Investment Evaluation Summary (IES)

Project Details:

Project Name:	Pole Replacements
Project ID:	00661
Business Segment:	Distribution
Thread:	Structures
CAPEX/OPEX:	CAPEX
Service Classification:	Standard Control
Scope Type:	B
Work Category Code:	REPOL
Work Category Description:	Pole Replacements
Preferred Option Description:	Replace poles based on condition.
Preferred Option Estimate (Dollars $2016/2017):	$70,720,260

	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29
Unit ($)	$9,230	$9,230	$9,230	$9,230	$9,230	$9,230	$9,230	$9,230	$9,230	$9,230
Volume	1362.00	1490.00	1532.00	1575.00	1703.00	1788.00	1916.00	2030.00	2075.00	2120.00
Estimate ($)	$12,571,260	$13,752,700	$14,140,360	$14,537,250	$15,718,690	$16,503,240	$17,684,680	$18,736,900	$19,152,250	$19,567,600
Total ($)	$12,571,260	$13,752,700	$14,140,360	$14,537,250	$15,718,690	$16,503,240	$17,684,680	$18,736,900	$19,152,250	$19,567,600

Governance:

Works Initiator:	David Eccles	Date:	05/11/2018
Team Leader Endorsed:	Darryl Munro	Date:	14/11/2018
Leader Endorsed:	Nicole Eastoe	Date:	20/11/2018
General Manager Approved:	Wayne Tucker	Date:	22/11/2018

Related Documents:

Description	URL
REPOL NPV	http://reclink/R1195030
Doc Number R260425 Overhead Line Structures - Distribution	http://assetzone.tnad.tasnetworks.com.au/strategic-asset-management/Management%20Plans/Forms/AllItems.aspx
Doc Ref R452795 Alternative Structures for Equipment & other High Risk Structures	http://assetzone.tnad.tasnetworks.com.au/strategic-asset-management/Strategic%20Plans/Forms/AllItems.aspx
UTAS Identification of soft rot fungi in eucalyptus hardwood pole samples	http://assetzone.tnad.tasnetworks.com.au/strategic-asset-management/Strategic%20Plans /UTAS%20Identification%20of%20soft%20rot%20decay%20fungi%20in%20eucalypt%20power%20pole%20samples.pdf
TasNetworks Transformation Roadmap 2025	https://www.tasnetworks.com.au/customer-engagement/submissions/
TasNetworks Corporate Plan - Planning period: 2017-18	http://reclink/R745475
Structures – Annual Equivalent Calculation	http://reclink/R295175
TasNetworks Business Plan 2017-18	http://reclink/R779008
TasNetworks Risk Management Framework	http://Reclink/R238142
National Electricity Rules (NER)	http://www.aemc.gov.au/Energy-Rules/National-electricity-rules/Current-Rules

Section 1 (Gated Investment Step 1)

1. Overview

1.1 Background

Structures provide support, insulation and adequate clearances between the overhead conductors, overhead switchgear, pole mounted transformers and the ground, vegetation and building infrastructure.

There are four main types of structure that are used in the distribution system:

- wood poles (natural and treated);
- steel and concrete poles (commonly known as Stobie poles);
- spun concrete poles; and
- steel structures, including:
  - steel lattice poles;
  - steel lattice towers;
  - railway section (RSJ) steel poles;
  - round steel service poles; and
  - square section steel service poles.

Some support structures are joint use with other services such as communications cables or public lighting. This investment evaluation summary relates only to TasNetworks owned wood poles (natural and Copper Chrome Arsenate (CCA) treated) installed in the TasNetworks distribution network, which represents 90 per cent of the overall fleet.

Table 1 below shows volumes of pole types installed on the distribution system.

Description	Number Installed (including Private Poles)	Number Installed (TasNetworks Owned)
Natural Wood Poles	4,080	2,972
CCA Treated Wood Poles	236,584	203,005
Steel and Concrete (Stobie) Poles	6,592	6,403
Concrete Poles	174	160
Steel Lattice Poles	1,350	1,300
Steel Lattice Towers	337	337
Railway Section Steel Poles	467	200
Steel Other	47,043	15,189
Other/Unknown	72	15
Total	296,895	229,716

Table 1: Support structure types installed in TasNetworks' distribution system (as at March 2017)

Accessories associated with support structures are:

- stays;
- stakes;
- pole operating platforms;
- fauna guards (such as possum guards, cattle/horse guards and bird perches);
- anti-climbing barriers;
- easements and way-leaves; and
- access tracks.

Significant effort has been placed into understanding the condition and performance of the wood pole population. It is important to ensure that wood pole performance is managed in a way that is consistent with our risk appetite as it relates to worker and public safety, and network reliability and service quality and in accordance with our asset management policy.

As can be seen in table 1, TasNetworks owns and maintains approximately 240,000 distribution support structures of which approximately 90 per cent are CCA treated wood poles and untreated (natural) poles. Wood poles are used extensively within the distribution network because they represent the least cost whole-of-life option for the majority of circumstances for support structures. Wood poles have an expected service life of between 40 and 50 years with the average age of the wood pole population being 28 years, and an average age of 38 years before staking is required. Approximately eight per cent of the wood pole population has reached or is approaching 50 years of in-service performance.

On installation, new wood poles are assigned a safety factor of 4.5. As the pole degrades over time its condition is assessed and determines if it:

- remains in service (safety factor greater than 3.5);
- is classified as impaired (safety factor between 2.6 and 3.5); or
- is classified as condemned (safety factor of 2.5 or less).

All treated wood poles are inspected on a 5 year cycle while the safety factor remains above 3. If the safety factor falls between 2.6 and 3, the inspection cycle is reduced to 3.5 years and the pole is considered for staking. Upon staking, a pole's safety factor reverts to that of a new pole and its life is typically extended by 10-15 years.

Staking of wood poles is a commonly used method deployed to reinforce the structural strength of wood poles at ground level and subsequently prolong the serviceable life of the pole.

Wood pole performance

Historically TasNetworks has experienced on average 10.5 unassisted pole failures per annum as shown in Figure 1.

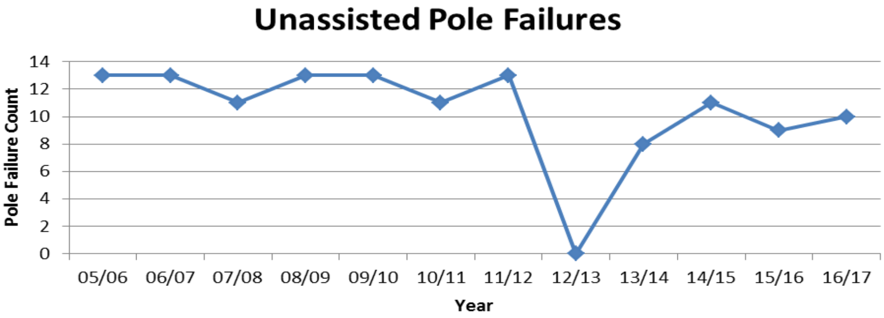


Figure 1: TasNetworks owned unassisted pole failures trend

TasNetworks pole failure rates are consistent with the national average based on other distribution network service provider's wood pole failure rates. Details obtained from the Energy Networks Australia (ENA) working group and shows TasNetworks compares favourably within its peer group.

Managing the aging staked pole population

Wood pole staking commenced in 2002 and the current staked wood pole population is approximately 30,000 poles. Wood poles are generally staked at 30-45 years of age with the staked pole typically lasting 10-15 years. Staking has proven to be a cost-effective way of ensuring the service life of 40-50 years is attained. Figure 2 shows the proportion of staked poles compared to the wood pole population. It shows that a large number of staked poles have now reached or are approaching end of life. On this basis it is anticipated that the number of staked poles needing to be replaced will increase in forthcoming years. *Figure 2* below shows the age profile of all installed poles on the distribution network including staked structures.

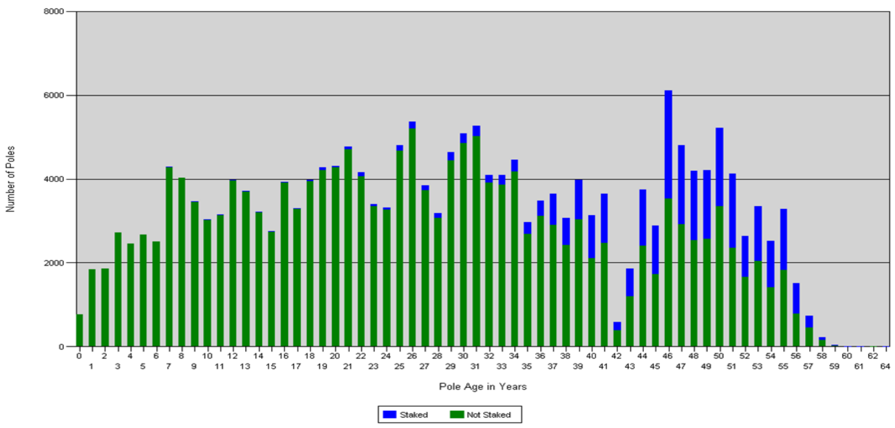


Figure 2: Age profile of distribution wood poles (natural and CCA treated) including staked poles

Natural Wood Poles

Natural wood poles come from an untreated eucalypt sourced from Tasmania under contract from the St Mary's district until 1994. These were originally sourced from old growth forest but in later years moved to regrowth forest. These natural wood poles were of the 'ironwood' (Eucalyptus siberius) species.

It was soon discovered that regrowth wood had pole integrity issues due to an increased susceptibility to heart rot. This has resulted in historical failures of natural wood poles with a life as little as seven years.

Natural wood poles have no preservative and therefore the sap wood is prone to deteriorate very quickly especially below ground level and does not provide the structural strength of a wood pole. Hence, the sap wood is not included in the calculation of pole strength on these poles, which results in more accurate assessment of the remaining strength of the poles.

CCA Wood Poles

The treated wood poles used in the distribution system are harvested and treated locally. These poles are typically Natural Durability Class 3 and 4 timbers (as per AS5604 Timber – Natural Durability Ratings), as there are no Natural Durability Class 1 and 2 poles grown within Tasmania.

Natural Durability Class 3 and 4 timbers are less dense and more prone to decay with a shorter life expectancy than the Natural Durability Class 1 and 2 timbers typically used in mainland Australia.

The treatment used on the poles is pressure impregnated Copper-Chrome Arsenate (CCA). The average treatment applied has increased over time, as indicated in Table 2.

Table 2: Level of CCA treatment

	Average Treatment (kg/m3)	Minimum Treatment (kg/m3)
Pre-1970	10	6.5
1971-1980	12	8

	Average Treatment (kg/m3)	Minimum Treatment (kg/m3)
1981-1994	15	10
Post-1994	24	18

Wood poles are purchased with a metal pole cap attached over the top of the pole to reduce the ingress of water from the top of the pole through the pole centre in order to reduce pole decay.

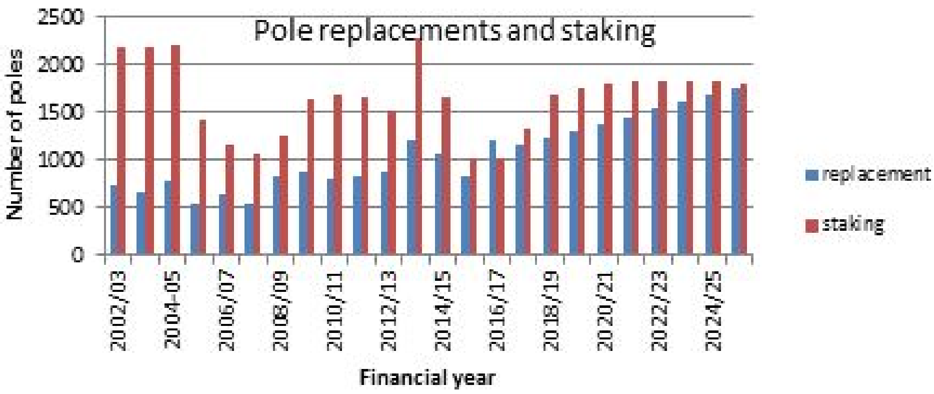
CCA wood poles are considered to be cost effective and also afford a significant insulation medium for bare overhead lines.

Analysis has been performed comparing the annual equivalent cost for Class 1 and 2 wooden poles, Class 3 and 4 wooden poles, concrete poles and steel poles. The analysis demonstrates that class 3 and 4 CCA wood poles are the most cost effective option for TasNetworks. Refer to R295175 Structures – Annual Equivalent Calculations.

Analysis of the condition and performance of the wood pole population has identified that additional investment will be required to sustain the performance of the wood pole population and to ensure the number of poles at or exceeding their service life remains manageable. In particular, the need to replace aged staked wood poles will result in an increased volume of pole replacements over forthcoming years.

As shown in Figure 3 below, there is an increasing annual rate of pole replacements based on the inspection results. This rise follows the ageing trend of the pole population, however, this annual increase does not fully cover the ageing profile rate. Parallel to this, the condemning and subsequent replacement of already staked wood poles is also anticipated to rise over the coming years as an increase in staking works carried out around 15 years ago reaches the end of their lifespan and thus, the annual replacement volumes will need to be further increased in the coming years as shown in Figure 3.

Figure 3: Historic and forecast replacement and staking volumes



The requirement to increase replacement volumes is also being supported through trials of alternative wood testing and rot management methods to improve TasNetworks ability to assess the remaining life of poles, allowing them to remain in service longer with more confidence or to increase staking rates to extend the service life of poles.

TasNetworks recently partnered with the University of Tasmania to undertake a recent project (Barry et al. 2017), to ascertain the type pf fungi present in the wood poles being used within Tasmania. The project showed that a range of potential soft-rot fungi were present in rot samples. This was studied by isolation of potential agents of rot, DNA sequencing of isolates and next-generation sequencing of fungal DNA directly from pole samples. The fungal species in rot samples were not always present, therefore, it is likely that there is no one single causal agent. The findings highlighted that future studies need to be completed to fully understand the timber rot and to ensure that the integrity of the pole fleet is known and effectively managed throughout the life-cycle, removing the risk of premature failure.

TasNetworks and other Australian distribution networks service providers are sponsoring a project for the University of Tasmania to undertake a National research and development project on detection methods for fungi (carroty rot) in eucalyptus power poles. It is hoped that through completing plant pathogen testing, TasNetworks and the University of Tasmania will be able to develop a biological control approach to stop or slow down the growth of the timber rot. This will ensure that the integrity of the pole is maintained throughout the life of the pole and improve the life-cycle management of the pole.

1.2 Investment Need

Analysis of the performance of the wood pole population has confirmed that performance has not materially deteriorated. However, performance needs to be closely monitored to ensure that failure rates do not increase, particularly given the age profile of the population. Notwithstanding the reasonable performance levels realised to date, additional investment will be required in future years to sustain the performance of the wood pole population and to ensure the number of poles at or exceeding their service life remains manageable. In particular, there will be a need to progressively increase the number of staked pole replacements as they reach the end of their service life. Replacement of poles following Major Event Days also needs to occur.

Wood poles are the major subpopulation in the TasNetworks pole population and both natural or treated are prone to natural deterioration. Soft rot attacks the outside of the pole and occurs from the ground line to a depth of 300 to 400 mm below the ground. Heart rot is a fungal attack on the interior of the pole and generally occurs within 300 mm of the ground line.

The rate of wood pole deterioration depends on a number of factors including:

- the species of timber;
- the initial preservative treatment;
- installation location;
- soil conditions;
- method of inspection;
- drilling;

- excavation; and
- reinstatement.

Decay occurs when both moisture and oxygen are present and available moisture is a limiter on the rate of rot. As wood poles age in service, more cracks, splits, and holes can increase the availability of moisture in the wood accelerating the rate of decay. The outcome of the wood decay results in the need to condemn the pole and replace with a new pole with structural integrity.

Other causes that result in the requirement to replace a pole include damage by storms, fires, and impacts by third parties.

This program has two components:

- Replace condemned pole; and
- Replace Poles following MED, commonly after storms/severe weather or bushfires.

Replace Condemned Pole

The aim of this program is to replace poles that are classified as condemned by TasNetworks' pole inspection program (IES 00689 Inspection OH & Structures AIOHS). These condemned poles require replacement within a set time period based on their assessed priority as defined in the Overhead Line Structures Asset Management Plan.

The primary driver for this program is public safety where TasNetworks is responsible to ensure that a pole at the end of its life is removed from service before it fails. Another driver for replacement is to maintain reliability of supply.

Approximately 25 per cent of impaired poles are replaced and the remaining 75 per cent are staked. The volumes are based on historical data and condition information that is gathered during audits (including safety factor and amount of rot). This pole replacement program is highly dependent on the successful execution of a parallel program for staking of poles, which is not included in this IES, as it is covered by the pole staking program (IES 00670 - pole staking (RESTK)).

Replace Poles after Major Event Days

This is a reactive work program to cover the capitalisation of pole replacements undertaken under fault during MEDs such as during a storm or bushfire.

The work is initially performed under the fault and emergency budget and later transferred to this program.

This is a pre-existing program and TasNetworks does not expect a change in the replacement rates due to major events days over the next regulatory period with forecast expenditure to remain consistent with historical volumes. However, TasNetworks will continue to monitor climate change predictions to assess potential future impacts on pole replacement volumes due to climate change, such as increased bushfires as well as some increase in extreme wind velocity.

1.3 Customer Needs or Impact

TasNetworks continues to undertake consumer engagement as part of business as usual and through the voice of the customer program. This engagement seeks in depth feedback on specific issues relating to:

- how it prices impact on its services;
- current and future consumer energy use;
- outage experiences (frequency and duration) and expectations;
- communication expectations;
- STPIS expectations (reliability standards and incentive payments); and
- Increasing understanding of the electricity industry and TasNetworks

Consumers have identified safety, restoration of faults/emergencies and supply reliability as the highest performing services offered by TasNetworks.

Consumers also identified that into the future they believe that affordability, green, communicative, innovative, efficient and reliable services must be provided by TasNetworks.

This project specifically addresses the requirements of consumers in the areas of safety, affordability, security of supply and restoration of faults/emergencies.

1.4 Regulatory Considerations

6.5.7(a) Forecast capital expenditure:

(3) to the extent that there is no applicable *regulatory obligation or requirement* in relation to:

(i) the quality, reliability or security of supply of *standard control services*; or

(ii) the reliability or security of the *distribution system* through the supply of *standard control services*,

to the relevant extent:

(iii) maintain the quality, reliability and security of supply of *standard control services*; and

(iv) maintain the reliability and security of the *distribution system* through the supply of *standard control services*; and

(4) maintain the safety of the *distribution system* through the supply of *standard control services.*

2. Project Objectives

The objective of this program is to replace condemned poles damaged by storms, fires, a third party or as identified by the pole inspection program as an unacceptable risk.

Five yearly inspection of all poles at ground line and for overhead line inspection is cost effective, but has identified some risk in undetected carroty rot soft rot as the cause of unassisted pole failure risk.

There are approximately 10.5 unassisted pole failures each year. These failed poles all undergo a forensic examination after failure to determine the cause of failure. About 50 per cent of these are found to be caused by undetected carroty rot, a form of soft rot. The other 50 per cent are structural failures mostly as a result of excessive strong winds beyond the design criteria of the distribution system.

TasNetworks is reviewing impacts on network assets with respect to published predictions for climate change in Tasmania over future years. Climate change predictions suggest increased drought and bushfire frequency with some change in seasonal wind velocities. At this point in time, TasNetworks does not predict significant increases in pole failures due to climate change and the increased replacement volumes in conjunction with alternative pole management practices outlined in this IES are expected to maintain unassisted pole failures at historical levels over the next regulatory period.

In 2016/17 there were nine unassisted pole failures and forensic examinations confirmed eight of these failures related to undetected carroty rot. The remaining poles' faliure was caused by strong winds, however, undetected carroty rot was also present in this pole.

To reduce the risk of failure to detect carroty rot in periodic inspection, research and development trials with the University of Tasmania (UTAS) are underway to more effectively identify carroty rot from drilled wood shavings in order to detect carroty rot for preventative action, thus reducing the risk without the need for increasing pole replacement volumes. It is anticipated that this method will be deployed in the near future and will enable more accurate condemning and hence replacement of poles. With this, the business is expecting that the overall replacement rate of the poles will increase, but not at the rate which would be expected if the current method continued. This is outlined in section 1.2.

3. Strategic Alignment

3.1 Business Objectives

Strategic and operational performance objectives relevant to this project are derived from TasNetworks 2017-18 Corporate Plan, approved by the Board in 2017. This project is relevant to the following areas of the corporate plan:

- We understand our customers by making them central to all we do;
- We enable our people to deliver value; and
- We care for our assets, delivering safe and reliable networks services while transforming our business.

3.2 Business Initiatives

The business initiatives reflected in TasNetworks Transformation Roadmap 2025 publication (June 2017) for transition to the future that have synergy with this project are as follows:

- Voice of the customer: We anticipate and respond to your changing needs and market conditions;
- Network and operations productivity: We'll improve how we deliver the field works program, continue to seek cost savings and use productivity targets to drive our business;
- Electricity and telecoms network capability: To meet your energy needs and ensure power system security, we'll invest in the network to make sure it stays in good condition, even while the system grows more complex;
- Predictable and sustainable pricing: To deliver the lowest sustainable prices, we'll transition our pricing to better reflect the way you produce and use electricity; and
- Enabling and harnessing new technologies and services: By investing in technology and customer service, we'll be better able to host the technologies you're embracing.

4. Current Risk Evaluation

The qualitative risk evaluation summarised in section 4.1 below shows the untreated risk associated with a do nothing option. It equates to a worst case scenario of inherent risk associated with a particular asset. A lower level of likelihood and / or consequence may be applied as part of the sensitivity analysis when calculating the total risk cost as part of the quantitative options analysis.

If TasNetworks does not continue to inspect and replaces distribution wood poles there is a risk that a pole failure could result in death or serious injury to a member of the public or staff or lead to a severe bushfire.

The business risk associated with these assets has been evaluated as High by using the TasNetworks risk management framework.

4.1 5x5 Risk Matrix

TasNetworks' business risks are analysed utilising the 5x5 corporate risk matrix, as outlined in TasNetworks Risk Management Framework.

Relevant strategic business risk factors that apply are as follows:

Risk Category	Risk	Likelihood	Consequence	Risk Rating
Customer	Localised interruption to supply.	Possible	Negligible	Low
Environment and Community	Pole failure results in catastrophic bushfire with widespread environmental and community damage including loss of property and potential fatality.	Unlikely	Major	Medium

Financial	Pole failure results in catastrophic bushfire, insurance providers refuse to cover TasNetworks for future events. Pole failure results in serious injury or fatality. Excessive payout of reliability incentive schemes (STPIS, GSL, NCEF) from declining network reliability.	Unlikely	Major	Medium
Network Performance	Localised interruption to distribution supply.	Possible	Minor	Low
Regulatory Compliance	Increased number of unplanned outages leads to systemic NCEF breaches.	Rare	Moderate	Low
Reputation	Pole failure results in catastrophic bushfire with significant media coverage. Pole failure results in serious injury or fatality with significant media coverage. Pole failure results in bushfire with significant media coverage.	Possible	Major	High
Safety and People	Pole failure results in injury or death to member of the public or staff.	Unlikely	Severe	High

Section 2 (Gated Investment Step 2)

5. Preferred Option:

The preferred option is to replace poles as they are deemed condemned by our pole inspection program. Not proceeding with this option may result in death or serious injury to a member of the public from pole failures. It is recommended that poles are replaced based on condition rather than age. As age has not proven to be the determining factor on condition, environmental factors have shown to have more effect.

5.1 Scope

The work to be undertaken is the renewal of unserviceable poles, that do not require design, and may be generated by:

1. Failed Inspections as undertaken by Asset Inspectors; or
2. Requests from Regional Area Managers (RAMs), Strategic Asset Management or Field crews attending faults.

Any work requiring a new wayleave is not covered by this IES and similarly, any pole replacement that requires a complex redesign is also not covered by this IES. In that instance the work is covered in other investment categories,such as alternative poles for bushfire risk mitigation.

Condemned poles are to be renewed within the time period allocated. Any variation will require approval from the authorised TasNetworks employee.

Poles should be replaced with the equivalent size pole and pole top arrangement. If the pole includes a transformer or other pole top assets, then the rating of the replacement pole should be suitable to support those assets inaccordance with the current TasNetworks Distribution Overhead Design and Construction Standard.

5.2 Expected outcomes and benefits

The expected outcomes of this program are continued safe and reliable operation of the network. Replacing poles based on their condition presents the lowest life cycle cost while reducing environmental and safety risk as well as reducing fault response and customer outages.

5.3 Regulatory Test

The asset replacements within this ongoing program do not require a Regulatory Investment Test for Distribution (RIT-D) as per the requirements of the NER.

6. Options Analysis

Completion of options analysis has been undertaken using a modified Net Present Value (NPV) tool, to include Risk Cost. Risk Cost represents the expected annual cost of risk events ($ million) associated with the failure of asset. The business as usual case (BAU) base case definition applied in the options analysis is aligned to AER repex planning guideline. The NPV outcomes for all options considered, is relative to the BAU base case. The NPV tool has also been modified to include a Basis of Preparation. This enables increased transparency of the methodology and analysis undertaken, outlining methodology, key inputs, key assumptions. The Risk Cost methodology is represented as below:

Annual Asset Risk Cost = Probability of Asset Failure (PoF) * Asset units (No) * Likelihood of Consequence of Failure (LoC) * Cost of Consequence (CoC).

The analysis of all options is aligned with the Australian Energy Regulators application note for asset replacement planning, to ensure alignment of our approach. The risk cost categories, likelihood and consequence ratings are aligned with TasNetworks Corporate Risk Framework. The categories can also be mapped to the AER's repex planning guideline.

AON, TasNetworks corporate insurer provided Cost of Consequence (CoC) and Likelihood of Consequence (LoC) data. We have also analysed our assets and sought additional benchmarked data to develop Likelihood of Failure, Likelihood of Consequence and Cost of Consequence when it can be obtained.

The summary of costs outlined in section 6.3 below indicates the planned capital expenditure for repex over the 2019-24 period.

6.1 Option Summary

Option description	
Option 0	Do nothing - do not replace poles due to poor condition or that have been damaged.
Option 1 (preferred)	Replace poles based on condition.
Option 2	Defer replacement program for five years.
Option 3	45 year Age Based Replacement.

6.2 Summary of Drivers

Option	
Option 0	Advantages: • lowest expenditure. Disadvantages:

	- does not reduce the likelihood of injury or fatality due to a failing pole; - does not reduce the likelihood of exposure of the public to energised electrical equipment or being hit by a failed pole; and - customers will be exposed to increased unplanned outages. If poles are not replaced after failure, it is likely TasNetworks would be unable to service some customers; and - undetected carroty rot is found in at least half the annual unassisted pole failures by forensic inspection. Carroty rot is found at any pole age, in new as well as aged poles. It is more likely in aged poles.
Option 1 (preferred)	Advantages: - most positive economic outcome based on NPV analysis including risk cost; - capital expenditure in completing this work is sustainable; - reduces likelihood of exposure to the public from fallen poles; - this condition-based prioritised risk based preventative program minimises unplanned supply outages; and - planned pole replacement works are more economical than unplanned emergency repairs. Disadvantages: - cannot completely eliminate the risk of in service pole failures; and - requires operational expenditure for successful delivery of routine pole inspection program.
Option 2	Advantages: - defers planned capital expenditure Disadvantages: - risk is not mitigated for five years. - significant OPEX expenditure to undertake this option as many poles will fail and be emergency OPEX replaced pre-maturely prior to end of life; - does not do enough to reduce the likelihood of a failed pole causing injury or fatality. By replacing poles purely after failure there is still a high risk of poor condition poles failing and therefore operational expenditure must still be incurred to replace failures and continue routine inspection program for poles ; - poles fully or partly supported by wires can fail above wires attachment to be partly supported by wires creating extra damage to adjoining structures and the safe resecuring of partly fallen poles has risks and risk controls issues which can delay safe replacement at increased costs. - deferrment allows ongoing environmental factors that have shown to have a greater influence on condition risk compared to age risk. - resource constraint to deliver increased capital replacement program at end of first five years . - cost of unplanned emergency OPEX pole replacement is more costly than planned works .
Option 3	Advantages: - reduces likelihood of exposure to the public of fallen poles; - this age-based prioritised risk based preventative program minimises unplanned supply outages; and - planned pole replacement works are more economical than unplanned emergency repairs. - undetected carroty rot impact is more likely in aged poles Disadvantages: - very high capital cost - cannot completely eliminate the risk of in-service pole failures; and - still requires operational expenditure for successful delivery of routine pole inspection program. - does not immediately reduce the likelihood of exposure of the public to energised electrical equipment or being hit by a failed pole based on condition; - customers will be exposed to increased planned outages. - undetected carroty rot is found in at least half the annual unassisted pole failures by forensic inspection. Carroty rot is found at any pole age, in new as well as aged poles. It is however more likely in aged poles - presently 18,000 poles over 50 years in service and over 40,000 over 40 years in service. Hence, an aged based replacement at 45 years would be a significant captial expenditure increase;

6.3 Summary of Costs

Option	Total Cost ($)
Option 0	$0
Option 1 (preferred)	$70,720,260
Option 2	$0
Option 3	$198,306,550

6.4 Summary of Risk

Option 0 - Do Nothing:

The associated risk of this option is unchanged and remains High in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The high risk to public and staff safety from pole failure;
- Reduced network reliability of customer supply due to increased incidents of unplanned outages due to pole failure; and
- This option has the lowest upfront expenditure however high additional costs to the business are incurred in the form of regulatory and compliance breaches. As this option does not address the risk to public safety it is highly likely to involve further costs due to incidents and legal proceedings.

Option 1 - Replace Based on Condition (Preferred Option):

By replacing overhead support structures once they are identified as condmened, the ongoing risk is considered Low in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The risks to public safety from pole failure are low but cannot be removed entirely;
- The likelihood of unplanned outages occuring due to pole failures are significantly reduced; and
- This is the lowest expenditure option that still addresses the risk to public safety and provides the most positive NPV outcome economically including risk cost.
- Is a prudent benchmarked and auditable Contingency Plan for Risk Management of the Network to comply with SAA AS5577-2013 .

Option 2 - Defer Replacement for five years:

The associated risk of this option is unchanged and remains High for atleast five years in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The high risk to public and staff safety from pole failure;
- Reduced network reliability of customer supply due to increased incidents of unplanned outages due to pole failure; and
- This option has the lowest upfront expenditure however high additional costs to the business are incurred in the form of regulatory and compliance breaches and unplanned works in Emergency OPEX to replace the failed pole damage and timely restore supply . As this option initially does not address the risk to public safety it is highly likely to involve further unplanned costs due to incidents and legal proceedings.
- increases risks of emergency work and of plannned works to remove or replace attached overhead conductors and aerial services on supported poles that rely on the conductors and stay wires to support the defective pole

Option 3 - Replace based once 45 years of age:

The associated risk of this option is reduced to Medium in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The risks to public safety from pole failure are lower than Option 0 but still does not adequately address public safety;
- There will be a lower incident of unplanned outages due to pole failure compared to Option 0 but a higher number of outages compared to Option 1; and
- This is the highest planned works expenditure option. This option necessitates the premature replacement of some assets. Additional costs to the business in the form of regulatory and compliance breaches are lower than for Option 0 and option 2 , but are likely to be higher than Option 1.

6.5 Economic analysis

Option	Description	NPV
Option 0	Do nothing - do not replace poles due to poor condition or that have been damaged.	-$273,257,968
Option 1 (preferred)	Replace poles based on condition.	$134,991,246
Option 2	Defer replacement program for five years.	$27,799,857
Option 3	45 year Age Based Replacement.	$55,436,028

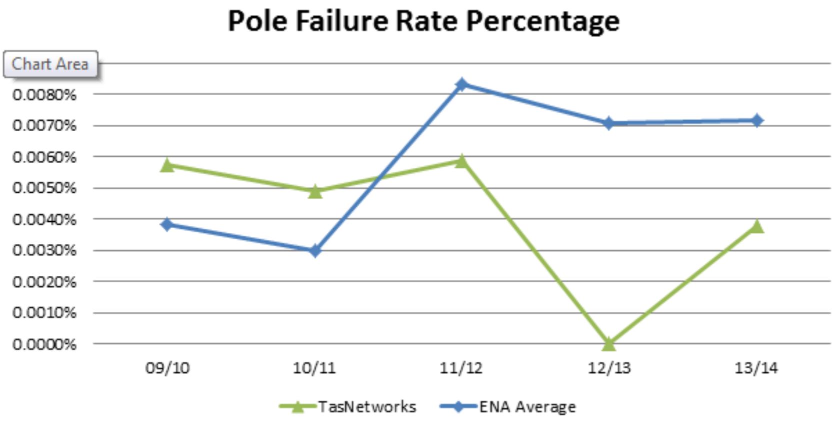
6.5.1 Quantitative Risk Analysis

A quantitative risk analysis has been completed including the cost of risk as described in section 6 above. The most positive option has been selected as the preferred option.

6.5.2 Benchmarking

The Electricity Networks Australia Power Pole and Crossarm Forum hold an annual Pole Failure Survey to capture unassisted pole failure rates around the country. In the past TasNetworks unassisted pole failure rate has been consistently below the average pole failure rate for all networks. The reduction in 2012/13 of no TasNetworks owned unassisted pole failures is due to an increased volume of pole replacements that year due to a change in work practices for applying pole safety factors, which lead to poles being condemned prematurely. The work practice has since reverted to previous, as the increased condeming rate was not sustainable. Figure 4 outlines the pole failure rate as provided by the Electricity Networks Australia annual Pole Failure Survey.

Figure 4 - Electricity Networks Australia annual pole failure rate



Another DNSP has also begun similar research with UTAS for its wood pole population inspection needs.

ENA support for the UTAS soft rot identification and bio control research and development has also begun preliminaries , noting the 6 million wood power poles population in Australian networks.

As a science comparison its noted a separate biocontrol reserach team for assessing similar wood soft rot biocontrol by fungii method has published a recent paper in April 2017 - Ribera et al

Integrated control of wood destroying basidiomycetes combining Cu ...

http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0174335

6.5.3 Expert findings

Not Applicable.

6.5.4 Assumptions

In addition to the replacement of poles, a number of new programs of work will be implemented to better manage the risks presented by carroty rot, high stress wind loading, the reliability of high risk and complex installations, and bush fire resilience.

Related Projects:

Composite Material Alternative Distribution Support Structure Trial - Alternate Pole installation in high risk, difficult access or critical support structures in place of regular TasNetworks Wood pole planned replacement after the original pole has been condemned by the pole inspection program or damaged by storms, fire or a third party.

Trial of UTAS Carroty Rot detection and BioControl (AIOHS) - Research and development supporting improved in-field inspection methods of detecting presently undetectable carroty rot.

Pole Staking (RESTK) - Reinforces impaired wooden poles for an extension of life of approximately 15 years.

Overhead Assets and Support Structure Inspection (AIOHS) - Routine inspection of all overhead and supporting (including wood poles) assets.