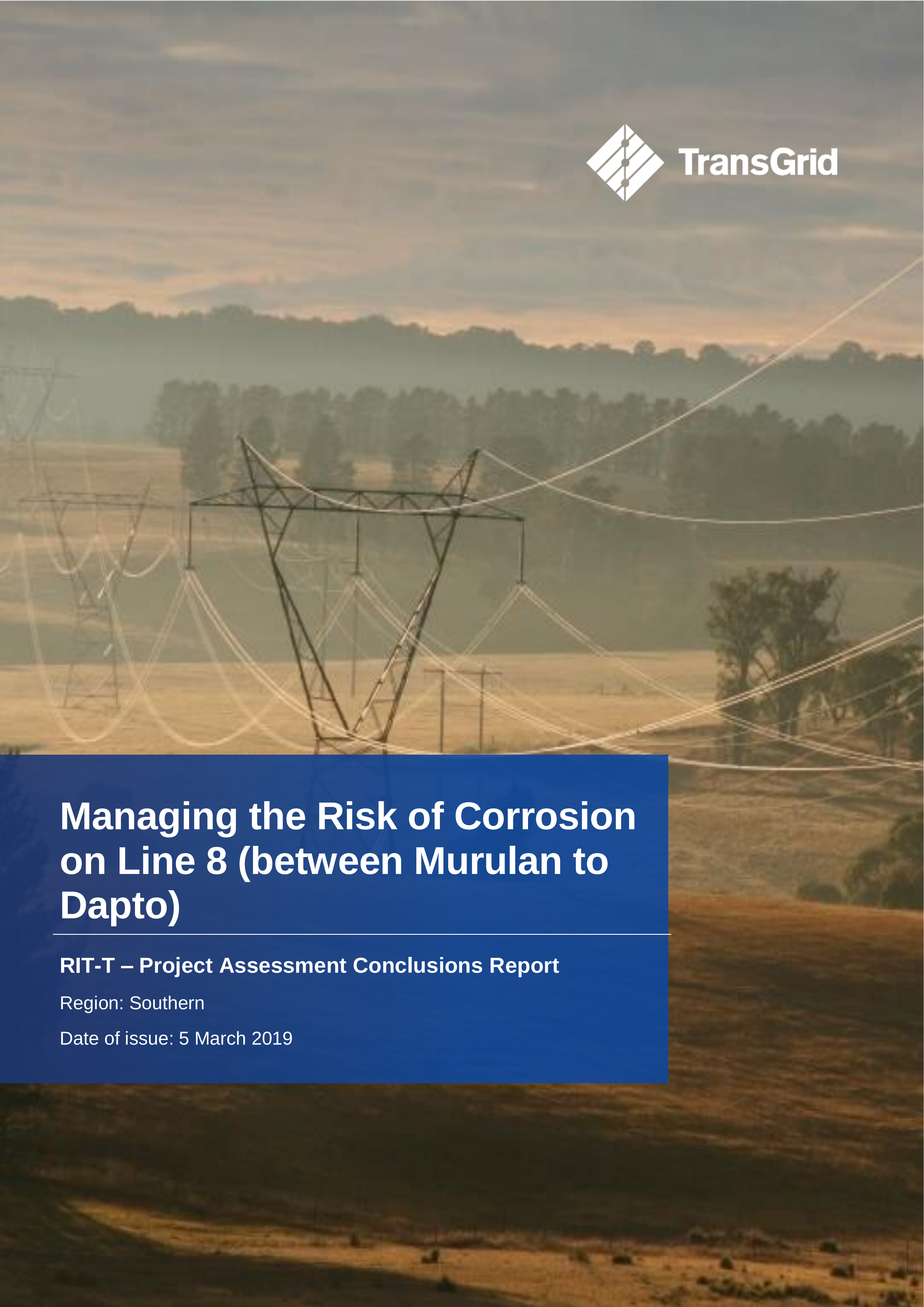

Managing the Risk of Corrosion on Line 8 (between Murulan to Dapto)

RIT-T – Project Assessment Conclusions Report

Region: Southern

Date of issue: 5 March 2019

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Executive summary

This Project Assessment Conclusions Report (PACR) is the final step in the application of the Regulatory Investment Test for Transmission (RIT-T) to options for mitigating risks caused by corrosion-related condition issues on Line 8 – a key 330 kV transmission line linking Murulan to Dapto.

Line 8 will continue to play a central role in supporting the flow of energy between regions to take advantage of naturally-diverse weather patterns, and in the safe and reliable operation of the power system throughout and after the transition to a low-carbon electricity future.

Line 8 has the capacity to support approximately 900 MW[1] – almost as large as the biggest smelter in New South Wales – and plays an important role in connecting southern generation (Snowy and Victoria) and the Sydney metropolitan area.

A significant proportion of the 175 transmission structures of Line 8 are impacted by various levels of corrosion. The affected components include steel towers, insulators, conductor fittings and conductor and earth wires. This greatly increases the likelihood of transmission structure failures, conductor drop, and subsequent bushfire and safety risks. The bushfire risks are exacerbated for Line 8 as it traverses farmland, national park areas, and climbs from the coastal plain up the Illawarra Escarpment.

The identified need for this RIT-T is to mitigate bushfire risks. Categorised as a reliability corrective action under the RIT-T, the proposed investment will enable TransGrid to meet regulatory obligations and standards. The option presented in this PACR will enable TransGrid to appropriately manage and mitigate bushfire and safety risks associated with corrosion on Line 8.

No submissions received in response to Project Specification Consultation Report

TransGrid published a Project Specification Consultation report (PSCR) on 11 September 2018 and invited written submissions on the materials presented within the document. No submissions were received in response to this PSCR.

The PSCR for this RIT-T presented a range of potential network options to address the identified need. The options included: a program of work to refurbish Line 8; staging the delivery of the remediation work over multiple years; replacing Line 8; and decommissioning the line.

The program of work to refurbish Line 8 is comprised of replacement of asset components, remediation of steelwork and foundation, and asbestos paint removal using solvents. Of the options considered, this is the only option that was found to be commercially and technically feasible.

The refurbishment of Line 8 is the preferred option presented in this PACR. The other options put forward for consideration in the PSCR were estimated to cost significantly more than the preferred option without any additional benefit. Therefore, they were found to be inferior.

TransGrid also considered and outlined alternate timings for delivery in the PSCR, however it was concluded that the optimal works delivery date is as soon as practicable, proposed for 2020/21.

In the PSCR, TransGrid noted that non-network options cannot assist with meeting the identified need as it cannot reduce the risk of bushfires occurring from failure of elements of Line 8. The relatively low overall cost of remediating the line by replacing or refurbishing identified components also makes the preferred option the most economical.

[1] or a rating of about 1000 MVA.

Conclusion: refurbishing Line 8 is optimal

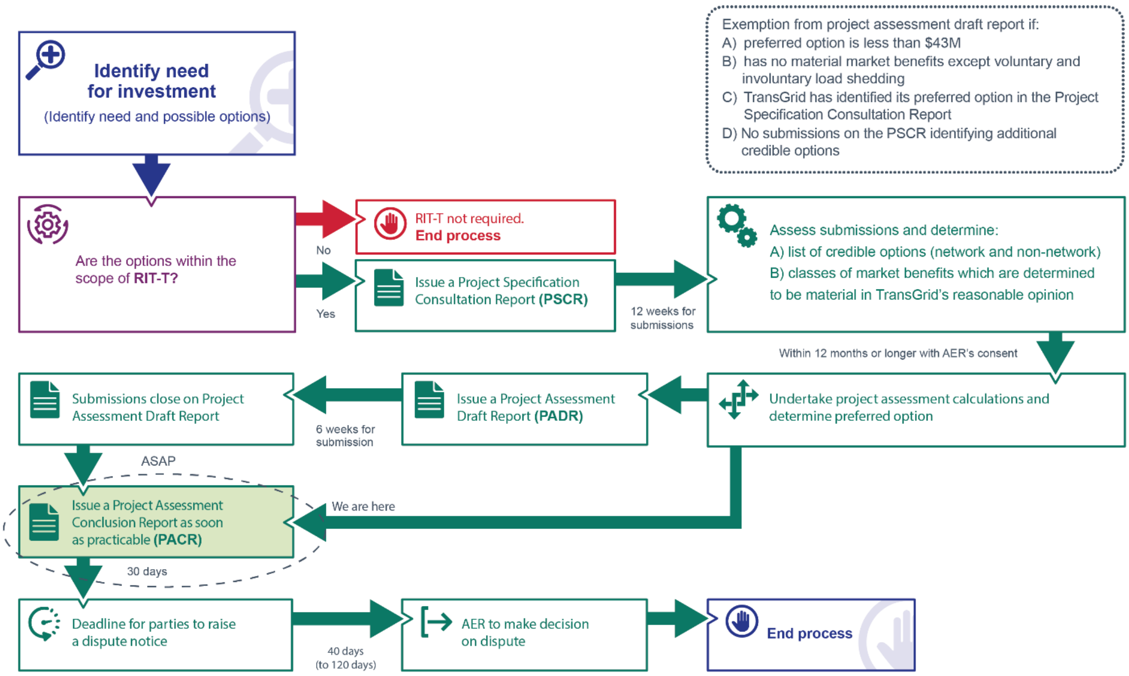
The optimal commercially and technically feasible option presented in the PSCR, the refurbishment of Line 8 by replacement of asset components, remediation of steelwork and foundation, and asbestos paint removal using solvents, remains the preferred option to meet the identified need.

Moving forward with this option is the most prudent and economically efficient solution to manage and mitigate bushfire and safety risk to the As Low As Reasonably Practical (ALARP) level. The estimated nominal capital cost of this option is approximately $6.1 million (weighted present value of $5.62 million) – significantly lower than the weighted benefits from reduced bushfire and safety risks which is estimated to be $6.97 million dollars. Routine operating and maintenance costs relating to planned checks by TransGrid field crew are approximately $70,000 per year in 2018/19 – similar to the cost under the base case. This figure has been updated since the PSCR but will not be material as this will be the same under the base case.

Next steps

This PACR represents the third step in a formal Regulatory Investment Test for Transmission (RIT-T) process undertaken by TransGrid. It follows a Project Specification Consultation Report (PSCR) released in September 2018. The second step, production of a Project Assessment Draft Report (PADR), was not required as TransGrid considered its investment in relation to the preferred option to be exempt from this part of the RIT-T process under NER clause 5.16.4(z1).This PACR represents the third stage of the formal consultation process in relation to the application of the RIT-T.

Figure E-1 This PACR is the third stage of the RIT-T process



Parties wishing to raise a dispute notice with the AER may do so prior to 5 April 2019 (30 days after publication of this PACR). Any dispute notices raised during this period will be addressed by the AER within 40 to 120 days, after which the formal RIT-T process will conclude.

TransGrid intends to undertake refurbishment works in between 2018/19 and 2020/21. Planning and procurement will occur between 2018/19 and 2019/20 and project delivery and construction will occur in 2020/21. All work is planned to be completed by 2020/21. Necessary network asset outages will be implemented to have minimal impact on network capacity.

Further details on the project can be obtained from TransGrid's Prescribed Revenue and Pricing team via RIT-TConsultations@transgrid.com.au. In the subject field, please reference "Line 8 project."

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1. Introduction

This Project Assessment Conclusions Report (PACR) is the final step in the application of the Regulatory Investment Test for Transmission (RIT-T) to options for mitigating risks caused by corrosion-related condition issues on Line 8 – a key 330 kV transmission line linking the Goulburn and Wollongong regions.

Line 8 will continue to play a central role in supporting the flow of energy between regions to take advantage of naturally-diverse weather patterns, and in the safe and reliable operation of the power system throughout and after the transition to a low-carbon electricity future.

The plan and timing to replace the identified components has been in place since 2016 after routine asset monitoring and maintenance identified a number of corrosion-related issues on Line 8. An allowance has, therefore, been made for this work in TransGrid's 2018-23 Revenue Proposal.[2]

The corresponding Project Specification Consultation Report (PSCR) released in September 2018 set out the reasons TransGrid proposes that action be undertaken (identified need). It also presented the option TransGrid considers optimal to address the identified need. Though it was outlined how non-network options are unlikely to contribute to meeting the identified need, TransGrid still outlined the technical characteristics that non-network options would need to provide.

No submissions were received in response to the PSCR.

1.1 Purpose of this report

The purpose of this PACR is to:

- describe the identified need
- describe and assess credible options to meet the identified need
- describe the assessment approach used
- provide details of the proposed preferred option to meet the identified need.

1.2 Next steps

TransGrid intends to undertake refurbishment works in between 2018/19 and 2020/21. Planning and procurement will occur between 2018/19 and 2019/20 and project delivery and construction will occur in 2020/21. All work is planned to be completed by 2020/21.

Further details on the project can be obtained from TransGrid's Prescribed Revenue and Pricing team via RIT-TConsultations@transgrid.com.au.

[2] TransGrid's Revised Regulatory Proposal for the Period 2018-23, available at: https://www.aer.gov.au/system/files/TransGrid%20-%20Revised%20Revenue%20Proposal%20-%201%20December%202017.pdf, viewed on 8 January 2019.

2. The identified need

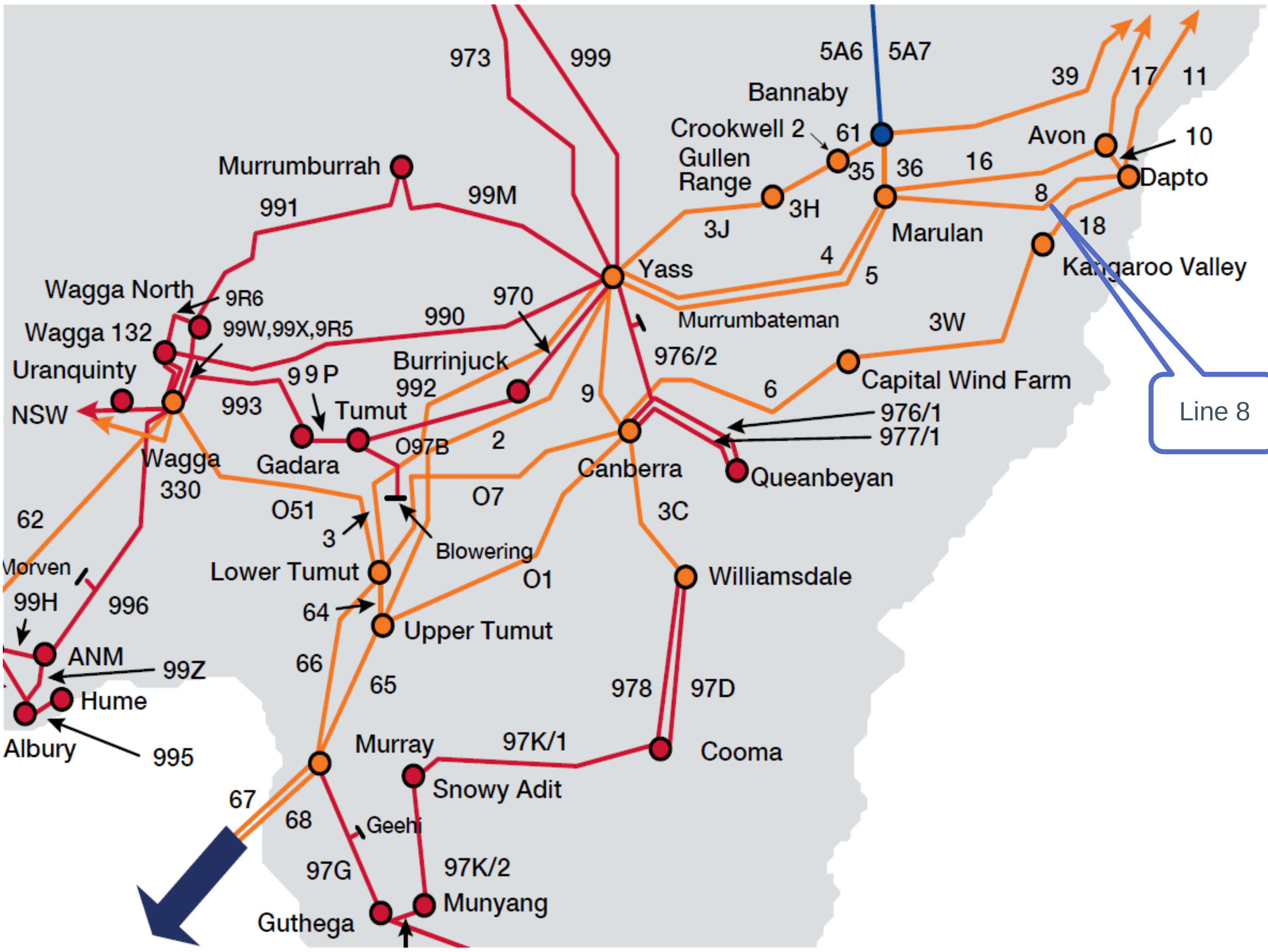
2.1 Background

Constructed in 1956 and 1962, Line 8 is a single circuit 330 kV transmission line that serves as a key link between Southern New South Wales and the Wollongong and Sydney load centres.

Spanning a route of approximately 70 km, the line encompasses 175 transmission structures and connects TransGrid's Marulan and Dapto 330kV substations on the southern New South Wales network. The route traverses farmland, national park areas, and climbs from the coastal plain up the Illawarra Escarpment.

The figure below provides an overview of the southern New South Wales network, with Line 8 located in the centre of the figure (and highlighted by a green arrow).

Figure 2-1 Southern New South Wales network



Corrosion-related issues have been found on a significant proportion of the 175 transmission structures on Line 8, including steel towers, insulators, conductor fittings, conductor, and earth wires. Further investigation found that the protective galvanising layer, coated at the time of manufacture, has been consumed over time leaving the steel unprotected from further and accelerated corrosion.

These steel components were coated during manufacturing, with a galvanising layer to protect the steel from corrosion. Over time this galvanising layer has been consumed and now the steel itself is being consumed, accelerating the corrosion process.

With respect to tower footings, the corrosion process has been exacerbated by the use of grillage footings, where the footings are constructed from hot-dip galvanised steel members extending from the tower body which is above ground, as a continuous member below ground, forming a grill which is directly buried. As a result, the footings are not encased in concrete, meaning they are more susceptible to the surrounding soil and associated corrosion consequences.

The figures below provide photos of corroded elements along Line 8.

Figure 2-2 Examples of corroded elements of Line 8

The single circuit transmission line structures used on Line 8 were designed to the standards at that time but were found to be of a lower set of design criteria compared with newer structures. There were a number of structure failures in extreme wind events in recent decades for asset types of similar design, age and construction methods. TransGrid's investigations found that these single circuit suspension towers had design deficiencies in the governing load combinations when compared to more recent design philosophies and standards. As a consequence, strengthening of structures with utilisation over 85 per cent at road crossings and public areas has already occurred across TransGrid's network.

In addition to the corrosion issues, inspections have also identified 42 structures on Line 8 that are coated with asbestos paint. The vast majority of the paint is restricted to the lower part of the tower legs, however, there are a small number of completely painted towers. The condition of the paint is varied across the affected towers, though most towers have been reported to be in average or poor condition. As a result, while the health risks associated with the asbestos paint are currently considered to be low, further deterioration of the assets will lead to the paint de-bonding from the steel and flaking – meaning the safety risk it poses to TransGrid field crew and members of the public may increase.

2.2 Description of the identified need

Further deterioration of the condition of the affected assets due to corrosion would mean an increase in bushfire and safety risks along Line 8. If left untreated, corrosion of some of the vital components of the steel towers could result in incidents such as conductor drop and tower collapse which may cause bushfire and safety risks. Such incidents have serious safety consequences for TransGrid field crew members who may be working on or near the assets, nearby residents and members of the public. As the line traverses farmlands and national parks, the risk of bushfire and on safety caused by structural failure of towers and conductor drop increases substantially.

TransGrid manages and mitigates bushfire and safety risks to ensure they are below tolerance levels or 'As Low As Reasonably Practicable' ('ALARP'), in accordance with TransGrid's obligations under the New South Wales *Electricity Supply (Safety and Network Management) Regulation 2014* and TransGrid's Electricity Network Safety Management System (ENSMS).[3] In particular, risks are mitigated unless it is possible to

[3] TransGrid ENSMS follows the ISO31000 risk management framework which requires following hierarchy of hazard mitigation approach.

demonstrate that the cost involved in further reducing the risk would be grossly disproportionate to the benefit gained.

TransGrid's analysis concludes that the costs of mitigating the bushfire and safety risks is less than the benefit of avoiding those risks. Categorised as a reliability corrective action under the RIT-T, 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.

A reliability corrective action differs from a 'market benefit'-driven RIT-T in that the preferred option is permitted to have negative net market benefits (on account of it being required to meet an externally imposed obligation on the network business).

3. Options that meet the identified need

TransGrid considers that the optimal timing for the most efficient option (line refurbishment) that meets the identified need to reduce the bushfire and safety risk to acceptable levels is as soon as possible, ie 2021/22.

In identifying the refurbishment of the existing line as a credible option, TransGrid has taken the following factors into account: energy source; technology; ownership; the extent to which the option enables intra-regional or intra-regional trading of electricity; whether it is a network option or a non-network option; whether the credible option is intended to be regulated; whether the credible option has proponent; and any other factor which TransGrid reasonably considered should be taken into account.[4]

TransGrid did not receive any responses to the PSCR.

3.1 Option 1 – Refurbish the existing line by remediating or replacing the identified components

Option 1 involves the remediation of Line 8, including the treatment of corrosion of tower steelwork, replacement of affected foundation components which have reached end of life due to corrosion, and asbestos paint removal.

This option is considered to address the identified need, be commercially and technically feasible and can be implemented in sufficient time to meet the identified need.[5]

The works are planned to be undertaken between 2018/19 and 2020/21. Planning and procurement (including completion of the RIT-T) will occur between 2018/19 and 2019/20, while project delivery and construction will occur in 2020/21. All works are planned to be completed by 2020/21.

Necessary outages of the line(s) in service will be planned appropriately in order to complete the works with minimal impact on the network.

The estimated nominal capital cost of this option is approximately $6.1 million. Routine operating and maintenance costs relating to planned routine checks by TransGrid field crew are approximately $70,000 per year in 2018/19 – same under the base case. This figure has been updated since the PSCR but will not be material as this will be the same under the base case.

Option 1 will enable TransGrid to meet the standard for this part of the network with minimal modification to the wider transmission assets. Driven by reliability corrective action, the refurbishment of Line 8 is categorised as replacement capital expenditure. It is not an expansion of the existing transmission system or an increase in its capacity to transmit electricity and is therefore not categorised as network augmentation capital expenditure.

Table 3-1 summarises the remediation works under Option 1 to address the key issues on Line 8.

Table 3-1 Remediation works for Line 8 under Option 1

Issue	Remediation
Corrosion of tower members	> Abrasive blast cleaning of steelwork to remove any corrosion product, application of coating – entire tower

4 In accordance with the requirements of NER clause 5.15.2(b).

5 In accordance with the requirements of NER clause 5.15.2(a).

Issue	Remediation
Corrosion of tower fasteners	> Replacement of fasteners
Corrosion of conductor fittings	> Replacement of conductor fittings
Corrosion of earth wire fittings	> Replacement of earth wire fittings
Insulator pin corrosion	> Replacement with composite longrod insulators
Corrosion of earth wire	> Like for like replacement of SC/GZ earth wire
Conductor vibration damper condition	> Replacement of vibration dampers
Corrosion of grillage foundation	> Replacement of end of life sacrificial anodes for towers located in nonaggressive soil > Buried steel remediation and concrete encasement for towers located in aggressive soil
Asbestos paint	> Removal of asbestos paint through the use of paint strippers.

3.2 Options considered but not progressed

The primary driver for the identified need is to mitigate bushfire and safety risks associated with condition issues on the Line 8 caused by corrosion. Three other options to address the need were considered but were not progressed further as they were not commercially viable when assessed against the preferred option.

Table 3-2 below provides a summary of these options and the reasons for not progressing.

Table 3-2 Options considered but not progressed

Option	Description	Reason(s) for not progressing
Option 2	Stage the delivery of Option 1 over multiple years	There are cost efficiencies associated with replacing all identified components in one year, as opposed to spreading this out across multiple years. In addition, delaying the replacement of any components comes with a greater expected risk value. The combination of greater costs and less benefits (in terms of avoided risk costs) makes this option less commercially feasible relative to Option 1.
Option 3	Replacing Line 8 (entire line)	The capital cost of replacing the entire line is estimated to be significantly higher than Option 1, about $67 million, but will not provide any additional benefits. In addition, not all components that make up Line 8 require replacement in coming years.

Option	Description	Reason(s) for not progressing
Option 4	Decommissioning and dismantling the line, and procure a non-network solution (or solutions)	To manage the risks to the safety of TransGrid field crew, members of the public, properties, and environment, Line 8, if decommissioned, must be dismantled. This requires: > physical disconnection of the line from the 330 kV switchbays at Dapto and Marulan substations > dismantling of line structures, fittings, and conductors > rehabilitation of the easement. The direct decommissioning cost is estimated to be greater than $18 million (depending on access and clearing costs), which is significantly higher than Option 1 but will not provide any additional benefits. In addition, TransGrid would need to procure significant quantities of non-network options to ensure compliance with the New South Wales transmission reliability standards. This would further increase the cost of this option.

The PSCR also outlined that non-network options cannot assist with meeting the identified need as it cannot reduce the risk of bushfires occurring from failure of elements of Line 8.

The relatively low overall cost of refurbishing the line also makes the preferred option more economical.

4. Assessment of credible options

There were no material changes since publication of the PSCR that affect the preference of Option 1.

The assessment compares the costs and benefits of the option to a base case where Line 8 will not be remediated, the exiting maintenance regime is continued, and the line will continue to operate as is.

4.1 Assessment under three different scenarios to address uncertainty

RIT-T assessments are based on cost-benefit analysis that includes assessment under 'reasonable scenarios' which are designed to test alternate sets of key assumptions and their impact on the ranking and feasibility of options.

TransGrid has constructed three alternative scenarios, summarised in the Table 4-1 below, to address uncertainty – namely:

> a low net benefit scenario, involving a number of assumptions that gives a lower bound and conservative estimates of NPV of net economic benefits

> a central scenario which consists of assumptions that reflect TransGrid's central set of variable estimates that provides the most likely scenario

> a high net benefit scenario that reflects a set of assumptions which have been selected to investigate an upper bound of net economic benefits.

Table 4-1 Summary of scenarios

Variable / Scenario	Central	Low net benefits	High net benefits
Scenario weighting	*50%*	*25%*	*25%*
Network capital costs	Base estimate	Base estimate + 25%	Base estimate - 25%
Avoided bushfire risks	Base estimate	Base estimate - 25%	Base estimate + 25%
Avoided corrective maintenance costs	Base estimate	Base estimate - 25%	Base estimate + 25%
Discount rate	7.04%	9.48%	4.60%

The three scenarios do not involve different assumptions about load forecasts or Value of Customer Reliability (VCR)[6] as the identified need for this RIT-T is not affected by demand.

Since it is based primarily on a set of expected/central assumptions, the central scenario is considered most likely and is assigned with 50 per cent weighting. The other two scenarios are equally weighted with 25 per cent each.

[6] A Value of Customer Reliability (VCR) measure indicates the value different types of customers place on having reliable electricity supplies under different conditions. AEMO Fact Sheet, available at: https://www.aemo.com.au/-/media/Files/PDF/AEMO_FactSheet_ValueOfCustomerReliability_2015.pdf, viewed on 6 February 2019.

4.2 Estimated gross economic benefits

Table 4-2 summarises the present values of the gross economic benefit estimates for Option 1 relative to the base case under the three scenarios.

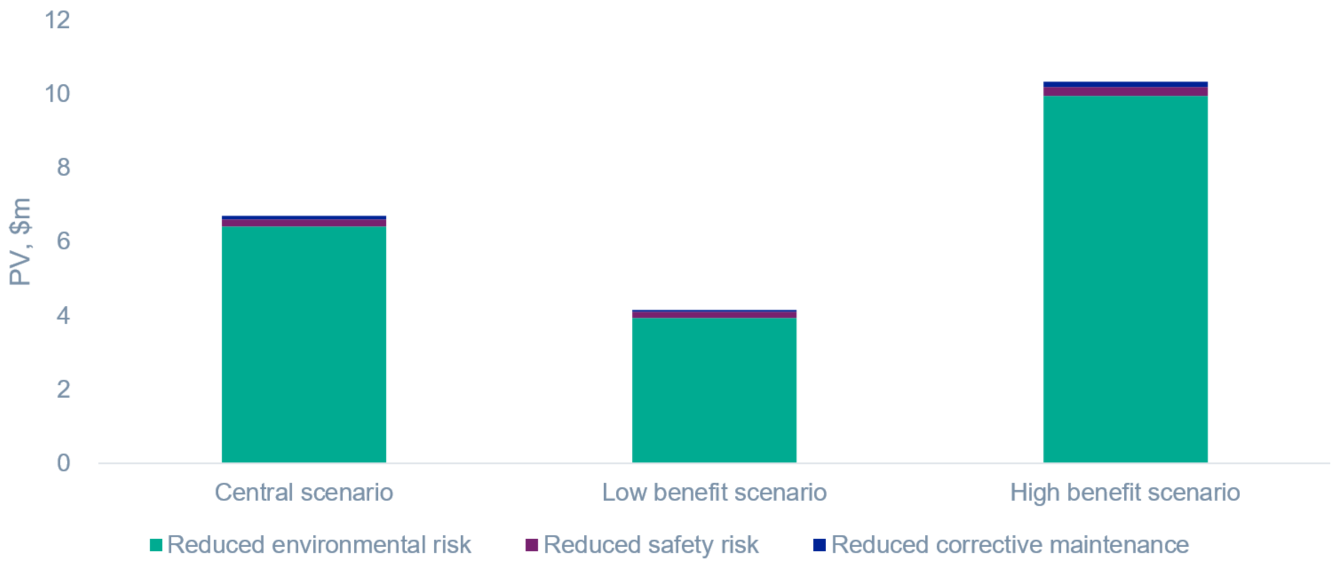
There are significant benefits from avoided costs associated with bushfire and safety risks, and reactive corrective maintenance. These *expected* costs are weighted based on the probability of the event occurring.

Table 4-2 Present value of gross economic benefits relative to the base case, PV $m 2017/18

Option/scenario	Central	Low net benefit	High net benefit	Weighted
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	6.70	4.17	10.32	6.97

Figure 4-1 breaks these benefits further and shows that most of the benefits are derived from avoided risk of bushfires.

Figure 4-1 Breakdown of gross economic benefits Option 1 relative to the base case, PV $m



4.3 Estimated costs

Table 4-3 below summarises the present value of costs of Option 1 relative to the base case under the three reasonable scenarios.

Table 4-3 Present value of costs of option 1 relative to the base case, PV $m 2017/18

Option	Central	Low net benefit	High net benefit	Weighted
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	5.63	6.93	4.28	5.62

4.4 Estimated net economic benefits

Table 4-4 summaries the present value of net benefit for Option 1 under the three scenarios. The estimated net benefit is the estimated gross economic benefits (section 4.2) less the estimated costs (section 4.3).

Option 1 is found to have positive net economic benefits for all scenarios investigated, except for the low net benefit scenario. On a weighted basis, Option 1 will deliver approximately $1.35 million in net economic benefits.

Table 4-4 Present value of net economic benefits relative to the base case, PV $m 2017/18

Option	Central	Low net benefit	High net benefit	Weighted NPV
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	1.07	-2.76	6.04	1.35

While the estimated net economic benefits are marginally negative under the low net benefit scenario, TransGrid notes that this scenario is comprised of an extreme combination of assumptions designed to investigate a reasonable lower bound on the net economic benefits.

In addition, under the base case, the failure rates and bushfire risk costs are conservatively assumed to be constant going forward, despite the likelihood that failure rates and risk costs may further increase as the asset further deteriorates.

4.5 Sensitivity testing

TransGrid has undertaken a thorough sensitivity testing exercise to understand the robustness of the conclusion to underlying assumptions about key variables. These are implemented in stages.

> Step 1 – tests the sensitivity of the optimal timing of the project ('trigger year') to different assumptions on key variables

> Step 2 – once a trigger year is determined, tests the sensitivity of the NPV of net benefit to different assumptions on key variables such as lower or higher bushfire risks.

4.5.1 Step 1 – Sensitivity testing of the optimal timing

The optimal timing for Option 1 is the year in which the NPV of net benefit is maximised. Shown on Figure 4-2, the optimal timing is 2020/21 and is found to be invariant between the central set of assumptions and a range of alternative assumptions for the following key variables:

> a 25 per cent increase/decrease in the assumed network capital costs

> lower discount rate of 4.60 per cent

> higher assumed bushfire risk

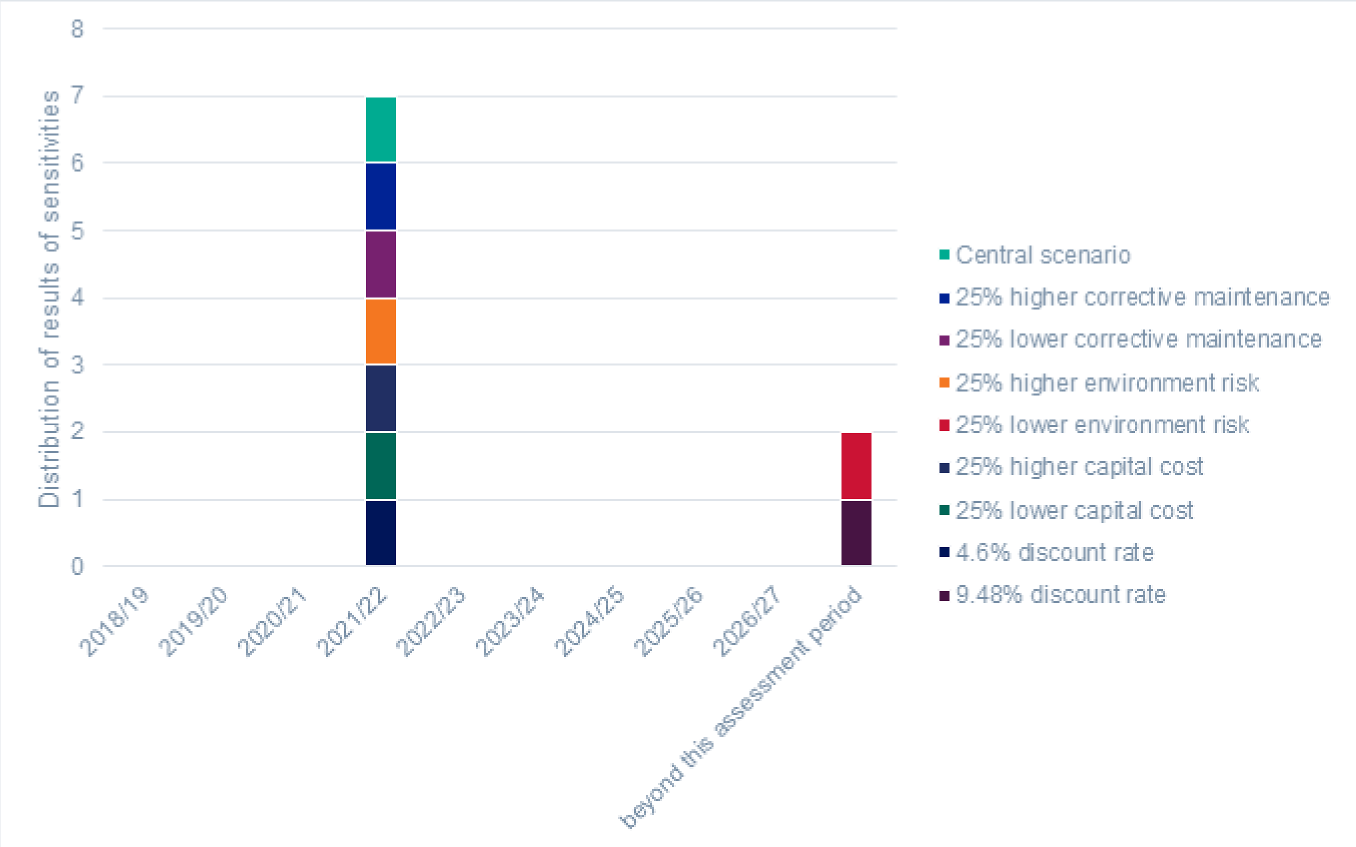
> lower (or higher) benefits associated with avoided corrective maintenance costs.

The figure below illustrates that for Option 1, the optimal commissioning date is beyond the assessment period for sensitivities around 25 per cent lower environmental risk and a higher commercial discount rate. TransGrid has not given a high weighting to the 25 per cent lower environmental risk and a higher commercial discount rate sensitivities in light of the conservative underlying assumption regarding a constant risk cost going forward.

Moreover, TransGrid considers that the sensitivity assessment below demonstrates that planning for any commissioning later than 2020/21 would be inconsistent with the ALARP obligations under the New South Wales Electricity Supply (Safety and Network Management) Regulation 2014. In particular, there would be lower net market benefits (due to higher risk cost associated with bushfire risk) if the replacement works were delayed.

No sensitivity tests have been undertaken on load forecasts or VCR as they are immaterial to the identified need.

Figure 4-2 Distribution of optimal project commissioning year for Option 1 under each sensitivity



4.5.2 Step 2 – Sensitivity of the overall net benefit

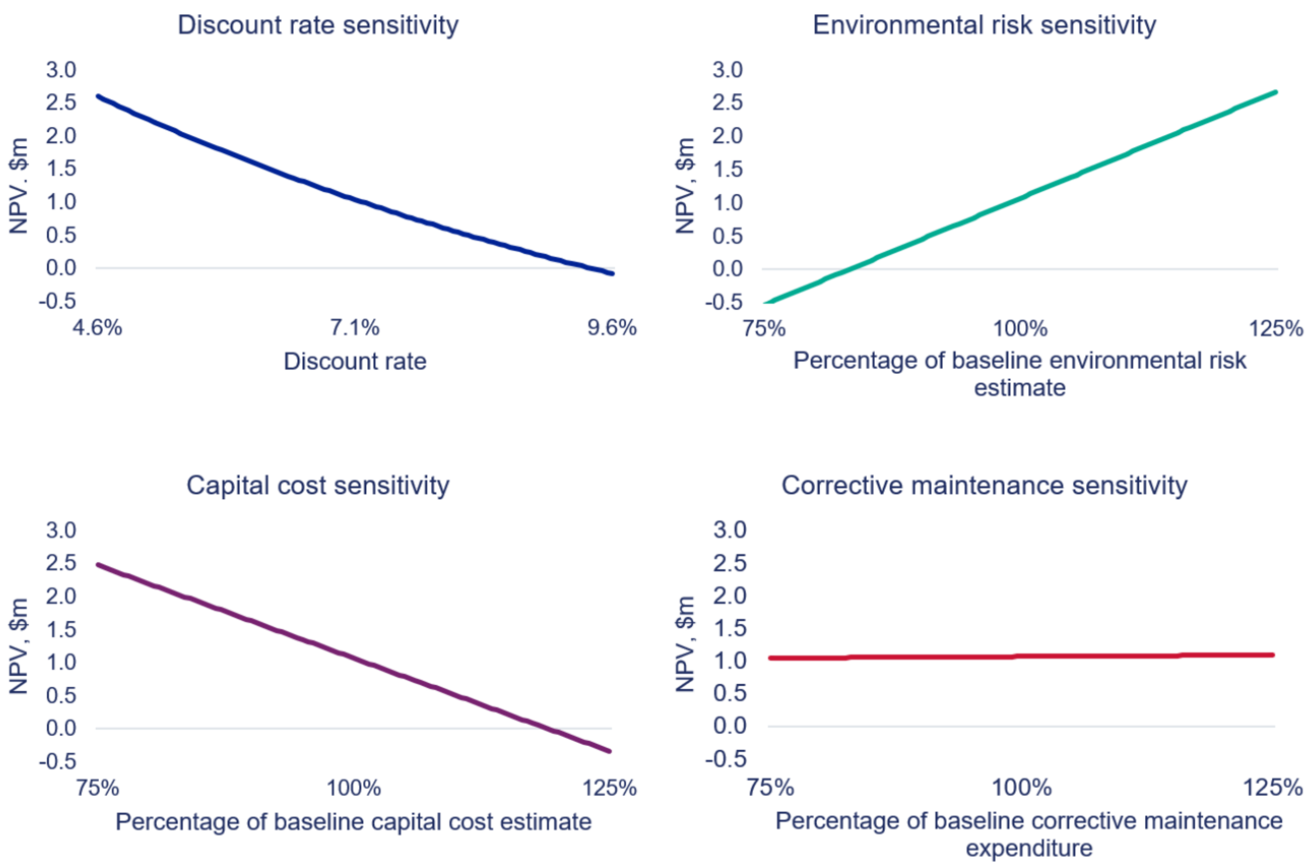
TransGrid has also conducted sensitivity analysis around the NPV of the net benefit assuming the optimal timing established in Step 1.

Specifically, TransGrid has investigated the same sensitivities under this step:

> a 25 per cent increase/decrease in the assumed network capital costs
> lower discount rate of 4.60 per cent, and a higher rate of 9.48 per cent
> lower (or higher) assumed bushfire risk
> lower (or higher) benefits associated with avoided corrective maintenance costs.

The figures below illustrate that for all sensitivity tests, the estimated net economic benefits of Option 1 are found to be predominantly positive.

Figure 4-3 Sensitivity testing of Option 1



The preferred option of refurbishing the line demonstrates strong positive net economic benefits and will appropriately manage the bushfire and safety risks associated with Line 8.

5. Final conclusion on the preferred option

The optimal commercially and technically feasible option presented in the PSCR, the refurbishment of Line 8 by remediating or replacing the identified corroded components that have reached end of serviceable life, remains the preferred option to meet the identified need. This preferred option, Option 1, is found to have strong positive net economic benefits under most scenarios investigated and on a weighted basis will deliver approximately $1.35 million in net economic benefits.

Moving forward with this option is the most prudent and economically efficient solution to manage and mitigate bushfire and safety risk to ALARP.

The estimated nominal capital cost of this option is approximately $6.1 million (weighted present value of $5.62 million) – significantly lower than the weighted benefits from reduced bushfire and safety risks which is estimated to be $6.97 million dollars. Routine operating and maintenance costs relating to planned checks by TransGrid field crew are approximately $70,000 per year in 2018/19 – similar to the cost under the base case. This figure has been updated since the PSCR but will not be material as this will be the same under the base case. However, corrective maintenance costs over the life of this option will reduce.

TransGrid has also conducted sensitivity analysis on the NPV of the net benefit to investigate the robustness of the conclusion to underlying key assumptions. TransGrid finds that under most sensitivities, positive net economic benefits results from remediating Line 8.

TransGrid intends to undertake refurbishment works in between 2018/19 and 2020/21. Planning and procurement will occur between 2018/19 and 2019/20 and project delivery and construction will occur in 2020/21. All works are planned to be completed by 2020/21.

The analysis undertaken and the identification of Option 1 as the preferred option satisfies the RIT-T.

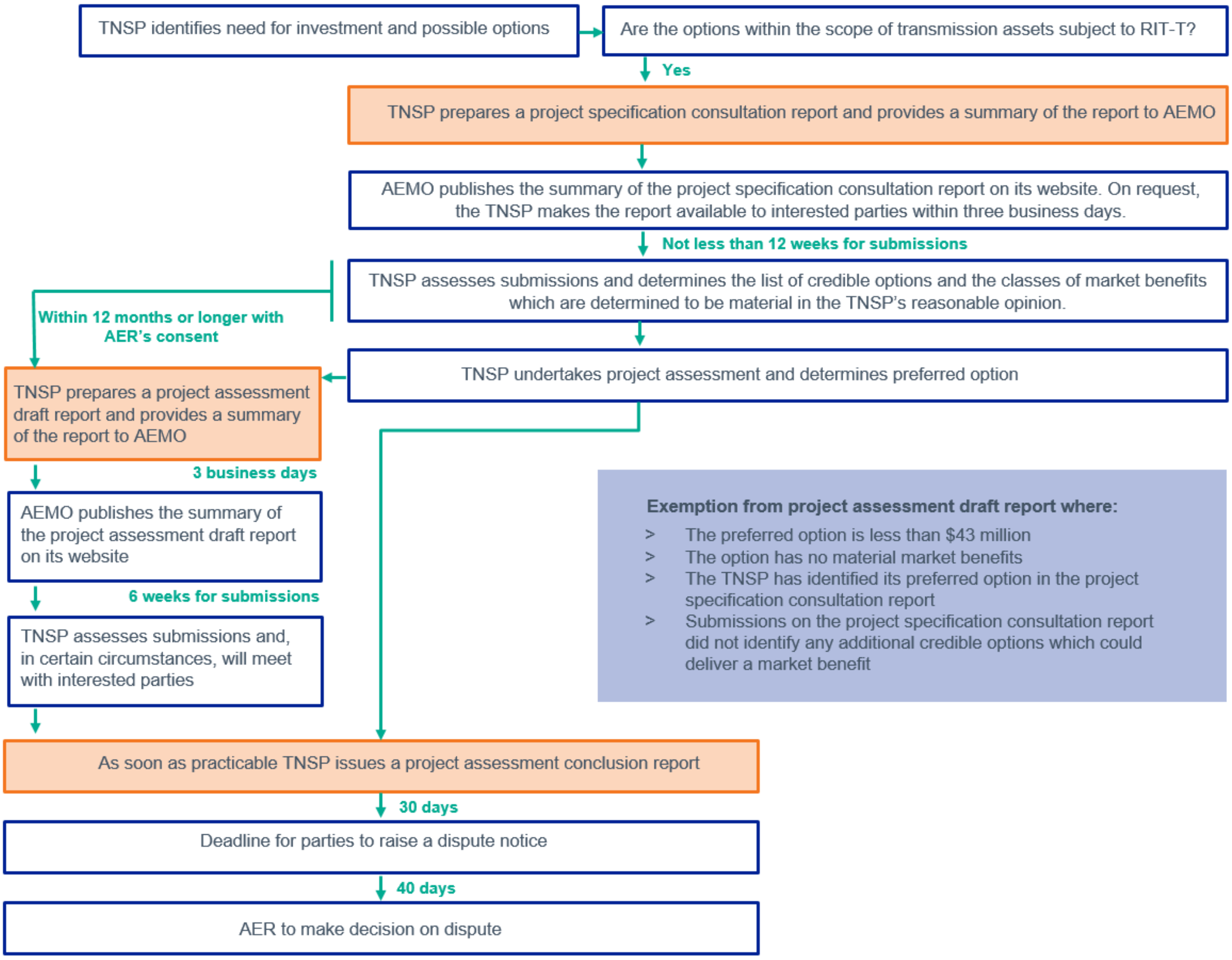
Appendix A – Compliance checklist

Rules clause	Summary of requirements	Relevant section(s) in PACR
5.16.4 (v)	The project assessment conclusions report must set out:	–
	(1) the matters detailed in the project assessment draft report as required under paragraph (k); and	See below.
	(2) a summary of, and the RIT-T proponent's response to, submissions received, if any, from interested parties sought under paragraph (q).	NA
5.16.4(k)	The project assessment draft report must include:	–
	(1) a description of each credible option assessed;	3
	(2) a summary of, and commentary on, the submissions to the project specification consultation report;	NA
	(3) a quantification of the costs, including a breakdown of operating and capital expenditure, and classes of material market benefit for each credible option;	3, 4, Appendix D & Appendix E
	(4) a detailed description of the methodologies used in quantifying each class of material market benefit and cost;	4, Appendix D & Appendix E
	(5) reasons why the RIT-T proponent has determined that a class or classes of market benefit are not material;	Appendix D
	(6) the identification of any class of market benefit estimated to arise outside the region of the Transmission Network Service Provider affected by the RIT-T project, and quantification of the value of such market benefits (in aggregate across all regions);	NA
	(7) the results of a net present value analysis of each credible option and accompanying explanatory statements regarding the results;	4
	(8) the identification of the proposed preferred option;	5
	(9) for the proposed preferred option identified under subparagraph (8), the RIT-T proponent must provide: (i) details of the technical characteristics; (ii) the estimated construction timetable and commissioning date; (iii) if the proposed preferred option is likely to have a material inter-network impact and if the Transmission Network Service Provider affected by the RIT-T project has received an augmentation technical report, that report; and (iv) a statement and the accompanying detailed analysis that the preferred option satisfies the regulatory investment test for transmission.	3 & 5

Appendix B – RIT-T process overview

For the purposes of applying the RIT-T, the NER establishes a typically three stage process, ie: (1) the PSCR; (2) the PADR; and (3) the PACR. This process is summarised in the figure below (in orange), as well as the criteria for PADR exemption that this RIT-T is seeking to apply (in blue).

Figure B-1 The RIT-T assessment and consultation process[7]



[7] Source: AER, Final Regulatory investment test for transmission application guidelines, 18 September 2017, pp. 42.

Appendix C – Assumptions underpinning the identified need

This appendix summarises the key assumptions and data from the risk assessment methodology that underpin the identified need for this RIT-T and the assessment undertaken for the Revenue Proposal.[8] Appendix E provides further details on the general modelling approaches applied including the commercial discounts rate used.

As part of preparing its Revenue Proposal for the current regulatory control period, TransGrid developed the Network Asset Risk Assessment Methodology to quantify risk for replacement and refurbishment projects. The risk assessment methodology:

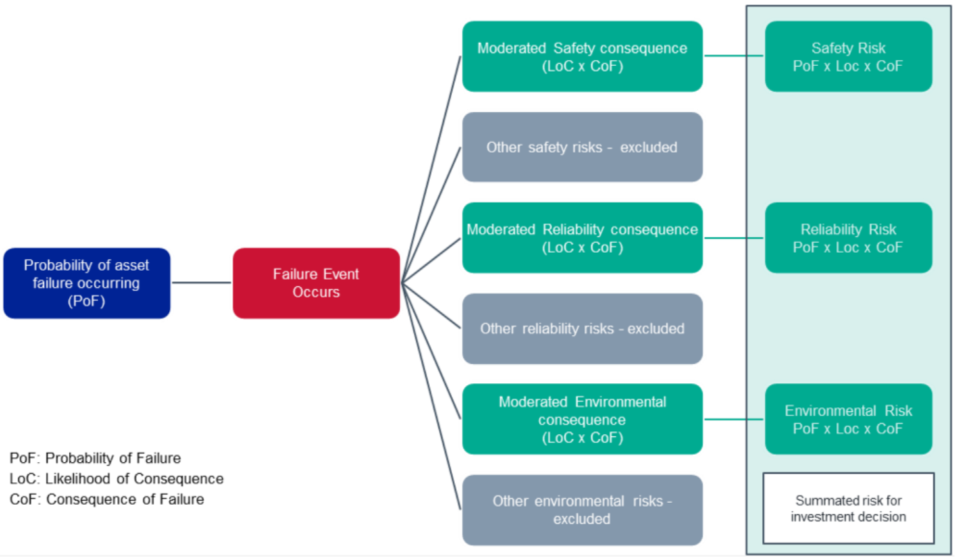
> uses externally verifiable parameters to calculate asset health and failure consequences
> assesses and analyses asset condition to determine remaining life and probability of failure
> applies a worst-case asset failure consequence and significantly moderates this down to reflect the likely consequence in a particular circumstance
> identifies safety and compliance obligations with a linkage to key enterprise risks.

C.1 Overview risks assessment methodology

A fundamental part of the risk assessment methodology is calculating the 'risk costs' or the monetised impacts of the reliability, safety, environmental and other risks.

Figure C-1 below summarises the framework for calculating the 'risk cost', which has been applied on TransGrid's asset portfolio considered to need replacement or refurbishment.

Figure C-1 Overview of TransGrid's 'risk cost' framework



The 'risk costs' are calculated based on the Probability of Failure (PoF), the Consequence of Failure (CoF), and

8 For additional information on the risk assessment methodology, refer to pages 63-69 of TransGrid's Revised Regulatory Proposal for the period 2018-23, available at: https://www.aer.gov.au/system/files/TransGrid%20-%20Revised%20Revenue%20Proposal%20-%201%20December%202017.pdf

the corresponding Likelihood of Consequence (LoC).

In calculating the PoF, each failure mode that could result in significant impact is considered. For replacement planning, only life-ending failures are used to calculate the risk costs. PoF is calculated for each failure mode based on 'conditional age' (health-adjusted chronological age), failure and defect history, and benchmarking studies. For 'wear out' failures, a Weibull curve may be fitted; while for random failures, a static failure rate may be used.

In calculating the CoF, LoC and risks, TransGrid uses a moderated 'worst case' consequence. This is an accepted approach in risk management and ensures that high impact, low probability (HILP) events are not discounted. The approach excludes the risk costs of low impact, high probability (LIHP) which would result in lower calculated risk.

C.2 Line 8 condition issues and their consequences

TransGrid's asset health assessments have identified a number of corrosion related issues on Line 8. Details are presented on Tables C-1 and C-2.[9]

Table C-1 Line 8's identified asset issues and their potential consequences

Issue	Cause	Extent (%line)	Quantity	Impact
Corroded insulators	Zinc galvanising end of life	66%	286 insulator strings	Conductor drop
Corroded earth wire	Zinc galvanising end of life	5%	4 km	
Corrosion of earth wire attachment fittings	Zinc galvanising end of life	5%	21 fittings	
Corroded conductor attachment fittings Corroded suspension insulators	Zinc galvanising end of life Corrosion of steel caps and pins, zinc sleeve protection end-of-life	5%	33 fittings	
Grillage buried steel corrosion	Zinc galvanising end of life	75%	138 towers	Structural failure
Corrosion of tower steel members	Zinc galvanising end of life	7%	12 towers	
Corroded fasteners	Zinc galvanising end of life	5%	9 towers	

9 The extent and quantities shown in this table are accurate as at the time of preparing TransGrid's 2018-23 Revenue Proposal, based off onsite inspections by field crew. These numbers are subject to change (increase) after future inspections are undertaken.

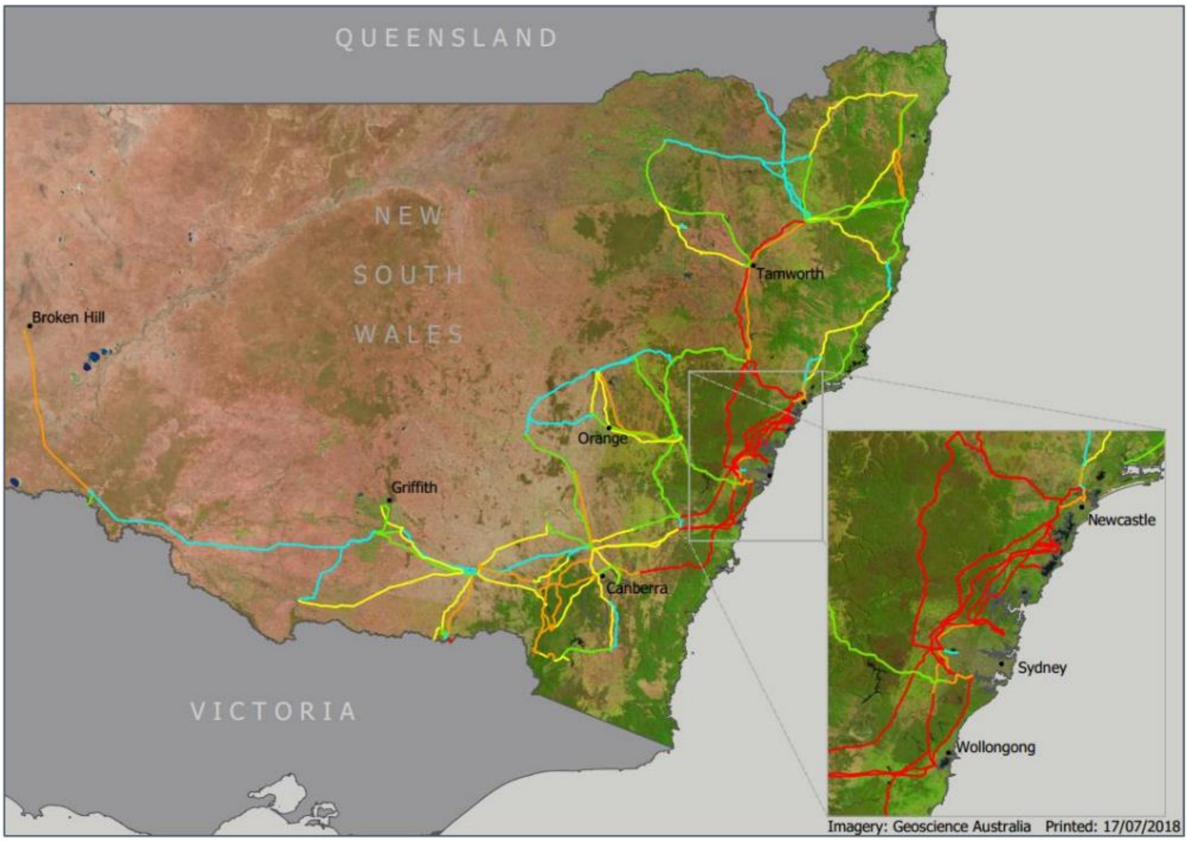
Issue	Cause	Extent (%line)	Quantity	Impact
Conductor dampers	Damaged/Weathered	10%	209 dampers	Accelerated conductor fatigue
Asbestos paint		25%	42 towers	Safety risks

C.3 Avoiding bushfire risks is the most substantial driver of this RIT-T

As the line traverses through farmland and national park areas, structural failure of towers and conductor drop caused by corrosion of steel pose exacerbated significant bushfire and safety risks.

The figure below shows that Line 8 is a transmission line at high risk of bushfire.

Figure C-2 Indication of the relative risk of all of TransGrid's lines



*Line colours on Figure C-2 represent the level of risk from highest risk to lowest risk respectively: red, orange, yellow, green, blue.

Using the risk assessment methodology on the issues around Line 8's conditions, TransGrid calculated the total risk cost to be approximately $1.25 million per year if corrosion of Line 8's affected components is not addressed. Predominantly made up of a bushfire risk,[10] this risk cost is likely to increase into the future as the asset deteriorates further and its probability of failure increases.

[10] This determination of per annum risk cost is based on TransGrid's Network Asset Risk Assessment Methodology and incorporates variables such as likelihood of failure/exposure, various types of consequence costs and corresponding likelihood of occurrence.

However, to adopt a proportionate and simplified approach for this RIT-T, TransGrid assumes that the failure rates, hence the bushfires risk costs, are constant into the future. This is a conservative approach to estimating bushfire risk costs as this effectively assumes that the probability of failure will not worsen.

To summarise, the need to undertake investment is to mitigate the environmental and safety risk caused by deteriorating condition of components of Line 8 from corrosion. This deterioration cannot be addressed by routine asset inspections and maintenance.

Appendix D – Materiality of market benefits

The section outlines the categories of market benefits prescribed in the NER and whether they are considered material for this RIT-T.[11]

D.1 Market benefits relating to the wholesale market are not material

The AER has recognised that if the credible options considered will not have an impact on the wholesale market, then a number of classes of market benefits will not be material in the RIT-T assessment, and so do not need to be estimated.[12]

Option 1 outlined above does not addresses network constraints between competing generating centres and are therefore not expected to result in any change in dispatch outcomes and wholesale market prices. Hence, TransGrid considers that the following classes of market benefits are not material for this RIT-T assessment:

> changes in fuel consumption arising through different patterns of generation dispatch
> changes in voluntary load curtailment (since there is no impact on pool price)
> changes in costs for parties other than for TransGrid (since there will be no deferral of generation investment)
> changes in ancillary services costs
> competition benefits
> Renewable Energy Target (RET) penalties.

Additionally, as part of the RIT-T process, TransGrid applied AEMO's screening criteria[13] to test whether or not Option 1 has material inter-network impact:

> a decrease in power transfer capability between the transmission networks or in another TNSP's network of no more than the minimum of 3 per cent of the maximum transfer capability and 50 MW
> an increase in power transfer capability between transmission networks of no more than the minimum of 3 per cent of the maximum transfer capability and 50 MW
> an increase in fault level by less than 10 MVA at any substation in another TNSP's network
> the investment does not involve either a series capacitor or modification in the vicinity of an existing series capacitor.

TransGrid concludes that there are no material inter-network impacts associated with Option 1.

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11 The NER requires that all categories of market benefit identified in relation to the RIT-T are included in the RIT-T assessment, unless the TNSP can demonstrate that a specific category (or categories) is unlikely to be material in relation to the RIT-T assessment for a specific option – NER clause 5.16.1(c)(6). Under NER clause 5.16.4(b)(6)(iii), the PSCR should set out the classes of market benefit that the NSP considers are not likely to be material for a particular RIT-T assessment.

12 AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, 18 September 2017, pp. 13-14. This was also reiterated in the recently updated AER RIT-T Guidelines, see: AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, December 2018, pp.39.

13 The screening test is set out in Appendix 3 of the Inter-Regional Planning Committee's Final Determination: Criteria for Assessing Material Inter-Network Impact of Transmission Augmentations, Version 1.3, October 2004.

D.2 All other categories of market benefits are also not material

In addition to the classes of market benefits listed above, NER clause 5.16.1(c)(4) requires TransGrid to consider the classes of market benefits.

Table D-1 sets out the reason TransGrid considers these classes of market benefits to be immaterial.

Table D-1 Immaterial classes of market benefits

Market benefits	Reason
Changes in in involuntary load curtailment	Since Line 8 forms part of a meshed network (N-1 and N-2 redundant) required to supply New South Wales, a failure due to the corroded assets results to extremely low chance of unserved energy.
Differences in the timing of expenditure	Option 1 is being undertaken to mitigate rising risk due to deteriorating asset condition and as the line is an existing asset, material market benefits will neither be gained nor lost due to timing of expenditure.
Option value	TransGrid notes the AER's view that option value is likely to arise where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change, and the credible options considered by the TNSP are sufficiently flexible to respond to that change.[14] TransGrid also notes the AER's view that appropriate identification of credible options and reasonable scenarios captures any option value, thereby meeting the NER requirement to consider option value as a class of market benefit under the RIT-T. TransGrid notes that changes in future demand levels are not relevant for this RIT-T, since the need for and timing of the required investment is being driven by asset condition rather than future demand growth. Thus, it is not relevant to consider different future demand scenarios in undertaking the RIT-T analysis. The estimation of any option value benefit would require a significant modelling assessment, which would be disproportionate to any additional option value benefit that may be identified for this specific RIT-T assessment. Therefore, TransGrid has not estimated any additional option value market benefit for this RIT-T assessment.
Changes in network losses	As there is no change to the capacity of the line, the impedance of the line, or the destination of the line under Option 1, there will not be material market benefits associated with changes to network losses.

[14] AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, 18 September 2017, pp. 37 & 74. This view was also reiterated in the recently updated AER RIT-T Guidelines, see: AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, December 2018, pp. 58-59.

Appendix E – Overview of the assessment approach

This appendix outlines the approach that TransGrid has applied in assessing the net economic benefits associated with refurbishing Line 8.

E.1 Overview of the assessment framework

All costs and benefits for Option 1 are measured against a base case in which TransGrid incurs regular and reactive maintenance costs, and bushfire and safety related risks costs that are caused by the corroded equipment resulting in a potential failure, eg conductor drop.

A 20-year outlook period, from 2018/19 to 2038/39, is considered in this analysis. This period takes into account the size, complexity, and expected life of the refurbishment option.

To properly incorporate capital costs of some replacement components for Option 1 that have serviceable lives greater than 20 years, TransGrid has taken a terminal value approach.

TransGrid has adopted a central real, pre-tax commercial[15] discount rate of 7.04 per cent as the central assumption for the NPV analysis presented. TransGrid considers that this is a reasonable contemporary approximation of a commercial discount rate, consistent with the RIT-T.

TransGrid has also tested the sensitivity of the results to the discount rate assumption. A lower bound real, pre-tax discount rate of 4.60 per cent, equal to the latest AER Final Decision for a TNSP's regulatory proposal at the time of preparing this PACR,[16] and an upper bound discount rate of 9.48 per cent (a symmetrical adjustment upwards) are used.

E.2 Approach to estimating project costs

TransGrid has estimated the capital costs of the Option 1 based on the scope of works necessary and costing experience from previous projects of a similar nature.

TransGrid estimates that the actual cost is within +/- 25 per cent of the central nominal capital cost estimate of $6.1 million (weighted present value of $5.62 million).

Routine operating and maintenance costs are approximately $70,000 per year in 2018/19 but are the same under the base case as these costs relate to planned routine checks of the line by TransGrid field crew. This figure has been updated since the PSCR but will not be material as this will be the same under the base case.

Reactive maintenance costs considers:

- level of reactive maintenance required to restore assets to working order following a failure
- probability and expected level of network asset faults, which translates to the level of corrective maintenance costs.

Option 1 reduces the likelihood of asset failures, and the expected repair and maintenance costs.

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15 The use of a commercial discount rate is consistent with the RIT-T and is distinct from the regulated cost of capital (or 'WACC') that applies to network businesses like TransGrid.

16 See TransGrid's PTRM for the 2018-23 period, available at: https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/transgrid-determination-2018-23