomes a problem. That is, a close parallel between two lines for many km.
- **Recognising this, the angle of a crossing is not significant, but the undercrossing 132kV line should not have structures on the 500kV easement at least not near the 500kV towers so that the space around the towers is available for the tower maintenance.** This might involve large trucks with elevating buckets or work platforms. This may also be the case within a span where access is suitable for such maintenance.

For the undercrossing of 99M as a double circuit, the conductors of each circuit will be in horizontal configuration. They could be individual poles with conductors terminated on each side (longitudinally) and horizontal line post insulators guiding the conductors around the poles.

Alternatively, as may be likely, two pole structures with a crossarm to attach the insulators in suspension or in tension, as can be seen on the Sydney West line arrangement map below. In this representation, 2 single circuit blue lines cross under a double circuit 330kV line shown as green lines. For the HumeLink arrangement, the 2 undercrossing 132kV single circuits would revert to a double circuit line once past the green lines. It is estimated that an area, including for access and safety, of 2 ha will be required for the structures, conductors, and accessories, as well as construction and maintenance access, and for farming operational passage.

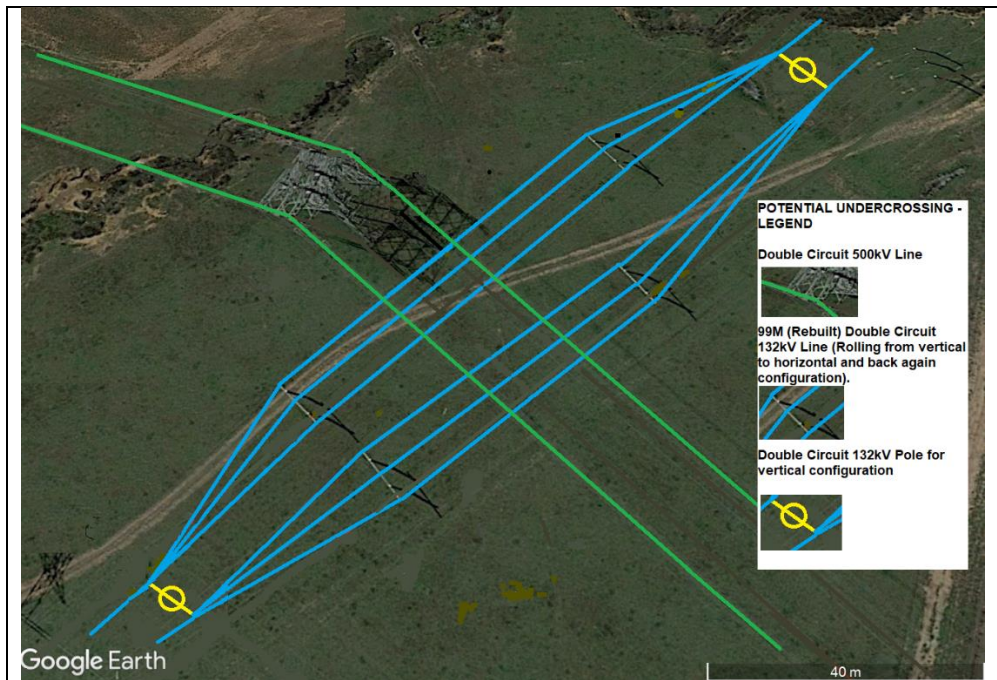


Figure 6: A potential typical arrangement with 132kV twin pole structures and a horizontal cross arm. Based on Sydney West modified 330kV and 132kV line arrangements.

Then again, the horizontally configured 132kV circuits could be held up on steel gantries. A similar concept is shown in the Uttar Pradesh Power Transmission Company (India) Diagram showing a 220kV double circuit line undercrossing a 400kV single circuit line with horizontal gantries:

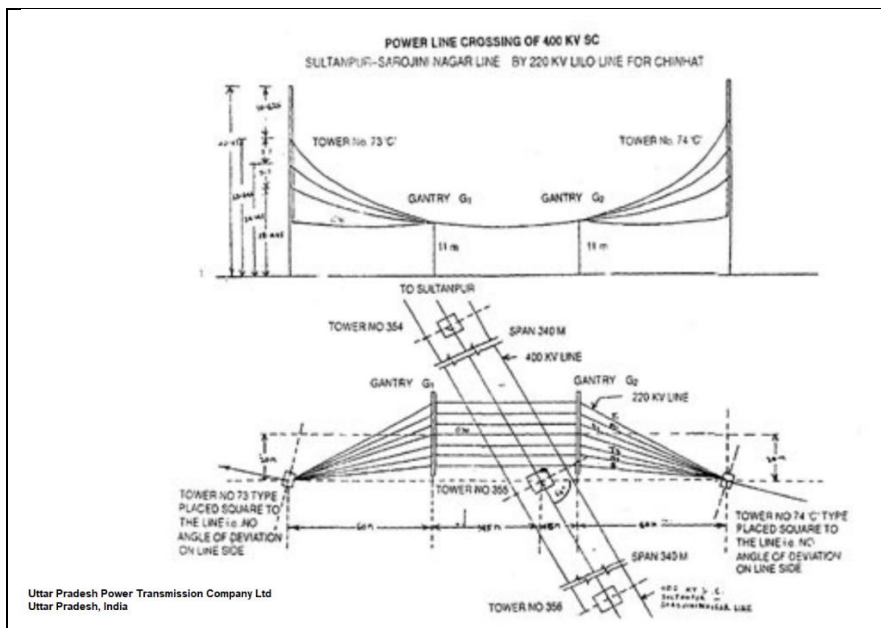


Figure 7: Indian design: 220kV double circuit line, undercrossing a 400kV single circuit line.

For Betts' property, a horizontal cross arm supported by wood poles would appear to be a likely design choice. It is anticipated that many redundant poles and accessories will be left over from the 99M rebuild, and these could be incorporated into the undercrossing design.

The undercrossing phases of each circuit would probably be spaced 4.6m and the spacing between the central alignment of the two circuits at the undercrossing might be as low as 30m apart at the undercrossing with the easement 60m wide. The 132kV circuits would normally have a 45m easement width so it could be wider than 60m. The designer has to leave space between the circuits to allow for safe maintenance work on either circuit with the other circuit in service.

The effect of this is that if the rebuilt 99M line (with 6 lines vertically stacked in two rows of three) is required to shift to a horizontal configuration at the point of crossing with the HumeLink this will occupy

a large area of land (approx. 2 hectares). Currently the crossing is proposed to occur at the Betts sheep yards.

The Betts need to know what the current status of the 99M rebuild project is. They are greatly concerned that the rebuilt line, being double circuit, such a crossing is likely to require more land area, and this will further constrain land use and farming operations, and subdivision in the vicinity. In addition, will have a substantial visual and social impact where HumeLink crosses it.

2.2 Cumulative Impact

The cumulative impact of the HumeLink and the approved 99M rebuild has not been assessed by Transgrid. The cumulative visual amenity and other impacts of the HumeLink and the 99M rebuild are likely to be significant. Of particular concern is the crossing by HumeLink over the rebuilt 99M line. Specifically, the space needed to locate the necessary structures will affect livestock movements and semitrailer access. Sheepyards, semitrailer livestock transport, and firm dry ground for heavy vehicle access are all in close vicinity to a Transgrid tension tower on their property. This can be seen on the map above. The space required for such an undercrossing depends on the detailed designer and what approach and methodology are adopted.

There is also the potential for significant cumulative construction impacts.

- if both constructed simultaneously, this would be the most logical, with the least amount of construction impact. It is assumed that if the 99M line were not ready, then those sections of 99M east and west of the HumeLink line could be left *in situ* a single circuit, with only the undercrossing constructed as double circuit.
- if constructed separately, depending on available line outages to do the work safely, it could be done satisfactorily, but may be inconvenient, working in proximity to live lines. Also, returning twice to site to carry out the construction work will be inconvenient, more costly and have a greater impact on farming operations.

3. ALTERNATIVE ROUTE WITH LESSER IMPACT

3.1 Alternative Route Plans

The Betts have identified a preferred alternative route for HumeLink on and adjacent to their property holding. This is depicted in Figure 8 below.

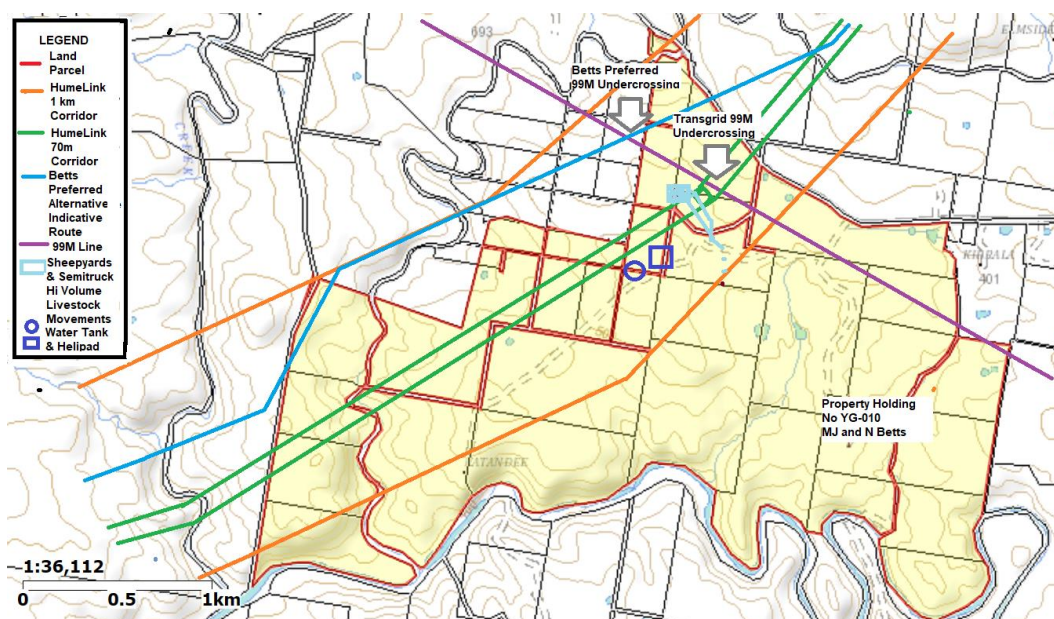


Figure 8: Current route and topographical map

Over the past three years, I am advised that the Betts have offered several alternative options to Transgrid to limit the HumeLink route impacts on the property holding. I have examined all of these options, as well as several others developed by ETAA. However, these options have all been rejected by Transgrid, with no on-site expertise visit and very little comment or reasoning.

The map in Figure 8 is evolutionary as it represents composite discussions between the Betts and me, with contributions from ETAA colleagues. I have developed the map and support the Betts' final preference for this alternative route, as discussed below. Note that it is by nature indicative and is subject to minor modifications which may arise should Transgrid carry out detailed design for that route.

As shown on the topography on the map, the Betts' new alignment has been chosen with regard to the terrain – aiming for a better route. The TransGrid alignment will have more difficult construction and greater ongoing impacts.

3.2 Transgrid HumeLink 70m Corridor Relocation Benefit.

It is estimated that 20ha of Grassy woodland areas with multiple hollow bearing Eucalypts on adjacent nearby properties can be retained if the Transgrid route were re-aligned as described below. Also, where the Betts' preferred route crosses Derringullen Creek to the northwest, there will be minimal ecological impact with an accessible, narrow creek crossing.

A major benefit of locating the crossover of the HumeLink and the 99M onto the adjacent property to Betts' is that more open land for the under crossing will be available if the HumeLink line route were altered to Betts' preference as described below. Locating an undercrossing off Betts' property will also avoid severe interruptions to their presently efficient farming operations. ie: Interference to the sheepyards, semitrailer livestock movements and firm, dry vehicular access.

In discussions with Transgrid, the Betts have been told that the 99M line and HumeLink should cross perpendicularly and would therefore constrain the placement of the HumeLink Transgrid preferred 70m alignment. However, this preference is not supported in practice, not even elsewhere on Transgrid's network. This is discussed in more detail in Appendix B.

Key Benefits of Betts' Preferred Route

It is appreciated that moving partially outside Betts' property holding to an adjacent property would require some rework by Transgrid in property negotiations. However, there are other benefits that outweigh these concerns, such as:

- The destruction of large amounts of established conservation areas, including opening up the line to confronting views, areas lost for public enjoyment and the emotional effect of the line presence. The latter would arise from Transgrid's lack of interest in the Betts' ongoing commitment to the improvement of the natural environment, sustained on their property holding over 5 generations.
- The Betts are also concerned about the cumulative visual amenity and other impacts of Transgrid's propose line route. Of particular concern to them is the crossing by HumeLink over the **rebuilt 99M line**, as well as the tree lines and bush walking tracks from which the transmission line would be extremely obvious.
- Transgrid's route passes very close to the proposed Ecolodge near Derringullen Falls and the line would be in a close and direct view, eliminating the peaceful ambience of the site.
- Transgrid's route runs through the most productive part of this very efficiently run grazing property, that produces a high production of fine merino wool with exceptional value. This efficiency is threatened as follows:
 - The tower proximity to the water tank and helipad in Transgrid's HumeLink route will affect helicopter movement and safety.

- It will reduce the effectiveness of the complex irrigation system of pipes, 28 troughs, and operational equipment due to Transgrid's proposal to "just to move it".
- In addition, this tower is immediately adjacent to the sheeppyards, semitrailer livestock transport and firm, dry transport access routes.
- Betts' preferred route lies totally within Transgrid's original 1km wide study corridor.
- More open land for the under crossing will be available on the adjacent land if the HumeLink line route were altered to Betts' preference as described below.
- Betts' preferred route crosses further up Derringullen Creek where there is minimal ecological impact at an accessible, narrow creek crossing.

CONCLUSION

In an effort to move forward this important issue regarding the provision of a pathway for the efficient use of renewable energy to electricity consumers, the Betts put forward their reasonable and justified position. Negotiations must be sought for a satisfactory outcome for both parties.

The Betts' preferred option is far superior to Transgrid's proposed HumeLink route. A revised, and re-calculated position recommended to cross the 99M, 132kv transmission line. The terrain surrounding Derringullen creek are pending to be resolved for this landholder.

It avoids the tragic impact of Transgrid's proposal caused by the destruction of a long term, viable and efficient operation of a high value and productive Merino wool business.

More than only their agricultural business though, five generations of the Betts' family have given their ongoing respect and positive support for the unique indigenous and natural environment, measuring an area of 175 ha so far. This is now largely threatened by Transgrid's proposal.

Yours sincerely



Stephen Noon
BE (Elec), MEEM

Appendix A

Information provided by the Betts on their current operations and ecological values of the property

The Betts have provided me with the following information regarding their farming operations and the ecological values of the property.

This property has been held by the Betts family for 5 generations, with the overall property going back to the days of explorer Hamilton Hume in the early 19th Century. The Betts employ modern farming techniques, combined with a genuine desire to continuously improve and restore its natural environment, and are very conscious of being custodians of the land and its indigenous heritage.

Efficient Farming Operations

The main farming business is the production of high value and quantity of merino wool, as well as the supply of suitable livestock to abattoirs.

Some smaller areas of their farm are utilised for the production of crops such as lucerne.

The methodologies employed and improved over time include the efficient merino sheep management process. Sheep yards and high-volume livestock and semi-trailer movements are accommodated in areas on the property holding.

All lambing paddocks are protected by tree lines, varying in size.

Paddock Productivity

The paddock productivity is managed by rotational grazing, in a sequence that leaves designated paddocks to rest and fallow whilst others are utilised, thus ensuring continued productivity of the soil and pastures.

Irrigation

Cement water troughs service all paddocks. This is carried out by a complex system of underground pipelines connecting large dams and transferred by a solar pump to large concrete tanks, then gravity fed to 28 troughs.

Helicopter Aerial Spraying

A helipad is situated close to the tank so that herbicide concentrate can be safely mixed for aerial helicopter spraying for the control of blackberries and other noxious weeds on the property holding.

Native Vegetation Protection, Improvement and Restoration

Improving and Restoring the Natural Environment

As mentioned above, over time, the Betts have built up and continued to respect the natural environment, by using both agricultural and cultural land use processes. They are very conscious of being custodians of the land and its indigenous heritage.

This long-established family philosophy is evidenced by the planting and regrowth of areas on their property with reserves of native vegetation (see map in Section 1.1).

Grassy Woodlands

The Grassy Woodlands are a prominent characteristic of the Australian countryside. Originally, it was distributed as an extensive band, 'the sheep-wheat belt', running from southern Queensland to central Victoria. Of the Grassy Woodlands, the Southern Tableland Grassy Woodlands Class is specific in the subject area. Distributed from the Sofala and Orange districts, the Class continues south through Goulburn and Yass, and into the foothills of the Victorian alps.

The Grassy Woodlands structure is 15-30 m tall, open eucalypt woodland, with a sparse non-sclerophyll shrub stratum and continuous groundcover of grasses and herbs. Tree-hollows and seed-bearing grasses and herbs host a variety of birds. Nectar- and pollen-feeding mammals are also present.

Grassy Woodlands have been extensively modified for agriculture. Remnants now occur as small patches in varying states of degradation, with episodic tree decline due to rural dieback.

The most botanically valuable occur in areas that have escaped land clearing, pasture improvement and overgrazing such as travelling-stock reserves, cemeteries, and churchyards. However, these refuges are now under threat from rural dieback, weed invasion, soil erosion and salinisation, over grazing by stock and feral herbivores and the effects of introduced predators like the European red fox.

Conservation Areas and Land Protection

The conservation areas were established by the Betts with areas of 40ha in the 1980s and 30ha in tree lines and fenced wet gullies. Developing Eco-tourism of an Eco-Lodge and bushwalking tracks commenced within the conservation areas in 2018. The areas encompass the ***entire length of the Derringullen Creek within their property, down to and including part of the Yass River.***

In addition, they have fenced out a 45ha area, 5km length of the Yass River. This helps to stabilise the riverbank natural re-generation and is not grazed with livestock, resulting in better erosion control and improved water quality, and wildlife corridor along this biodiverse important part of the river.

Erosion and weed control are continually addressed with helicopter application where impractical for ground spray units to access steep terrain.

As well, 70ha rocky cliffs along part of the eastern edge of the property have been fenced off for their protection. (As part of the Rivers of Carbon Project- ARRC) on the eastern side of the Derringullen Creek, from the waterfall down to the Yass River.

So, in total, about 125ha has been set aside for environmental protection along Derringullen Creek, with 50ha set aside ***along the entire length*** of the Yass River on their property. ***A total of 185ha, is restricted grazing to zero grazing conservation land.*** This amounts to almost 30% of the 609ha area of their property holding.

Cultural and Indigenous Heritage

A culturally significant “women’s site” is located on the property within the 200m transmission line corridor.

Eco-tourism

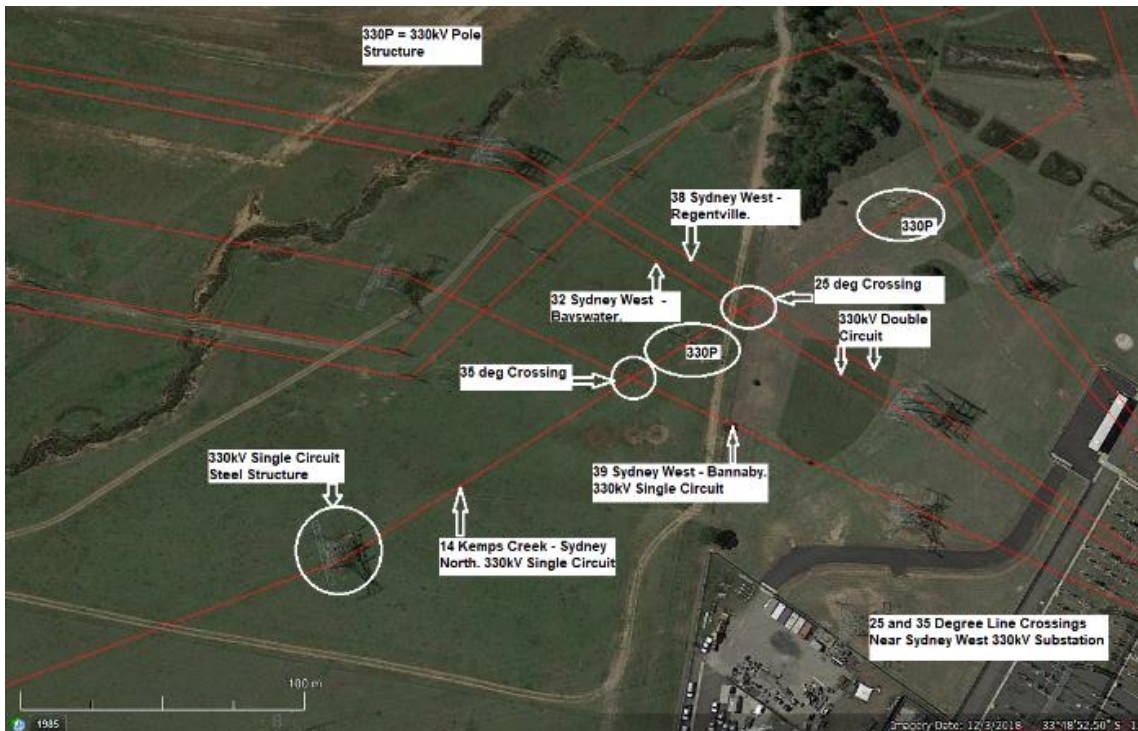
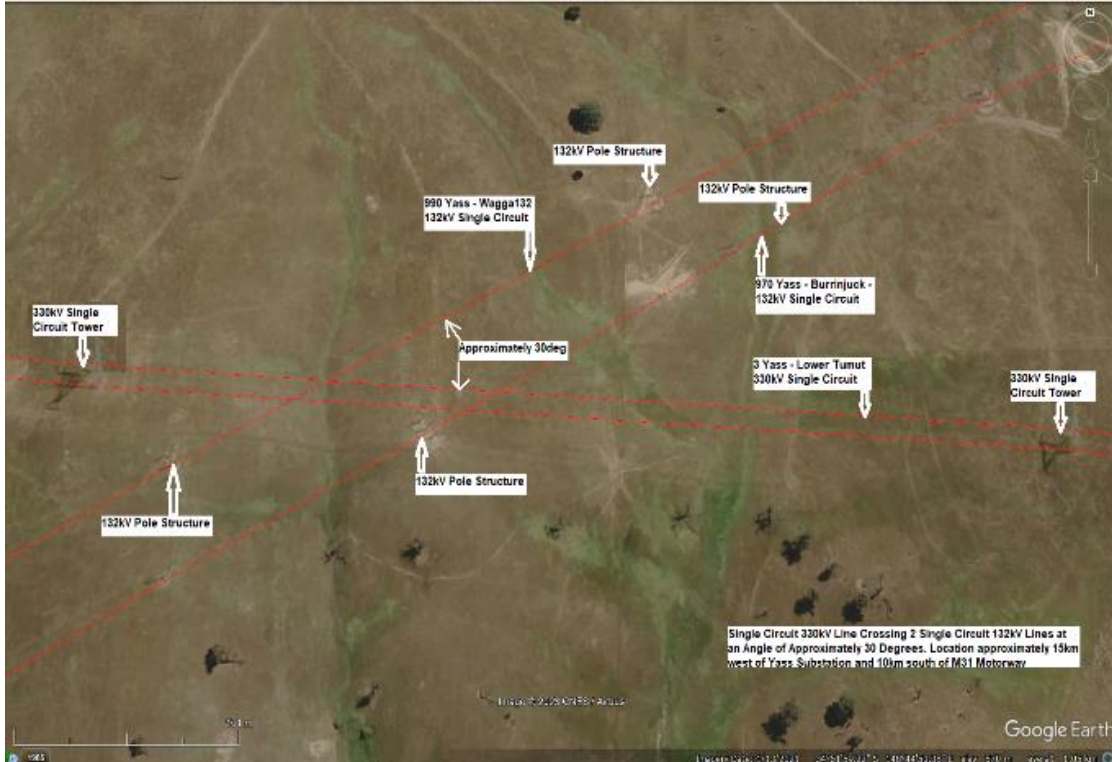
The Betts have started the process of lodging a development application to establish an Ecolodge for visitor accommodation. This will allow them to diversify their business enterprises, with Eco-Tourism and regional developments. They are also building walking tracks and establishing new areas of native vegetation.

Some of the tracks lead down to the future Ecolodge near Derringullen Creek, then run through the fenced reserve areas, leading to Derringullen Falls and on to the Yass River. The waterfall is very impressive.

Appendix B - Existing 99M Line Undercrossing Angle with HumeLink

Discussion

There are many line crossing examples on Transgrid's network and quite a few where the crossing angle measured from the perpendicular is within a 30 degrees angle. eg: near Yass and Sydney West:



To determine whether a particular crossing angle is allowable or not, reference is made to the **Transgrid Transmission Line Design Standard**, which itself refers to Australian Standards on magnetic induction.

In this standard (including the referred standards) there are no guidelines for this situation.

The Transgrid design standard is a minimalist document. It does not reflect the higher standards adopted by Transgrid in the past. Detailed designers are expected to use their discretion.

It includes references to AS/NZS 4853 and SA HB 102 regarding the assessment of risk and mitigation measures for magnetic fields coupling with nearby metallic objects.

- For the reference **AS/NZS 4853:2012 - Electrical Hazards on Metallic Pipelines**: this relates to underground and above ground pipelines and other metallic crossings not other power lines.
 - Clause 1 Scope says ... This standard *does not cover electrical hazards on electricity power plant* Such hazards are covered by **AS/NZS 7000:2016 Overhead Line Design**.
- For the reference **HB 102-1997 (CJC 6) - Coordination of Power and Telecommunications — Low Frequency Induction (LFI) — Application Guide to the LFI Code**: this applies to interference and voltage induced into telecommunications lines, so it does not apply either.

So **only AS/NZS 7000 applies**.

Section 3 Electrical Requirements and Appendix H: Electrical Design Aspects are relevant as follows:

- **Section 3.7.1** addresses **crossings of conductors** on different supports but its concern is minimum spacing of the overpassing circuit above the undercrossing circuit and Table 3.1 requires at least 5.1m clearance under no wind conditions with upper 500kV circuit at maximum operating temperature and lower circuit at minimum ambient temperature.
- **Section 3.14.2 Electric and magnetic field induction** says the designer should consider mitigation measures to "reduce these effects to acceptable levels contained in relevant Standards and Codes". It mentions SA HB 102 and AS/NZS 4853, but these refer back to AS/NZS 7000.
- **Section 3.14.4 Electrostatic Induction** draws attention to the possible effects and it cross references Appendix H for thresholds of perception.
- **Appendix H** addresses **ELECTROSTATIC INDUCTION** and **ELECTROMAGNETIC INDUCTION** (EMI) but only the list of 6 mitigation measures for electromagnetic induction is relevant and they do not include anything about angle of crossings. Method (d) is relevant:
 - **Method (d) Increase the separation between the circuit or object and the overhead line.**
This is the only relevant Standard or Code known.

Conclusion

The following potential line design constraints that have been considered:

- Crossing at 90 degrees,
- Crossing as close to 90 degrees as practicable
- Crossing at 30 degrees or less

are all rules of thumb or internal guidelines that seek to give expression to Method (d) above.

Therefore, it is clear that the crossing angle is not of any great importance. There remains a preference for crossings to be closer to right angles, but there is no prohibition for any angle. There are measures to take like fence earthing against electrostatic induction and limiting lengths of line parallels to limit EMI (by introducing insulated sections).

HumeLink

In the specific case of the HumeLink double circuit 500kV line crossing the 132kV double (rebuilt single) circuit 99M line on the Betts' property:

- A 132kV line is insulated for a large margin above its operating voltage e.g. switching and lightning surges. Hence, the voltage induced by a 500kV fault lasting a tenth of a second or less can be quite big before it becomes a problem. That is, a close parallel between two lines for many km.
- **Recognising this, the angle of a crossing is not significant, but the undercrossing 132kV line should not have structures on the 500kV easement at least not near the 500kV towers so that the space around the towers is available for the tower maintenance.** This might involve large trucks with elevating buckets or work platforms. This may also be the case within a span where access is suitable for such maintenance.

Accordingly, Transgrid crossing angle potential constraints would NOT affect the placement of the 99M undercrossing of the HumeLink elsewhere on the adjacent properties, and offers greater access avoiding varying ground elevations, and intensive agricultural, animal husbandry operations.