OPTION FEASIBILITY STUDY (OFS)

Support South Western NSW for Renewables

OFS- 000000001746C revision 0.0

Option description: Duplicate X5 and 63 Lines and additional voltage support

Ellipse Project No: P0010447

Project reason: Economic Efficiency - Network developments to achieve market benefits
Project category: Prescribed - Augmentation

Approvals

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Date submitted for approval	20 December 2016	

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1. Request

This Option Feasibility Study is provided in response to Option Screening Analysis 1746 Rev 0 – Support South Western NSW for Renewables – Option C – Duplicate X5 and 63 Lines and additional voltage support.

This Need aims to reinforce the transmission network in this area (west of Wagga) to address supply shortfalls in NSW following the retirement of NSW generation, as well as providing market benefits to NSW and the NEM by facilitating renewable generation connections in the South West of NSW.

Portfolio Management is 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 is associated with this project option.

- Uprating the existing X5/1 and X5/3 Lines to 275 kV operation.
- Construction of a 400 km 275 kV single circuit transmission line, strung with twin Lemon ACSR conductor for an operating temperature of 85°C, between Buronga, Balranald and Darlington Point.
- 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
    - Extension of the switchyard bench as required for the installation of new high voltage equipment.
    - Installation of two 330 kV 25 MVAr capacitor banks and associated switchbays.
    - Installation of one new 330 kV line switchbay.
    - Installation of a new 330 kV bus section switchbay.
    - Replacement of all 220 kV switchgear by 275 kV switchgear.
    - Removal of the existing X5/1 Line Reactor.
    - Installation of a new 275 kV bus section switchbay.
    - Installation of two new 275 kV 35 MVAr shunt reactors on the X5/1 Line and one associated switchbay.
    - Replacement of the existing 330/220 kV transformers by two new 330/275 kV 350 MVA transformers.
    - Secondary systems upgrades required for the new substation and line arrangements.
    - Installation of a new primary spill oil tank.
    - Relocation of the secondary oil containment dam.
- Balranald Substation
    - Acquisition of property required for the switchyard bench extension.
    - Extension of the switchyard bench as required for the installation of new high voltage equipment.
    - Installation of a secondary systems building.
    - Installation of high voltage connections required for the new equipment.
    - Installation of a new 275kV bus section switchbay.
    - Installation of three 275 kV 35 MVAr capacitor banks and associated switchbays.

  - Installation of four new 275 kV line switchbays for the new 275 kV lines.
  - Installation of two new 275 kV 50 MVAr line shunt reactors.
  - Commission the existing No.1 220/22 kV Transformer for 275/22 kV operation.
  - Secondary systems upgrades required for the new substation and line arrangements.
- Buronga Substation
  - Extension of the switchyard bench as required for the installation of new high voltage equipment.
  - Replacement of the existing primary oil containment tank.
  - Installation of a 275/220 kV 400 MVA transformer and associated switchbays.
  - Establishment of a 275 kV busbar.
  - Installation of a new 275kV bus section switchbay.
  - Installation of two new 275 kV line switchbays for the new 275 kV lines.
  - Installation of two new 275 kV 50 MVAr line shunt reactors.
  - Installation of three 275 kV 35 MVAr capacitor banks and associated switchbays.
  - Retermination of the existing X5/3 Line onto a new gantry and installation of a new 275 kV line switchbay.
  - Installation of approximately 300 m of 275 kV cable to connect the X5/3 Line to the new 275 kV line switchbay.
  - Convert the existing X5/3 line reactor to a bus connected shunt reactor by removal of the redundant switchgear and HV connections.
  - Secondary systems upgrades required for the new substation and line arrangements.
- Construction of a 330 kV line switchbay at Wagga 330 kV Substation.
- Replacement of the existing line droppers at Yanco on the 132 kV Yanco to Uranquinty 99F Line.

2.1 Substation Works

2.1.1 Darlington Point

2.1.1.1 Site general arrangement and access

Darlington Point 330kV Substation is located approximately 140 km north-west of Wagga Wagga and is TransGrid’s furthermost western substation 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.

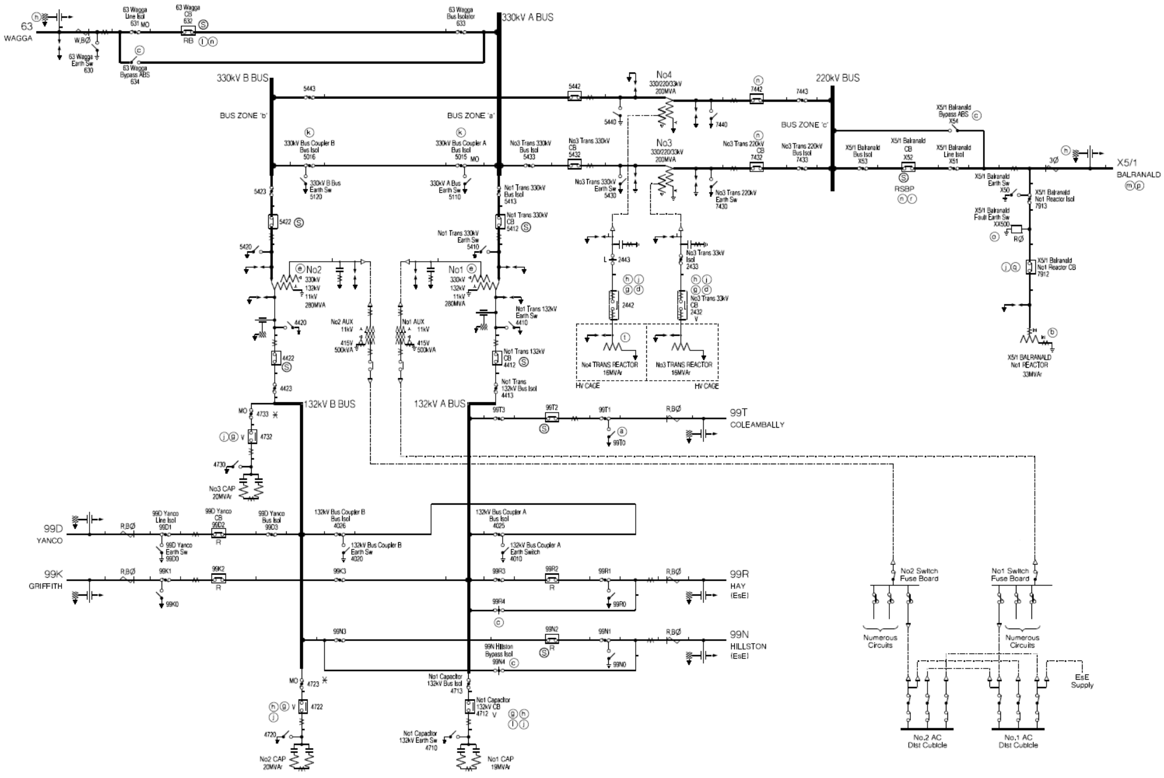

Figure 2.1.1.1.a – Darlington Point Substation High Voltage Operating Diagram

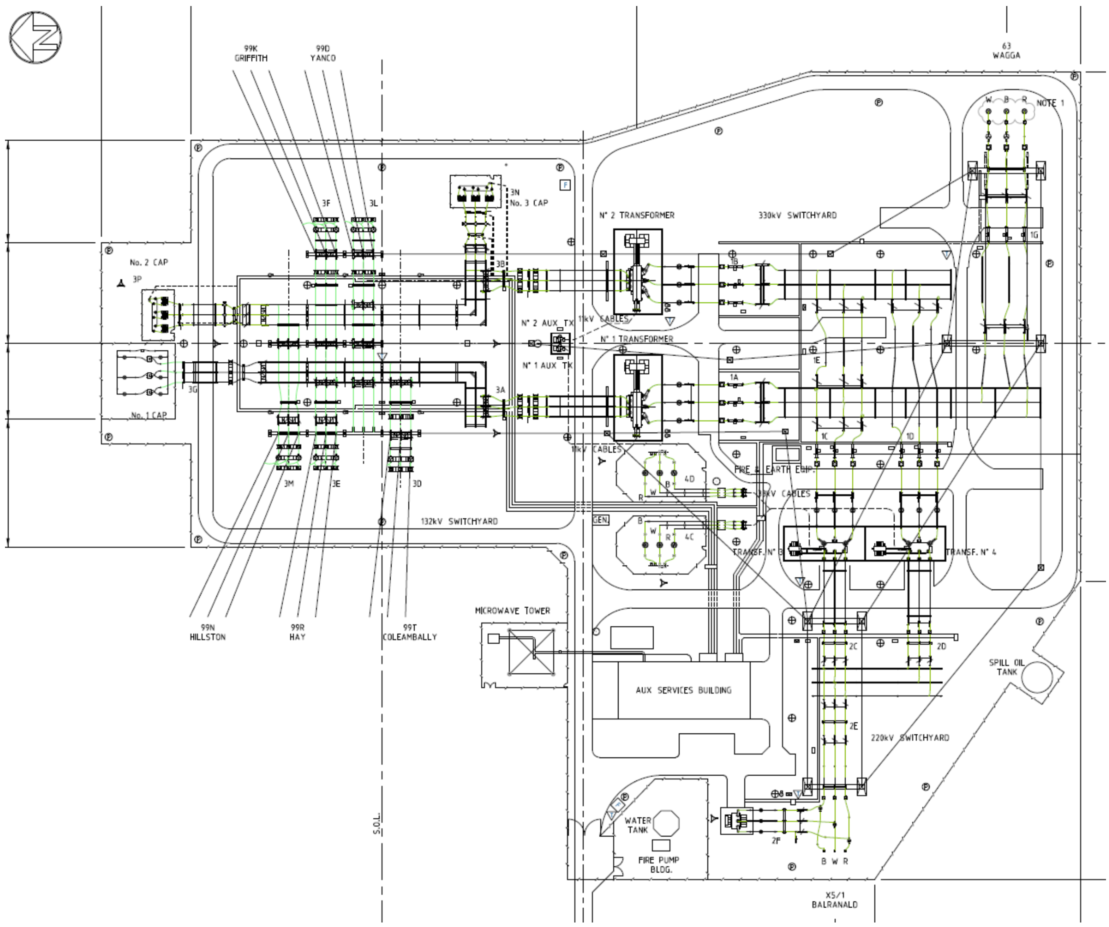

Figure 2.1.1.1.b – Darlington Point Substation General Arrangement

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

- Construction of switchyard bench on existing TransGrid freehold property.
- Installation of two 330 kV cap banks and associated switchbays.
- Installation of one 330 kV bus section switchbay.
- Installation one 275 kV reactor and associated switchbay.
- Installation of one 275 kV line switchbay
- Replacement of the existing 220 kV X5/1 Line shunt reactor by a new 275 kV shunt reactor.
- Replacement of the existing 220 kV X5/1 Line and shunt reactor switchbays by 275 kV equipment.
- Replacement of the existing No.3 and No.4 transformers including connections to the existing 33kV reactors.
- Replacement of the existing No.3 and No.4 Transformer 220 kV switchbays by 275 kV equipment in the same location.
- Installation of one 275 kV bus section switchbay.
- Installation of a new primary spill oil tank.
- Relocation of the secondary oil containment dam.

The proposed Darlington Point Substation single line diagram is shown in Figure 2.1.1.1.c, below.

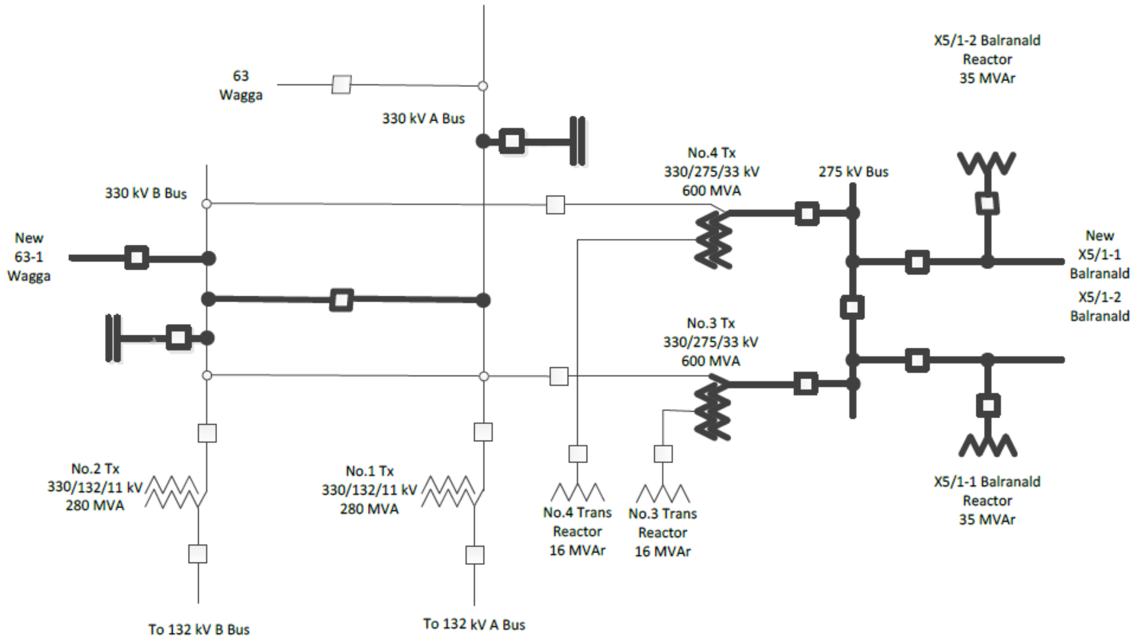

Figure 2.1.1.1.c – Proposed Darlington Point Substation Single Line Diagram

2.1.1.2 Civil works

The construction of new switchyard bench and a new compound will required to accommodate the new 275 kV equipment. The area proposed for the switchyard bench extension is located close to the secondary containment dam, and is expected to be affected by the bench extension.

Existing gantries are suitable to be re-used.

New cable trenches will be required to accommodate the LV cabling associated with the new 275 kV equipment.

It is not expected that the existing transformer compounds will be suitable for the new transformers and will therefore need to be rebuilt. It is not anticipated that noise walls will be required, however, a firewall will be required between the two transformers.

It is expected that the existing reactor compound will be suitable for the new reactor.

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

The existing primary spill oil tank at Darlington Point has a capacity of 132 kL. However, as the new transformers required are 600 MVA units, a new primary spill oil tank has been included in the scope of works.

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.

- 2 x 330/275 kV 600 MVA transformers.
- 2 x 330 kV 25 MVAr capacitor bank.
- 2 x 275 kV 35 MVAr shunt reactors.

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

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

The existing 220 kV switchyard will need to be rebuilt at 275 kV. Existing clearances and post insulators are suitable for 275 kV operation assuming the existing 950 kV lightning impulse withstand voltage (LIWV) is suitable. A study will need to be undertaken by Power System Analysis to determine whether a LIWV of 950 kV is suitable when the switchyard is operated at 275 kV. There is a risk that additional surge arresters may need to be installed if the LIWV of 950 kV is not suitable. Therefore, it is proposed to re-use existing busbars and HV connections where possible, however, all the existing switchgear is rated at 220 kV and will require replacement.

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

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 uprated 275 kV line will be able to utilise the broadband communications established as part of this project and protect the line using VF intertripping with PLC as a backup.

2.1.1.9 Communications

New communications links will be established on the new transmission lines.

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 Balranald

2.1.2.1 Site general arrangement and access

Balranald 220 kV Substation is located approximately 350 km west-north-west of Wagga Wagga and is connected to Darlington Point, Buronga and Broken Hill through a 220 kV network. Balranald Substation was constructed with primary equipment rated at 275 kV and 330 kV nominal voltage and installed to maintain minimum electrical clearances required for 330 kV operation.

Balranald Substation accommodates the following high voltage equipment.

- 220 kV X5/1 Line.
- 220 kV X5/3 Line.
- 1 x 220/22 kV 30 MVA transformer.
- 1 x 22 kV busbar.
- 3 x 22 kV lines.

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

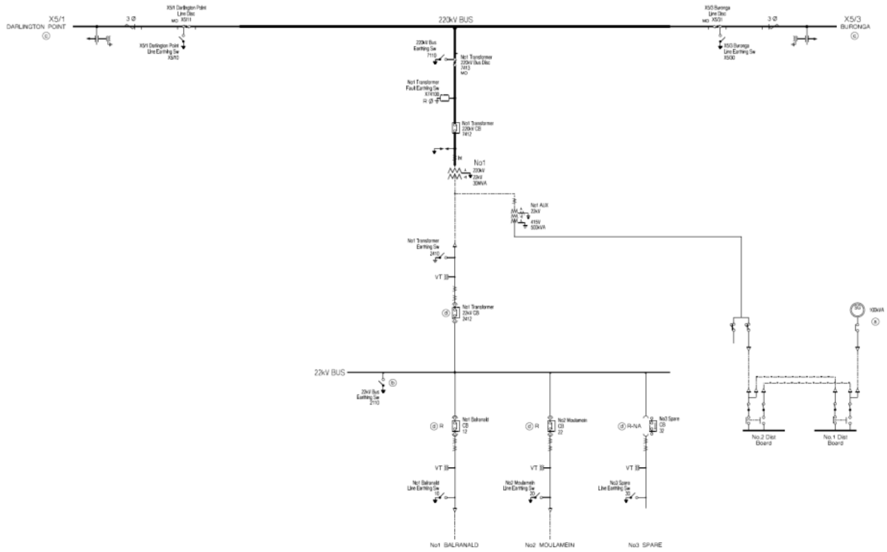

Figure 2.1.2.1.a – Balranald Substation High Voltage Operating Diagram

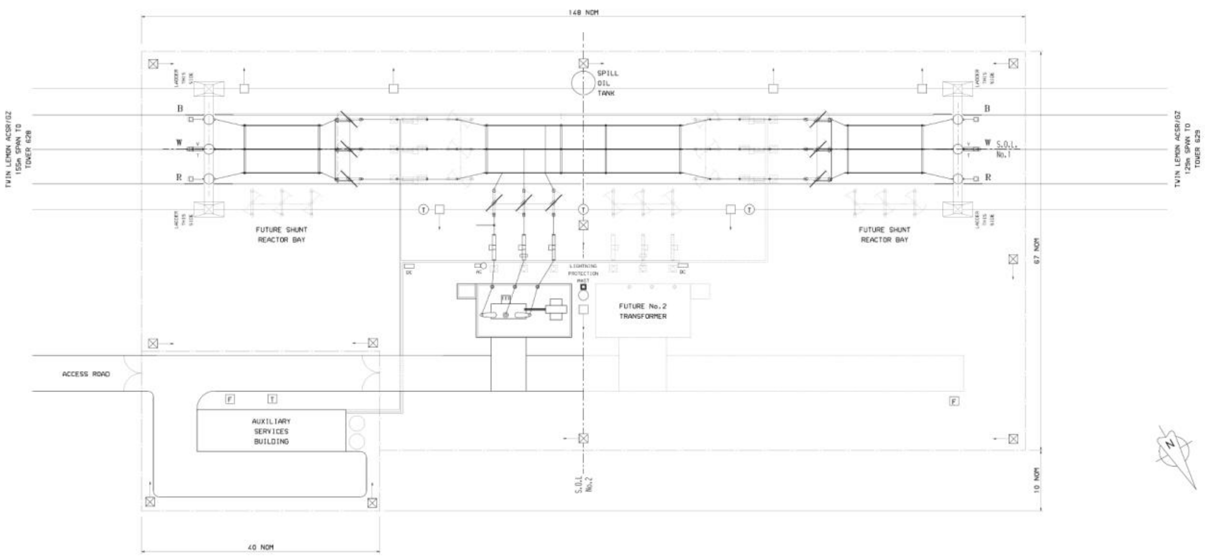

Figure 2.1.2.1.b – Balranald Substation General Arrangement

TransGrid

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

- Acquisition of property required for the switchyard bench extension.
- Construction of switchyard bench.
- Installation of a secondary systems building (SSB).
- Installation of high voltage connections required for the new equipment.
- Installation of three 275 kV capacitor banks.
- Installation of four 275 kV line switchbays.
- Installation of one 275 kV bus section switchbay.
- Installation of two 275 kV line shunt reactors.
- Removal of existing transformer fault thrower and installation of new transformer switchbay current transformers suitable for the protection requirements.
- Recommissioning of existing 220 kV operated equipment and transformer at 275 kV.

The proposed Balranald Substation single line diagram is shown in Figure 2.1.2.1.c, below.

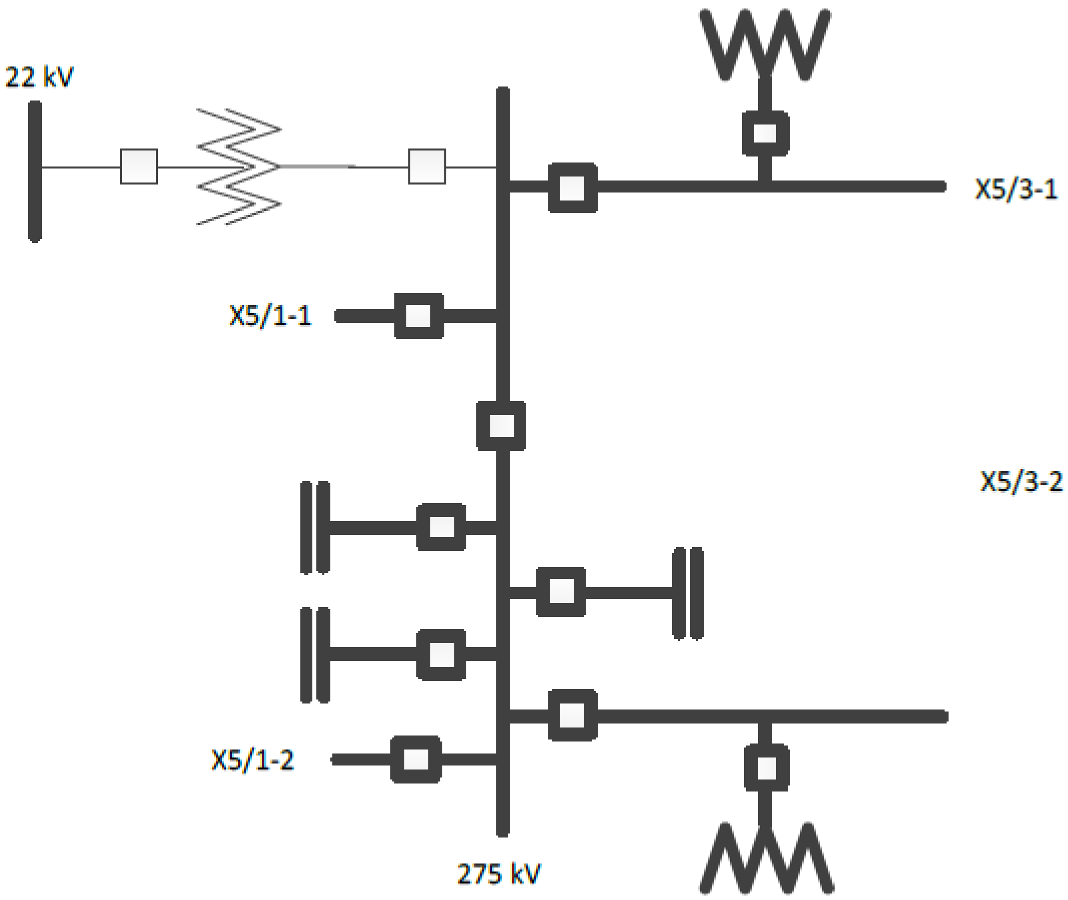

Figure 2.1.2.1.c – Proposed Balranald Substation Single Line Diagram

2.1.2.2 Civil works

The switchyard bench will need to be extended to accommodate the new primary equipment.

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.

The existing primary spill oil tank at Balranald has a capacity of 64 kL. Therefore, it is expected that the existing primary spill oil tank will have capacity to accommodate the new reactors, however, there is a risk that the existing primary spill oil tank will require replacement to accommodate the new reactors.

2.1.2.3 Building works

The existing Auxiliary Services Building does not have sufficient capacity required to accommodate the secondary systems associated with the new reactive plant required as part of this project. Therefore, the installation of a new secondary systems building (SSB) has been included in the scope of works at Balranald.

2.1.2.4 Major plant and equipment

The following major plant will need to be procured.

- 3 x 275 kV 35 MVAr capacitor banks.
- 2 x 275 kV 50 MVAr shunt reactors.
- 1 x secondary systems building.

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

The existing 220/22 kV 30 MVA transformer was designed with two high voltage tap ranges with nominal voltages of 220 kV and 275 kV. Therefore, the existing transformer is able to be configured to operate at 275 kV nominal volts. It is anticipated that the transformer tank will need to be drained to reconfigure the tap connections and the refill the tank for commissioning and is expected that the work could be completed in a day.

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

All existing high voltage connections and switchgear was designed for a maximum operating voltage of 275 kV and therefore does not require any modification to be operated at 275 kV, except for the transformer which needs to be reconfigured to be operated at 275 kV.

New earth grid and lighting will need to be installed within the proposed switchyard bench extension.

2.1.2.7 Secondary systems

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

2.1.2.8 Protection

Standard protections can be implemented on the new lines and equipment at Balranald.

2.1.2.9 Communications

New communications links will be established on the new transmission lines.

Communications suitable for SSB services will need to be established in the new SSB and fibre optic rings will be required between the new SSB and existing ASB.

2.1.2.10 Control systems

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

2.1.2.11 Auxiliary supplies

No modification of the AC auxiliary supply and distribution systems will be required as part of this project.

There is a risk the existing 110 V DC batteries and chargers will require replacement due to the additional DC load at the site.

2.1.3 Buronga

2.1.3.1 Site general arrangement and access

Buronga 220 kV Substation is located approximately 485 km west-north-west of Wagga Wagga and is connected to Darlington Point, Balranald and Broken Hill through a 220 kV network.

Buronga Substation accommodates the following high voltage equipment.

- 220 kV X5/3 Line.
- 220 kV X5/3 Line 33 MVAr shunt reactor.
- 220 kV X2 Line.
- 220 kV X2 Line 24 MVAr shunt reactor.
- 220 kV 0X1 Line
- 2 x 220 kV busbars.

The Buronga high voltage operating diagram and General Arrangement are shown in Figures 2.1.3.1.a and 2.1.3.1.b, below.

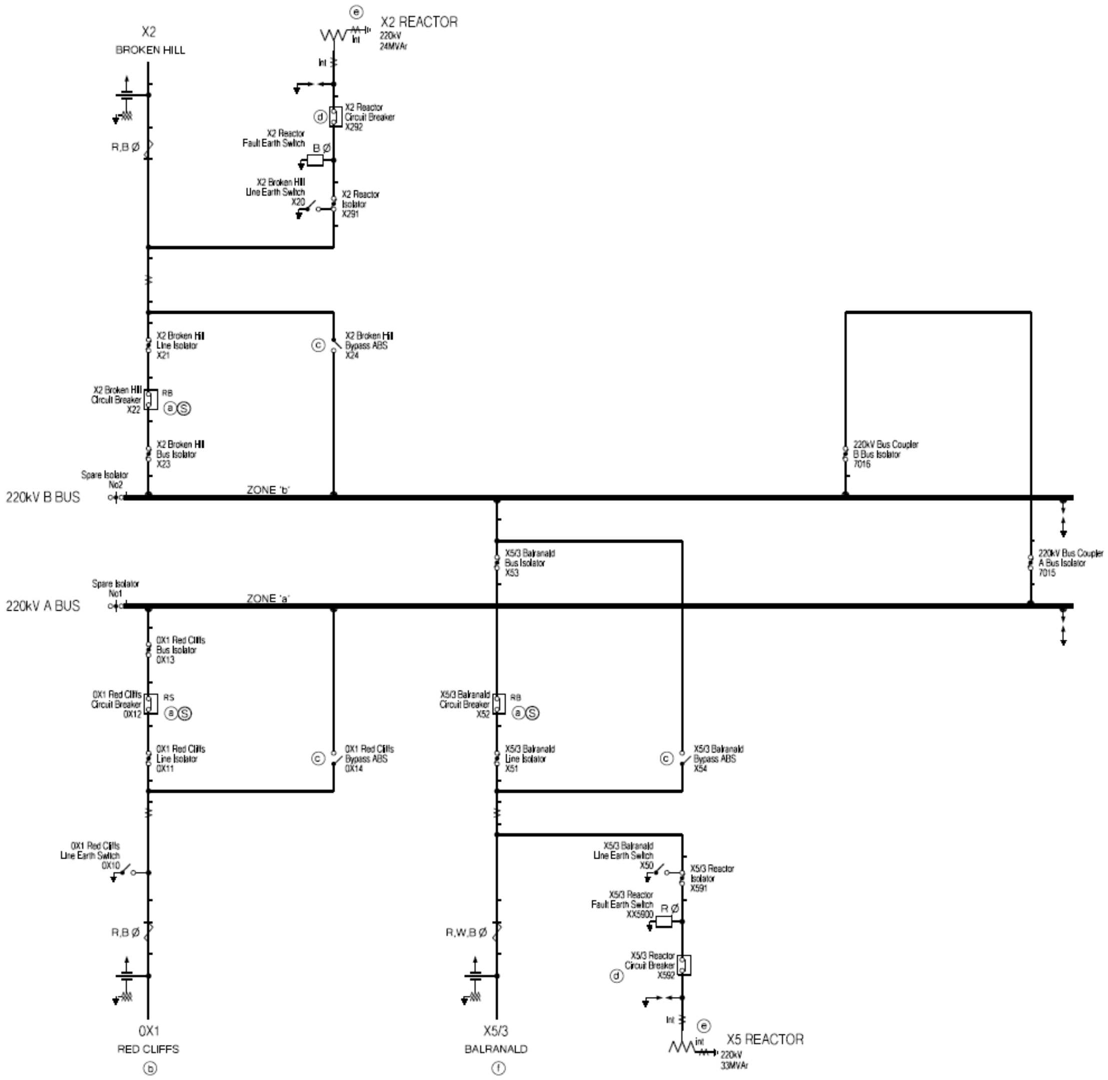

Figure 2.1.3.1.a – Buronga Substation High Voltage Operating Diagram

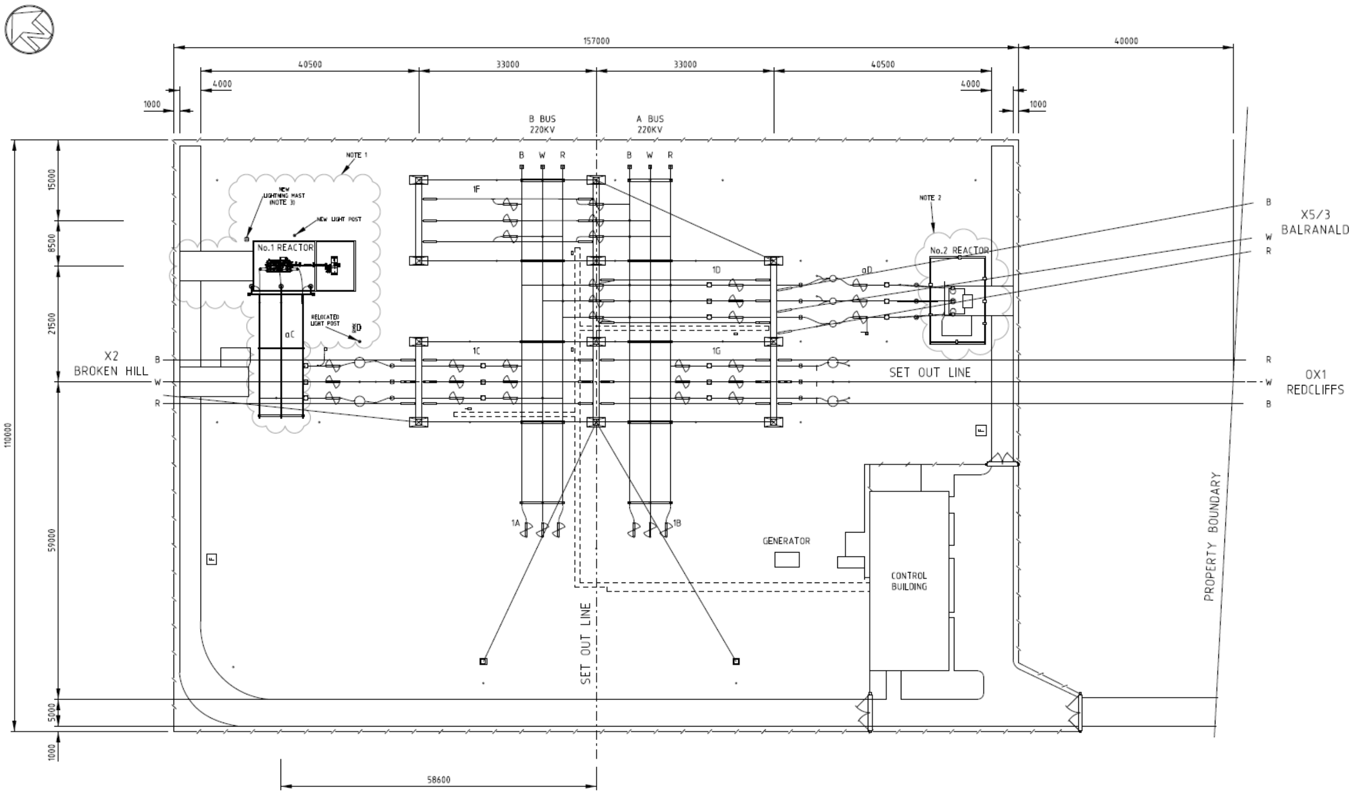

Figure 2.1.3.1.b – Buronga Substation General Arrangement

The scope of works at Buronga should be designed to avoid outages of the X2 Line and 220 kV B Bus as it is extremely difficult to obtain outages of the X2 Line which would result in TransGrid being charged for operation of the diesel generators at Broken Hill.

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

- Construction of switchyard bench on existing TransGrid freehold property.
- Replacement of the existing primary oil containment tank.
- Installation of one 220/275 kV transformer.
- Installation of one 275 kV busbar.
- Installation of one 275 kV bus section switchbay.
- Installation of three 275 kV capacitor banks.
- Installation of two 275 kV line switchbays.
- Installation of two 275 kV reactors.
- Installation of one 275 kV cable.
- Re-termination of existing X5/3 Line in the new 275 kV line switchbay.
- Decommissioning and removal of redundant 220 kV switchgear.

The proposed Buronga Substation single line diagram is shown in Figure 2.1.3.1.c, below.

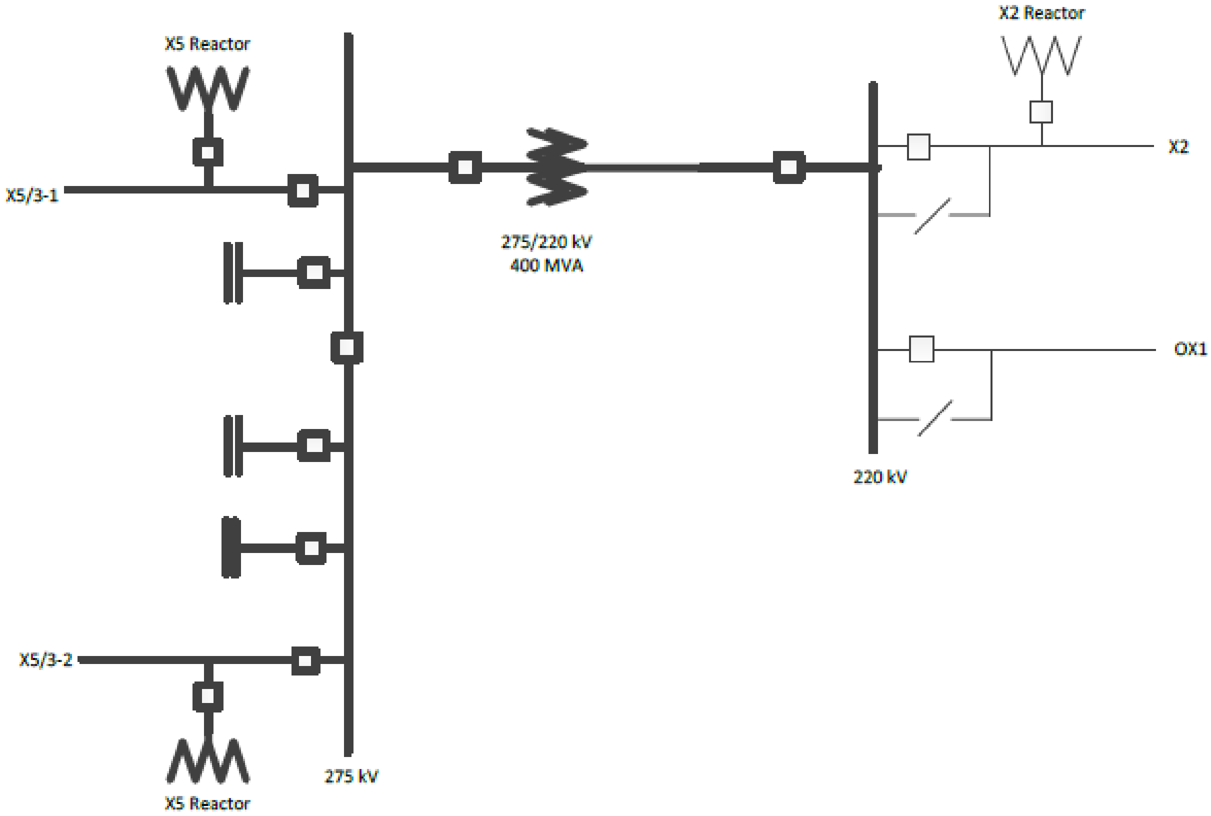

Figure 2.1.3.1.c – Proposed Buronga Substation Single Line Diagram

2.1.3.2 Civil works

Construction of new switchyard bench and transformer compounds will be required to accommodate the new transformers, reactive plant and high voltage equipment. It is not anticipated that noise walls will be required. It is likely that the switchyard bench extension can be constructed on TransGrid's existing freehold land, however, there is a risk that some property may need to be acquired to provide sufficient area required for the bench extension.

The existing reactors, gantry structures, busbar supports, disconnectors and earth switches are supported on piled footings. Therefore, the high voltage equipment footings will require piles as described, below.

- Transformer/reactor compounds and capacitor footings include 6 x 4.6 m piles.
- Gantry footings include 4 x 6 m piles.
- Busbar support footings include 2 x 4 m piles.
- Disconnector footings include 6 x 4 m piles.
- Earth switch footings include 3 x 4 m piles.

All existing circuit breakers, current transformers, line traps and voltage transformers are supported on mass concrete footings, and therefore, it is anticipated that new circuit breakers, current transformers, line traps and voltage transformers will be supported on mass concrete footings.

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

The existing primary spill oil tank at Buronga has a capacity of 54 kL. Therefore, it is not expected that the existing primary spill oil tank will have capacity to accommodate the oil capacity of the new phase shifting transformer and therefore, will need to be replaced.

2.1.3.3 Building works

No building works is anticipated for this project option.

2.1.3.4 Major plant and equipment

The following major plant will need to be procured.

- 1 x 220/275 400 MVA transformer.
- 3 x 275 kV 35 MVAr capacitor bank.
- 2 x 275 kV 50 MVAr shunt reactors.
- 300 m x 275 kV cable.

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

2.1.3.5 Minor plant and equipment

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

2.1.3.6 Electrical works

The existing X5/3 Line will be re-terminated onto a new gantry and connected to a new 275 kV switchbay via a 275 kV cable. The existing X5/3 Line reactor will be retained and connected to the busbar and therefore, redundant switchgear in the switchbay will need to be removed.

New earth grid and lighting will need to be provided with the proposed switchyard bench extension.

2.1.3.7 Secondary systems

Buronga 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.

2.1.3.8 Protection

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

It is anticipated that the new and uprated 275 kV line will be able to utilise the broadband communications established as part of this project and protect the line using VF intertripping with PLC as a backup.

2.1.3.9 Communications

New communications links will be established on the new transmission lines.

2.1.3.10 Control systems

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

2.1.3.11 Auxiliary supplies

A new auxiliary transformer will be required to supply the No.1 LV AC distribution system. The existing external supply which currently supplies the No.1 and No.2 LV AC distribution systems will be retained to supply the No.2 LV AC distribution system. The diesel generator will be retained to provide a backup supply.

There is a risk the existing 110 V DC batteries and chargers will require replacement due to the additional DC load at the site.

2.1.4 Yanco

Replace droppers of Uranquinty – Yanco 132 kV line 99F at Yanco end with increased MVA rating to achieve line conductor rating of 125 (continuous) / 137 (sustained emergency) / 143 MVA (15-minute) MVA.

2.2 Transmission Line Works

2.2.1 Conversion of X5 Line to 275 kV

2.2.1.1 Design

The X5 Line is of steel lattice construction that has been designed to be operated at a nominal 220 kV, with a maximum system voltage of 275 kV. It is currently split into two sections. X5/1 is 250 km long and runs between Darlington Point and Balranald, and X5/3 is 148 km long and runs between Balranald and Buronga.

The X5 line is constructed with the following structure quantities.

Line	Suspension Structures	Tension Structures	Total
X5/1	598	35	633
X5/3	357	14	371

Due to the small diameter of the lemon conductors that are currently on the line, any increase in the line voltage will result in significant corona discharge. In order to combat this, it is anticipated that grading rings will be added to the insulator hot ends at every structure.

Another important factor to consider is that although the existing insulators provide suitable phase to earth clearances for operation at 275 kV, the fact they are in a heavily polluted environment will result in a reduced creepage distance. It is anticipated that all insulator strings will need to be replaced.

2.2.1.2 Community and environmental issues

The increase in corona discharge associated with increasing the voltage to 275 kV will increase the audible noise being generated by the line. Although this is not yet anticipated to be problematic, there is a significant risk associated with obtaining environmental approval should landowners voice concern over an increase in noise levels.

The replacement of insulator strings and the installation of grading rings will require every structure to be accessed with an elevated work platform. Although it is anticipated that the existing access to structures is good, there may be some disruption to landowners.

2.2.1.3 Extent of possible clearing

Given that the upgrade works will be limited to works on existing structures on an existing easement, no clearing works are expected.

2.2.2 New 275 kV Parallel X5 Line

2.2.2.1 Existing X5 Design and New Parallel 275 kV Line

Figure 2.2.2.1.a – Existing X5 Line Transmission Line Route

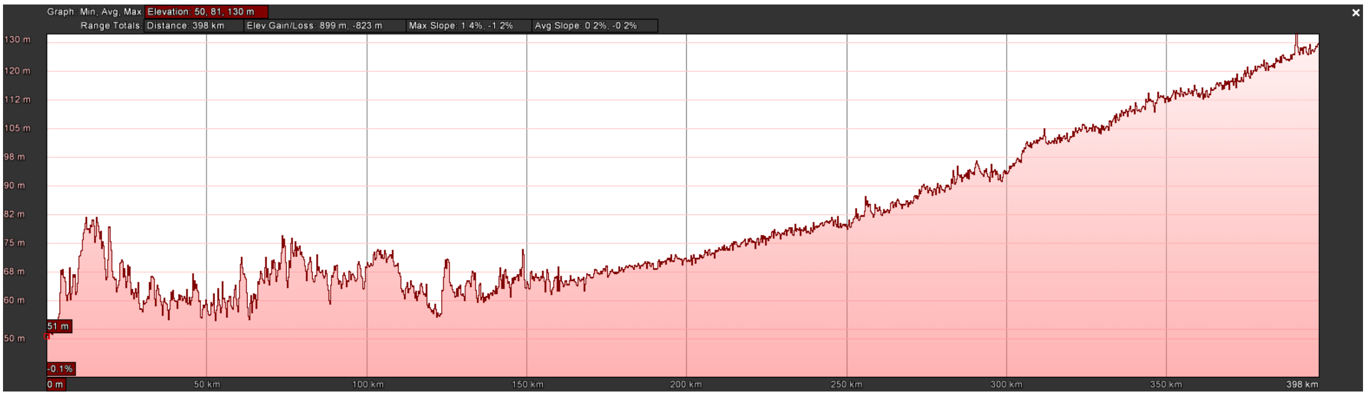

Figure 2.2.2.1.b – Existing X5 Line Elevation Profile (from Google Earth)

X5 line is currently split into two sections. X5/1 is 250 km long and runs between Darlington Point and Balranald, and X5/3 is 148 km long and runs between Balranald and Buronga.

The X5 line is constructed with the following structure quantities.

Line	Suspension Structures	Tension Structures	Total
X5/1	598	35	633
X5/3	357	14	371

Due to the small diameter of the lemon conductors that are currently on the line, any increase in the line voltage will result in significant corona discharge. It is currently anticipated that the resulting corona discharge at a maximum system voltage of 363 kV will be unacceptable.

The existing phase to earth clearances along the line will likely not be sufficient for the switching surges that would be experienced on the line.

The only viable solution is to rebuild the transmission line with larger diameter conductors and appropriate phase to earth clearances.

2.2.2.2 New 275 kV Parallel X5 Line Design

It is anticipated that the new 275 kV line will run parallel to the existing X5 line for the majority of the route with a deviation slight deviation close to Buronga so as to terminate at a new 275 kV switchbay. Given the number of deviations along the line will remain the same as the existing line, and the terrain is identical, the same tension to suspension structure ratios have been assumed.

The line will be constructed as a single circuit 275 kV line, strung with twin Lemon conductor for an operating temperature of 85°C. An average span length of 350 m is expected to be achievable for a double circuit construction. The vacant circuit can be strung at a later date to provide additional capacity.

2.2.2.3 Communications

At this stage it is anticipated that the new 275 kV transmission line will be equipped with OPGW.

Given the distance limitations of communications over single mode fibre (generally limited to about 150km) an allowance has been included for the construction of a fibre repeater station along the length of the transmission line between Darlington Point and Balranald.

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

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

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

In order to enable communications over the OPGW, fibre optic terminal equipment and multiplexers will be installed at Darlington Point, Balranald and Buronga.

2.2.2.4 Extent of Possible Clearing

The new line will be parallel to the existing line and share the existing easement. As a result, the existing transmission line easement will be expanded by 35 to 40 m.

2.2.2.5 Land Use

The predominant land use along the transmission line route is farming.

2.2.2.6 National Parks

The existing transmission line route from Darlington Point to Balranald passes through the Yanga State Conservation Area.

2.2.2.7 Heritage

There are at least two known locations of aboriginal heritage along the existing easement from Darlington Point to Balranald and a further five known locations along the easement from Balranald to Buronga. Transmission line design and construction methods will need to consider potential impacts to aboriginal heritage sites.

2.2.2.8 Flora and Fauna

There are no known threatened species along the existing transmission line route between Darlington Point and Buronga via Balranald.

2.2.3 New 330 kV Line Between Darlington Point and Wagga

2.2.3.1 Design

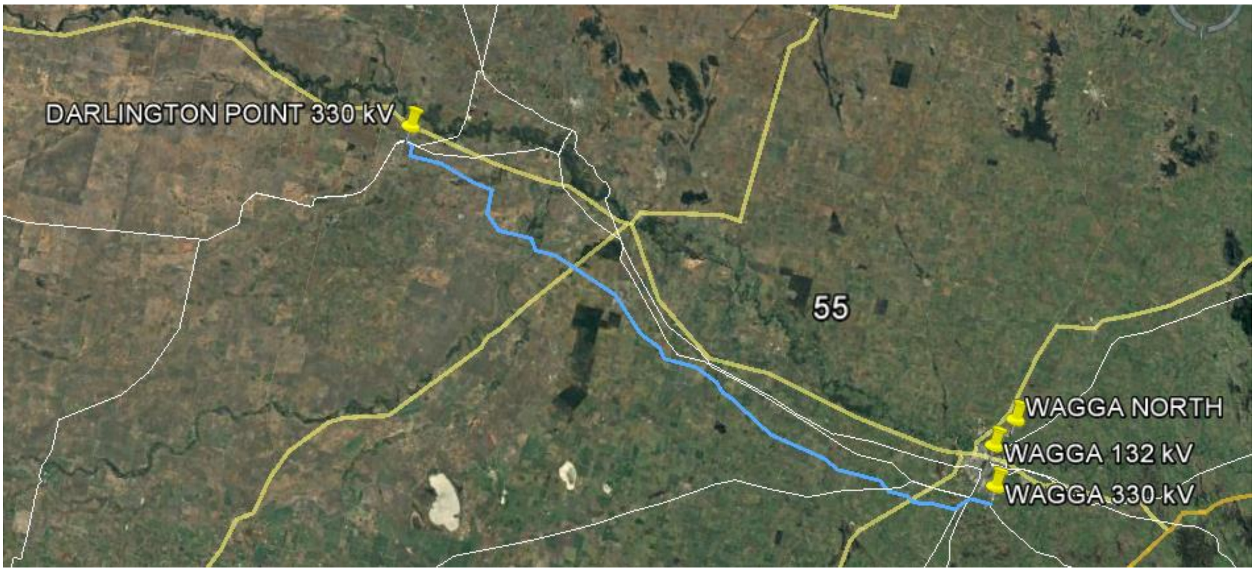

Figure 2.2.3.1.a – Existing Transmission Line Route between Darlington Point and Wagga 330kV

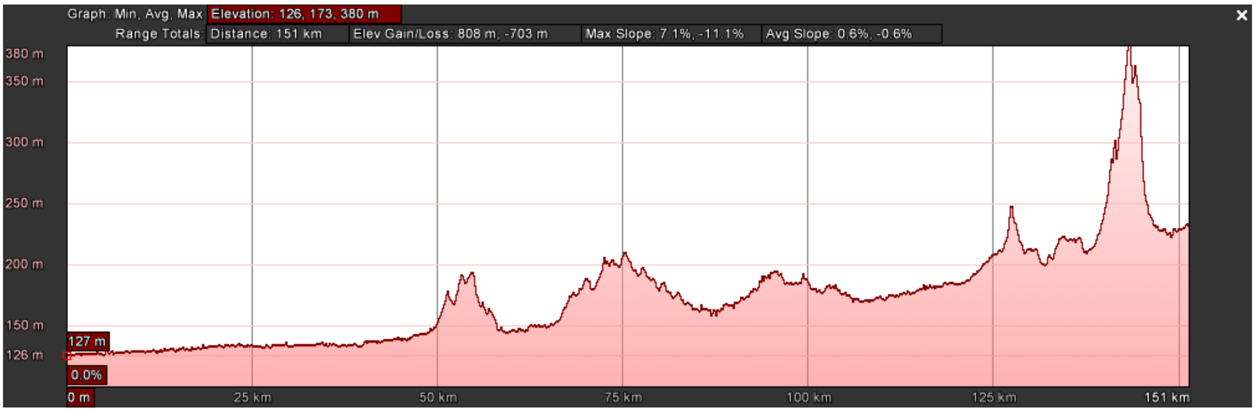

Figure 2.2.3.1.b – Existing 63 Line Elevation Profile (from Google Earth)

The new 330 kV transmission line between Darlington Point and Wagga 330 kV substation will be of single circuit construction with twin Mango conductor for an operating temperature of 85°C. 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 390 m and a tension to suspension structure ratio of 1:10, the following structure quantities have been calculated.

Suspension Structures	Tension Structures	Total
351	39	390

2.2.3.2 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 **Error! Reference source not found.**.

2.2.3.3 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.

Based on the assumption that the existing transmission line easement for the 63 Line will be widened to accommodate an additional transmission line, it is anticipated that for the majority of the transmission line route the existing access will be suitable.

2.2.3.4 Land Use

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

2.2.3.5 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.

2.2.3.6 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.

2.2.3.7 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.

3. Outage requirements

A detailed assessment of the outages required for the works has not been undertaken, however, outages of most equipment associated with this project are available during April to October.

Note, as stated in Section 2.1.3.1, above, the scope of works at Buronga Substation should be designed to avoid outages of the X2 Line and 220kV B Bus as it is extremely difficult to obtain outages of the X2 Line which would result in TransGrid being charged for operation of the diesel generators at Broken Hill.

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 and 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 275 kV transmission line between Buronga, Balranald and Darlington Point Substations and for the new 330kV transmission line between Darlington Point and Wagga Substation.

Additional property will need to be acquired at Balranald to allow for expansion of the Balranald Substation. There is also a risk that addition property will need to be acquired at Buronga to allow expansion of the Buronga Substation.

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 will cost $451m ± 25% in $2016-17.

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)	451	3	10	34	404

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 in each year (i.e. the amount in 2018-19 is in forecast $2018-19)is as follows:

	Total Project Budget Cost	2019-20	2020-21	2021-22	2022-23
Nominal escalated cost ($m)	550	3	11	40	496

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
Substation Augmentation		
Detailed Design/Specification Preparation	4	17
Tender and Tender Analysis Period	4	21
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 Transmission Lines		
Detailed Design/Specification Preparation	6	19
Tender and Tender Analysis Period	5	24
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 equivalents 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.

d) It is currently anticipated that the existing 220 kV X5 line can readily be operated at 275 kV with minor upgrade works. If the corona discharge and radio interference is too large at the higher operating voltage, then there will be significant change to scope to accommodate a rebuild of the entire line. This would likely produce similar delays to the environmental assessments and approvals.

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. 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.

Risk	Treatment
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.
Uprating of the X5 line will increase the amount of corona discharge from the conductors, resulting in an increase in audible noise and radio interference.	Conduct an Environmental Assessment of Project in accordance with TransGrid's standard policies and procedures.
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. Implement a Communication Strategy in accordance with TransGrid's standard policies and procedures.
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. 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.

Risk	Treatment
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.
Other Cost Risks (not included above)	
The scope of work detailed in this document assumes that the audible noise and radio interference from the uprating of X5 line will be acceptable to TransGrid and the community. If this is not the case, then the line will need to be rebuilt.	Conduct corona testing of the twin Lemon conductor at voltages of 303 kV and 363 kV as soon as possible to confirm the magnitude of corona discharge that will be experienced.

9. Change History

Revision	Approver	Amendments
0	J. Howland	Initial Issue

TransGrid