OPTIONS EVALUATION REPORT (OER)

Line 963 - Refurb

OER- N2606 revision 1.0

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

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

Approvals

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Change history

Revision	Date	Amendment
0	04/10/2021	Initial Issue
1	15/11/2021	Minor Formatting

Executive summary

Line 963 is a 132 kV transmission line between Tomago and Taree, commissioned in 1992. TransGrid own the line north of the Karuah River (Structure 185 onwards) to Taree, Ausgrid own the line to the south (including the river crossing), to Tomago. The TransGrid section has a route length of 108.7km, and consists of 334 structures, of which 289 are wood pole structures.

Detailed analysis of asset condition information records indicate that the line has several condition issues which require refurbishment to address its health and maintain appropriate risk levels across the network. Total number of wood poles to be replaced is 16. 6km of conductor and 28km of earthwire which had significant heat stress during the bushfire event are also to be replaced.

In addition to the wood pole condition issues and bushfire impact, detailed analysis of asset condition information has identified that various condition issues impact 102 of the 334 structures across multiple line components. These have been set out based on the criteria set out in the Transmission Line Refurbishment Criteria document.

The main drivers of the need to remediate these issues are:

- Manage network safety risk levels "As-Low-As Reasonably-Practicable" 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'; and
- Provide economic benefit to consumers through reduction in safety and bushfire risks

The assessment of the options considered to address the need/opportunity appears in Table 1.

Table 1 - Evaluated options

Option	Description	Direct capital cost ($m)	Network and corporate overheads ($m)	Total capital cost[1] ($m)	Weighted NPV (PV, $m)	Rank
Option A	Remediate all identified condition issues on the line as per the Transmission Line Refurbishment Criteria. In addressing these condition issues, the identified wood pole structures are to be replaced with concrete or steel pole structures.	6.14	0.57	6.71	134.93	2

[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.

Option	Description	Direct capital cost ($m)	Network and corporate overheads ($m)	Total capital cost[1] ($m)	Weighted NPV (PV, $m)	Rank
Option B	Remediate all identified condition issues on the line as per the Transmission Line Refurbishment Criteria. In addressing these condition issues, the identified wood pole structures are to be replaced with concrete or steel pole structures. Replace the conductor between Structure 442 to 463 with equivalent conductor. Replace all conductor components, hardware and fittings, including all insulators.	7.65	0.66	7.65	144.07	1

The preferred option is Option B, as it has the highest weighted NPV result of the technically and commercially feasible options which were considered. It is therefore recommended that Option B be scoped in detail and progressed from DG1 to DG2[2]. In consideration of the delivery requirements and the economic benefit NPV analysis for the need, its optimal timing is 2025/2026.

[2] DG stands for 'decision gate' that forms a part of TransGrids investment decision process.

1. Need/opportunity

Line 963 is a 132 kV transmission line between Tomago and Taree, commissioned in 1992. TransGrid own the line north of the Karuah River (Structure 185 onwards) to Taree, Ausgrid own the line to the south (including the river crossing), to Tomago. The TransGrid section has a route length of 108.7km, and consists of 334 structures, of which 289 are wood pole structures.

Detailed analysis of asset condition information records indicate that the line has several condition issues which require refurbishment to address its health and maintain appropriate risk levels across the network.

Wood Pole Structures

Since 2011, there have been 16 wood pole structures that have been identified as defective requiring maintenance replacement, or 6% of wood pole structures. Further, available recent inspection data and existing asset condition records have identified that another two structures currently have condition issues which require altered maintenance practices. Another four structures on the line have been identified as having decay or deterioration. These other known condition issues affect six structures, or 2% of the line.

Inspection records indicate a relatively good condition outlook on the remaining structures on Line 963. As the wood poles may have an extended life remaining before they are deemed unserviceable, only targeted replacement is propose as part of the refurbishment option.

Total number of structures to be replaced with deterioration of ground line wood condition is 6.

Bushfire Impacts

Line 963 was impacted by the Hillville Fire in November 2019. The fire impacted a total of 42 structures between Structures 435 and 475 (35 of them wood poles structures) over a route length of 13.7km. One pole (Structure 446) was significantly damaged by the fire, and had to be replaced at the time.

Figure 1: Line 963 Structure 446 Fire Damage

The immediate focus in the aftermath of the event was the restoration of the line to a serviceable condition to meet network needs in the mid-north coast of NSW, noting that other lines also impacted by fire had to be taken out of

service at the time. Subsequent inspections of the sections impacted by the fire identified eight structures as burnt and charred (Structures 445, 446 [3], 449, 451, 452, 457, 460, 462). The fire damage affects the outer annulus of the pole at the region in the vicinity of the ground line and above. This is the main load bearing area of the structure, and damage to this section of the pole can impact its structural integrity. This may also provide a vector for advanced deterioration through termite and rot attack.

Figure 2: Structure 451 with Fire Damage

Total number of bushfire impacted structures to be replaced is 8.

The conductor, particularly in the vicinity of Structure 446 has had significant heat stress during the bushfire event, which can cause aluminium to anneal and lose mechanical strength. Further, the heat would have caused the conductor to lose its grease, which may have subsequent corrosion issues. It is noted that this structure is located only 14km from the coast, and accordingly has a greater exposure to conditions conducive to atmospheric corrosion. All structures noted with fire damage are on the one tension section ranging from Structure 442 to 463.

[3] It is noted that Structure 446 is again included, as the immediate repairs to restore the line into service only addressed the pole which suffered extensive damage. The other pole on the structure remains with the burnt condition issues.

Condition issues of other lines

In addition to the wood pole condition issues and bushfire impact, detailed analysis of asset condition information has identified that various condition issues impact 102 of the 334 structures across multiple line components. These have been set out based on the criteria set out in the Transmission Line Refurbishment Criteria document.

The most significant element of concern is the condition of the insulators, particularly the pins on the disc insulators. The line is situated in a coastal zone which corresponds to a higher susceptibility to atmospheric corrosion, and the insulator pins, which have lower levels of galvanising thickness compared to some other line components. If left unaddressed, this could lead to an insulator failure and a fallen conductor scenario.

Other issues on the line include:

- Deterioration of conductor and earthwire fittings due to corrosion – failure of these components can lead to a conductor drop
- Deterioration of the earthwire due to corrosion – failure can lead to a conductor drop
- Deterioration of structure earthing due to corrosion – failure of these components result in transfer potential, earth current, voltage gradient issues and reduced line reliability
- Deterioration of guys and anchors – failure of these components can potentially compromise structural integrity
- Deterioration on asset components relating to public safety such as climbing deterrents, warning signage and aerial marker balls

It is noted that the expected service life of these other line components are typically shorter than that of the wood poles. In consideration of this, and that these condition issues might not be addressed through the replacement of the wood pole structures for an extended time, the above option is progressed to enable these issues to be remediated.

If the condition issues on the line are not addressed in sufficient time, then the asset will operate with increasing risk of failure as it continues to deteriorate. The level of reactive corrective maintenance needed to keep the line operating within required standards may also increase, particularly when asset failures ultimately occur.

Consequently, the proposed project has an economic benefits need, and addressed this need will provide avoided cost savings from reduced in bushfire and safety risk, and maintenance costs that would otherwise occur without refurbishment.

Appendix B provides a summary of the number of structures with condition issues within each asset component category. The figures are based on the Transmission Line Refurbishment Criteria document.

2. Related needs/opportunities

- Need N2606: Line 964 Refurbishment
- Need N2492: Line 963/96P Refurbishment

3. Options

The base case for this assessment is a ‘do nothing’ scenario, where the assets are left in service until they fail and require replacement. In addition to the base case, two remediation options have been considered. Option A involves remediation of all identified condition issues on the line as per the Transmission Line Refurbishment Criteria. In addressing these condition issues, the identified wood pole structures are to be replaced with concrete or steel pole structures.

Option B, involves the same approach as Option A, but proposes to replace the conductor between Structure 442 to 463 with equivalent conductor, replace all conductor components and hardware.

3.1 Base case

It is noted that a 'run to fail' scenario, where the issues are addressed through increased asset monitoring and preventative maintenance tasks, is not a valid base case for this Need. The condition issues on the asset have already been identified through maintenance inspections, and increasing the frequency of inspections to monitor the condition issues will not necessarily address them.

The base case will instead be defined as a 'do nothing' scenario, where the assets are left in service until they fail and require replacement. The replacement cost has been captured in the NPV assessment under financial risk cost.

3.2 Options evaluated

Option A — Remediate all identified condition issues on the line as per the Transmission Line Refurbishment Criteria. In addressing these condition issues, the identified wood pole structures are to be replaced with concrete or steel pole structures. [NOSA N2606, OFS N2606A]

Option A will address all the identified condition issues on the line with the exception of the bushfire impacted conductor. Total number of wood poles to be replaced is 16.

It is estimated that this option would cost $6.71 million ± 25% in $2020-21.

This project is expected to be completed within 28 months following DG1.

Option B — Remediate all identified condition issues on the line as per the Transmission Line Refurbishment Criteria. In addressing these condition issues, the identified wood pole structures are to be replaced with concrete or steel pole structures. Replace the conductor between Structure 442 to 463 with equivalent conductor. Replace all conductor components, hardware and fittings, including all insulators. [NOSA N2606, OFS N2606B]

Option B will address all the identified condition issues on the line including the bushfire impacted conductor to provide efficiency in delivery. Total number of wood poles to be replaced is 16. This option also includes replacement of 6km of conductor and 28km of earthwire.

It is estimated that this option would cost $7.65 million ± 25% in $2020-21.

This project is expected to be completed within 29 months following DG1.

3.3 Options considered and not progressed

The following options were considered but not progressed:

Table 2 Options considered but not progressed

Option	Reason for not progressing
Increased inspections	The condition issues have already been identified and cannot be rectified through increased inspections, and therefore is not technically feasible.
Elimination of all associated risk	This can only be achieved through retirement and decommissioning of the associated assets which is not technically feasible.
New transmission line	Due to significant costs of this option, a new 132 kV transmission line is not considered commercially feasible.
Non-network solutions	TransGrid does not consider non-network options to be commercially and technically feasible to assist with meeting the identified need, as non-network options will not mitigate the environment (bushfire) and safety posed as a result of corrosion-related asset deterioration.

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 the table below.

Table 3 Scenario Inputs

Parameter	Central scenario	Lower bound scenario	Higher bound scenario
Discount rate	4.8%	7.37%	2.23%
Capital cost	100%	125%	75%
Risk benefit	100%	75%	125%
Scenario weighting	**50%**	**25%**	**25%**

Parameters used in this commercial evaluation:

Table 4 Parameters

Parameter	Parameter Description	Value used for this evaluation
Discount year	Year that dollar values are discounted to	2020/2021
Base year	The year that dollar value outputs are expressed in real terms	2020/2021 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
Expected asset life	Period of depreciation of the asset	50 years
ALARP disproportionality	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 0 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 feasible options is set out in Table 5. Details appear in Appendix A.

Table 5 - Commercial evaluation (PV, $ million)

Option	Capital Cost PV	Central scenario NPV	Lower bound scenario NPV	Higher bound scenario NPV	Weighted NPV	Ranking
Option A	5.49	117.44	50.77	254.08	134.93	2
Option B	6.16	125.31	53.97	271.71	144.07	1

Based on the commercial analysis, Option B is the preferred option as it yields the highest weighted NPV and is technically and commercially feasible. The main driver of the benefit in the NPV is bushfire risk benefit.

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.

In its Network Risk Assessment Methodology, under the ALARP test with the application of a gross disproportionate factor[4], 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 or 6 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction.

Results of the ALARP evaluation are set out in Table 6.

Table 6 - Reasonably practicable test ($ million)

Option	Network Safety Risk Reduction	Annualised Capex	Reasonably Practicable?[5]
A	2.13	0.36	Y
B	2.24	0.41	Y

The result of the ALARP evaluation is that Option A meets the ALARP threshold.

4.4 Preferred option

The preferred option is Option B, as it has the highest weighted NPV result of all the technically and commercially feasible options considered as part of this need. Option B also meets the ALARP threshold. The optimal delivery date for this option is 2025/2026 based on an optimal timing analysis (see Section 5)

[4] 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.

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

Capital and Operating Expenditure

The capital cost for the project is expected to be $7.65 million.

Regulatory Investment Test

A regulatory investment test for transmission (RIT-T) will be required, as the estimated capital cost for the preferred option is above the threshold of $6 million.

5. Optimal Timing

In consideration of the delivery requirements and the NPV analysis for the need, its optimal timing is 2025/2026.

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 the meet the commissioning year based on the OFS.

The results of optimal timing analysis is:

- Optimal commissioning year: 2025/2026
- Commissioning year annual benefit: $2.49 million
- Annualised cost: $0.41 million

Based on the optimal timing, the project is expected to be completed in the 2024-2028 Regulatory Period

6. Recommendation

The preferred option is Option B, as it has the highest weighted NPV result of all the technically and commercially feasible options considered as part of this need. It is therefore recommended that this option be scoped in detail, so that it can be progressed from DG1 to DG2. Total project cost is $7.65 million including an amount of $0.5 million to progress the project from DG1 to DG2.

Appendix A – Option Summaries [6]

Project Description	Line 963 Refurbishment		
Option Description	Option A - Remediate all identified condition issues on the line as per the Transmission Line Refurbishment Criteria. In addressing these condition issues, the identified wood pole structures are to be replaced with concrete or steel pole structures.		
Project Summary			
Option Rank	*2*	Investment Assessment Period	*25*
Asset Life	*50*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	117.44	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 0.36
NPV @ Lower Bound Scenario (PV, $m)	50.77	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 2.13
NPV @ Higher Bound Scenario (PV, $m)	254.08	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, $m)	134.93	Optimal Timing	Optimal timing (Business Case) 2026
Cost (Central Scenario)			
Total Capex ($m)	6.71	Cost Capex (PV,$m)	5.49
Terminal Value ($m)	3.22	Terminal Value (PV,$m)	0.79
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 8.80	Reliability Risk (Post) 4.95	Pre – Post 3.85
Financial (PV,$m)	Financial Risk (Pre) 6.30	Financial Risk (Post) 0.74	Pre – Post 5.56
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,$m)	Safety Risk (Pre) 0.33	Safety Risk (Post) 0.29	Pre – Post 0.04
Environmental (PV,$m)	Environmental Risk (Pre) 122.43	Environmental Risk (Post) 10.42	Pre – Post 112.01
Reputational ($m)	Reputational Risk (Pre) 0.74	Reputational Risk (Post) 0.08	Pre – Post 0.66
Total Risk (PV,$m)	Total Risk (Pre) 138.61	Total Risk (Post) 16.47	Pre – Post 122.13
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 122.13

[6] Figures may not add due to rounding

Commissioning year annual benefit ($k): **2311.68**

Project Description	**Line 963 Refurbishment**		
Option Description	Option B - Remediate all identified condition issues on the line as per the Transmission Line Refurbishment Criteria. In addressing these condition issues, the identified wood pole structures are to be replaced with concrete or steel pole structures. Replace the conductor between Structure 442 to 463 with equivalent conductor. Replace all conductor components, hardware and fittings, including all insulators		
Project Summary			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	*50*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	125.31	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 0.41
NPV @ Lower Bound Scenario (PV, $m)	53.97	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 2.24
NPV @ Higher Bound Scenario (PV, $m)	271.71	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, $m)	144.07	Optimal Timing	Optimal timing (Business Case) 2026
Cost (Central Scenario)			
Total Capex ($m)	7.65	Cost Capex (PV,$m)	6.16
Terminal Value ($m)	3.67	Terminal Value (PV,$m)	0.90
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 8.80	Reliability Risk (Post) 0.34	Pre – Post 8.46
Financial (PV,$m)	Financial Risk (Pre) 6.30	Financial Risk (Post) 0.42	Pre – Post 5.88
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,$m)	Safety Risk (Pre) 0.33	Safety Risk (Post) 0.01	Pre – Post 0.32
Environmental (PV,$m)	Environmental Risk (Pre) 122.43	Environmental Risk (Post) 7.22	Pre – Post 115.21
Reputational ($m)	Reputational Risk (Pre) 0.74	Reputational Risk (Post) 0.05	Pre – Post 0.69
Total Risk (PV,$m)	Total Risk (Pre) 138.61	Total Risk (Post) 8.04	Pre – Post 130.57
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 130.57

Commissioning year annual benefit ($k): **2486.33**

Appendix B - Structure with Condition Issues by Asset Category

Asset Component Category	Cause	Effect	Consequence	No. of Structures
Conductor Fittings	Corrosion of fittings.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	10
Earthwire	Corrosion of earthwire.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	15
Earthwire Fittings	Corrosion of fittings.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	13
Guy and Anchor	Deteriorated.	Fallen structure	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	3
Insulator	Corrosion of insulator pins.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	66
Public Safety – Climbing Deterrents	Deteriorated.	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	1
Public Safety – Dangers Signs	Deteriorated.	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	1

Asset Component Category	Cause	Effect	Consequence	No. of Structures
Public Safety – Structure ID Signs	Deteriorated.	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	7
Structure Earthing	Poor connection.	Possible transfer potential, earth current and voltage gradient issues	Safety incident resulting in potential injury or death. Reduced line reliability.	4
Tower Fasteners	Corrosion of fasteners, which can compromise structural integrity.	Fallen structure and conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	2
Wood Pole	Deterioration of ground line wood condition. This can compromise structural integrity.	Fallen structure and conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	6
	Bushfire damage to the base of the wood pole structure which can compromise structural integrity.	Fallen structure and conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	8 (as per 2.2.1)