# OPTION FEASIBILITY STUDY (OFS)

Reinforcement of South Western Network

OFS- 000000001570E revision 0.0

**Option description:** Darlington Point / Wagga Higher Capacity Connection

**Ellipse project description:** P0009227

**Project reason:** Reliability - To meet overall network reliability requirements
**Project category:** Prescribed - Augmentation

**Approvals**

| | | |
|---|---|---|
| **Author** | Jamie Blake | Project Feasibility Studies Engineer |
| | Owen Crampton | Project Feasibility Studies Engineer |
| **Endorsed** | Daniel Burn | Project Feasibility Studies Manager |
| **Approved** | John Howland | Manager / Portfolio Management |
| **Date submitted for approval** | 1 December 2016 | |

# Table of contents

# 1. Request

This Option Feasibility Study is provided in response to Option Screening Analysis 1570 Rev 2 – Reinforcement of Southern Western Network – Option E – Darlington Point / Wagga Higher Capacity Connection.

To increase system security of the South Australia (SA) power system and supply security and reliability to SA loads and to increase market benefits, a new AC interconnection between New South Wales (NSW) and South Australia (SA), called the NSW to SA interconnector (NSI) has been proposed.

Portfolio Management were requested to undertake a desktop assessment of the cost, timing of activities, risk analysis and practicality of carrying out the works.

# 2. Considerations

The following scope of work associated with this project option.

- Construction of 728 km of 330 kV double circuit transmission line, strung on both sides with twin Mango ACSR conductor for an operating temperature of 85°C, including the provision of OPGW, between Darlington Point in NSW and Robertstown in SA.
- Acquisition of easements required for the new 330 kV transmission line between Darlington Point and Robertstown.
- Construction of a 152 km 330 kV single circuit transmission line, strung with twin Mango ACSR conductor for an operating temperature of 85°C, between Darlington Point and Wagga Wagga.
- Darlington Point Substation
    - Construction of a new secondary containment dam and spill oil tank.
    - Extension of the switchyard bench as required for the installation of new high voltage equipment.
    - Extension of the 330 kV A Bus.
    - Extension of the 330 kV B Bus.
    - Installation of three 330 kV line switchbays.
    - Installation of four 330 kV 400 MVA ± 40° phase shifting transformers and associated switchbays.
    - Installation of a new 330 kV ±300 MVAr SVC (or STATCOM) and associated switchbay.
    - Installation of two 330 kV 50 MVAr capacitor banks and associated switchbays.
    - Installation of four 330 kV 50 MVAr reactors on the new 330kV line and associated switchgear.
    - Secondary systems upgrades required for the new substation and line arrangements.
- Construction of a 330 kV line switchbay at Wagga 330 kV Substation.

As requested in the OSA, a high level estimate has been provided for the following scope of works.

- Acquisition of property required for the establishment of the 330/275 kV substation near the existing Robertstown 275/132 kV Substation.
- Establishment of a 330/275 kV substation near the existing Robertstown 275/132 kV Substation.
- Installation of four 330kV 50 MVAr shunt reactors at Robertstown.
- Installation of two 330kV 50 MVAr capacitor banks at Robertstown.
- Acquisition of easements and the construction of 275kV line connections between the new 330/275 kV substation and existing Robertstown 275/132 kV Substation.

- Acquisition of property adjacent to the existing Robertstown 275/132 kV Substation required for the installation of additional high voltage equipment.
- Construction of the switchyard bench extension at the existing Robertstown 275/132 kV Substation.
- Extension of the 275 kV A and B busbars and installation of four 275 kV switchbays at the existing Robertstown 275/132 kV Substation.
- Installation of a new 275kV 100 MVAr capacitor bank and associated switchbay and civil works at Tailem Bend.
- Stringing of one side of the Tailem Bend to Tungkillo 275 kV transmission line with Olive ACSR conductor, which is 62 km in length.

## 2.1 Substation Works

### 2.1.1 Darlington Point

#### 2.1.1.1 Site general arrangement and access

Darlington Point 330 kV Substation is located approximately 140 km north-west of Wagga Wagga and is TransGrid's furthermost western substation which is connected to the 330 kV network. Darlington Point Substation is electrically connected to Balranald, Buronga and Broken Hill through a 220 kV network west of the substation.

Darlington Point Substation accommodates the following high voltage equipment.

- 330 kV 63 Line.
- 2 x 330 kV busbars.
- 2 x 330/220/33 kV 200 MVA transformers.
- 2 x 33 kV 16 MVAr shunt reactors.
- 220 kV X5/1 Line.
- 220 kV X5/1 Line 33 MVAr shunt reactor.
- 2 x 330/132 kV 280 MVA transformers.
- 2 x 132 kV busbars.
- 5 x 132 kV lines.
- 3 x 132 kV cap banks.

The Darlington Point high voltage operating diagram and General Arrangement are shown in Figures 2.1.1.1.a and 2.1.1.1.b, below.

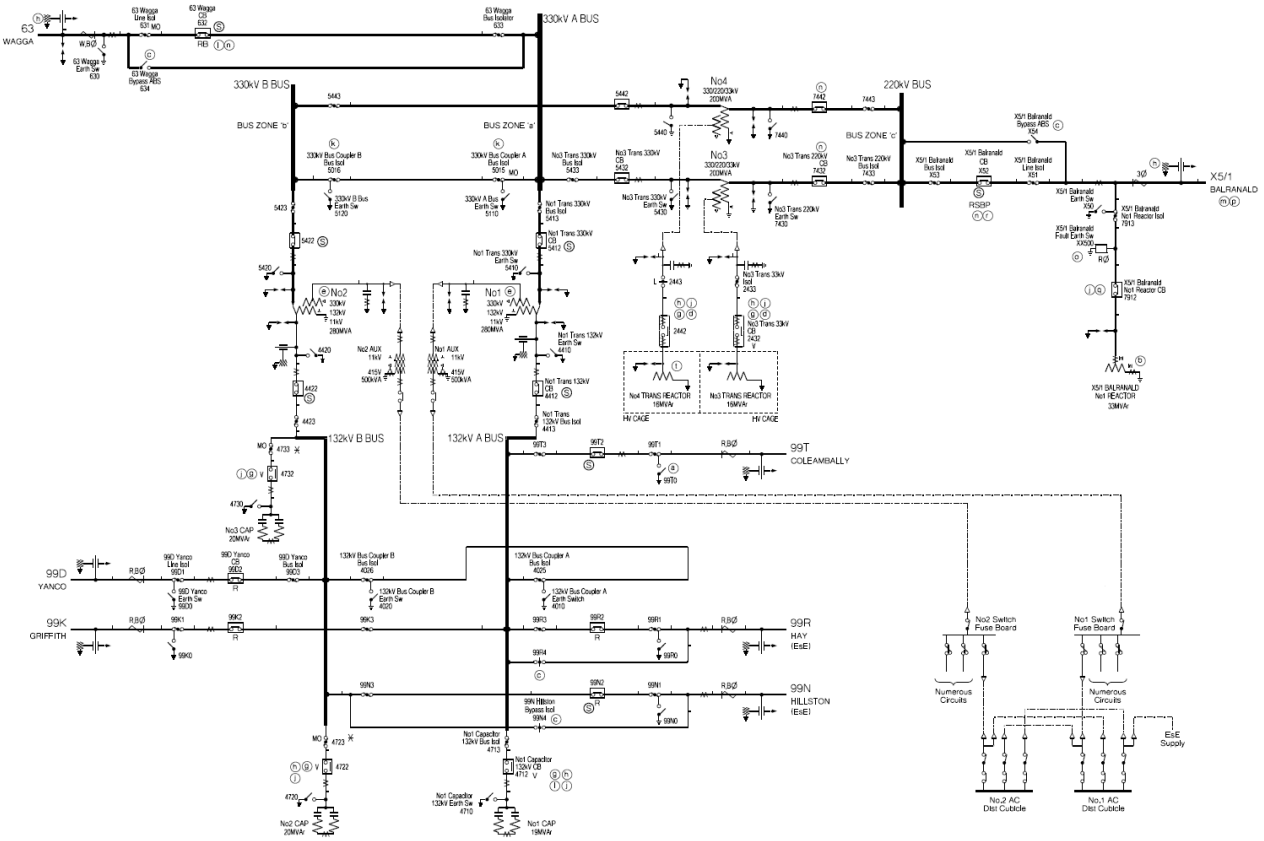


**Figure 2.1.1.1.a – Darlington Point Substation High Voltage Operating Diagram**

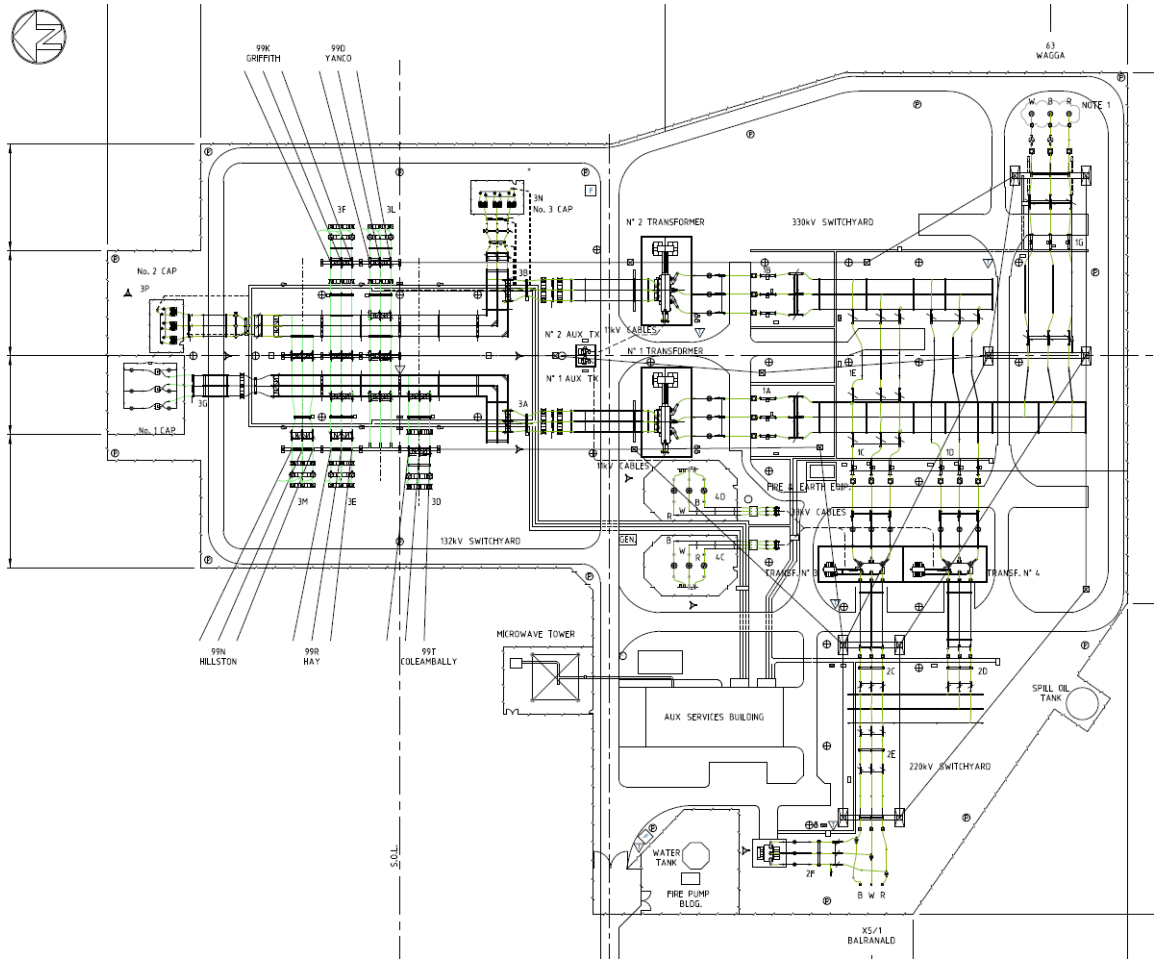


**Figure 2.1.1.1.b – Darlington Point Substation General Arrangement**

The following scope of works will be required at Darlington Point Substation.

- Construction of a new spill oil tank and secondary containment dam.
- Construction of switchyard bench on existing TransGrid freehold property.
- Installation of two 330 kV capacitor banks and associated switchbays.
- Extension of the existing 330 kV A Bus.
- Extension of the existing 330 kV B Bus.
- Installation of a 330 kV SVC.
- Installation of four 330 kV phase shifting transformers.
- Installation of three 330 kV line bays.
- Installation of four 330 kV reactors and associated switchbays.

The proposed Darlington Point Substation single line diagram and general arrangement drawings are shown in Figures 2.1.1.1.c and 2.1.1.1.d, below.

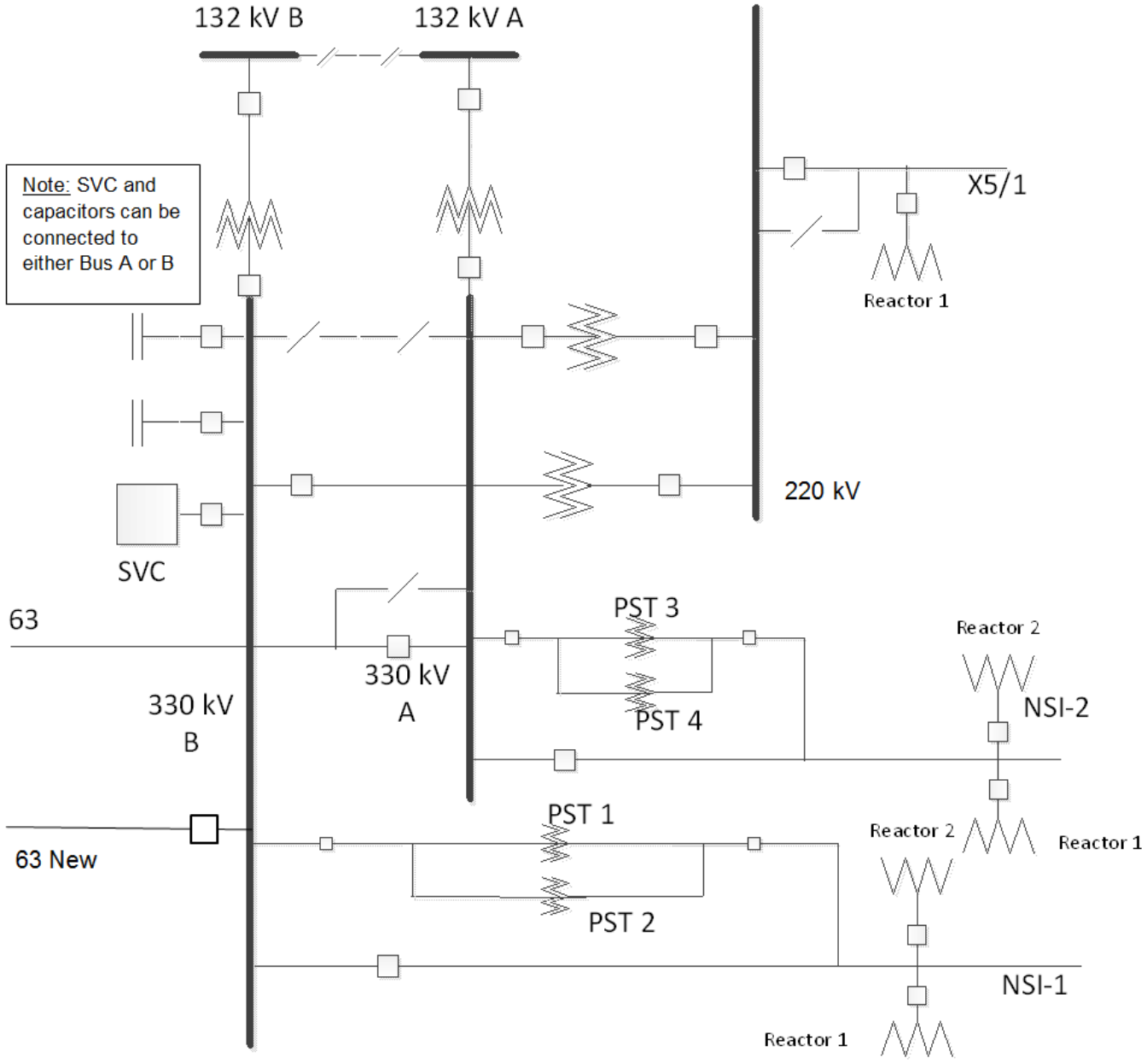


**Figure 2.1.1.1.c – Proposed Darlington Point Substation Single Line Diagram**

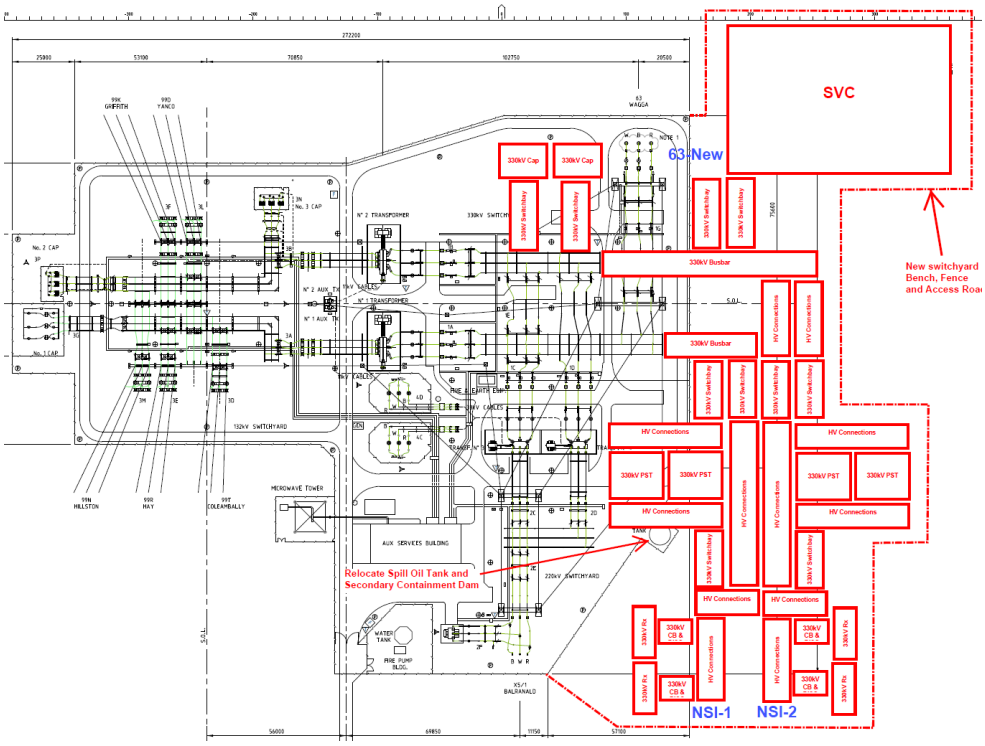


**Figure 2.1.1.1.d – Proposed Darlington Point Substation General Arrangement**

### 2.1.1.2 Civil works

The construction of new switchyard bench will be required to accommodate the new 330kV equipment. The area proposed for the switchyard bench extension is located over the primary spill oil tank and secondary containment dam and will require them to be installed in another location. Further analysis should be undertaken during project scoping to determine if a suitable general arrangement can be designed without the requirement of relocating the primary spill oil tank and secondary containment dam.

New cable trenches will be required to accommodate the LV cabling associated with the new 330kV equipment.

All new equipment will be installed on standard footings and structures.

Darlington Point presently does not have noise walls surrounding the transformers and reactors and therefore, it is not anticipated that noise walls will be required for the new phase shifting transformers and reactors. Fire walls will be required between the phase shifting transformers and between the reactors.

### 2.1.1.3 Building works

No building works is anticipated for this project option.

### 2.1.1.4 Major plant and equipment

The following major plant will need to be procured.

- 4 x 330 kV 400 MVA ±40 degrees phase shifting transformers.
- 1 x 330 kV ±300 MVAr static var compensator (SVC).*
- 4 x 330 kV 50 MVAr shunt reactors.
- 2 x 330 kV 50 MVAr capacitor banks.

All major plant should have procurement lead times of less than 24 months.

*Note that the OSA requests either a SVC or static synchronous compensator (STATCOM) be installed. This OFS is based in the installation of a SVC. Information provided to TransGrid from manufacturing companies indicates that SVCs and STATCOMs are similar in price. Therefore, only one cost estimate has been provided in this feasibility study and it can be assumed that the cost for installation of a SVC or STATCOM will be within ±25% of the cost estimate.

#### 2.1.1.5 Minor plant and equipment

All minor plant required for this project should have lead times of less than 12 months.

#### 2.1.1.6 Electrical works

New earth grid will be required within the proposed switchyard bench extension.

The electrical work involves the installation of the high voltage equipment, high voltage connections, secondary control cabling, installation of control and protection schemes, testing and commissioning.

#### 2.1.1.7 Secondary systems

Darlington Point Auxiliary Services Building has capacity for additional secondary systems panels and therefore it is envisaged that the new secondary systems will be installed within the existing building.

#### 2.1.1.8 Protection

Standard protections will be required on the transformers and reactive plant.

It is anticipated that the new 330 kV line will be able to utilise the broadband communications established as part of this project and protect the line using VF intertripping.

#### 2.1.1.9 Communications

New broadband communications links will be established between Darlington Point and Robertstown via OPGW on the new line. At Darlington Point it is envisaged that the existing communications room will have sufficient space to accommodate the required Optical Distribution Frame and fibre optic terminal equipment.

#### 2.1.1.10 Control systems

Standard control systems will be required for the new and uprated equipment.

#### 2.1.1.11 Auxiliary supplies

Existing auxiliary transformers will continue to provide the site LV supply. Therefore, no modification of the auxiliary supply and distribution systems will be required as part of this project.

### 2.1.2 Wagga Wagga 330 kV

#### 2.1.2.1 Site general arrangement and access

Wagga 330 kV Substation accommodates the following high voltage equipment.

- 3 x 330 kV lines.
- 2 x 330 kV busbars.
- 1 x 330 kV bus coupler switchbay.
- 2 x 330/132 kV 375 MVA transformers and associated switchbays.
- 3 x 132 kV busbars.
- 1 x 132 kV bus coupler switchbay.
- 1 x 132 kV bus section switchbay.
- 2 x 132 kV 80 MVAr capacitor banks and associated switchbays.
- 1 x 132 kV 50 MVAr capacitor bank and associated switchbay.
- 8 x 132 kV lines.

The Wagga 330 high voltage operating diagram and General Arrangement are shown in Figures 2.1.2.1.a and 2.1.2.1.b, below.

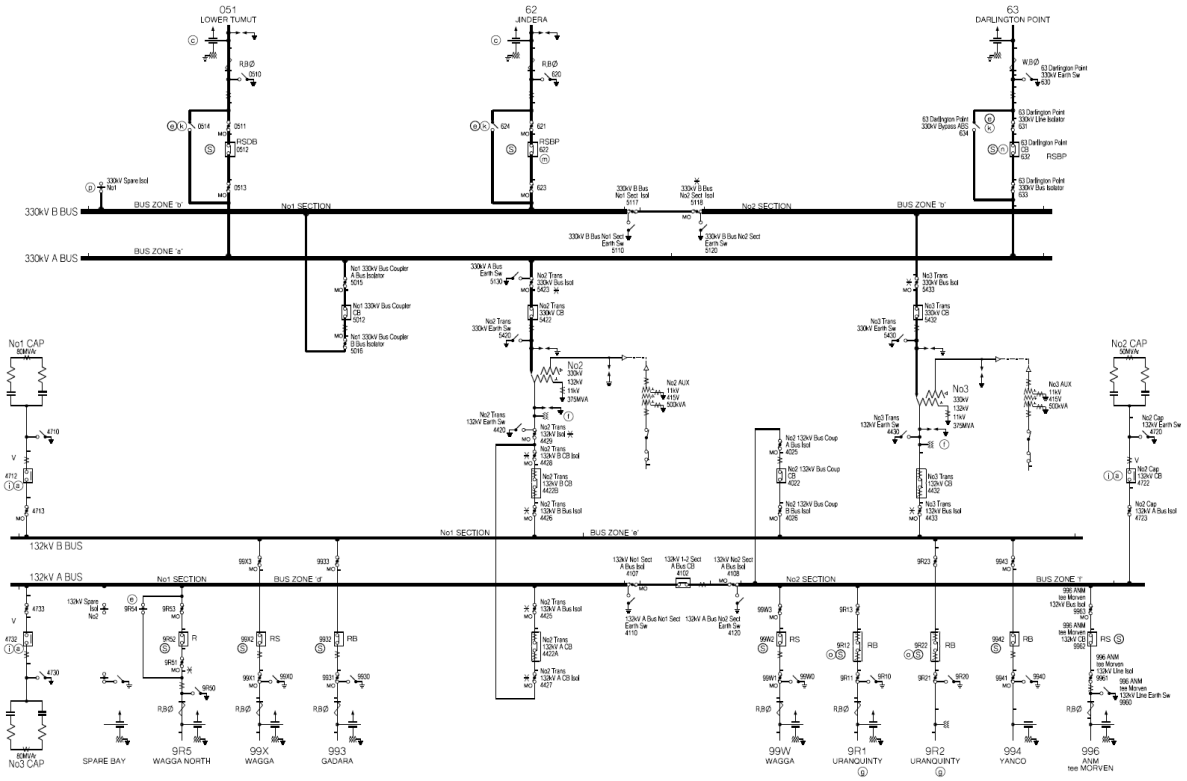


**Figure 2.1.2.1.a – Wagga 330 Substation High Voltage Operating Diagram**

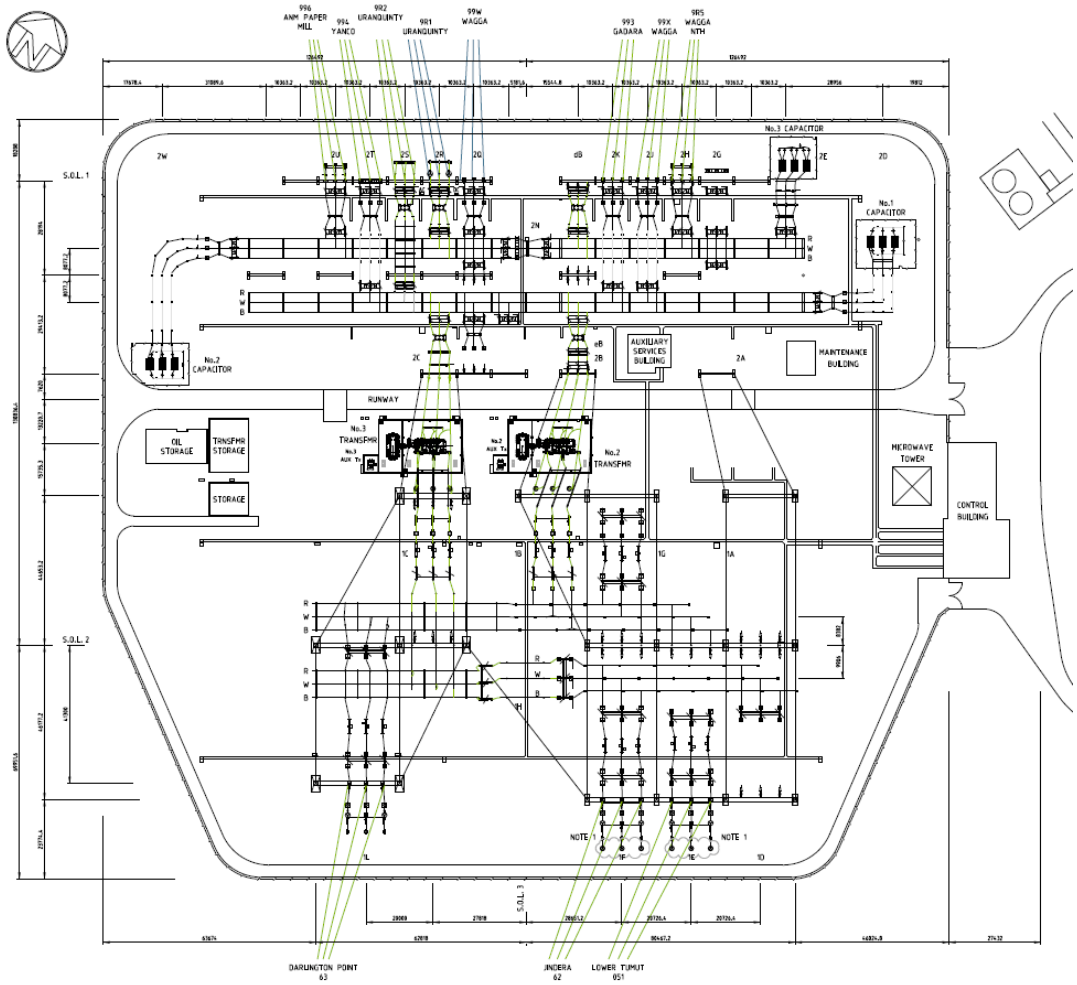


**Figure 2.1.2.1.b – Wagga 330 Substation General Arrangement**

The following scope of works will be required at Balranald Substation.

- Installation of a new 330kV line switchbay connected to the 330 kV B Bus.

The proposed Wagga 330 Substation single line diagram and general arrangement drawings are shown in Figures 2.1.2.1.c and 2.1.2.1.d, below.

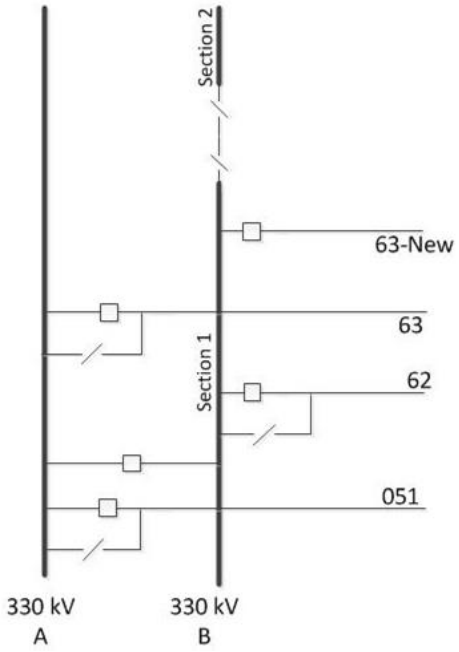


**Figure 2.1.2.1.c – Proposed Wagga 330 Substation Single Line Diagram**

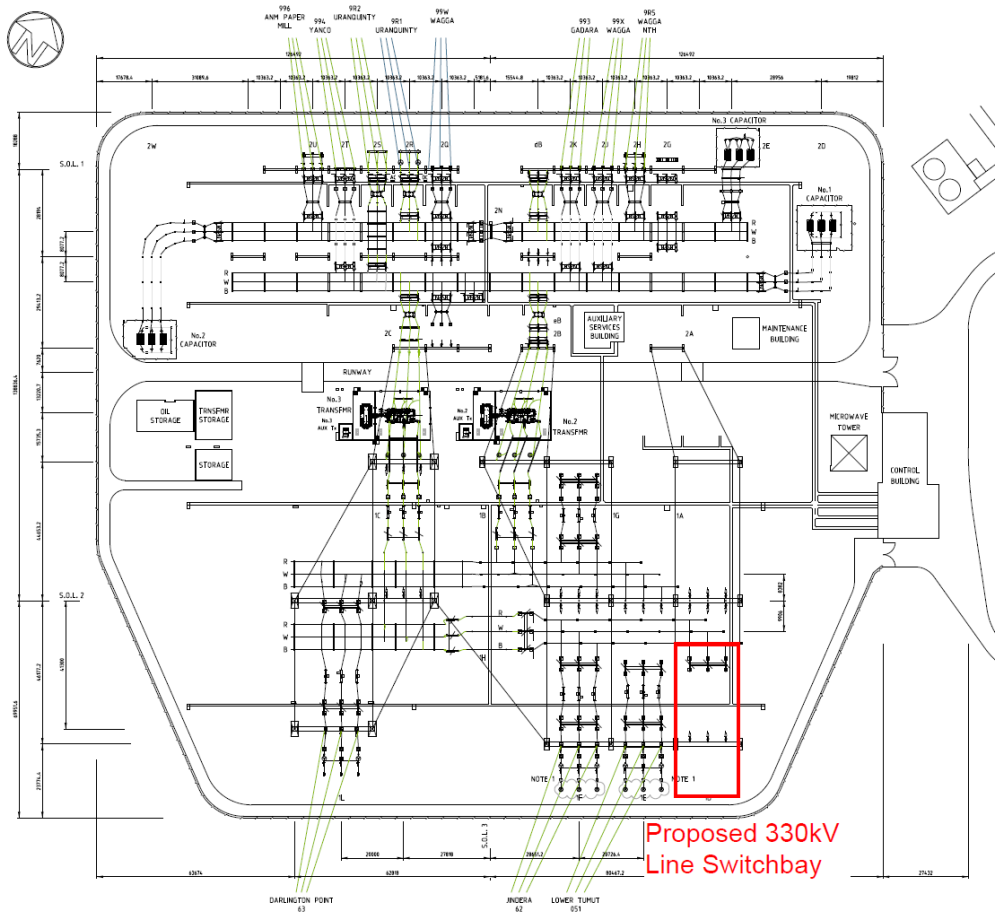


**Figure 2.1.2.1.d – Proposed Wagga 330 Substation General Arrangement**

#### 2.1.2.2 Civil works

New cable trenches will be required to accommodate the LV cabling associated with the new high voltage equipment.

All new equipment will be installed on standard footings and structures.

The existing gantries will be re-used.

#### 2.1.2.3 Building works

No building works is required for this project option.

#### 2.1.2.4 Major plant and equipment

No major plant is required for this project option.

#### 2.1.2.5 Minor plant and equipment

All minor plant required for this project should have lead times of less than 12 months.

#### 2.1.2.6 Electrical works

The electrical work involves the installation of the 330kV switchbay, high voltage connections, secondary control cabling, installation of control and protection schemes, testing and commissioning.

#### 2.1.2.7 Secondary systems

All new secondary systems will be installed in the existing control building.

#### 2.1.2.8 Protection

Standard line protection will be required for the new line.

#### 2.1.2.9 Communications

New communications equipment will be required to terminate the OPGW on the new line.

#### 2.1.2.10 Control systems

Standard control systems will be required for the new equipment.

## 2.2 Reactive Power Support in VIC and SA

### 2.2.1 Tailem Bend 275kV Substation

It is proposed that the below works will be required at Tailem Bend substation in SA. The estimate for these works is indicative only as the works are unlikely to be delivered by TransGrid.

- Installation of shunt capacitor banks of approx. 1x100 MVAr at Tailem Bend substation at 275 kV bus in SA.


**Figure 2.2.1.a – Indicative locations and Area of the Proposed Reactive Plant at Tailem Bend**

The new capacitor is anticipated to be accommodated within the existing footprint. This is based on the latest site aerial photo from 2009. Hence, there is a risk that the over layout is not feasible. If this is the case then the switchyard bench may need to be extended for the installation of the new capacitor.

The footprint of the new capacitor is expected to be approximately 30m x 50m with a connection onto the existing bus.

### 2.2.2 Robertstown 275kV Substation

Robertstown 275/132 kV Substation is connected in a 275 kV breaker and a half arrangement, as shown in Figure 2.2.2.a, below.

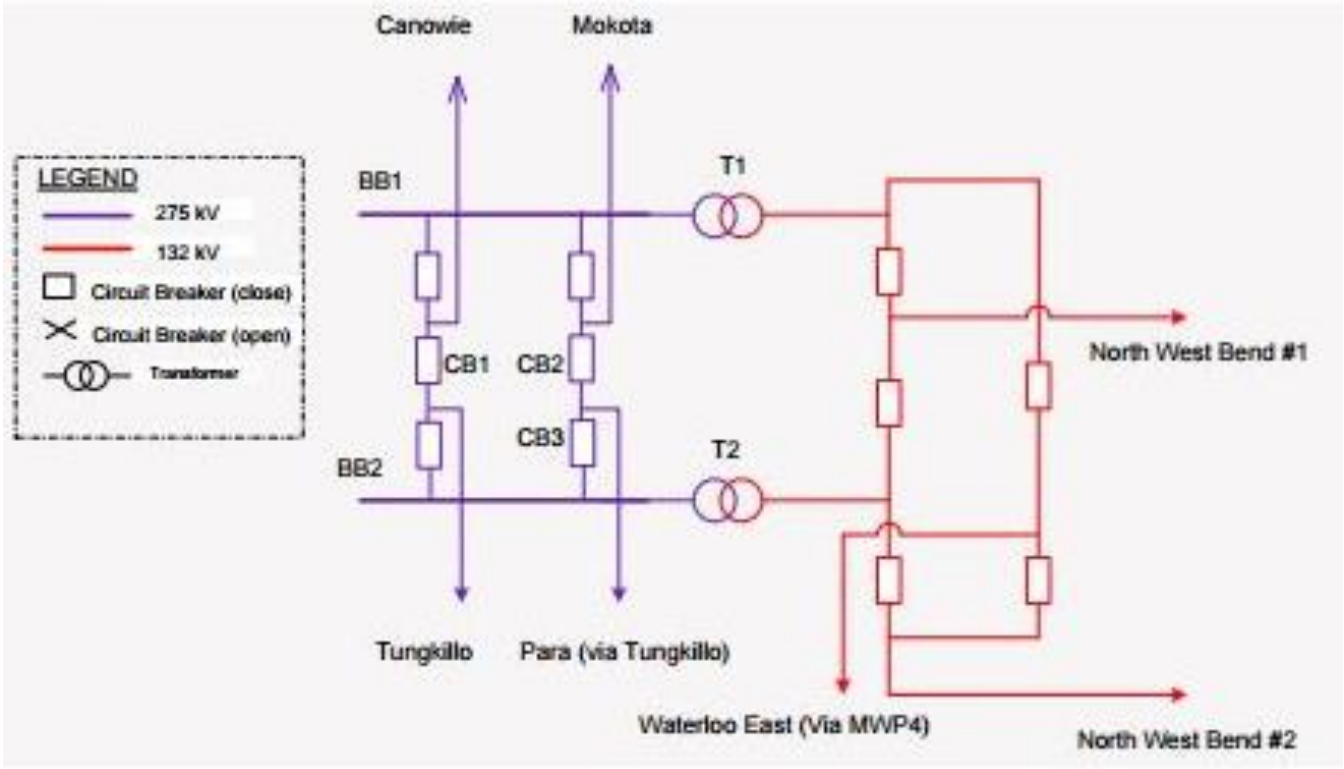


**Figure 2.2.2.a – Robertstown 275/132 kV Substation Single Line Diagram[1]**

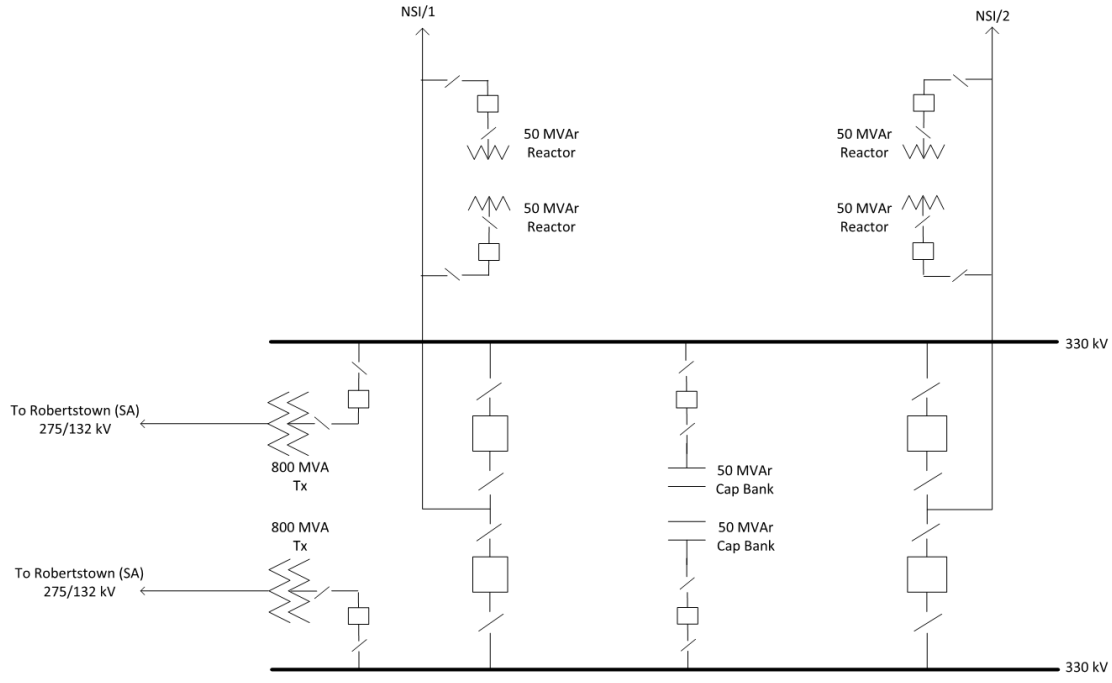


**Figure 2.2.2.b - Single Line Diagram of the Proposed Substation at Robertstown**

[1] Diagram taken from an AEMO report *Independent Planning Review – ElectraNet Preliminary Capital Expenditure Projects*, accessible from AEMO web site: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/South-Australian-Advisory-Functions

The OSA has requested high level costs for the works required at Robertstown which includes the following.

- Acquisition of property required for the establishment of a 330/275 kV substation near the existing Robertstown 275/132 kV Substation.
- Establishment of a 330/275 kV substation as depicted in Figure 2.2.2.b.
- Acquisition of easements and the construction of two 275kV single circuit transmission line connections between the new 330/275 kV substation and existing 275/132 kV substation.
- Acquisition of property adjacent to the existing Robertstown 275/132 kV Substation required for the additional high voltage equipment associated with the 275kV connection.
- Augmentation works at the existing Robertstown 275/132 kV Substation which includes the following.
    - Switchyard bench extension required for the new high voltage equipment.
    - Extension of the 275 kV A and B Busbars.
    - Installation of two 275 kV line double switchbays.
    - Secondary systems upgrades required for the new substation and line arrangements.

## 2.3 Transmission Line Works

### 2.3.1 New Darlington Point to Robertstown Transmission Line

#### 2.3.1.1 Indicative Transmission Line Route

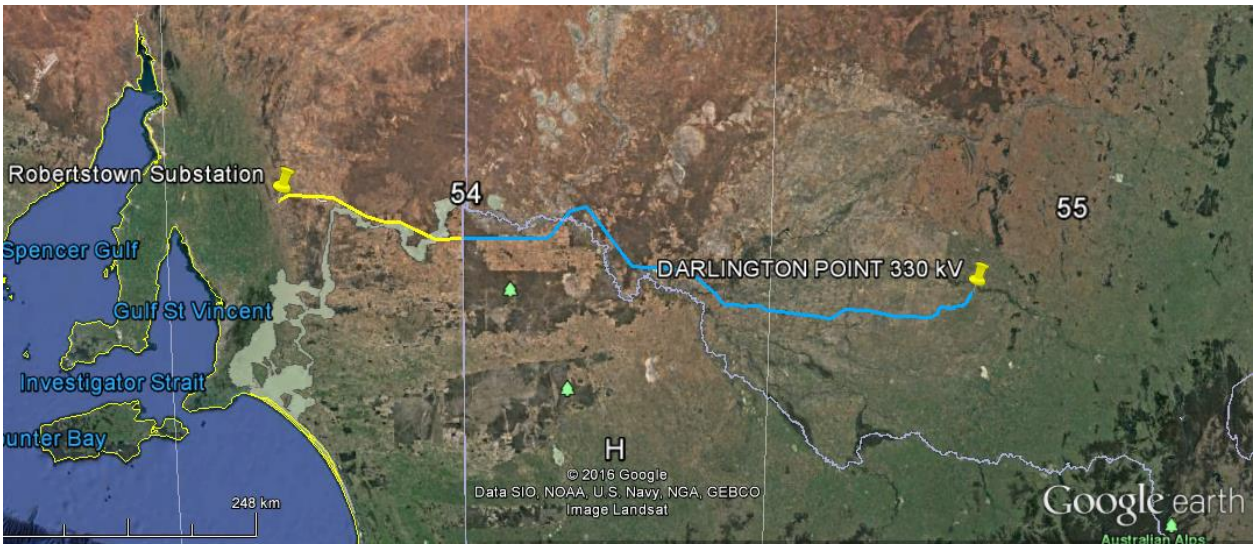


**Figure 2.3.1.1.a - Indicative Transmission Line Route Between Darlington Point and Robertstown**

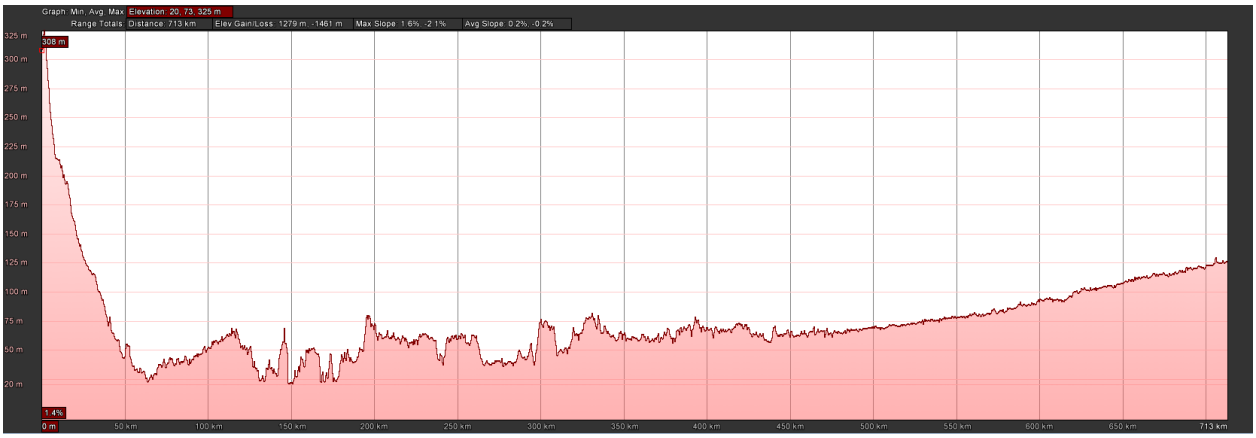

**Figure 2.3.1.1.b – Elevation Profile of the Proposed Route (from Google Earth)**

In Figure 2.3.1.1.a above, the TransGrid portion of the new 330 kV interconnector is shown in blue. It is approximately 528 km in length and runs parallel to the existing X5 220kV transmission line between Darlington Point and Buronga before crossing the border into Victoria and running parallel to the Sturt Highway. The portion of the interconnector that runs in South Australia is shown in yellow. It is approximately 200 km in length.

### 2.3.1.2 Design

The new 330 kV interconnector will be a total of 728 km in length and will be of double circuit steel lattice construction. It is proposed that each circuit of the line will be strung with twin Mango conductors for an operating temperature of 85°C.

Given the predominantly flat landscape along the proposed transmission line route, it is currently anticipated that an average span length of 350m will be achievable. It is anticipated that for the route running parallel to the existing X5 220 kV line, the ratio of tension to suspension structures will mimic the X5 line given the identical number of deviations and ground profile. The X5 line has a 95:5 suspension to tension structure ratio. For the transmission line route between Buronga and Robertstown where the route is less certain, a 90:10 suspension to tension structure ratio has been used. Therefore, it is expected the following structures will be required for the Darlington Point to Robertstown transmission line.

| Portion | Suspension Structures | Tension Structures | Total |
|---|---|---|---|
| NSW/VIC | 1446 | 97 | 1543 |
| SA | 514 | 57 | 571 |

### 2.3.1.3 Communications

At this stage it is anticipated that the new 330 kV interconnector will be equipped with OPGW primarily for protection signalling.

Given the distance limitations of communications over single mode fibre (generally limited to about 150km) an allowance has been included for the construction of fibre repeater stations along the length of the transmission line. Three repeater stations will be along the TransGrid portion of the line and one will be along the South Australia portion of the line.

It is assumed that each repeater site will be in a fenced compound within the transmission line easement and will contain:

- Communications shelter.
- Fibre optic communication equipment.
- 50 V DC supplies.

It is anticipated that the repeater stations will be located such that a 415 V AC supply will be readily available.

### 2.3.1.4 Land use

The land use along the proposed transmission line route is predominantly farming with some sections skirting the Calperum Station and Taylor Station pastoral leases in South Australia. It is anticipated that some sections of land covered by native vegetation heritage agreements will be impacted by the transmission line.

The transmission line will have to pass through the Murray River Water Protection Area in South Australia that is affected by the River Murray Act 2003.

### 2.3.1.5 National parks

The proposed transmission line passes through the Bretts State Forest and Yanga State Conservation Area in NSW, along the X5 transmission line route.

In Victoria the line will pass through the Murray Sunset National Park.

In South Australia the line passes through, or in close proximity to:

- Murray River National Park;
- Pooginook Conservation Park; and
- White Dam Conservation Park.

#### 2.3.1.6 Extent of possible clearing

The proposed transmission line route is sparsely vegetated. It is expected that the majority of clearing and access work will require new gates to be installed, establishment of new access tracks and pads for mobile plant.

Based on a desktop assessment of the line route, the following factors have been used to calculate clearing along the line route.

| Clearing Type | NSW – X5 Route | NSW – Buronga to SA border | SA |
|---|---|---|---|
| Very Light | 50% | 75% | 79.5% |
| Light | 0% | 13% | 10% |
| Medium | 0% | 9% | 10% |
| Heavy | 0% | 3% | 0.5% |

### 2.3.2 New 330 kV Line Between Darlington Point and Wagga

#### 2.3.2.1 Design

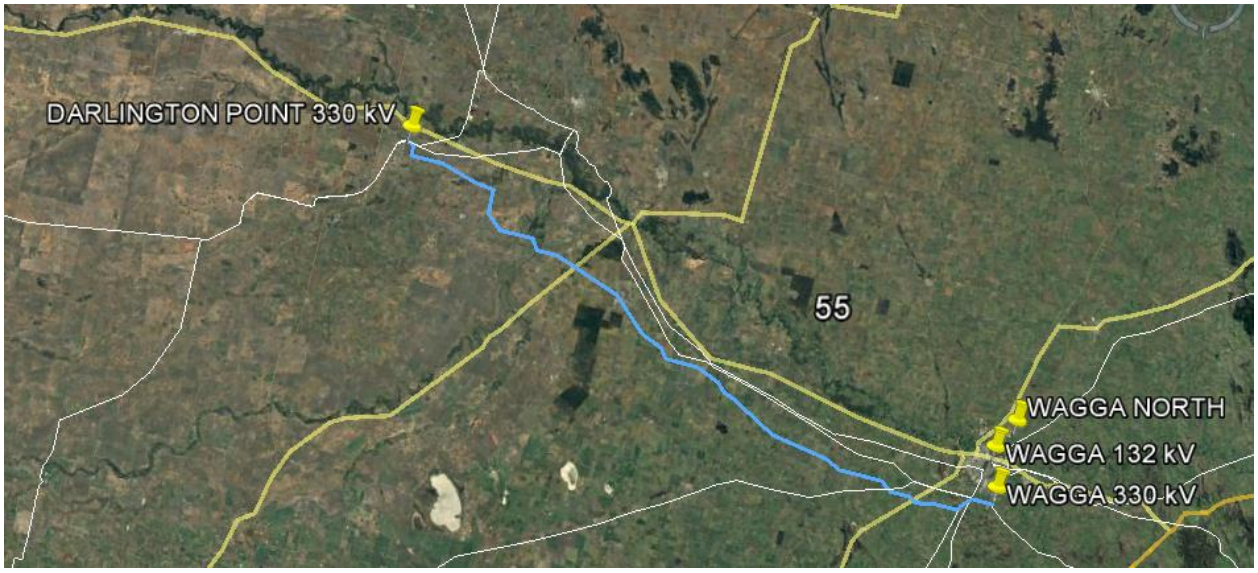


**Figure 2.3.2.1.a – Existing Transmission Line Route between Darlington Point and Wagga 330kV**

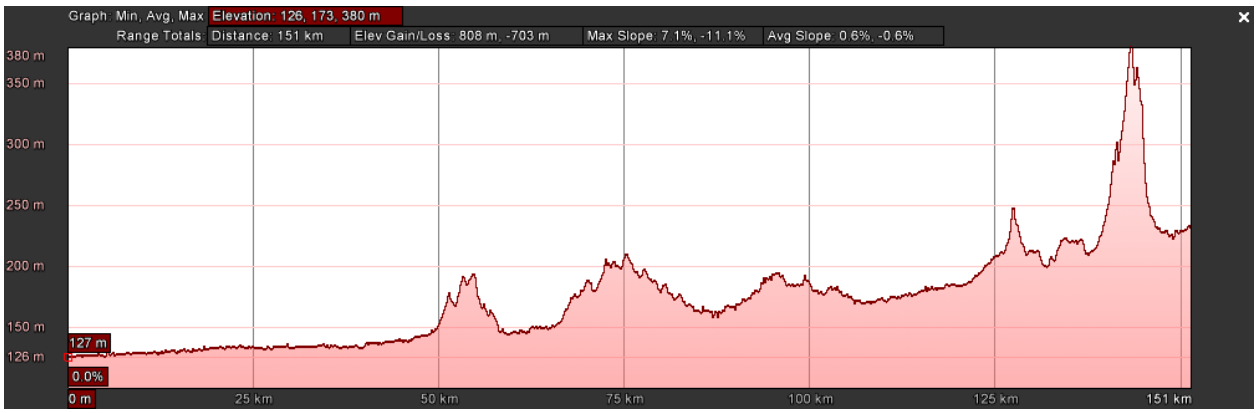


**Figure 2.3.2.1.b – Existing 63 Line Elevation Profile (from Google Earth)**

The new 330 kV transmission line between Darlington Point and Wagga 330 kV substation will be of single circuit construction with twin Mango conductor. It is envisaged that the new line will be built parallel to the existing 63 line between Darlington Point and Wagga 330 kV substations.

Based on a route length of 152 km, an average span length of 390m and a tension to suspension structure ratio of 10:90, the following structure quantities have been calculated.

| Suspension Structures | Tension Structures | Total |
|---|---|---|
| 351 | 39 | 390 |

#### 2.3.2.2 Communications

At this stage it is anticipated that the new 330 kV transmission line will be equipped with OPGW.

It is anticipated that fibre optic cores will be terminated at the existing fibre optic terminal equipment at Wagga 330 kV substation and the terminal equipment at Darlington Point as detailed in Section 2.1.1.9.

#### 2.3.2.3 Extent of Possible Clearing

It is anticipated that the new single circuit transmission line will be constructed on the existing easement. In order to accommodate the second transmission line, the easement will be widened by approximately 40 m.

Given that the new line will run parallel to the existing 63 line, it is anticipated that for the majority of the transmission line route the existing access will be suitable.

#### 2.3.2.4 Land Use

The area around Wagga 330 kV substation is urban and agricultural land. Further from Wagga, the transmission line route is dominated by grazing and cropping.

#### 2.3.2.5 National Parks

The existing transmission line route from Darlington Point to Wagga 330 kV substation passes in close proximity of the Murrumbidgee Valley National Park and the Southwest Woodland Nature Reserve.

#### 2.3.2.6 Heritage

There are no known heritage sites within the existing transmission line easement, however there are a number of recorded sites in the broader area. A few heritage sites in close proximity to the existing easement may be impacted by the expansion of the easement and associated transmission line construction.

Given the number of water way crossings and existence of undisturbed vegetation, it is considered possible that sites of aboriginal heritage will be found.

#### 2.3.2.7 Flora and Fauna

There is one recorded sighting of the Superb Parrot along the transmission line route, however given the generally sparse nature of threatened or endangered species sighting in the vicinity of the line, the presence of this recorded sighting is not considered as impacting upon the feasibility of this option.

A more thorough assessment should be undertaken as part of project scoping to determine the full environmental impacts of the transmission line construction.

### 2.3.3 Tailem Bend to Tungkillo

The OSA requested the a high level cost be provided for stringing the vacant Tailem Bend to Tungkillo 275 kV circuit with Moose ACSR/GZ conductor. Therefore, the high level cost has been provided for stringing 62km of transmission line between Tailem Bend and Tungkillo with the metric equivalent Olive ACSR conductor.

## 3. Outage requirements

The preliminary assessment of outage requirements is as follows.

| Equipment | Scope | Outage Duration | Recall | Availability |
|---|---|---|---|---|
| Darlington Point 330 kV A Bus | Make HV connections to busbar. | Daily | 4 hours | April – October |
| Darlington Point 330 kV B Bus | Make HV connections to busbar. | Daily | 4 hours | April – October |
| Wagga 330 330kV B Bus Section 1 | Make HV connections to the bus disconnector. | Daily | 4 hours | April – October |

## 4. Environmental and development approvals

This project has the potential to have a significant impact on the environment and is likely to trigger state significant and federal assessment processes. This project is expected to require appropriate assessment and approval in accordance with NSW, South Australian, Victorian and Federal environmental planning processes.

A more detailed assessment of environmental risk at an early stage should be undertaken as timeframes for approval and potential biodiversity offsetting may be significant. There are also additional risks to the project program as there are no agreements in place between TransGrid, ElectraNet and AEMO with regards to the responsibilities for the preparation of assessments. These risks should be further investigated as part of early project development.

Public consultation is a statutory requirement of this process.

This option involves significant investment; therefore it is considered that this option will be subject to the RIT-T process.

## 5. Property considerations

This option will require transmission line easements to be procured for the new 330 kV transmission line between Darlington Point and Robertstown substations. The route parallel to the X5 line will require the existing easement to be widened, with new easements over the rest of the line route.

The cost for purchasing the easements and acquiring property has been included based on the assumption of acquisition via private treaty over freehold land.

At the current point in time there are no agreements in place between TransGrid and ElectraNet with regards to the responsibilities for property acquisition. This has the potential to delay property negotiations with the appropriate landowners and hence, delay project commencement.

While all effort will be made to achieve property acquisition via private treaty, some degree of compulsory acquisition would normally be anticipated for a project of this size. Compulsory acquisition will require the support of the appropriate state Minister. There is a risk that support will not be provided, which would greatly increase acquisition costs and time.

# 6. Cost estimate

## 6.1 Capital Expenditure

It is estimated that this option would cost $887m ± 25% in $2016-17 as per the following table.

| Item | Cost ($m) |
|---|---|
| New 330kV Interconnector between Darlington Point to Robertstown (double circuit towers, strung both sides) – NSW portion of work | 614.2 |
| New 330kV circuit between Darlington Point and Wagga 330 (single circuit towers) | 103.4 |
| Substation Augmentations/Upgrades at Darlington Point | 167.6 |
| Substation Augmentations/Upgrades at Wagga 330 | 1.7 |
| **TOTAL PROJECT COST (excl Capitalised interest)** | **887** |

Although the costs provided below are required as part of this project option, they are outside TransGrid's scope of work and are not necessarily costed to the degree of accuracy as the other portions of work.

| Non-NSW Works | Cost ($m) |
|---|---|
| New 330kV Interconnector between Darlington Point to Robertstown (double circuit towers, strung on both sides) – SA portion of work | 241.3 |
| Establishment of Robertstown 330/275 kV Substation, 275kV line connections and Robertstown 275/132 kV Substation augmentation works, excluding new reactive support | 65.5 |
| Reactive support required at Robertstown | 19.5 |
| Tailem Bend Capacitor | 2.5 |
| String vacant Tailem Bend to Tungkillo 275 kV circuit | 16.5 |

The expected expenditure profile for this project (excluding capitalised interest) based on a standard spending curve distribution is as follows:

| | Total Project Base Cost | Year -3 | Year -2 | Year -1 | Year 0 |
|---|---|---|---|---|---|
| Estimated Cost– non-escalated ($m 2016-17) | 887 | 5 | 16 | 58 | 808 |

Notes:

1. The detailed breakdown provided in the above table is approximate only and is based on the total scope and nature of works included in the option.
2. The cost has been estimated from a scope of work determined by a limited review of the project, as detailed in section 2.
3. The values used in the estimate were generally obtained using PS / PSE's Estimating System.
4. The estimate has been prepared on the basis of standard bays and allowances for the works, with adjustments as detailed in this study for the specific option scope.
5. The estimate has an uncertainty of +/- 25%
6. No allowance has been included in the estimate for exchange rate variations.
7. No adjustment for forward escalation has been included in the totals above. Based on forecast commodity escalation, the nominal estimated cost is as follows:

| Item | Nominal Cost ($m) |
|---|---|
| New 330kV Interconnector between Darlington Point to Robertstown (double circuit towers, strung on both sides) – NSW portion of work | 753.1 |
| New 330kV circuit between Darlington Point and Wagga 330 (single circuit towers) | 126.9 |
| Substation Augmentations/Upgrades at Darlington Point | 196.0 |
| Substation Augmentations/Upgrades at Wagga 330 | 2.0 |
| **TOTAL NOMINAL ESCALATED PROJECT COST (excl Capitalised interest)** | **1,078** |

Although the nominal costs provided below are required as part of this project option, they are outside TransGrid's scope of work and are not necessarily costed to the degree of accuracy as the other portions of work.

| Non-NSW Works | Nominal Cost ($m) |
|---|---|
| New 330kV Interconnector between Darlington Point to Robertstown (double circuit towers, strung both sides) – SA portion of work | 295.9 |
| Establishment of Robertstown 330/275 kV Substation, 275kV line connections and Robertstown 275/132 kV Substation augmentation works, excluding new reactive support | 78.4 |
| Reactive support required at Robertstown | 23.0 |
| Tailem Bend Capacitor | 3.0 |
| String vacant Tailem Bend to Tungkillo 275 kV circuit | 20.0 |

8. Based on forecast commodity escalation, the nominal estimated cost in each year (i.e. the amount in 2018-19 is in forecast $2018-19), excluding the non-NSW works, is as follows:

| | Total Project Budget Cost | 2019-20 | 2020-21 | 2021-22 | 2022-23 |
|---|---|---|---|---|---|
| Nominal escalated cost ($m) | 1,078 | 6 | 19 | 67 | 986 |

## 7. Project and implementation method

The project is expected to be completed in an estimated 47 months from the issue of a Request for Project Scoping, allowing 13 months for completion of scoping studies and issue of the PAD and 34 months for project completion following issue of the PAD.

The key dates for this program are detailed below:

| Milestone | Duration (Months) | End of Month |
|---|---|---|
| Issue of RPS | 0 | 0 |
| Concept Design Complete | 4 | 4 |
| Environmental Approval Complete | 12 | 13 |
| Regulatory Approval Complete | 12 | 13 |
| Property Acquisition Complete | 24 | 25 |
| Issue PSS | 12 | 12 |
| Issue PAD (DG2) | 1 | 13 |
| SVC at Darlington Point | | |

| Milestone | Duration (Months) | End of Month |
|---|---|---|
| Detailed Design/Specification Preparation | 3 | 16 |
| Tender and Tender Analysis Period | 6 | 22 |
| Funding Approval and Award Contract | 1 | 23 |
| Manufacture, Delivery and Erection | 24 | 47 |
| Substation Augmentation | | |
| Detailed Design/Specification Preparation | 4 | 17 |
| Tender and Tender Analysis Period | 4 | 21 |
| Funding Approval and Award Contract | 1 | 22 |
| Possession of Site | 4 | 26 |
| SSB Design, Manufacture, Fitout and Test and Deliver to Site | 8 | 30 |
| Practical Completion | 12 | 38 |
| New 330kV Transmission Line | | |
| Detailed Design/Specification Preparation | 6 | 19 |
| Tender and Tender Analysis Period | 5 | 24 |
| Funding Approval and Award Contract | 1 | 25 |
| Possession of Site | 4 | 29 |
| Practical Completion | 18 | 47 |
| In-Service Date | 0 | 47 |

This timeframe assumes the completion of the following steps prior to issue of the PAD:

- Environmental Assessment complete;
- Concept design complete;
- Regulatory Approval progressed sufficiently so as to not prevent award of contracts; and
- PAD issued within one months of completion of PSS.

For this option the following key risks to the completion of project scoping and PAD issue have been identified:

a) Environmental assessment is expected to require approvals from NSW Minister for Planning, the SA and Victorian equivalent and the Commonwealth Department of Environment. Significant delays to environmental approval may be experienced if the project gains a high public profile and becomes the subject of public political debate.

b) There is currently no formal agreements with the other TNSPs regarding the preparation of environmental assessments for the various aspects of this project. The commencement of environmental assessments may be delayed while agreements are negotiated.

c) Some degree of compulsory acquisition can be expected for a new transmission line construction project of this size. Should the NSW Minister not support TransGrid exercising compulsory acquisition powers, then property acquisition could take significantly longer than currently anticipated.

In the event that these risks occur, project completion will be delayed and the project needs date may not be met. It is recommended that the RPS be issued with sufficient float to minimise the risk of the needs date not being met. Alternatively, contingency plans should be developed for the risk that the needs date cannot be met.

The program is based on the specific scope included in this report. If this option is combined with other options on the same site, the total project construction time frame will extend by a period that will be dependent on the

availability of outages and staging of the total package of works. This should be allowed for when determining the date for issue of the RPS.

It should be noted that construction rates of 80 km per year are typical for new 330 kV transmission lines. To achieve the 18 month construction duration multiple work crews will be required to work simultaneously on each of the given lines. Achieving the required resourcing levels should be a key consideration when developing the transmission line construction specification.

## 8. Project delivery risks

The key risks outlined in the table below have been identified and will need to be managed as part of this project. In the event that these risks occur there could be impacts to both project cost and time for completion. These risks should be assessed in detail during project scoping.

| Risk | Treatment |
|---|---|
| **Safety Risks** | |
| There are the normal risks associated with working on a construction project or in a live high voltage station and in close proximity to a live line. | Ensure that all works are carried out in accordance with TransGrid's Safety Rules and standard policies and procedures. All site works are to be managed using a site specific safety management plan. |
| There are normal risks associated with the design of substations and transmission lines and the associated access. | Ensure that all design works are carried out in accordance with TransGrid's standard designs, policies and procedures.<br>Ensure that all design work is carried out in accordance with TransGrid's safety in design processes. |
| **Environment Risks** | |
| There are the normal risks associated with the delivery of large capital projects that may impact on the environment. | Conduct an Environmental Assessment of Project in accordance with TransGrid's standard policies and procedures. |
| There is a risk that additional equipment noise will affect total site noise levels and require noise reduction measures now or in the future. | Conduct a noise assessment to determine whether noise reduction is required. Ensure designs allow for future installation of noise reduction measures. |
| The proposed transmission line route may impact on heritage sites as well as threatened or endangered flora and fauna. | Conduct an Environmental Assessment of Project in accordance with TransGrid's standard policies and procedures. |
| **Property Risks** | |
| Easement acquisition may be cost more than anticipated and take considerably longer if large amounts of land become subject to compulsory acquisition. | Conduct an Environmental Assessment of Project in accordance with TransGrid's standard policies and procedures. |
| Transmission line construction activities have the potential to cause significant disruption to the normal use of land. | Conduct an Environmental Assessment of Project in accordance with TransGrid's standard policies and procedures.<br>Implement a Communication Strategy in accordance with TransGrid's standard policies and procedures. |

| Risk | Treatment |
|---|---|
| **Community Risks** | |
| There are the increased risks associated with the delivery of large capital projects that may impact on local communities given the number of communities potentially impacted by the project. | Implement a Communication Strategy in accordance with TransGrid's standard policies and procedures. |
| **Project Delivery and Program Risks** | |
| There are significant risks associated with the delivery of capital projects, above the normal risks, given the size of the project and level of co-operation required between TNSPs. | Implement TransGrid's standard policies and procedures during all phases of the work. |
| Program may be delayed if Regulatory Approval has not been completed in time. | Ensure that Regulatory Approval is completed in a timely manner. |
| Requiring separate environmental assessments for each state will add complexity to the environmental assessment and approval. Project cost and time may be adversely impacted. | Negotiate responsibilities for preparing environmental assessments with ElectraNet and AEMO as soon as possible. |
| Compulsory acquisition is subject to Minister support. Failure to gain this support has the potential to significantly delay the project. | Ensure that Regulatory Approval is completed in a timely manner.<br>Conduct an Environmental Assessment of Project in accordance with TransGrid's standard policies and procedures. |
| Program may be delayed if the equipment orders are not placed with sufficient lead time | Ensure that equipment is ordered as early as possible to suit the project program. |
| Program may be delayed if outages cannot be obtained | Prepare an implementation plan and providing the earliest possible notification of the required outages. |
| Project may be delayed if appropriate resources are not available | Ensuring that the project is given the appropriate priority. |
| The complexity of substation works may cause delays due to the co-ordination of multiple construction contractors. | Ensure that each construction contract is discrete in scope so that there are minimal dependencies with other works. |
| Project may be delayed as a result of issues detailed in Section 7 of this report. | Issue RPS with sufficient float to ensure that the needs date can be met. |
| **System Risks** | |
| Outage clashes in the south west part of the transmission network may constrain power flows between New South Wales and Victoria. | Prepare an implementation plan and providing the earliest possible notification of the required outages. |

## 9. Change History

| Revision | Approver | Amendments |
|---|---|---|
| 0 | J. Howland | Initial Issue |