OPTIONS EVALUATION REPORT (OER)

FY24-28 Steelwork Remediation Program

OER- N2485 revision 1.0

Ellipse project no(s):
TRIM file: [TRIM No]

Project reason: Capability - Asset Replacement for end of life condition
Project category: Prescribed - Asset Renewal Strategies

Approvals

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Change history

Revision	Date	Amendment
00	04/11/2021	Initial revision
01	10/11/2021	Minor update

Executive summary

Gantries support the high voltage connections between switchbays and busbars and from the equipment within the substation to the first transmission line tower or pole. Gantries are connected to concrete footings by concrete plinths, holding down bolts and baseplates. They also support overhead earthwires that protect the substation equipment from direct lightning strikes and are essential for the safe and reliable operation of the substation.

Condition assessments have identified corrosion on gantries at several TransGrid substations indicating they are reaching the end of their serviceable life. The corrosion of holding down bolts and structural components, or 'members', ranges from initial development through to loss of steel thickness (cross-sectional area).

TransGrid's analysis indicates that the holding down bolts and gantry sections will reach the end of serviceable life by the end of 2023-2028 regulatory period. After this time, the loss of physical cross-sectional area from corrosion will decrease their capacity to provide structural support. This reduces structural integrity and significantly increases their probability of structural failure, especially during high wind events and short circuit scenarios.

Remediation is targeted based on condition assessment and structural modelling and includes the following:

- Holding down bolts and base plates
  - Exposing and removal of concrete plinths
  - Removal of corrosion, painting and repair of holding down bolts and base plates
  - Reinstatement of concrete plinths
- Gantry Replacement
  - Remove and replace existing corroded gantry structures with new gantries.
  - Removal of gantries that are not essential to the future operation of the substation.
- Insulator and Fittings
  - Replacement of insulators and fittings which have reached end of life or have corrosion

This is an economic benefits need with the following benefits:

- Reduction of risk as quantified as a direct impact to TransGrid and consumers including:
  - Changes in involuntary load shedding
  - Safety and environmental hazards associated with a catastrophic failure.
- Avoided operating expenditure related to corrective maintenance;

A single option has been considered to address the increasing risk of hold down bolt and gantry failure at Wagga, Albury, Sydney South, Sydney East and Dapto, as shown in Table 1 below.

The preferred option is the replacement of the gantries together with holding down bolt renewal (Option A). This option is technically and commercially feasible and exhibits the highest Net Present Value.

Table 1 - Evaluated options ($ million)

Option	Direct capital cost	Network and corporate overheads	Total capital cost[1]	Weighted NPV	Rank
Option A – Replacement Dapto	29.40	2.34	31.74	111.58	1
Option A – Replacement Sydney South	28.37	3.26	31.63	261.78	1
Option A – Replacement Sydney East	3.80	0.30	4.10	142.40	1
Option A – Replacement Wagga 132kV	6.00	0.89	6.89	159.97	1
Option A – Replacement Albury	2.25	0.23	2.48	70.72	1
Option A – Replacement Hume	2.69	0.36	3.05	-2.07	2
Option A – Replacement Tomago	68.64	4.65	73.29	153.56	2
Option A – Replacement Sydney North	71.18	7.60	78.78	-58.47	2

The selected program consists of Dapto, Sydney South, Sydney East, Wagga 132kV and Albury with a total Capex of $76.84 million and a positive, weighted NPV of $746.45 million. Option A for these sites is optimally timed to be completed before the end of the 2023-2028 regulatory period.

The program excludes Hume and Sydney North on the basis they exhibit negative net benefits, while Tomago has also been excluded based on the following review.

Tomago Substation plays a critical role in the transmission network and supplies Tomago Aluminium Smelter which comprises of about 10% of the NSW load. The reliability risk (based on expected consequences and probability of failure) associated with extended outages is significant even when pre and post-investment probability of failures are comparable. The project has been excluded from the program as the steelwork has not reached end of life based on asset condition and structural modelling, despite having this high reliability risk.

[1] Total capital cost is the sum of the direct capital cost and network and corporate overheads. Total capital cost is used in this OER for all analysis.

2. Need/opportunity

Gantries support the high voltage connections between switchbays and busbars. They are mainly used to support conductors in both directions between the transmission tower closest to the substation and the equipment within the substation via the use high voltage insulators. Gantries are connected to concrete footings by concrete plinths, holding down bolts and baseplates. They also support overhead earthwires that protect the substation equipment from direct lightning strikes and are essential for the safe and reliable operation of the substation. Figure 1 below, illustrates the role of gantries in the substation.

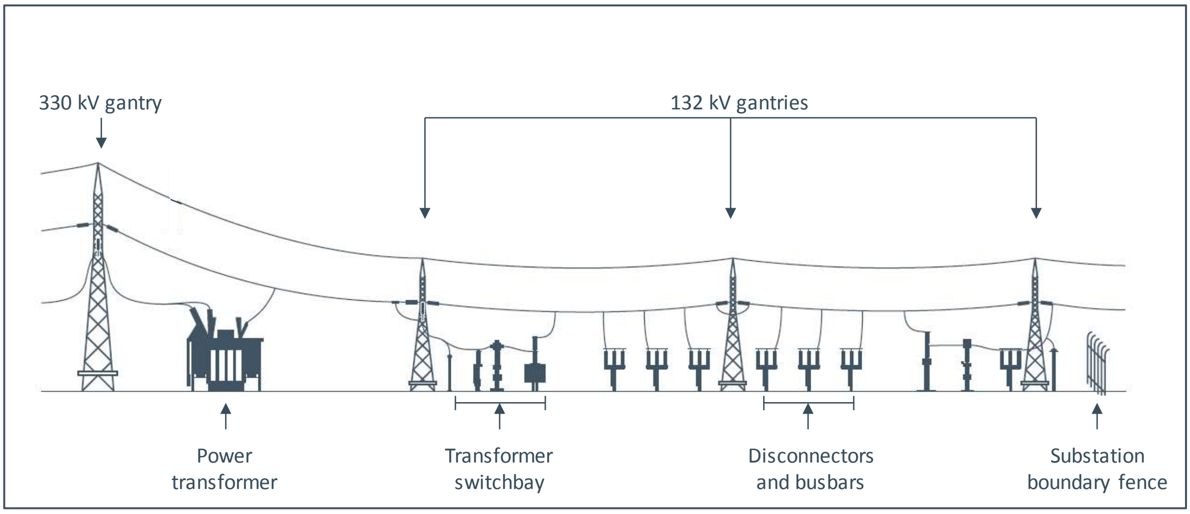

Figure 1: Simplified diagram of substation elements highlighting the role that gantries play

Gantry structural members across the remediation sites exhibit evidence of corrosion that has resulted in loss of thickness in gantry steelwork, commonly referred to as members and bolts. The loss of thickness in members and bolts reduces the structural integrity of gantry structures, which over time leads to increasing risk of structural failure, particularly during high wind events and short circuit scenarios. Examples of corrosion on gantry structural members are shown in the Figure 2.

Figure 2: Typical gantry steel members showing corrosion

Figure 3 show examples of holding down bolts, base plates and member connection bolts displaying advanced stages of corrosion that TransGrid consider need to be addressed as a matter of urgency as some have already reached the end of their lives.

Figure 3: Typical corrosion to holding down bolts and baseplates

Steelwork inspections were carried out to collect condition data on beams, columns, footings, baseplates and holding down bolts. The condition of each component was assessed on visual corrosion, galvanic and rust thickness.

Structural models were developed for each substation using the collected condition data. The individual gantry's annual probability of capacity exceedance is calculated under wind loading conditions to determine the annual probability of failure (PoF). This is the same methodology as other transmission line structures.

The model also considers the current condition of the steelwork and forecast corrosion over the next 30 years to predict the rate of degradation and its effect on the structural capacity. Short circuit forces under the ultimate design are used in utilisation calculations but it is not used in the capacity exceedance and PoF calculations.

Using the capacity of exceedance for each gantry and TransGrid's Network Asset Risk Assessment Methodology (NRAM) the risk associated with the failure of each gantry is calculated as follows:

- Safety, environmental, reputational and reliability risk is calculated based on the asset that has the highest impact due to the failure of the gantry regardless of the number of services and assets that is serviced by the gantry.
- Financial risk is calculated based on the failure of the gantry and all of the high voltage equipment that is serviced by the gantry.
- Restoration of services after a failure of 30 days which is the minimum expected time due to extent of damage to associated high voltage assets and the design and procurement of a new gantry.

Table 2 provides an overview of the total number of gantries at each substation and the portion which are considered for replacement based on the condition assessment, structural modelling and investment evaluation in this OER.

Table 2 - 2023-2028 Gantry Planned Remediation

Substation	≤ 132kV Gantries			330kV Gantries		
	Total	Planned Remediation	(%)	Total	Planned Remediation	(%)
Dapto	11	4	36%	6	5	83%
Sydney South	6	4	67%	7	0	0%
Sydney East	15	2	13%	11	0	0%
Wagga 132kV	12	1	8%	-	-	-
Albury	8	1	13%	-	-	-
Hume	3	0	0%	-	-	-
Tomago	7	0	0%	11	0	0%
Sydney North	21	0	0%	20	0	0%

Substations with identified issues to consider remediation:

- **Dapto** is supplied by four 330kV overhead lines from Kangaroo Valley, Avon, Marulan and Sydney South. It was built in 1962 and supplies residential and industrial loads such as Bluescope steel and also connects Tallawarra Power Station to the 330kV network.
- **Sydney South** was commissioned in 1961 and connects to TransGrid's Haymarket and Beaconsfield substations via two 330 kV underground cables which are Ausgrid's bulk supply points (BSP). The substation also supplies load to 12 Ausgrid overhead 132kV transmission lines with six transformers are connect by five 330kV overhead transmission lines.
- **Sydney East** was established in 1974 and is located north of the Sydney Central Business District. It plays a critical role in suppling areas north of Sydney Harbour including North Sydney, Ryde, Macquarie Park, Chatswood, and the suburbs along the Northern Beaches. The substation is supplied by two 330kV lines from Sydney North and has three 330kV transformers.
- **Wagga 132kV** supplies load to the Wagga Wagga area at 66kV. Supply is taken from the Wagga North, Yass 330/132kV and Wagga 330/132kV Substations through four 132kV lines. Two 120 MVA transformers substation supply load to seven 66kV feeder bays. The substation was commissioned in 1955.
- **Albury** was built in 1958 and has both Essential Energy and TransGrid assets. It is connected to six 132kV lines from Essential Energy and TransGrid. The Essential Energy load is a mixture of residential and commercial loads in the local area.

The proposed investment to address the corroded gantries and hold down bolts has significant benefits as the investment will avoid the likelihood of prolonged and involuntary load shedding across Dapto, Sydney South, Sydney East, Wagga 132kV and Albury.

In addition, the increased risk of failure presents a safety risk which TransGrid is obligated to manage. Rectifying the worsening condition of the gantries and hold down bolts will reduce safety risks, as well as lower planned and unplanned corrective maintenance costs.

The key economic benefits associated with addressing this need are summarised as:

- Reduction of risk as quantified as a direct impact to TransGrid and consumers including:
  - Involuntary load shedding
  - Safety and environmental hazards associated with a catastrophic failure.
- Avoided operating expenditure related to corrective maintenance;

3. Options

3.1 Base case

Under the 'Base Case' scenario, there is no consideration for planned replacement of the gantries or hold down bolts. This is a 'run to fail' scenario and will lead to an increase in the identified risks, the gantry's eventual failure, and the materialisation of the expected consequences. This case shall only be considered as a last resort should no option be deemed viable through the economic evaluation process.

Replacement of a failed gantry is expensive and requires at least 30 days to restore capacity. Key considerations affecting the base case are:

- TransGrid does not hold spare gantries at any voltage as gantries are typically bespoke and a specific design to each site. Gantries would need to be designed and manufactured which is expected to take between 2-3 weeks.
- If the gantry failure has caused catastrophic failure of HV equipment, there is substantial clean up and disposal costs especially for oil filled equipment such as transformers and reactors, this is likely to take 1 to 2 weeks.
- Damaged equipment such as circuit breakers, instrument transformers and busbar equipment will also need replacement with suitable spares from inventory and may require design and civil modifications to suit.
- Constructing the gantries on-site and reinstating the high voltage conductors and earth wires will require outage planning and execution to minimise further load shedding

3.2 Options evaluated

Option A — Steelwork Replacement [NOSA N2485, OFS in Table 3]

This option replaces the gantries and remediates hold down bolts which have reached end of life. The option will address the identified need by installing new gantries leading to a very low probability of failure, marked reduction in associated risks and lower operating costs.

This option involves:

- Remediating the holding down bolts and base plates by:
  - Exposing and removal of concrete plinths
  - Removal of corrosion, painting and repair of holding down bolts and base plates
  - Reinstatement of concrete plinths
- Replacing the gantry:
  - Remove and replace existing corroded gantry structures with new gantries.
  - Removal of gantries that are not essential to the future operation of the substation.
- Insulator and Fittings
  - Replacement of insulators and fittings which have reached end of life or have corrosion

Gantry replacement and hold down bolt remediation is likely to be staged across multiple regulatory periods due to outage constraints.

The estimated Capex based on addressing only the portion of gantries identified in Table 2 is shown in Table 3.

Table 3 - Capex Estimates for Proposed Sites

Site	Capex estimate ($ million)	Option Feasibility Study (OFS)
Dapto	31.74	OFS N2485 DPT A
Sydney South	31.63	OFS N2485 SYS A
Sydney East	4.10	OFS N2485 SYE A
Wagga 132kV	6.89	OFS N2485 WG2 A
Albury	2.48	OFS N2485 ALB A
Hume	Nil (no remediation)	OFS N2485 HUM A
Tomago	Nil (no remediation)	OFS N2485 TOM A
Sydney North	Nil (no remediation)	OFS N2485 SYN A

The estimated total Capex with this option is $76.84 million with an expected asset life of 45 years.

Appendix B includes the proposed scope and drawings and for each substation.

3.3 Options considered and not progressed

Table 4 - Options not progressed

Option	Reason for not progressing
(B) On/Off-site Refurbishment	This option involves in-situ renewal of the steelwork by grit blasting to remove corrosion, painting and replacement of components and is expected to extend the steelwork life by 10-15 years depending on the local environment. TransGrid has undertaken investigations to refurbish steelwork and utilised multiple blasting techniques on site. The field trials demonstrated: > Grid blasting in a live switchyard takes significantly longer than originally anticipated primarily due to network outage constraints > Blasting requires extensive outages of all nearby high voltage plant due to garnet overspray > There are safety risks and cost impacts of blasting steelwork with lead contaminated paint Due to the issues described above and the cost of refurbishment being equivalent to replacement (OFS N2485 B) Option B was not progressed as it is not economically feasible.
(C) Elimination of gantries by alternate methods such as Gas Insulated Switchgear (GIS) or PASS (Plug and Switch System)	Gantries cannot be eliminated within a substation with GIS or PASS. Gantries would still be required as a landing structure to function as a transition point between the substation and the transmission lines. To eliminate the need for gantries, the overhead conductors would need to be replaced with either HV underground cables or with Gas Insulated Lines (GIL). Option C was not progressed as it is not technically feasible to eliminate gantries without requiring additional technologies such as cables and GIL.

Option	Reason for not progressing
Increased maintenance or inspections	The condition issues have already been identified and cannot be rectified through increased maintenance or inspections, and therefore is not technically feasible to address the need.
Elimination of all associated risk	This can only be achieved by retiring the assets, which is not technically feasible as they are supporting infrastructure for the entire substation which is required to maintain the existing network reliability
Non-network solutions	TransGrid does not consider non-network options to be commercially feasible to assist with meeting the identified need.

4. Evaluation

4.1 Commercial evaluation methodology

The economic assessment undertaken for this project includes three scenarios that reflect a central set assumptions based on current information that is most likely to eventuate (central scenario), a set of assumptions that give rise to a lower bound for net benefits (lower bound scenario), and a set of assumptions that give rise to an upper bound on benefits (higher bound scenario).

Assumptions for each scenario are set out in Table 5.

Table 5 – Scenario assumptions

Parameter	Central scenario	Lower bound scenario	Higher bound scenario
Discount rate	4.8%	7.37%	2.23%
Capital cost	100%	125%	75%
Operating expenditure benefit	Not applicable in this assessment		
Risk cost benefits	100%	75%	125%
Other benefits	Not applicable in this assessment		
Scenario weighting	**50%**	**25%**	**25%**

Parameters used in this commercial evaluation are in Table 6

Table 6 - Commercial evaluation parameters

Parameter	Parameter Description	Value used for this evaluation
Discount year	Year that dollar values are discounted to	2020/21
Base year	The year that dollar value outputs are expressed in real terms	2020/21 dollars
Period of analysis	Number of years included in economic analysis with remaining capital value included as terminal value at the end of the analysis period.	25 years

ALARP	Multiplier of the environmental and safety related risk cost included in NPV analysis to demonstrate implementation of obligation to reduce to ALARP.	Refer to section 4.3 for details.

The capex figures in this OER do not include any real cost escalation.

4.2 Commercial evaluation results

The commercial evaluation of the technically and commercially feasible options is set out in Table 3. Details appear in Appendix A

Table 7 - Commercial evaluation (PV, $ million)

Option	Capital Cost PV	Central scenario NPV	Lower bound scenario NPV	Higher bound scenario NPV	Weighted NPV	Ranking
Option A – Replacement Dapto	27.57	96.71	29.01	223.89	111.58	1
Option A – Replacement Sydney South	27.03	231.33	95.45	489.01	261.78	1
Option A – Replacement Sydney East	3.51	126.69	59.33	256.88	142.40	1
Option A – Replacement Wagga 132kV	5.89	144.02	69.06	282.76	159.97	1
Option A – Replacement Albury	2.12	62.21	27.93	130.52	70.72	1
Option A – Replacement Hume	2.61	-2.13	-2.78	-1.25	-2.07	2
Option A – Replacement Tomago	62.63	124.94	11.28	353.07	153.56	2
Option A – Replacement Sydney North	67.33	-59.40	-74.06	-41.03	-58.47	2

The selected program consists of Dapto, Sydney South, Sydney East, Wagga 132kV and Albury with a total Capex of $76.84 million.

The program excludes Hume and Sydney North on the basis they exhibit negative net benefits, while Tomago has also been excluded based on the following review.

Tomago Substation plays a critical role in the transmission network and supplies Tomago Aluminium Smelter which comprises of about 10% of the NSW load. The reliability risk (based on expected consequences and probability of failure) associated with extended outages is significant even when pre and post-investment probability of failures are comparable. The project has been excluded from the program as the steelwork has not reached end of life based on asset condition and structural modelling, despite having this high reliability risk.

4.3 ALARP evaluation

TransGrid manages and mitigates bushfire and safety risk to ensure they are below risk tolerance levels or ‘As Low As Reasonably Practicable’ (‘ALARP’), in accordance with the regulation obligations and TransGrid’s business risk appetite. Under the Electricity Supply (Safety and Network Management) Regulation 2014 Section 5 ‘A network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network (or any part of its network) is safe.' TransGrid maintains an Electricity Network Safety Management System (ENSMS) to meet this obligation.[2]

In its Network Risk Assessment Methodology, under the ALARP test with the application of a gross disproportionate factor[3], the weighted benefits are expected to exceed the cost. TransGrid's analysis concludes that the costs are less than the weighted benefits from mitigating bushfire and safety risks. The proposed investment will enable TransGrid to continue to manage and operate this part of the network to a safety and risk mitigation level of ALARP.

Evaluation of the above options has been completed in accordance with As Low As Reasonably Practicable (ALARP) obligations. The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 3 x Safety Risk Reduction + 3 x Other Environmental Risks + 0.1 x Reliability Risk Reduction.

Results of the ALARP evaluation are set out in Table 8.

Table 8 - Reasonably practicable test ($ million)

Option	Network Safety Risk Reduction	Annualised Capex	Reasonably Practicable?[4]
A (Dapto)	3.46	1.73	No
A (Sydney South)	5.26	1.73	No
A (Sydney East)	0.93	0.22	No
A (Wagga 132kV)	2.42	0.38	No
A (Albury)	0.22	0.14	No

The disproportionality test does not apply to this need, as the reliability risk is greater than 50% of the total pre-investment network safety risk reduction.

4.4 Preferred option

The preferred option is the replacement (Option A) of gantries and remediation of hold down bolts, as this is technically and commercially feasible and has the highest positive NPV. This option addresses the need by achieving the largest risk reduction. New gantries have a relatively low probability of failure (PoF) and corresponding post-investment risk.

Capital and Operating Expenditure

There is no capex to opex trade-offs considered in this evaluation.

Regulatory Investment Test

A Regulatory Investment Test for Transmission (RIT-T) is expected to be required for some substations as the preferred option is approximately $6 million.

The Sydney South steelwork renewal RIT-T is currently in progress, TransGrid has published the Project Specification Consultation Report (PSCR, September 2018) and Project Assessment Draft Report (PADR,

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[2] TransGrid's ENSMS follows the International Organization for Standardization's ISO31000 risk management framework which requires following hierarchy of hazard mitigation approach

[3] The values of the disproportionality factors were determined through a review of practises and legal interpretations across multiple industries, with particular reference to the works of the UK Health and Safety Executive. The methodology used to determine the disproportionality factors in this document is in line with the principles and examples presented in the AER Replacement Planning Guidelines and is consistent with TransGrid's Revised Revenue Proposal 2023/24-2027/28.

[4] Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction.

December 2019). Due to the complexities and scale of the project the Project Assessment Conclusion Report (PACR) has still not been published as there were uncertainties in scope, outage planning and construction methodology. It is expected that the RIT-T will be published in 2022 once trials and investigations are finalised.

4.5 Optimal Timing

The test for optimal timing of the preferred option has been undertaken. The approach taken is to identify the optimal commissioning year for the preferred option where net benefits (including avoided costs and safety disproportionality tests) of the preferred option exceeds the annualised costs of the option. The commencement year is determined based on the required project disbursement to meet the commissioning year based on the OFS.

The results of optimal timing analysis are:

- Optimal commissioning year: 2023/24 – 2027/28. As this project is program of various substations, the optimal timing is dependent on the individual project. 2023/24 is the earliest feasible commissioning year due to the significant lead time required to plan, design and procure gantries.
- Commissioning year annual benefit: $39.12 million
- Annualised cost: $4.20 million

Due to the complexities in outage planning and to minimise energy at risk, some sites may extend into the 2028-2033 Regulatory Period.

5. Recommendation

It is therefore recommended that Option A replacement of the required gantries and remediation of hold down bolts at Dapto, Sydney South, Sydney East, Wagga 132kV and Albury be scoped in detail.

The total project cost is $76.84 million, including $8.2 million to progress the project from DG1 to DG2.

Appendix A Option Summaries

Project Description	N2485 - FY24-28 Steelwork Remediation Program (Dapto)		
Option Description	Option A - Replacement of Steelwork		
Project Summary			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	*45*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	[Net Present Value (Standard - OER)] 96.71	Annualised CAPEX ($m)	Annualised Capex - Standard (Business Case) 1.73
NPV @ Lower Bound Scenario (PV, $m)	[Net Present Value (Upper Bound)] 29.01	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 3.46
NPV @ Higher Bound Scenario (PV, $m)	[Net Present Value (Lower Bound)] 223.89	ALARP	ALARP Compliant? *N*
NPV Weighted (PV, $m)	[Net Present Value (Weighted)] 111.58	Optimal Timing (Average)	Optimal timing (Business Case) 2024
Cost			
Direct Capex ($m)	29.40	Network and Corporate Overheads ($m)	2.34
Total Capex ($m)	31.74	Cost Capex (PV,$m)	27.57
Terminal Value ($m)	13.40	Terminal Value (PV,$m)	3.44
Risk (central scenario)	Pre	Post	Benefit
Reliability (PV,$m)	Reliability Risk (Pre) *53.48*	Reliability Risk (Post) *6.71*	Pre – Post *46.77*
Financial (PV,$m)	Financial Risk (Pre) *19.83*	Financial Risk (Post) *3.94*	Pre – Post *15.89*
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) *0.00*	Pre – Post *0.00*
Safety (PV,$m)	Safety Risk (Pre) *69.26*	Safety Risk (Post) *14.12*	Pre – Post *55.14*
Environmental (PV,$m)	Environmental Risk (Pre) *2.55*	Environmental Risk (Post) *0.46*	Pre – Post *2.09*
Reputational ($m)	Reputational Risk (Pre) 1.22	Reputational Risk (Post) *0.25*	Pre – Post *0.97*
Total Risk Benefit (PV,$m)	Total Risk (Pre) *146.34*	Total Risk (Post) *25.49*	Pre – Post *120.85*
OPEX Benefit (PV,$m)			OPEX Benefit *0.00*
Other benefit (PV,$m)			Incremental Net Benefit *0.00*
Total Benefit (PV,$m)			Business Case Total Benefit *120.85*

Project Description	N2485 - FY24-28 Steelwork Remediation Program (Sydney South)		
Option Description	Option A - Replacement of Steelwork		
Project Summary			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	*45*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	[Net Present Value (Standard - OER)] 231.33	Annualised CAPEX ($m)	Annualised Capex - Standard (Business Case) 1.73
NPV @ Lower Bound Scenario (PV, $m)	[Net Present Value (Upper Bound)] 95.45	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 5.26
NPV @ Higher Bound Scenario (PV, $m)	[Net Present Value (Lower Bound)] 489.01	ALARP	ALARP Compliant? *N*
NPV Weighted (PV, $m)	[Net Present Value (Weighted)] *261.78*	Optimal Timing (Average)	Optimal timing (Business Case) 2024
Cost			
Direct Capex ($m)	28.37	Network and Corporate Overheads ($m)	3.26
Total Capex ($m)	31.63	Cost Capex (PV,$m)	27.03
Terminal Value ($m)	13.35	Terminal Value (PV,$m)	2.98
Risk (central scenario)	Pre	Post	Benefit
Reliability (PV,$m)	Reliability Risk (Pre) *177.33*	Reliability Risk (Post) *27.65*	Pre – Post *149.68*
Financial (PV,$m)	Financial Risk (Pre) *30.14*	Financial Risk (Post) *5.51*	Pre – Post *24.63*
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) *0.00*	Pre – Post *0.00*
Safety (PV,$m)	Safety Risk (Pre) *92.24*	Safety Risk (Post) *18.90*	Pre – Post *73.34*
Environmental (PV,$m)	Environmental Risk (Pre) *7.83*	Environmental Risk (Post) *1.52*	Pre – Post *6.31*
Reputational ($m)	Reputational Risk (Pre) 1.74	Reputational Risk (Post) *0.32*	Pre – Post *1.42*
Total Risk Benefit (PV,$m)	Total Risk (Pre) *309.28*	Total Risk (Post) *53.90*	Pre – Post *255.38*
OPEX Benefit (PV,$m)			OPEX Benefit *0.00*
Other benefit (PV,$m)			Incremental Net Benefit *0.00*
Total Benefit (PV,$m)			Business Case Total Benefit *255.38*

Project Description	N2485 - FY24-28 Steelwork Remediation Program (Sydney East)		
Option Description	Option A - Replacement of Steelwork		
Project Summary			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	*45*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	[Net Present Value (Standard - OER)] 126.69	Annualised CAPEX ($m)	Annualised Capex - Standard (Business Case) 0.22
NPV @ Lower Bound Scenario (PV, $m)	[Net Present Value (Upper Bound)] 59.33	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 0.93
NPV @ Higher Bound Scenario (PV, $m)	[Net Present Value (Lower Bound)] 256.88	ALARP	ALARP Compliant? *N*
NPV Weighted (PV, $m)	[Net Present Value (Weighted)] *142.40*	Optimal Timing (Average)	Optimal timing (Business Case) 2026
Cost			
Direct Capex ($m)	3.80	Network and Corporate Overheads ($m)	0.30
Total Capex ($m)	4.10	Cost Capex (PV,$m)	3.51
Terminal Value ($m)	1.73	Terminal Value (PV,$m)	0.39
Risk (central scenario)	Pre	Post	Benefit
Reliability (PV,$m)	Reliability Risk (Pre) *139.27*	Reliability Risk (Post) *19.34*	Pre – Post *119.93*
Financial (PV,$m)	Financial Risk (Pre) *1.37*	Financial Risk (Post) *0.19*	Pre – Post *1.18*
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) *0.00*	Pre – Post *0.00*
Safety (PV,$m)	Safety Risk (Pre) *9.51*	Safety Risk (Post) *1.23*	Pre – Post *8.28*
Environmental (PV,$m)	Environmental Risk (Pre) *0.34*	Environmental Risk (Post) *0.04*	Pre – Post 0.30
Reputational ($m)	Reputational Risk (Pre) 0.14	Reputational Risk (Post) *0.02*	Pre – Post *0.12*
Total Risk Benefit (PV,$m)	Total Risk (Pre) *150.63*	Total Risk (Post) *20.82*	Pre – Post *129.81*
OPEX Benefit (PV,$m)			OPEX Benefit 0.00
Other benefit (PV,$m)			Incremental Net Benefit 0.00
Total Benefit (PV,$m)			Business Case Total Benefit *129.81*

Project Description	N2485 - FY24-28 Steelwork Remediation Program (Wagga)		
Option Description	Option A - Replacement of Steelwork		
Project Summary			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	*45*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	[Net Present Value (Standard - OER)] 144.02	Annualised CAPEX ($m)	Annualised Capex - Standard (Business Case) 0.38
NPV @ Lower Bound Scenario (PV, $m)	[Net Present Value (Upper Bound)] *69.06*	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 2.42
NPV @ Higher Bound Scenario (PV, $m)	[Net Present Value (Lower Bound)] 282.76	ALARP	ALARP Compliant? *N*
NPV Weighted (PV, $m)	[Net Present Value (Weighted)] *159.97*	Optimal Timing (Average)	Optimal timing (Business Case) 2021
Cost			
Direct Capex ($m)	6.00	Network and Corporate Overheads ($m)	6.89
Total Capex ($m)	6.89	Cost Capex (PV,$m)	5.89
Terminal Value ($m)	2.91	Terminal Value (PV,$m)	0.65
Risk (central scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) *181.78*	Reliability Risk (Post) *54.33*	Pre – Post *127.45*
Financial (PV,$m)	Financial Risk (Pre) *5.51*	Financial Risk (Post) *1.65*	Pre – Post *3.86*
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) *0.00*	Pre – Post *0.00*
Safety (PV,$m)	Safety Risk (Pre) *16.00*	Safety Risk (Post) *4.78*	Pre – Post *11.22*
Environmental (PV,$m)	Environmental Risk (Pre) *9.36*	Environmental Risk (Post) *2.80*	Pre – Post *6.56*
Reputational ($m)	Reputational Risk (Pre) 0.24	Reputational Risk (Post) *0.07*	Pre – Post *0.17*
Total Risk Benefit (PV,$m)	Total Risk (Pre) *212.89*	Total Risk (Post) *63.63*	Pre – Post *149.26*
OPEX Benefit (PV,$m)			OPEX Benefit *0.00*
Other benefit (PV,$m)			Incremental Net Benefit *0.00*
Total Benefit (PV,$m)			Business Case Total Benefit *149.26*

Project Description	N2485 - FY24-28 Steelwork Remediation Program (Albury)		
Option Description	Option A - Replacement of Steelwork		
Project Summary			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	*45*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	[Net Present Value (Standard - OER)] 62.21	Annualised CAPEX ($m)	Annualised Capex - Standard (Business Case) 0.14
NPV @ Lower Bound Scenario (PV, $m)	[Net Present Value (Upper Bound)] 27.93	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 0.22
NPV @ Higher Bound Scenario (PV, $m)	[Net Present Value (Lower Bound)] 130.52	ALARP	ALARP Compliant? *N*
NPV Weighted (PV, $m)	[Net Present Value (Weighted)] *70.72*	Optimal Timing (Average)	Optimal timing (Business Case) 2021
Cost			
Direct Capex ($m)	2.25	Network and Corporate Overheads ($m)	0.23
Total Capex ($m)	2.48	Cost Capex (PV,$m)	2.12
Terminal Value ($m)	1.05	Terminal Value (PV,$m)	0.23
Risk (central scenario)	Pre	Post	Benefit
Reliability (PV,$m)	Reliability Risk (Pre) *69.90*	Reliability Risk (Post) *6.67*	Pre – Post *63.23*
Financial (PV,$m)	Financial Risk (Pre) *0.24*	Financial Risk (Post) *0.02*	Pre – Post *0.22*
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) *0.00*	Pre – Post *0.00*
Safety (PV,$m)	Safety Risk (Pre) *0.43*	Safety Risk (Post) *0.04*	Pre – Post *0.39*
Environmental (PV,$m)	Environmental Risk (Pre) *0.27*	Environmental Risk (Post) *0.03*	Pre – Post *0.24*
Reputational ($m)	Reputational Risk (Pre) 0.01	Reputational Risk (Post) *0.00*	Pre – Post *0.01*
Total Risk Benefit (PV,$m)	Total Risk (Pre) *70.86*	Total Risk (Post) *6.76*	Pre – Post *64.10*
OPEX Benefit (PV,$m)			OPEX Benefit *0.00*
Other benefit (PV,$m)			Incremental Net Benefit *0.00*
Total Benefit (PV,$m)			Business Case Total Benefit *64.10*

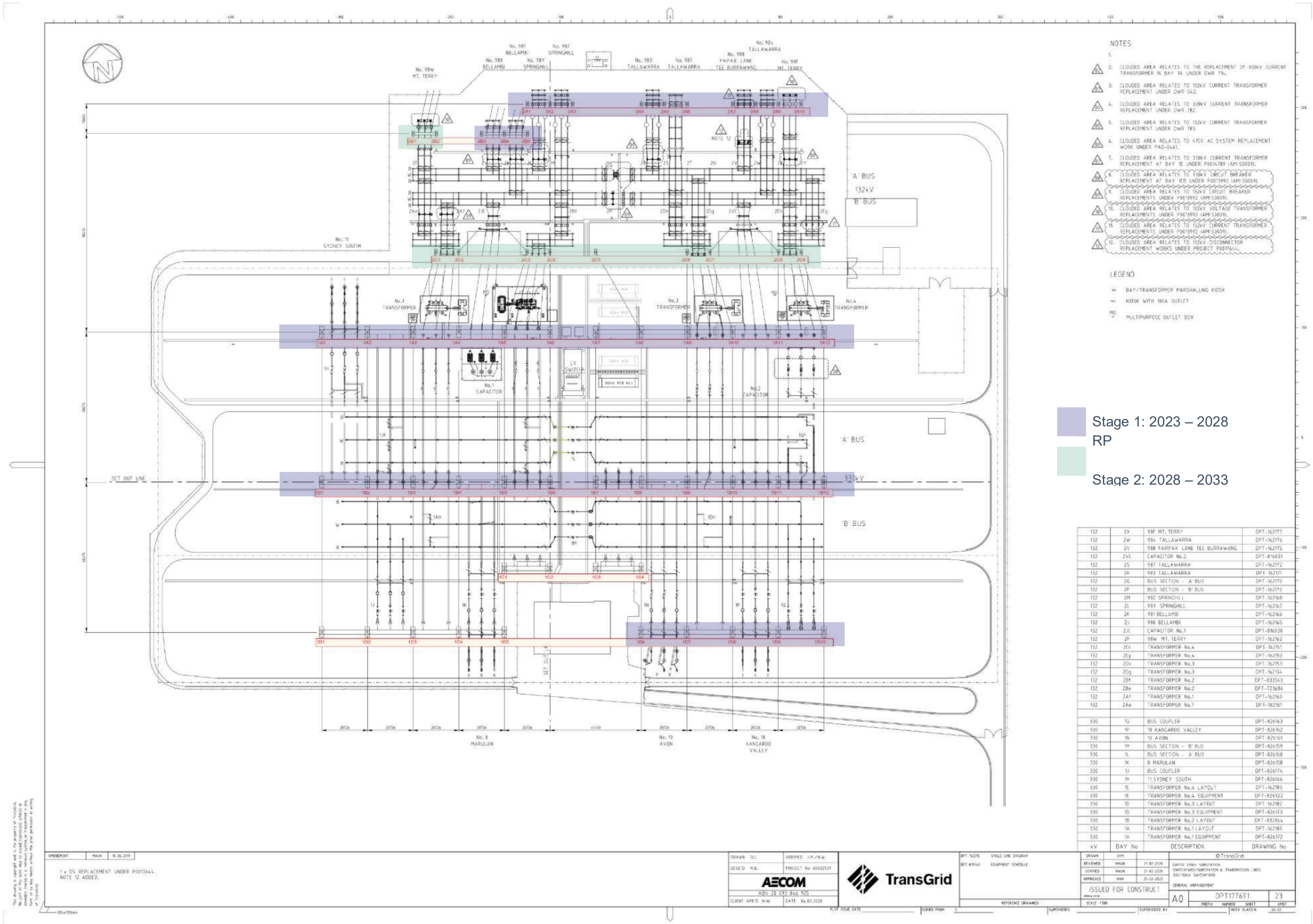
Appendix B Gantry Renewal

The steelwork remediation included in OER -N2485 covers the scope in the 2028-2033 Regulatory Period. Table 9 shows the steelwork remediation program is a long term project that will span multiple regulatory periods as the steelwork condition deteriorates.

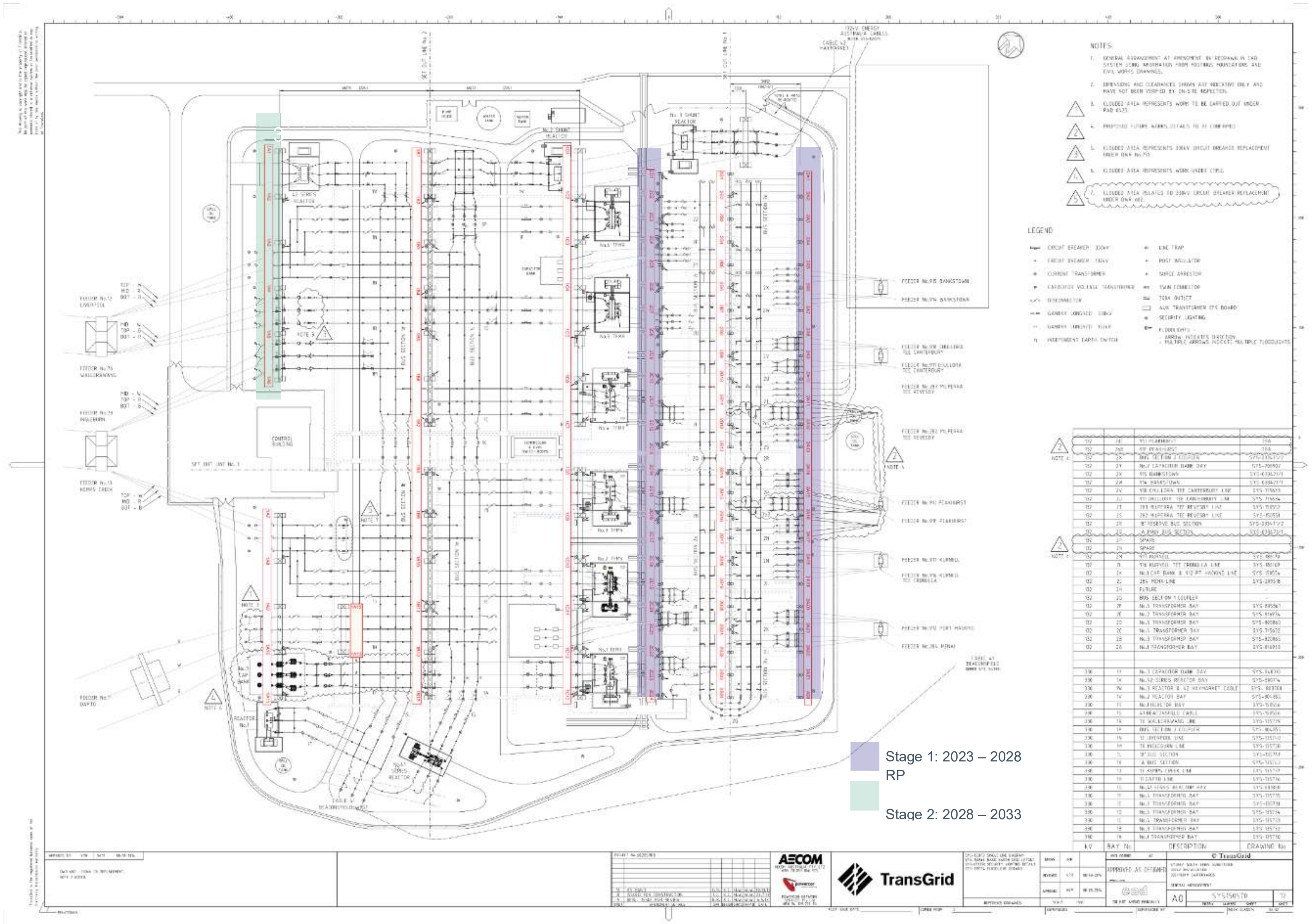
Table 9 - Gantry Remediation Summary

Substation	Stage 1 - 2023 – 2028 Gantries	Stage 2 - 2028 – 2033 Gantries
Dapto	2A1 – 2A10 2B3 – 2B5 1A1 – 1A6 1A7 – 1A12 1B1 – 1B12 1D6 – 1D10	2B1 – 2B2 2C1 – 2C9
Sydney South	2A1 - 2A13 2A14 - 2A24 2C1 - 2C13 2C14 - 2C24	1A1 - 1A6
Sydney East	1A3 – 1A5 1B1 – 1B2	Nil
Wagga 132kV	4A1 - 4A8	Nil
Albury	2A5 – 2A8	Nil
Hume	Nil	Nil
Tomago	Nil	Nil
Sydney North	Nil	Nil

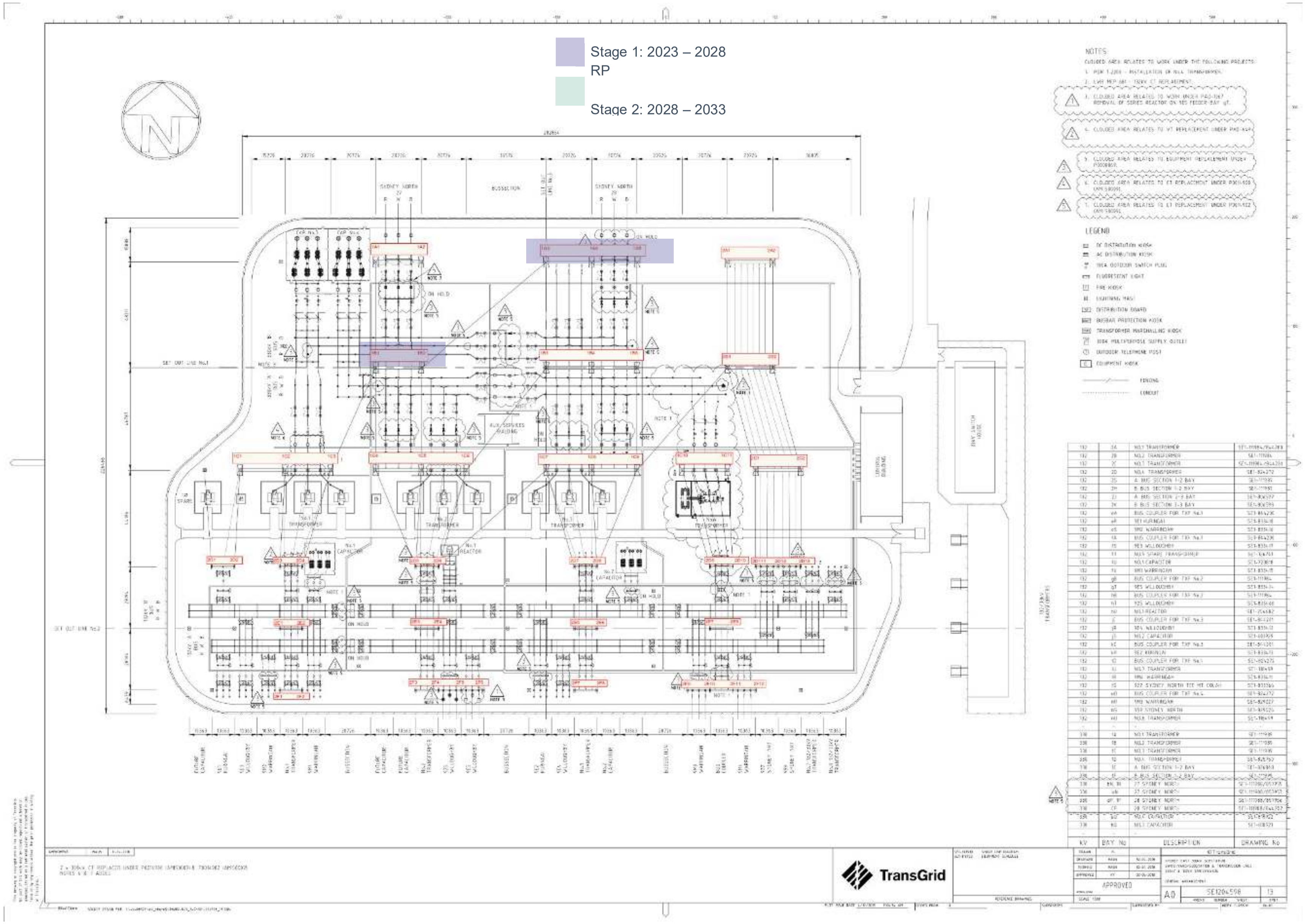
Dapto Substation



Sydney South Substation



Sydney East Substation



Wagga 132kV Substation

Albury Substation