# OPTIONS EVALUATION REPORT (OER)

Line 11 - Sydney Sth - Dapto - Twr Repl

OER- 000000001600 revision 1.0

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

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

### Approvals

| | | |
|---|---|---|
| **Author** | Zaeem Khan | Transmission Lines & Cables Asset Analyst |
| **Endorsed** | Charles Kurniawan | Transmission Lines and Cables Asset Managers |
| | Debashis Dutta | Asset Analytics and Insights Manager |
| **Approved** | Andrew McAlpine | A/Head of Asset Management |
| **Date submitted for approval** | 15 November 2021 | |

### Change history

| Revision | Date | Amendment |
|---|---|---|
| 00 | 23/10/2021 | Initial Issue |
| 01 | 15/11/2021 | Minor Formatting and Update to Appendix B table |
| | | |
| | | |

# Executive summary

Line 11 is a single circuit steel tower 330kV transmission line between Dapto and Sydney South Substations, with a route length of 68km. There are 154 structures on this single circuit line including 129 suspension towers and 25 tension towers. The line is a key link in the Sydney South coastal region, and its route traverses urban areas near the substations, bushland in the Illawarra Escarpment, Sydney Water Catchment and National Park areas and also crosses the Princes Motorway (M1) at several locations.

Line 11 is considered to have the highest level of corrosion among TransGrid's transmission lines and has a history of corrosion related defects affecting tower members, conductor/earthwire fittings, insulators and fasteners (nuts and bolts). A refurbishment project was completed in early 2018 on tension towers in line with the strategy to refurbish tension towers prior to steel loss and end of life and replace suspension structures at end of life. This need focuses on the suspension structures which are at the end of life.

Detailed analysis of asset condition information has identified that 153 of the 154 structures on Line 11 have several condition issues which require refurbishment/replacement to address its health and maintain appropriate risk levels across the network.

The total number of suspension structures to be replaced is 127. This includes the replacement of 10km of earthwire and 68 km of conductor.

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 reliability, 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 ( $m) | Rank |
|---|---|---|---|---|---|---|
| Option A | Replace 55 suspension structures identified as having priority condition issues with concrete or steel poles<br>Refurbish the line components on the other remaining structures that have been identified as having condition issues | 32.42 | 1.57 | 33.99 | 195.04 | 3 |

[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 ( $m) | Rank |
|---|---|---|---|---|---|---|
| Option B | Replace all suspension structures with concrete or steel poles except Structures 30 and 129<br>Refurbish the line components on the other remaining structures that have been identified as having condition issues | 67.55 | 3.29 | 70.84 | 409.06 | 2 |
| Option C | Replace all suspension structures with concrete or steel poles except Structures 30 and 129<br>Replace the existing conductors on the line with twin Olive ACSR/GZ<br>Replace all conductor components, hardware, fittings and insulators<br>Refurbish the line components on the other remaining structures that have been identified as having condition issues | 79.87 | 3.88 | 83.75 | 703.90 | 1 |

The preferred option is Option C, as it has the highest weighted NPV result of the technically and commercially feasible options which were considered. It is therefore recommended that the option be scoped in detail and progressed from DG1 to DG2. In consideration of the delivery requirements and the economic benefit NPV analysis for the need, its optimal timing is 2027/2028.

# 1. Need/opportunity

Line 11, between Dapto and Sydney South substations, form a key link in the Sydney South coastal region. Its route traverses urban areas near the substations, bushland in the Illawarra Escarpment, Sydney Water Catchment and National Park areas and also crosses the Princes Motorway (M1) at several locations. Constructed in 1962, there are 154 structures on this single circuit line:

- 129 suspension towers
- 25 tension towers

Due to its location, Line 11 is considered to have the highest level of corrosion among TransGrid's transmission lines and has a history of corrosion related defects affecting tower members, conductor/earthwire fittings, insulators and fasteners (nuts and bolts). A refurbishment project was completed in early 2018 on tension towers in line with the strategy to refurbish tension towers prior to steel loss and end of life and replace suspension structures at end of life. This need focuses on the suspension structures which are at end of life.

Detailed analysis of asset condition information have identified that 153 of the 154 structures and/or other components on the single circuit portion of Line 11 have condition issues, all of which increase the probability of asset failure. This presents a bushfire and safety risk which TransGrid is obligated to manage.

**Suspension Towers**

All 127 suspension towers on Line 11 have been identified as having condition issues with the structure and/or other components. Of these, 55 towers have been identified as having priority condition issues, that is, the tower has one or more members that have been identified as having a condition issue with the worst possible ratings.

It should be noted that suspension Towers 30 and 129 have been assessed to have prohibitive access at their locations, and accordingly deemed as unable to be practicably replaced. These were painted as part of the tension tower refurbishment project to extend the life of the steelwork.

The most significant element of concern is the condition of the conductor fittings, earthwire fittings and corona rings due to corrosion. These items generally had a significantly thinner layer of galvanising at the time of manufacturing compared with other steelwork on the tower. Fasteners also have no galvanising on the nut thread. Failure of these fitting attachments can result in fallen conductors.

**Conductor Issues**

Conductor condition issues have been identified and discussed under Needs N2595 and N2396. Smart Aerial Image Processing (SAIP) inspections carried out in 2020 have identified multiple issues with conductor along several spans on the line, including broken strands and the presence of possible conductor corrosion (indicated by bulging, visible white product, and discolouration of the conductor).

Deterioration of conductor can compromised mechanical capacity and overheating which can lead to conductor failure.

In consideration of the refurbishment works proposed under this need, there may be advantages in performing the works under a combined package, and accordingly, options have been considered under this need to address the conductor condition issues.

There is a need to remediate these issues to:

- 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.'

- Provide an economic benefit to consumers through reductions in reliability, safety and bushfire risks. The direct impact of asset failure can result in fallen structure and/or conductor event with potential fire ignition and/or safety hazard consequences to the general public, as evaluated in the associated modelling. Line 11 is one of the highest bushfire consequence location.

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.

**Appendix B** provides a summary of the condition issues by asset component category, including the issues identified on Structures 30 and 129.

## 2. Related needs/opportunities

- Need N2493: Line 76/77 Refurbishment
- Need N2476: Line 12/76 Refurbishment
- Need N2474: Line 13/78 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, three remediation options have been considered. These are:

- **Option A**
  - Replace all suspension structures on the line that have been identified as having priority condition issues (55 towers) with concrete or steel pole structures, including all relevant hardware and attachments
  - Remediate line components on suspension structures 30 and 129 only that have identified condition issues based on the latest Transmission Line Refurbishment Criteria document
  - Identified conductor spacer and aerial marker condition issues across all spans, are to be addressed as per Transmission Line Refurbishment Criteria document
- **Option B**
  - Replace all suspension structures on the line with concrete or steel pole structures with the exception on Structures 30 and 129, including all relevant hardware and attachments
  - Remediate line components on suspension structures 30 and 129 only that have identified condition issues based on the latest Transmission Line Refurbishment Criteria document
  - Identified conductor spacer and aerial marker condition issues across all spans, are to be addressed as per Transmission Line Refurbishment Criteria document
- **Option C**
  - Replace all suspension structures on the line with concrete or steel pole structures with the exception on Structures 30 and 129, including all relevant hardware and attachments
  - Replace existing conductor with twin Olive equivalent conductor
  - Replace all conductor components, hardware and fittings, including insulators
  - Remediate any other line components with identified condition issues that have not been addressed as part of the above, as per the latest Transmission Line Refurbishment Criteria document

### 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** — Replace 55 suspension structures identified as having priority condition issues with concrete or steel poles. Refurbish the line components on the other remaining structures that have been identified as having condition issues. [NOSA N1600, OFS N1600A]

It is estimated that this option would cost $33.99 million ± 25% ($2020-21). This includes the replacement of 10km of earthwire. This option is expected to be completed within 33 months following DG1.

**Option B** — Replace all suspension structures with concrete or steel poles except Structures 30 and 129. Refurbish the line components on the other remaining structures that have been identified as having condition issues. [NOSA N1600, OFS N1600B]

The total number of suspension structures to be replaced is 127. This includes the replacement of 10 km of earthwire.

It is estimated that this option would cost $70.84 million ± 25% ($2020-21). This option is expected to be completed within 43 months following DG1.

**Option C** — Replace all suspension structures with concrete or steel poles except Structures 30 and 129. Replace the existing conductors on the line with twin Olive ACSR/GZ. Replace all conductor components, hardware, fittings and insulators. Refurbish the line components on the other remaining structures that have been identified as having condition issues. [NOSA N1600, OFS N1600C]

The total number of suspension structures to be replaced is 127. This includes the replacement of 10 km of earthwire and 68 km of conductor. This option will provide the delivery efficiency through single mobilisation whilst reducing the bushfire and safety risks.

It is estimated that this option would cost $83.75 million ± 25% ($2020-21). This option is expected to be completed within 49 months following DG1.

## 3.3 Options considered and not progressed

The following options were considered but not progressed:

**Table 2 Options considered and not progressed**

| Option | Reason for not progressing |
|---|---|
| Increased inspections | The condition issues have already been identified and cannot be rectified through increased inspections. |
| Elimination of all associated risk | This can only be achieved through retirement and decommissioning of the associated assets which is not feasible as transfer capacity of line 11 is needed in this part of the network. |
| Non-network solutions | TransGrid will invite proposals for potential non-network solutions as part of the RIT-T process. |

# 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 parameters**

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

Parameters used in this commercial evaluation:

**Table 4 Key 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 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 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 | 26.95 | 171.50 | 68.10 | 369.07 | 195.04 | 3 |
| Option B | 54.16 | 359.74 | 145.23 | 771.53 | 409.06 | 2 |
| Option C | 63.38 | 621.07 | 266.94 | 1306.53 | 703.90 | 1 |

Based on the commercial analysis, Option C 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.[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 + 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?[4] |
|---|---|---|---|
| **A** | **11.89** | **2.02** | **Y** |
| **B** | **24.71** | **4.22** | **Y** |
| **C** | **38.55** | **4.99** | **Y** |

The result of the ALARP evaluation is that all three options meet the ALARP threshold.

## 4.4 Preferred option

[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.

The preferred option is Option C, as it has the highest weighted NPV result of all the technically feasible options considered as part of this need. Option C also meets the ALARP threshold. The optimal delivery date for this option is 2027/2028 based on an optimal timing analysis (see Section 5).

**Capital and Operating Expenditure**

The required capex expenditure is $83.75 million

**Regulatory Investment Test**

A regulatory investment test for transmission (RIT-T) is 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 economic benefit NPV analysis for the need, its optimal timing is 2027/2028

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 risk costs and safety disproportionality tests) of the preferred option exceeds the annualised costs of the option. The optimal timing assessment considers the delivery requirements of the project and the estimated delivery timeline of two years in the OFS.

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 is:

- Optimal commissioning year: 2027/2028
- Commissioning year annual benefit: $38.9 million
- Annualised cost: $4.45 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 C, 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 $83.75 million including an amount of $2.0 million to progress the project from DG1 to DG2.

# Appendix A – Option Summaries[5]

| Project Description | Line 11 Tower Replacement | | |
|---|---|---|---|
| Option Description | Option A - Replace 55 suspension structures identified as having priority condition issues with concrete or steel poles | | |
| **Project Summary** | | | |
| Option Rank | *3* | Investment Assessment Period | *25* |
| Asset Life | *50* | NPV Year | 2021 |
| **Economic Evaluation** | | | |
| NPV @ Central Benefit Scenario (PV, $m) | 171.50 | Annualised CAPEX @ Central Benefit Scenario ($m) | Annualised Capex - Standard (Business Case) 1.80 |
| NPV @ Lower Bound Scenario (PV, $m) | 68.10 | Network Safety Risk Reduction ($m) | Network Safety Risk Reduction 11.89 |
| NPV @ Higher Bound Scenario (PV, $m) | 369.07 | ALARP | ALARP Compliant? Yes |
| NPV Weighted (PV, $m) | 195.04 | Optimal Timing | Optimal timing (Business Case) 2027 |
| **Cost (Central Scenario)** | | | |
| Total Capex ($m) | 33.99 | Cost Capex (PV,$m) | 26.96 |
| Terminal Value ($m) | 16.32 | Terminal Value (PV,$m) | 4.00 |
| **Risk (Central Scenario)** | **Pre** | **Post** | **Benefit** |
| Reliability (PV,$m) | Reliability Risk (Pre) 0.00 | Reliability Risk (Post) 0.00 | Pre – Post 0.00 |
| Financial (PV,$m) | Financial Risk (Pre) 7.33 | Financial Risk (Post) 5.96 | Pre – Post 1.37 |
| Operational/Compliance (PV,$m) | Operational Risk (Pre) 0.00 | Operational Risk (Post) 0.00 | Pre – Post 0.00 |
| Safety (PV,$m) | Safety Risk (Pre) 1.61 | Safety Risk (Post) 1.31 | Pre – Post 0.30 |
| Environmental (PV,$m) | Environmental Risk (Pre) 920.90 | Environmental Risk (Post) 728.26 | Pre – Post 192.64 |
| Reputational ($m) | Reputational Risk (Pre) 0.85 | Reputational Risk (Post) 0.69 | Pre – Post 0.16 |
| **Total Risk (PV,$m)** | Total Risk (Pre) 930.69 | Total Risk (Post) 736.23 | Pre – Post 194.46 |
| 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 194.46 |

**Commissioning year annual benefit ($k): 11986.52**

[5] Figures may not add due to rounding.

| Project Description | Line 11 Tower Replacement | | |
|---|---|---|---|
| Option Description | Option B - Replace all suspension structures with concrete or steel poles except Structures 30 and 129 | | |
| **Project Summary** | | | |
| Option Rank | *2* | Investment Assessment Period | *25* |
| Asset Life | *50* | NPV Year | 2021 |
| **Economic Evaluation** | | | |
| NPV @ Central Benefit Scenario (PV, $m) | 359.74 | Annualised CAPEX @ Central Benefit Scenario ($m) | Annualised Capex - Standard (Business Case) 3.76 |
| NPV @ Lower Bound Scenario (PV, $m) | 145.23 | Network Safety Risk Reduction ($m) | Network Safety Risk Reduction 24.71 |
| NPV @ Higher Bound Scenario (PV, $m) | 771.53 | ALARP | ALARP Compliant? Yes |
| NPV Weighted (PV, $m) | 409.06 | Optimal Timing | Optimal timing (Business Case) 2027 |
| **Cost (Central Scenario)** | | | |
| Total Capex ($m) | 70.84 | Cost Capex (PV,$m) | 54.17 |
| Terminal Value ($m) | 35.42 | Terminal Value (PV,$m) | 8.68 |
| **Risk (Central Scenario)** | **Pre** | **Post** | **Benefit** |
| Reliability (PV,$m) | Reliability Risk (Pre) 0.00 | Reliability Risk (Post) 0.00 | Pre – Post 0.00 |
| Financial (PV,$m) | Financial Risk (Pre) 7.33 | Financial Risk (Post) 4.31 | Pre – Post 3.02 |
| Operational/Compliance (PV,$m) | Operational Risk (Pre) 0.00 | Operational Risk (Post) 0.00 | Pre – Post 0.00 |
| Safety (PV,$m) | Safety Risk (Pre) 1.61 | Safety Risk (Post) 0.78 | Pre – Post 0.83 |
| Environmental (PV,$m) | Environmental Risk (Pre) 920.90 | Environmental Risk (Post) 519.87 | Pre – Post 401.03 |
| Reputational ($m) | Reputational Risk (Pre) 0.85 | Reputational Risk (Post) 0.50 | Pre – Post 0.35 |
| **Total Risk (PV,$m)** | Total Risk (Pre) 930.69 | Total Risk (Post) 525.46 | Pre – Post 405.23 |
| 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 405.23 |

**Commissioning year annual benefit ($k):** **24923.34**

| Project Description | Line 11 Tower Replacement | | |
|---|---|---|---|
| Option Description | Option C - Replace all suspension structures with concrete or steel poles except Structures 30 and 129 Replace the existing conductors on the line with twin Olive ACSR/GZ Replace all conductor components, hardware, fittings and insulators | | |
| **Project Summary** | | | |
| Option Rank | *1* | Investment Assessment Period | *25* |
| Asset Life | *50* | NPV Year | 2021 |
| **Economic Evaluation** | | | |
| NPV @ Central Benefit Scenario (PV, $m) | 621.07 | Annualised CAPEX @ Central Benefit Scenario ($m) | Annualised Capex - Standard (Business Case) 4.45 |
| NPV @ Lower Bound Scenario (PV, $m) | 266.94 | Network Safety Risk Reduction ($m) | Network Safety Risk Reduction 38.55 |
| NPV @ Higher Bound Scenario (PV, $m) | 1306.53 | ALARP | ALARP Compliant? Yes |
| NPV Weighted (PV, $m) | 703.90 | Optimal Timing | Optimal timing (Business Case) 2027 |
| **Cost (Central Scenario)** | | | |
| Total Capex ($m) | 83.75 | Cost Capex (PV,$m) | 63.38 |
| Terminal Value ($m) | 43.55 | Terminal Value (PV,$m) | 10.67 |
| **Risk (Central Scenario)** | **Pre** | **Post** | **Benefit** |
| Reliability (PV,$m) | Reliability Risk (Pre) 0.00 | Reliability Risk (Post) 0.00 | Pre – Post 0.00 |
| Financial (PV,$m) | Financial Risk (Pre) 7.33 | Financial Risk (Post) 1.95 | Pre – Post 5.38 |
| Operational/Compliance (PV,$m) | Operational Risk (Pre) 0.00 | Operational Risk (Post) 0.00 | Pre – Post 0.00 |
| Safety (PV,$m) | Safety Risk (Pre) 1.61 | Safety Risk (Post) 0.46 | Pre – Post 1.15 |
| Environmental (PV,$m) | Environmental Risk (Pre) 920.90 | Environmental Risk (Post) 254.27 | Pre – Post 666.63 |
| Reputational ($m) | Reputational Risk (Pre) 0.85 | Reputational Risk (Post) 0.23 | Pre – Post 0.62 |
| **Total Risk (PV,$m)** | Total Risk (Pre) 930.69 | Total Risk (Post) 256.90 | Pre – Post 673.78 |
| 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 673.78 |

**Commissioning year annual benefit ($k):** **38891.76**

## Appendix B - Structure with Condition Issues by Asset Category

| Asset Component Category | Cause | Effect | Consequence | No. of Structures<br><br>All Options |
|---|---|---|---|---|
| Conductor Dampers | Dampers are drooping. | Damaged conductor | Bushfire resulting in potential loss of property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 3 |
| Conductor Fittings | Corrosion of fittings. | Fallen conductor | Bushfire resulting in potential loss of property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 21 |
| Conductor Spacers | Corrosion of spacers. | Fallen conductor | Bushfire resulting in potential loss of property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 104 |
| Corona Rings | Minor repair required due to missing corona ring | Fallen conductor | Bushfire resulting in potential loss of property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 16 |
| Earthwire | Corrosion of Earthwire | Fallen conductor | Bushfire resulting in potential loss of property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 10 |
| Earthwire Bonding | Poor connection and bird caging. | Possible transfer potential, earth current and voltage gradient issues | Safety incident resulting in potential injury or death | 11 |
| Earthwire damper | Damaged | Fallen Conductor | Bushfire resulting in potential loss of property and/or life<br>Safety incident resulting in potential injury | 1 |

| Asset Component Category | Cause | Effect | Consequence | No. of Structures All Options |
|---|---|---|---|---|
| | | | or death<br>Line outage with potential network reliability impacts | |
| Earthwire Fittings | Corrosion of fittings | Fallen conductor | Bushfire resulting in potential loss and property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 35 |
| Foundations | Corrosion on foundations and hole adjacent to foundations | Fallen structure and conductor | Bushfire resulting in potential loss and property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 2 |
| Groundline steel | Corrosion on leg at the ground line. Deteriorated members and foundations can impact the structural integrity of the tower. | Fallen structure and conductor | Bushfire resulting in potential loss and property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 18 |
| Insulator | Porcelain insulators have reached end of serviceable life | Fallen Conductor | Bushfire resulting in potential loss and property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 62 |
| Public Safety – Aerial Marker Balls | Faded. | Aircraft collision with conductor. | Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 3 |
| Public Safety – Climbing Deterrents | Deteriorated | Unauthorised access | Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 93 |
| Public Safety – Danger Signs | Deteriorated | Unauthorised access | Safety incident resulting in potential injury or death Line outage with potential network reliability impacts | 68 |
| Public Safety | Deteriorated | Unauthorised | Safety incident resulting in potential | 28 |

| Asset Component Category | Cause | Effect | Consequence | No. of Structures<br><br>All Options |
|---|---|---|---|---|
| – Structure ID signs | | access | injury or death Line outage with potential network reliability impacts | |
| Structure Earthing | Poor connection | Possible transfer potential, earth current and voltage gradient issues | Safety incident resulting in potential injury or death | 4 |
| Tower Base | Corrosion of Tower members. Failure of critical members can compromise structural integrity | Fallen Structure and Conductor | Bushfire resulting in potential loss of property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 45 |
| Tower Body | Corrosion of tower members. Failure of critical members can compromise structural integrity. | Fallen structure and conductor | Bushfire resulting in potential loss of property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 86 |
| Tower Crossarm | Corrosion of tower members. Failure of critical members can compromise structural integrity | Fallen structure and conductor | Bushfire resulting in potential loss of property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 86 |
| Tower Fasteners | Corroded fasteners. Can compromise structural integrity. | Fallen structure and conductor | Bushfire resulting in potential loss of property and/or life<br>Safety incident resulting in potential injury or death<br>Line outage with potential network reliability impacts | 101 |