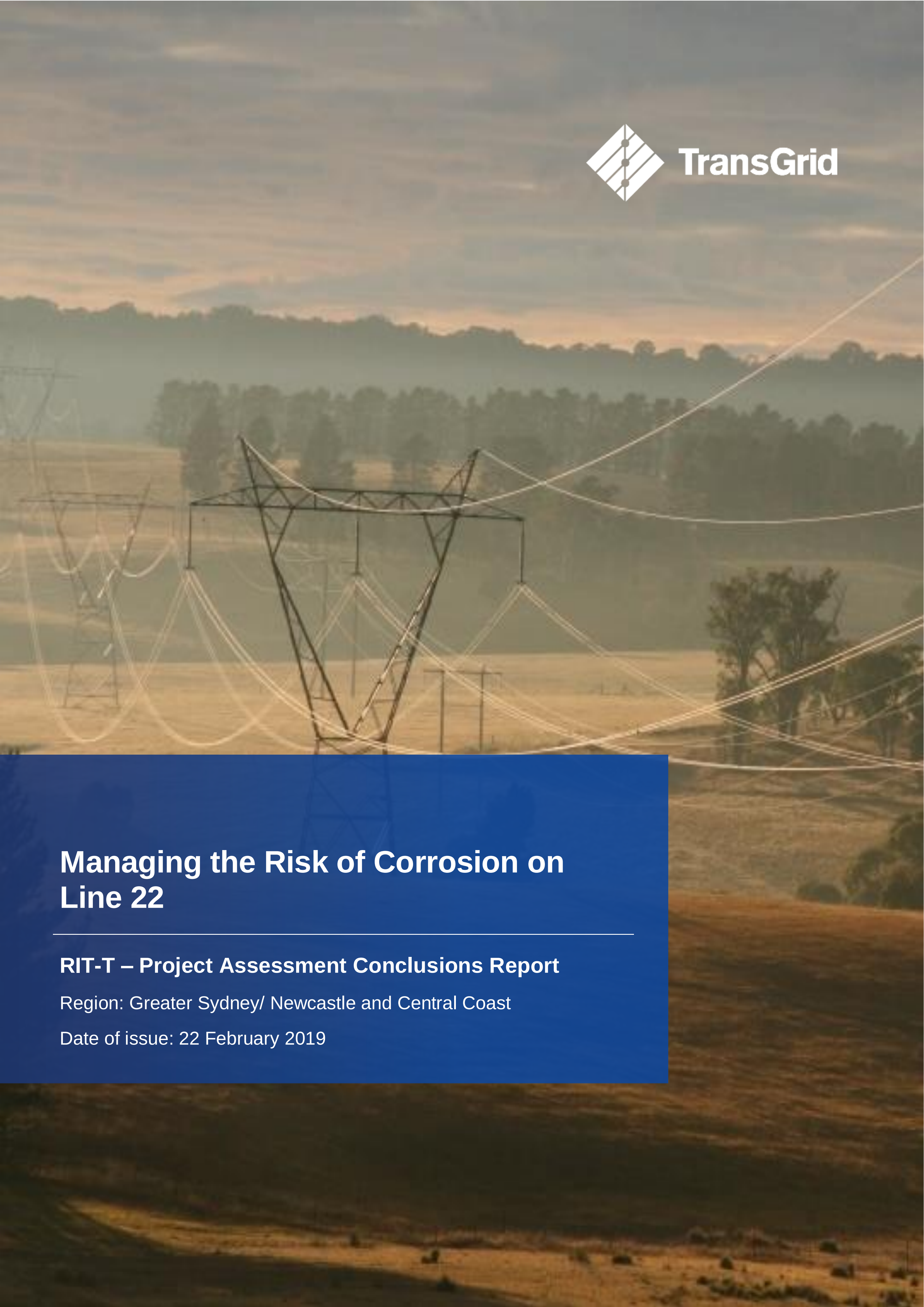

TransGrid

Managing the Risk of Corrosion on Line 22

RIT-T – Project Assessment Conclusions Report

Region: Greater Sydney/ Newcastle and Central Coast

Date of issue: 22 February 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 mitigating risks caused by corrosion related condition issues on Line 22 – a key 330 kV transmission line from the Central Coast to Sydney.

TransGrid expects that Line 22 will continue to play a central role in the safe and reliable operation of the power system throughout and after the transition to a low-carbon electricity future.

TransGrid's routine asset monitoring maintenance found that many of the 190 transmission structures of Line 22 are impacted by various levels of corrosion. This greatly increases the likelihood of conductor drop, and subsequent bushfire and safety risks. The bushfire risks are exacerbated for Line 22 as it traverses substantial sections of bushland, much of which surrounds residential and urban areas.

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 22.

No submissions received in response to Project Specification Consultation Report

TransGrid published a Project Specification Consultation report (PSCR) on 30 August 2018 and invited written submissions on the material 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 22; staging the delivery of the refurbishment work over multiple years; replacing the entire line; and decommissioning and dismantling the line. The program of work to refurbish Line 22 is comprised of treatment of corroded tower steelwork and replacement of components that have reached the end of their serviceable life due to corrosion. Of the options considered, this is the only option that was found to be commercially and technically feasible.

The refurbishment of Line 22 is the preferred option presented in this PACR. The other options put forward for consideration in the PSCR were either estimated to cost significantly more than the preferred option without any additional benefit or were technically or commercially infeasible. 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 2021/22.

In the PSCR, TransGrid noted that non-network solutions cannot assist with meeting the identified need as it cannot reduce the risk of bushfires occurring from failure of elements of Line 22. The relatively low overall cost of remediating the line by replacing or refurbishing identified components also makes the preferred option the most economical.

Conclusion: refurbishing Line 22 is optimal

The optimal commercially and technically feasible option presented in the PSCR, the refurbishment of Line 22 by remediating corroded tower steelwork and replacing of components that have reached end of serviceable life, remains the preferred option to meet the identified need.

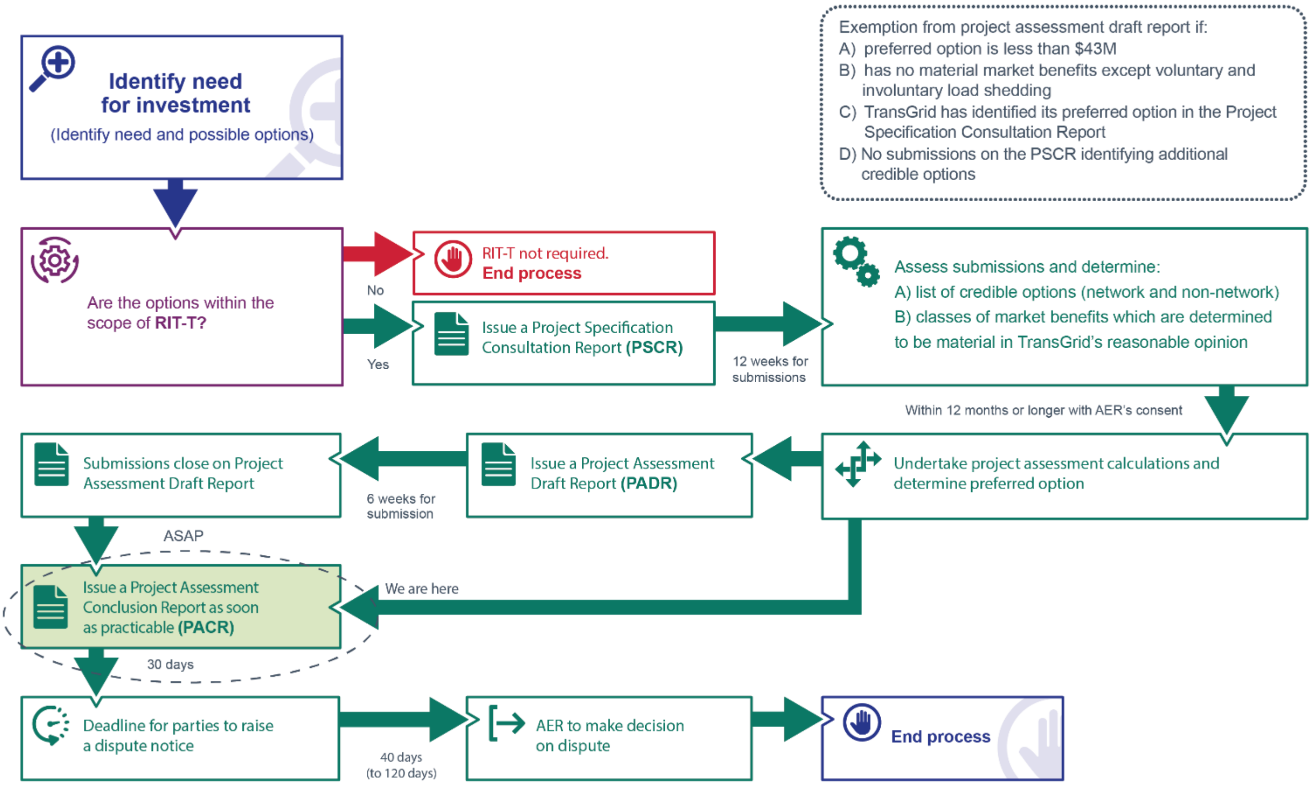
Moving forward with this option is the most prudent and economically efficient solution to manage and mitigate bushfire and safety risk to the As Low As Reasonably Practical (ALARP) level. The estimated nominal capital cost of this option is approximately $9.08 million (weighted present value of $7.58 million) – almost half of the amount of the benefits from reduced bushfire risks which is estimated to be $18.4 million dollars.

TransGrid also conducted sensitivity analysis on the overall net present value (NPV) of the net benefit to investigate the robustness of the conclusion to key assumptions. TransGrid finds that under all sensitivities, positive net benefits are expected from refurbishing Line 22.

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 August 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 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 25 March 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 expected to be completed by 2021/22.

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

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1. Introduction

This Project Assessment Conclusions Report (PACR) represents the final step in the application of the Regulatory Investment Test for Transmission (RIT-T) to options mitigating risks that are caused by corroding components of Line 22 – a key 330 kV transmission line from the Central Coast to Sydney.

TransGrid expects that Line 22 will continue to play a central role 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 was established in 2016 after routine asset health assessments identified a number of corrosion-related issues on Line 22. An allowance has, therefore, been made for this work in TransGrid's 2018-23 Revenue Proposal.[1]

The corresponding Project Specification Consultation Report (PSCR) released in August 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 noted that how non-network solutions are unlikely to contribute to meeting the identified need, TransGrid still outlined the technical characteristics that non-network solutions 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 expected to be completed by 2021/22.

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

[1] 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

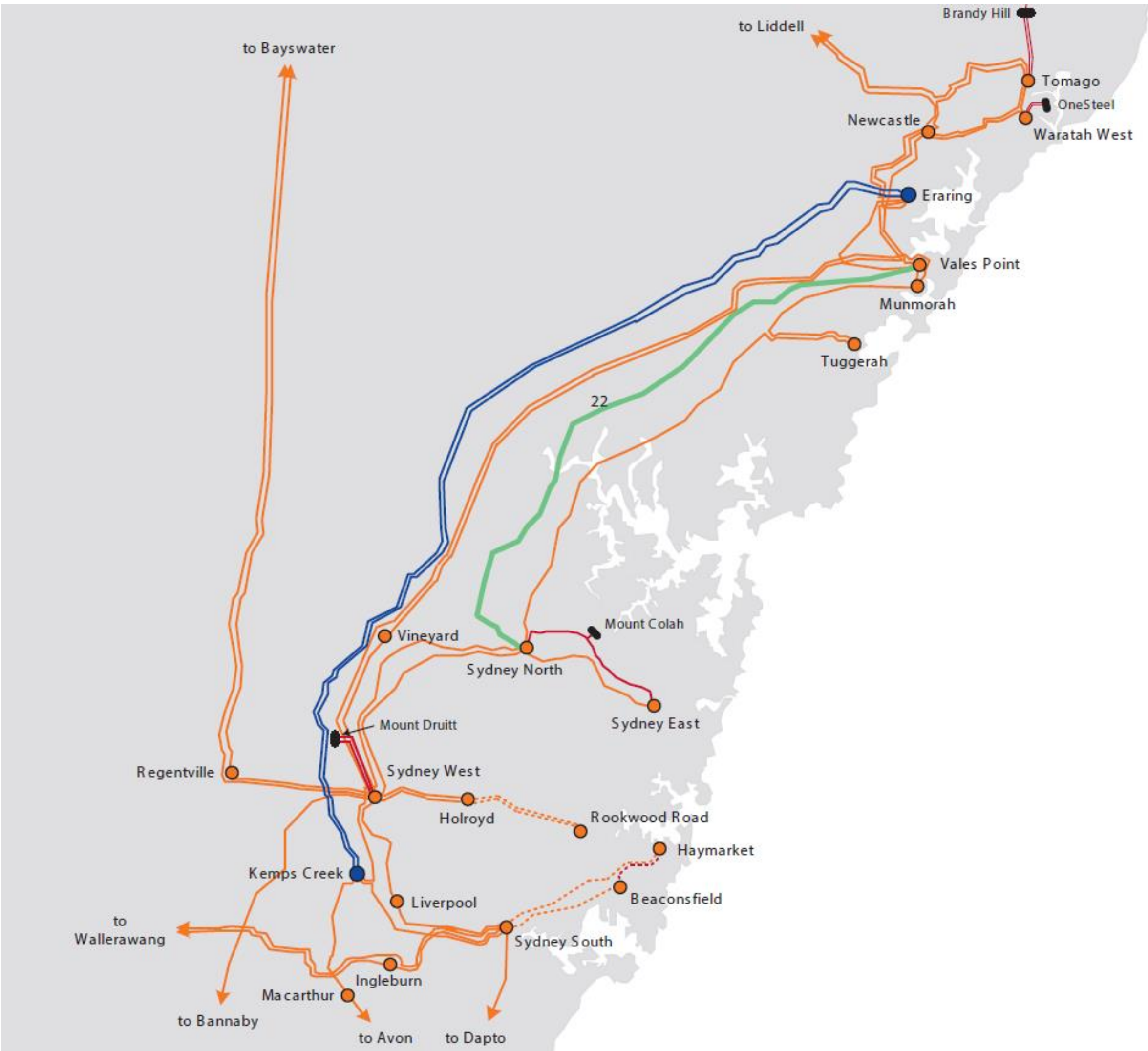
2.1 Background

Line 22 is a steel tower-supported 330 kV single circuit transmission line built in 1962 to connect Vales Point and Sydney North 330 kV substations. This 86 km long transmission line traverses small rural holdings, heavily timbered ridgetops, and national parks. It also crosses the M1 Motorway, Pacific Highway, Main Northern Railway line, and numerous local roads.

The transmission line is part of the meshed network that connects existing generators north of Sydney and the major load centres in Sydney East and Sydney North. It also provides transmission supply redundancies to Sydney and assists in meeting the relevant reliability standard.

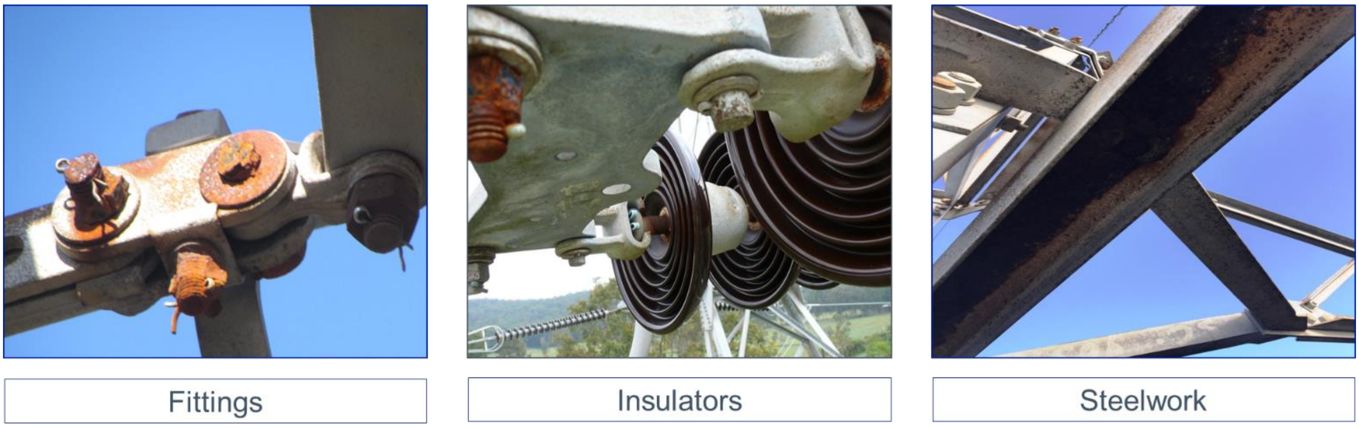
Highlighted in green, Line 22 is presented in the overview of the greater Sydney, Newcastle and Central Coast transmission network, Figure 2.

Figure 2 Greater Sydney, Newcastle and Central Coast transmission network



TransGrid's ongoing routine asset monitoring maintenance revealed that many of the 190 transmission structures including steel towers, insulators, conductor fittings, and conductor/earth wire are already corroded, see Figure 3. The sacrificial galvanising coating that protects the steel from corrosion has also been consumed over time and has exposed the core steel component to harsh elements.

Figure 3 Examples of corroded elements of Line 22



These condition issues increase the likelihood of potential conductor drop, and resultant bushfire and safety risks. For Line 22, the bushfire risks are exacerbated as the line traverses substantial sections of bushland, much of which surrounds residential and urban areas.

This causes several significant concerns such as:

- ground line corrosion of steel transmission tower legs at the footings – these load-bearing members of the tower cannot be easily refurbished once it passes a stage where rectification work becomes impossible
- buried steel corrosion on segments of Line 22 on low lying and coastal areas
- earth strap corrosion due to soil erosion which further raises public safety risks
- buried concrete foundations
- corrosion of tower members, fasteners, insulator pin, fittings, and dampers.

Details can be found in Appendix C.

2.2 Description of the identified need

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).[2] In particular, risks are mitigated unless it is possible to 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).

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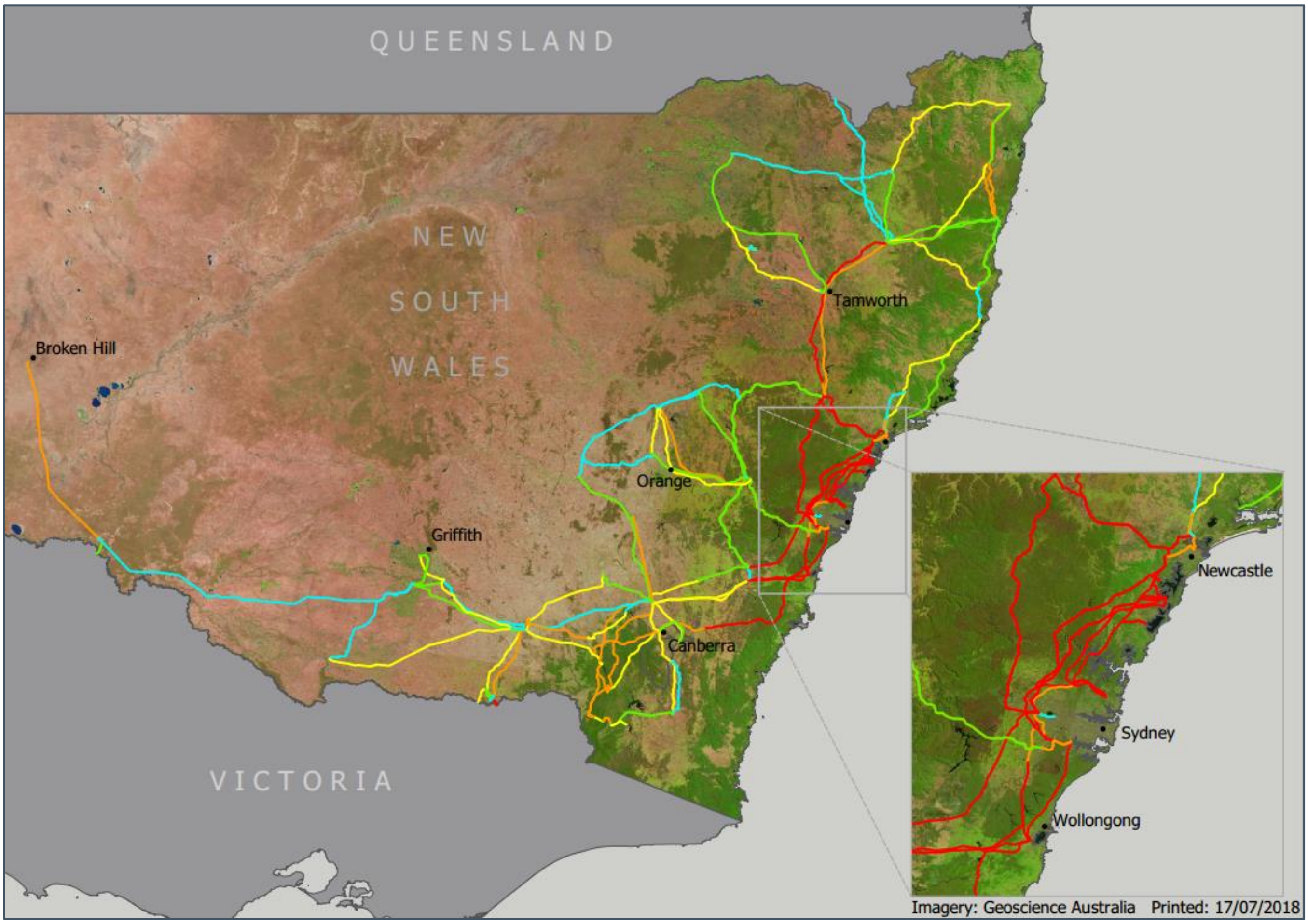
[2] TransGrid ENSMS follows the ISO31000 risk management framework which requires following hierarchy of hazard mitigation approach.

Figure 4 shows a significant proportion of Line 22 traverses through bushland. Because of this, structural failure of towers or conductor drop due to corrosion of steel is likely to increase bushfire and safety risks.

Figure 4 Indication of the relative risk of all of TransGrid's lines*



*Line colours on Figure 3 represent the level of risk from highest risk to lowest risk respectively: red, orange, yellow, green, blue.

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.

TransGrid did not receive any responses to the PSCR.

3.1 Option 1 – Refurbish the existing line

Option 1 involves the refurbishment of Line 22 by treatment of corroded tower steelwork and replacement of identified components that have reached end of serviceable life due to corrosion.

This network 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.[3]

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]

The works are expected 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 expected to be completed by 2021/22.

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 $9.08 million. Routine operating and maintenance costs relating to planned routine checks by TransGrid field crew are approximately $100,000 per year in 2018/19. This figure has been updated since the PSCR but will not be relevant 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 only, the refurbishment of Line 22 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.

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

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

Table 1 below summarises the refurbishment works to address the key issues on Line 22 under Option 1.

Table 1 – Refurbishment works for Line 22 under Option 1

Issue	Refurbishment works
Ground line corrosion of steel at footing	Abrasive blast cleaning of steelwork to remove any corrosion Application of coating and concrete encasement to mitigate against future corrosion
Buried concrete foundations	Dig out tower legs, abrasive blast cleaning of steelwork to remove any corrosion, application of coating and establishment of drainage channel
Corrosion of earth straps	Replacement of earth straps in line with current standard
Corrosion of tower members	Abrasive blast cleaning of steelwork to remove any corrosion, application of coating
Corrosion of tower fasteners	Replacement of fasteners
Insulator pin corrosion – suspension insulators	Replacement with composite long rod insulators
Insulator pin corrosion – tension insulators	Replacement with composite long rod insulators Replacement of tension hot and cold end fittings
Corrosion of conductor fittings	Replacement of conductor fittings
Corrosion of earth wire fittings	Replacement of earth wire fittings
Corrosion of earth wire	Like for like replacement of galvanised steel (SC/GZ) earth wire
Damaged conductor vibration dampers	Replacement of vibration dampers
Damaged of earth wire vibration dampers	Replacement of vibration dampers

3.2 Options considered but not progressed

The primary driver for the identified need is to mitigate bushfire and safety risks associated with corrosion related condition issues on the line. 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 2 below provides a summary of these options and the reasons for not progressing.

Table 2 Options considered but not progressed

Option	Description	Reason(s) for not progressing
Option 2	Staged 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 replacement 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 expected benefits (in terms of avoided risk costs) makes this option less commercially feasible relative to Option 1.
Option 3	Replacing Line 22 entirely	The capital cost of replacing the entire line is estimated to be significantly higher than Option 1, about $90 million, and is not expected to provide any additional benefits. In addition, not all components that make up Line 22 require replacement in coming years.
Option 4	Decommissioning and dismantling the line, and procure a non-network solution(s)	To manage risks to the safety of TransGrid field crew, public safety, properties, and environment, Line 22, if decommissioned, must be dismantled. This requires: • physical disconnection of the line from the 330 kV switchbays at Vales Point and Sydney North substations • dismantling of line structures, fittings, and conductors • rehabilitation of the easement. The direct decommissioning cost is estimated to be between $19 million to $25 million (depending on access and clearing costs), which is significantly higher than Option 1 and is not expected to provide any additional benefits. In addition, TransGrid would need to procure significant quantities of non-network solutions 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 solutions cannot assist with meeting the identified need as it cannot reduce the risk of bushfires occurring from failure of elements of Line 22.

The relatively low overall cost of remediating the line by replacing or refurbishing identified corrosion affected components also makes the preferred option more economical.

4. Assessment of the credible option

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 22 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 3 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 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 benefits.

Table 3 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)[5] 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.

[5] The Value of Customer Reliability (VCR), in dollars per MWh, is used to evaluate the wider economic impact of involuntary load shedding on customers under the RIT-T. AEMO, *Value of Customer Reliability Review*, September 2014, Final Report.

4.2 Estimated gross benefits

Table 4 summarises the estimated gross benefit of Option 1 relative to the base case under the three reasonable scenarios.

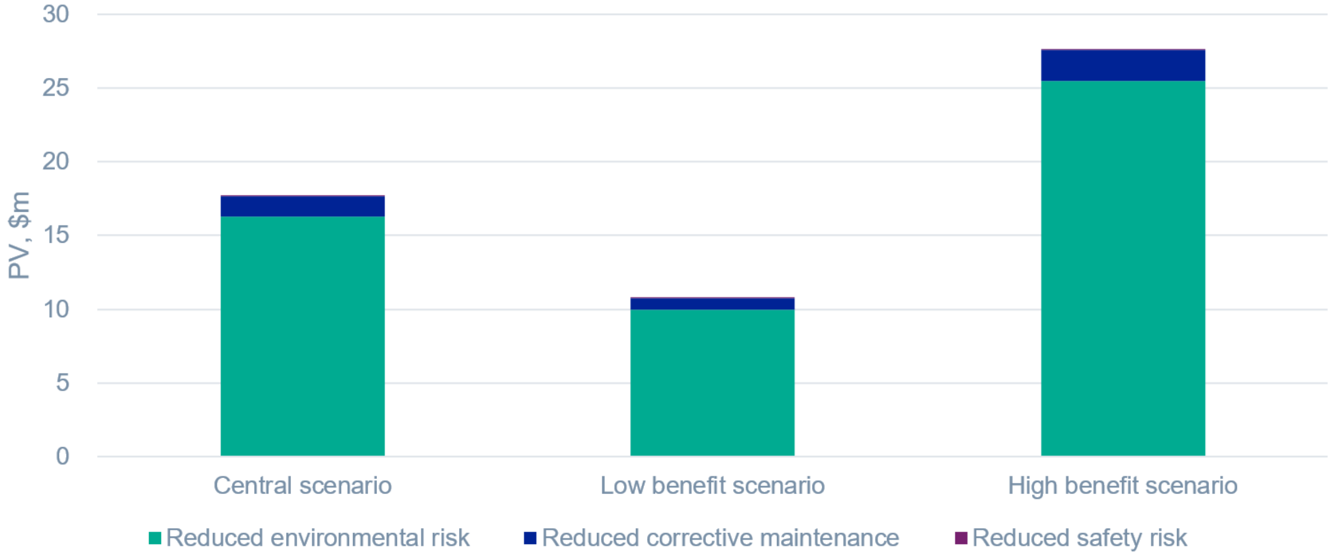
While TransGrid considers there are no material market benefits for this RIT-T assessment, there are significant benefits from avoided costs associated with bushfire and safety risks, and reactive corrective maintenance. These *expected* costs are weighted based on the probability of the event occurring.

Table 4 Present value of gross benefits of Option 1 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	17.64	10.76	27.56	18.40

Figure 5 breaks these benefits further and shows that most of the benefits are derived from avoided risk of bushfires.

Figure 5 Breakdown of gross benefits Option 1 relative to the base case, PV $m 2017/18



4.3 Estimated costs

Table 5 below summarises the present value of costs of Option 1 relative to the base case under each of the three reasonable scenarios.

Table 5 Present value of costs of Option 1 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	7.61	9.27	5.82	7.58

4.4 Estimated net benefits

Table 6 summaries the present value of net benefit for Option 1 under the three scenarios. The estimated net benefit is the estimated gross benefits (section 4.2) less the estimated costs (section 4.3).

Option 1 is found to have positive net benefits for all scenarios investigated. On a weighted basis, Option 1 is expected to deliver approximately $11 million in net benefits.

Table 6 Present value of net 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	10.03	1.49	21.74	10.82

While the estimated net benefits are marginally positive 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 expected net benefits.

In addition, under the base case, the failure rates and bushfire risk costs are assumed constant going forward. This produces a lower estimates of risk costs. In reality, failure rates and expected costs would 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.

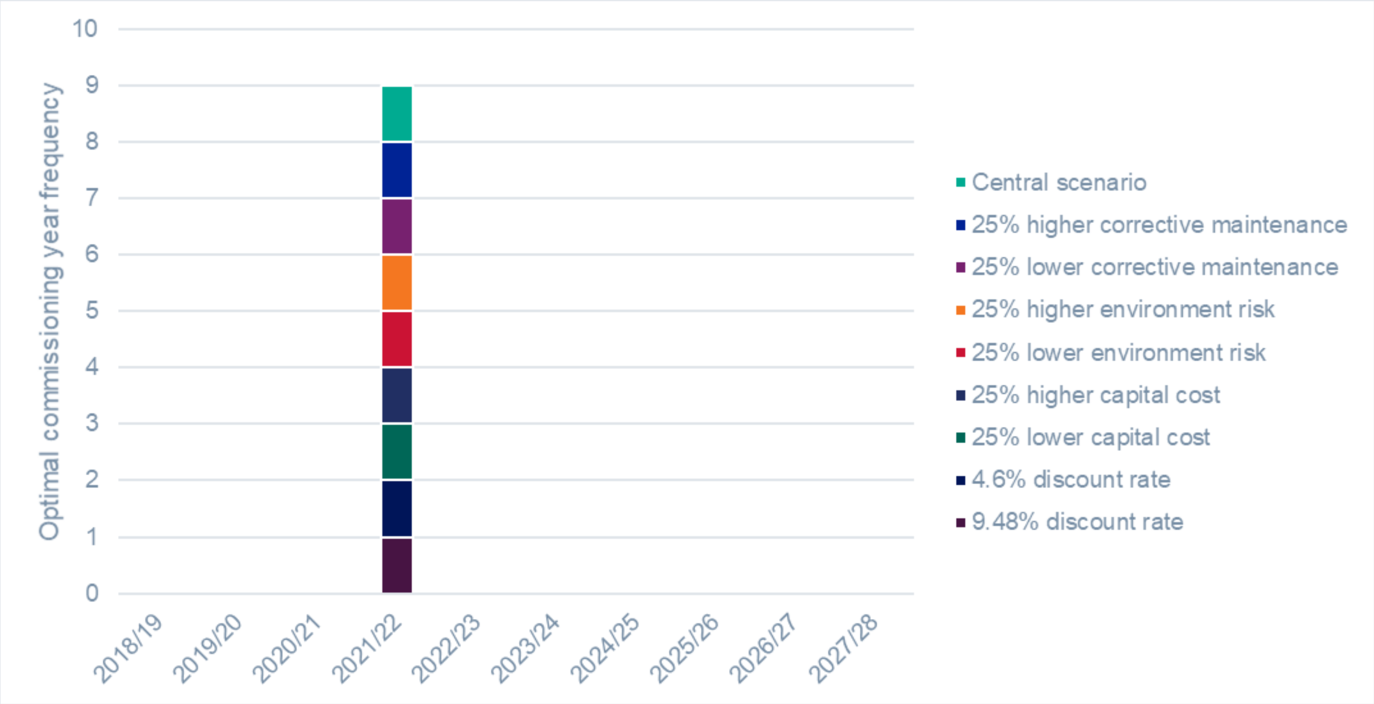
4.5.1 Step 1 – Sensitivity testing of the assumed optimal timing for the credible option

The optimal timing for Option 1 is the year in which the NPV of net benefit is maximised. Shown on Figure 6, the optimal timing is 2021/22 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, 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.

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

Figure 6 Distribution of optimal project commissioning year for Option 1



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.

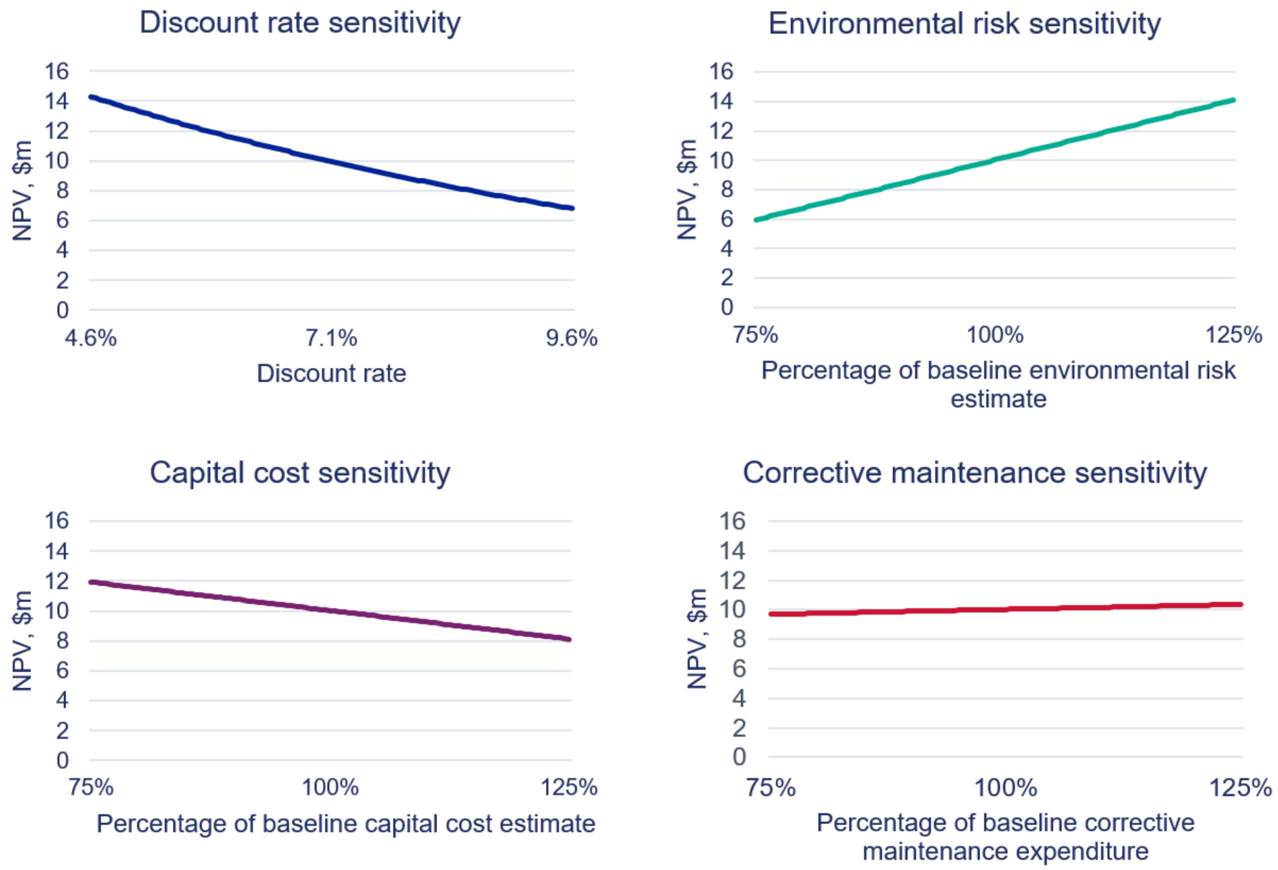
Specifically, TransGrid has investigated the same sensitivities under this step:

- 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 benefits of Option 1 are found to be positive.

While it also shows that the results are most sensitive to the avoided bushfire (environmental) risk, it would take approximately 61 per cent reduction in the avoided bushfire risk estimates under the central scenario for the NPV of net benefits to be zero. TransGrid considers it extremely unlikely that the central estimate of bushfire risk would fall outside this sensitivity.

Figure 7 Sensitivities of Option 1



5. Final conclusion on the preferred option

The optimal commercially and technically feasible option presented in the PSCR, the refurbishment of Line 22 remains the preferred option to meet the identified need. This preferred option, Option 1, is found to have strong positive net benefits under all scenarios investigated and on a weighted basis is expected to deliver approximately $11 million in net benefits.

Option 1 is the refurbishment of Line 22 by treatment of corroded tower steelwork and refurbishment or replacing of components that have reached end of serviceable life due to corrosion. 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 $9.08 million (weighted present value of $7.58 million), almost half the cost of other methods to reduce bushfire risks which is estimated to be $18.4 million dollars.

Routine operating and maintenance costs relating to planned checks by TransGrid field crew are approximately $100,000 per year in 2018/19.

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 all sensitivities, positive net benefits are expected from remediating Line 22.

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 expected to be completed by 2021/22.

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

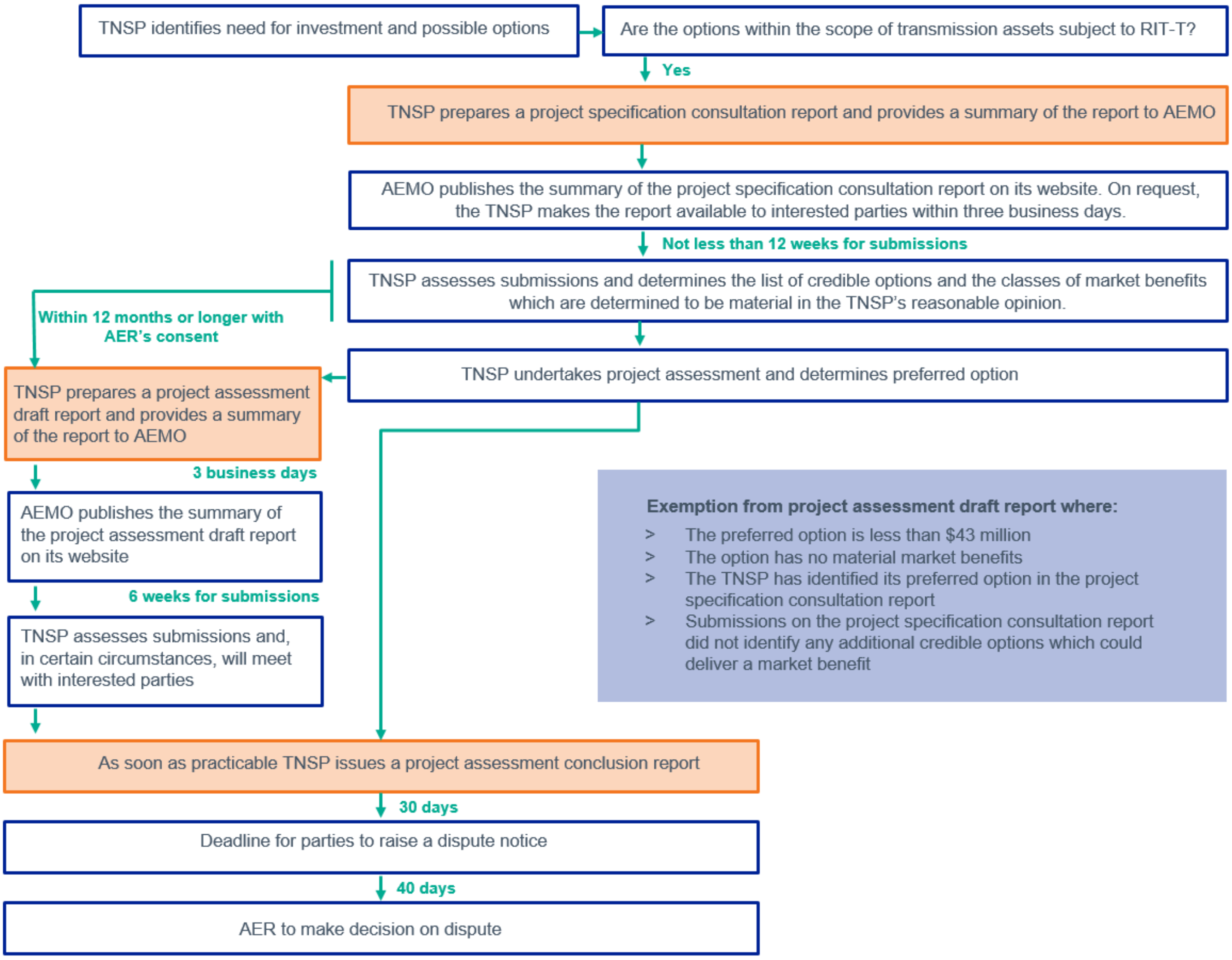
Appendix A – Compliance checklist

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 8 The RIT-T assessment and consultation process



Source: AER, Final Regulatory investment test for transmission application guidelines, 18 September 2017, p. 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.[6] 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:

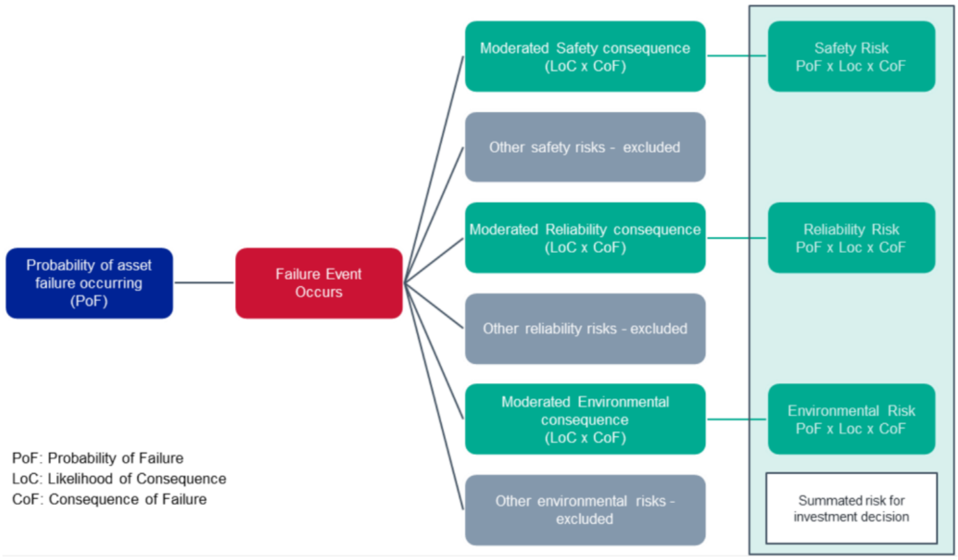
- uses externally verifiable parameters to calculate asset health and failure consequences
- assesses and analyses asset condition to determine remaining life and probability of failure
- applies a worst-case asset failure consequence and significantly moderates this down to reflect the likely consequence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

C.1 Overview of 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 9 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 9 Overview of TransGrid's 'risk cost' framework



[6] For additional information on the risk assessment methodology, please 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 ‘risk costs’ are calculated based on the Probability of Failure (PoF), the Consequence of Failure (CoF), and 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. But it excludes the risk costs of low impact, high probability (LIHP) which would results in lower calculated risk.

C.2 Line 22 conditions issues and their consequences

TransGrid’s asset health assessments have identified a number of corrosion related issues on Line 22. Details are presented on Table 7.[7]

Table 7 Line 22’s identified asset issues

Issue	Cause	Extent (% line)	Quantity	Immediate Impact
Corroded earth wire	Zinc galvanising end of serviceable life	40%	70km (35 km route length)	Conductor drop
Corroded suspension insulators	Corrosion of steel caps and pins. Zinc sleeve protection end of serviceable life	30%	117 insulator strings	
Corroded conductor attachment fittings	Zinc galvanising end of serviceable life	20%	163 fittings	
Corrosion of earth wire attachment fittings	Zinc galvanising end of serviceable life	15%	76 fittings	
Corroded tension insulators	Corrosion of steel caps and pins. Zinc sleeve protection end of serviceable life	11%	42 insulator strings	
Ground line corrosion of steel at footing	Buried steelwork at footing	35%	67 towers	Structural failure of tower
Corrosion of tower steel members	Zinc galvanising end of serviceable life	35%	66 towers	

[7] 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	Immediate Impact
Corroded fasteners	Zinc galvanising at end of serviceable life	1%	86 towers	
Earth wire dampers	Damaged/weathered	20%	151 dampers	Accelerated asset fatigue due to vibration
Conductor dampers	Damaged/weathered	10%	454 dampers	
Buried concrete foundations	Erosion of soil building up around footings	45%	86 towers	Accelerated corrosion of critical member
Earth strap	Corrosion as buried at footing	5%	10 towers	Earthing safety hazard

C.3 Bushfire risks are the most substantial driver of this RIT-T

Failure of the transmission structures due to corrosion may also result in forced outages of the line and safety risks to TransGrid field crew.

Using the risk assessment methodology on the issues around Line 22's conditions, TransGrid calculated the total risk cost to be approximately $2.2 million per year if corrosion of Line 22's components is not addressed. Predominantly made up of a bushfire risk,[8] this risk cost is estimated to increase into the future as the asset deteriorates further and its probability of failure increases.

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 gives a lower bound on bushfire risk costs as, effectively, the probability of failure are not assumed to worsen.

To summarise, the need to undertake investment is to mitigate the environmental and safety risk caused by deteriorating condition of components of Line 22 from corrosion. This deterioration cannot be addressed by routine asset inspections and maintenance.

[8] 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.

Appendix D – Materiality of market benefits

The appendix outlines the classes of market benefits prescribed in the NER and whether they are considered material for this RIT-T.[9]

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.[10]

Option 1 outlined above does not address 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[11] 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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[9] The NER requires that all classes 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 class (or classes) is unlikely to be material in relation to the RIT-T assessment for a specific option – NER clause 5.16.1(c)(6).

[10] 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.

[11] 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 classes 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, listed in Table 8, arising from each credible option.

Table 8 sets out the reason TransGrid considers these classes of market benefits to be immaterial.

Table 8 Immaterial classes of market benefits

Market benefit	Reason
Changes in in involuntary load curtailment	Since Line 22 forms part of a meshed network (N-1 and N-2 redundant) required to supply Sydney, 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 Transmission Network Service Provider (TNSP) are sufficiently flexible to respond to that change.[12] 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.

[12] 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 benefits associated with refurbishing Line 22.

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'[13] 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,[14] 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 $9.08 million.

Routine operating and maintenance costs are expected to be approximately $100,000 per year in 2018/19 but are expected to be the same under the base case as these costs relate to planned routine checks of the line by TransGrid field crew.

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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13 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.

14 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