Cockatoo Conductor Replacement Program

Regulatory Business Case (RBC) 2024-29

PowerWater

Contents

PowerWater

1. Summary

This business case has been prepared to support the 2024-29 Regulatory Proposal. The business case demonstrates that Power and Water has undertaken appropriate analysis of the need for the expenditure and identified credible options that will resolve the need and ensure that Power and Water continues to meet the National Electricity Objectives and maintain the quality, reliability, and security of supply of standard control services and maintain the safety of the distribution system.

The proposed expenditure identified in this business case will undergo further assessment and scrutiny through Power and Water's normal governance processes prior to implementation and delivery.

This business case addresses the condition, compliance and obsolescence risks of cockatoo conductor installed in the 22kV network in the Manton zone substation area.

1.1 Business need

Cockatoo type conductors were installed on the 22kV overhead network in the Manton zone substation area in the mid-1970s. This includes the Lake Bennett feeder, Manton Feeder, Acacia Feeder and Town feeder

This conductor has been identified as having reached the end of its serviceable life due to condition, obsolescence, and maintainability, indicated by:

- Severe breaches of the minimum ground clearance limits prescribed in the Electricity Reform (Safety and Technical) Regulation and the AS7000:2016 Standard on multiple segments/spans along the entire route. This is a result of the type of conductor and the long spans between poles and poses compliance and safety risks.
- The reliability of the asset is decreasing. Widespread defects and deteriorating condition of the conductor have been identified, causing higher than average rates of failure, which in turn has resulted in long duration customer outages. The affected feeders are amongst the worst performing on the network, providing poor service to our customers.
- The conductor is a non-standard imperial gauge type that was installed using non-standard high-tension techniques. Hence, it is difficult to maintain as specialist equipment, tools and field crew training is required. This results in extended outage durations when there is an asset failure.
- The high tension installation means that when it fails, the force of the conductor failure can create secondary assets to fail such as poles and pole tops, as well as being a significant safety hazard to field crews.

This type of conductor therefore poses a risk to continued maintenance and the ability to rectify faults efficiently, both due to the lack of spare parts and the specialised equipment required to be mobilised. Additional risks to the safe and reliable operation of the network are present, and will continue to increase if left unmitigated.

There is an existing program that involves rebuilding affected lines with a modern equivalent conductor and additional poles to reduce the span length – Lake Bennett conductor replacement. As a result of community concerns and objections to extended outages, Power and Water rescheduled the current program to meet community expectations. As a result, completion of 30 km of the originally planned 40 km route length of conductor replacement will be completed by 2024.

At the start of the 2024-29 regulatory period, approximately 24 km of cockatoo conductor is estimated to be remaining on the network.

1.2 Options analysis

The options considered to resolve the identified need are shown in Table 1.

Table 1 Summary of credible options

Option No.	Option name	Description	Recommended
1	Replace on failure	Counterfactual. This option will involve reactive replacement of conductor upon failure.	No. Does not meet identified need and has increasing risk.
2	Mid-span pole installation and re-conductoring	Implement a program to replace three sections of feeder sequentially, representing the remaining route length of Cockatoo conductor.	Yes. Fully meets identified need.
3	Line re-build	Complete line rebuild. Implement a program of works to rebuild the existing line which includes replacing existing overhead Cockatoo conductors with a new conductor and all the associated hardware.	No. Fully meets identified need but at a significantly increased cost.

As part of a holistic assessment, non-network solutions, capex/opex trade-offs and retirement or derating options were also considered, but found that none of these options addressed the underlying network issues.

A cost benefit analysis was completed for each of the options where the risk reduction, compared to Option 1, was used as the benefit achieved by the option.

1.3 Recommendation

The recommended option is Option 2 - Mid-span pole installation and re-conductoring had the highest NPV among the options, addressed the need and was deliverable. It is therefore the recommended option to resolve the identified network issue prudently and efficiently. The estimated cost is $4.7 million (real 2021/22) to replace the remaining 24 km which includes 10 km of route length originally planned for the current period, but not replaced due to community concerns.

Option 2 is a continuation of the existing approved program. There is a clearly identified business need, appropriate scope of works, including the need to reduce long spans that cause breaches of ground clearance limits and deal with widespread defects and deteriorating condition of conductors. Appropriate consideration has been made of credible options and costing in accordance with the ongoing need.

Table 2 below shows a summary of the expenditure requirements for the 2024-29 regulatory period.

Table 2 Annual capital and operational expenditure ($'000, real FY22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	1,019	1,786	1,933	0	0	4,738
Opex	-	-	-	-	-	0
Total	**1,019**	**1,786**	**1,933**	**0**	**0**	**4,738**

2. Identified need

This section provides the background and context for this business case, identifies the issues that are posing increasing risks to Power and Water and its customers, describes the current mitigation program and its delivery status, highlights the consequence of asset failure, and provides a risk assessment of the inherent risk if no investment is undertaken.

2.1 Background

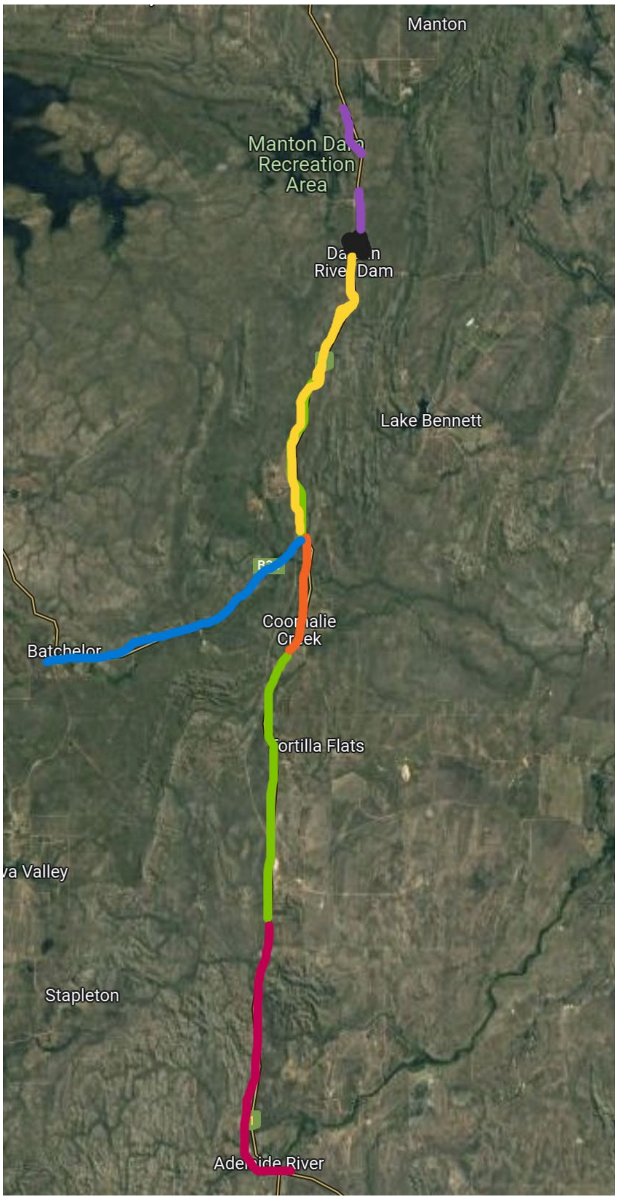
Cockatoo type conductors were installed on the 22kV overhead network in the Manton zone substation area in the mid-1970s. This includes the Lake Bennett feeder, Manton Feeder, Acacia Feeder and Town feeders. The amount currently installed on the network as of December 2022 is shown in Figure 4.

Table 3 Summary of the length of cockatoo conductor installed by feeder and suburb

Feeder name	Suburb	Length (km)
22BA04 TOWN	BATCHELOR	1.9
22BA04 TOWN	RUM JUNGLE	0.2
22BA05 MANTON	COOMALIE CREEK	3.9
22BA05 MANTON	RUM JUNGLE	6.1
22MT06 LAKE BENNETT	ADELAIDE RIVER	5.7
22MT06 LAKE BENNETT	COOMALIE CREEK	7.3
22MT06 LAKE BENNETT	STAPLETON	7.1
22MT06 LAKE BENNETT	TORTILLA FLATS	5.4
22MT07 ACACIA	DARWIN RIVER DAM	0.2
22MT07 ACACIA	LAKE BENNETT	4.8
Total		**42.7**

Investigations related to operational performance of the cockatoo conductors on these feeders identified a range of issues including higher than average failures, insufficient ground clearance creating public safety hazards and compliance risk, conductor damage due to ageing, broken strands due to excessive tension, and corrosion. These issues are detailed further in Section 2.3.

Figure 1 below shows the geographical area where the affected Cockatoo conductor is located on the network. There is a radial 22kV overhead feeder emanating northward from the zone substation, a radial 22kV overhead feeder emanating southward, and a tee-off towards Batchelor.

	Legend

Colour	Description	Length (km)
Purple	22MT07 Acacia	5
Blue	22BA04 Town and 22BA05 Manton	12.2
Green	22MT06 Lake Bennett	4.5
Orange	22MT06 Lake Bennett (Coomalie creek section)	3
Red	22MT06 Lake Bennett	16
Yellow	22MT06 Lake Bennett (Stage 1 and 2 completed)	13
Total		**55.5**

Notes:
1. Coloured sections are indicative only, not drawn to scale.
2. The yellow section between Manton ZSS (black dot) and the t-off to Batchelor has been completed in the current period.
3. Differences of total length to Table 3 are due to the completed Yellow section being excluded from Table 3 and rounding.

Figure 1 Cockatoo conductor

2.2 Current mitigation program

There is an existing project established to address the issues on a portion of the cockatoo conductor. The program was called the Lake Bennett conductor replacement as the Lake Bennett feeder had the largest volume of the conductor and was the focus of the initial stages of the project. The project had a budget of $5.1 million and the original scope of the project was to replace approximately 40km of the feeder route, including the tee-off line to Batchelor and all lines below the tee-Off point.

The delivery of this program has been delayed, and the project re-scoped to address customer concerns and objections to the outages required to facilitate the line replacement. The key issues that contributed to the delay were:

- The COVID-19 pandemic caused a delay to implementation due to the impact on the business and its ability to carry out the planned replacement activities.
- The heavy weight and imperial gauge of Cockatoo conductor requires specialised tools, plant, and vehicles suitable for the asset. Unavailability of the specialised equipment and tools caused delay in replacement activities.
- There have been significant encroachments by private properties along the feeder route. These encroachments need to be resolved prior to any works being undertaken. This has caused the project to be rescheduled.
- Major outages were required for conductor replacement due to the radial feeder network configuration. Customers opposed this planned work due to the extended interruptions. Power and Water responded to this issue, by reprioritising the replacement program by carrying out conductor replacement in areas as agreed with the wider community. The steps taken by Power and Water align with the strategic focus area of *Customer and Community at the Centre* by engaging with the community and taking into account all customer considerations. However, the re-scoping and customer engagement resulted in reduced volume for replacement under this project.

Due to a combination of the factors described above, approximately 30 km of Cockatoo conductor replacement will be completed against an initial plan for 40 km route length, a reduction of 10 km of conductor. This will leave 24 km of cockatoo conductor on the network at the start of the 2024-29 regulatory period.

The budgeted and actual capex profiles associated with this mitigation program in the current 2019-24 regulatory period are shown in Figure 2.

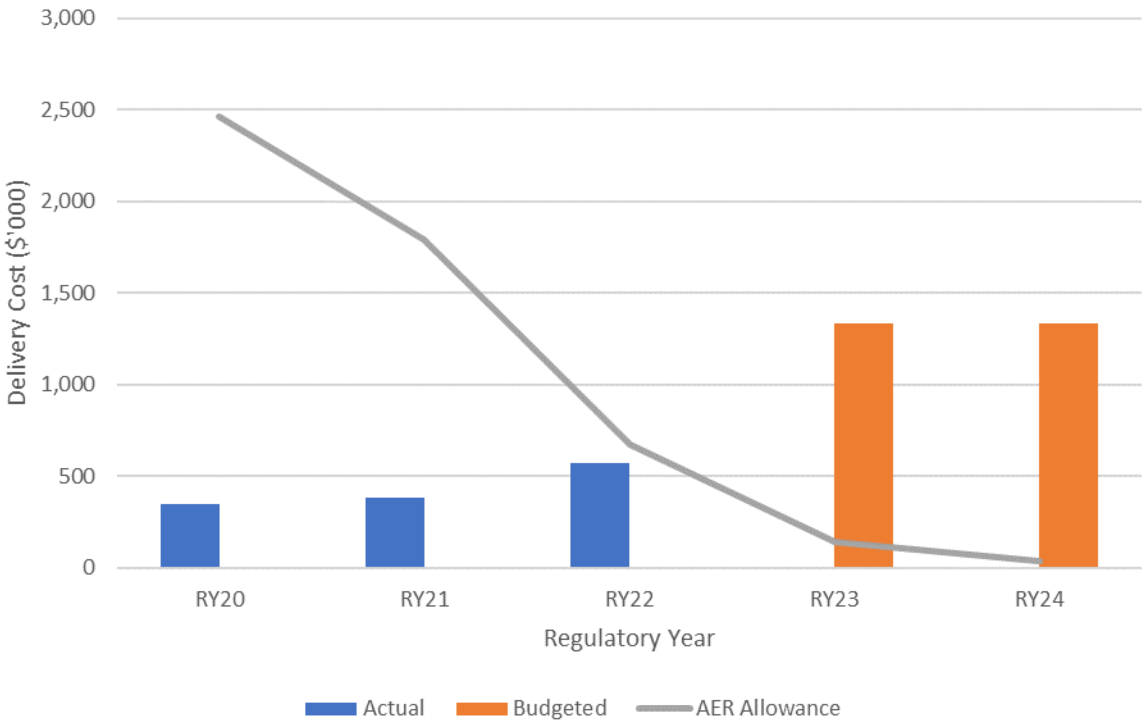


Figure 2 Actual / estimate capex in the current regulatory period ($,000 FY22)

2.3 Identified Issues

This section details the issues with the existing Cockatoo conductors on the 22kV Lake Bennett, Manton and Acacia overhead feeders highlighted in Figure 1, the extent of the issue, the consequences of conductor failures and the risks posed.

The primary drivers for the replacement of the cockatoo conductors is the combination of the deteriorated condition and unique type (imperial gauge, high tension stringing) which is resulting in poor service to our customers.

2.3.1 Unique asset type

Cockatoo conductors were installed in the mid-1970s and use an imperial gauge and high stringing tension. When constructed, this was used to create very long span lengths through the remote areas. However, it is now causing issues for maintenance and restoration of supply:

- Components that are compatible with the imperial gauge are becoming difficult to obtain.
- The high-tension stringing is a non-standard design and requires specialist training and equipment.
- The field crew do not like working on this asset type as it is difficult to manage and is considered dangerous. Field crews have reported that due to the high tension, when the conductor snaps the force has caused cross arms to twist, insulators to break and poles to bend.

These issues make it increasingly difficult to maintain this asset type as its condition deteriorates.

2.3.2 Deteriorated asset condition

There are various issues affecting the operational performance of this feeder that demonstrate it has reached the end of its serviceable life. The major issues are conductor damage, failure of conductor strands and corrosion. The conductor has been reported by field crew as fatigue failing, meaning it is failing due to deteriorated condition.

The deterioration of the cockatoo conductor is also accelerated by the “poly-pipe” style bat protection that has been installed. The Poly-pipe bat guards provide a physical barrier and prevent bats causing a short circuit between phases, however, the pipes can allow water ingress which remains in contact with the conductor and accelerates corrosion. Eventually the corrosion results in failure of the conductor.

Since these conductors are used in radial feeders, and are a type that is difficult to repair due to the weight, imperial gauge, high stringing tension and equipment required, outages result in loss of supply to all downstream customers for an extended duration.

Figure 3 shows there have been four outages per year caused by asset failure, and Figure 4 and Figure 5 show examples of the different deterioration and failure modes of the cockatoo conductors.

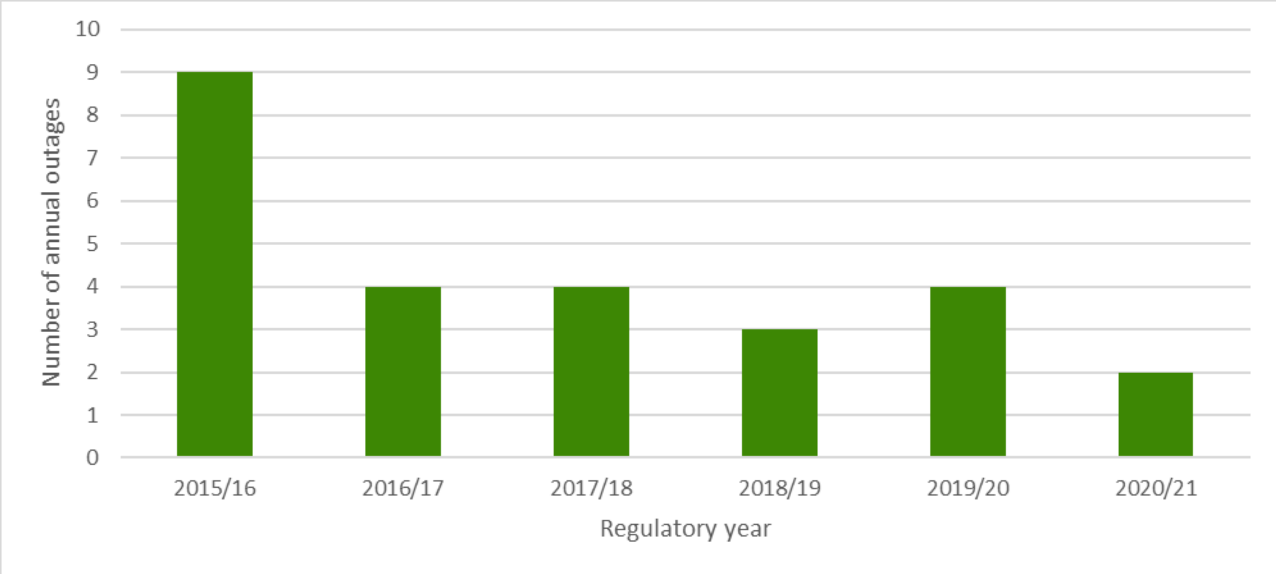


Figure 3 Historical number of outages caused by asset failure

Figure 4 Cockatoo conductor photos showing broken strands, burning and corrosion

A typical conductor using poly-pipe construction is shown in Figure 5 below.

Figure 5 Damaged conductor Due to “poly-pipe” bat guards

2.3.3 High numbers of outages

Figure 3 (above) shows that there is a high number of outages annually on the feeders with Cockatoo conductors. There are approximately 4 outages occurring every year and the time to repair depends on the extend of the consequential damage to poles and insulators, as well as the time of the year as heavy equipment is required to re-string the lines. Field crews have reported failures without secondary damage requiring up to eight hours to repair, while in at least one case it has taken several months. For most of the feeder, supply can be restored through back feed from Adelaide River or Batchelor zone substations.

The Lake Bennett and Acacia feeders were ranked the first and fourth worst based on their performance, respectively, by total outage duration for all feeders that experienced asset failures from FY15 to FY20. When assessed for any outage reason they were ranked tenth and eighth worst, respectively.

This indicates that they are performing poorly, considering the number of failures and long duration of outages caused by asset failures. The extended duration following asset failure is a result of needing specialist equipment to undertake the repairs, distance to the feeder and the difficulty working with the cockatoo conductor type.

The economic cost of these outages is shown in Figure 6 below, using the Northern Territory value for residential Value of Customer Reliability ($18.99 per kWh). There is no clear trend, but the average value of energy not supplied across the five-year period is $220,000 per year.

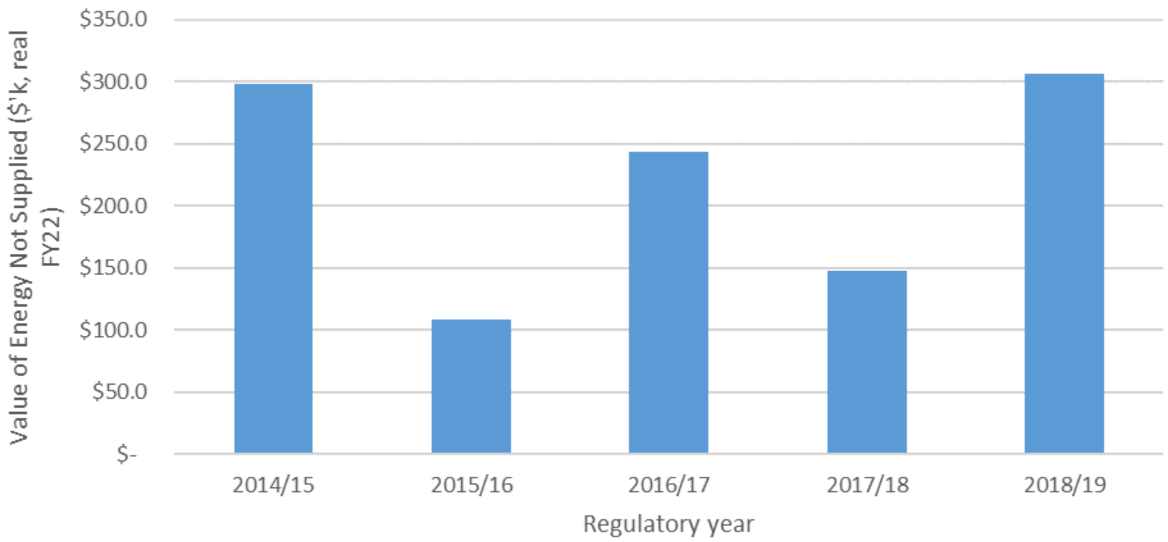


Figure 6 Value of energy not supplied

2.3.4 Long spans

The Lake Bennett feeder design involved long span lengths of 200 - 300m which, as shown in Figure 7, are very long compared to the standard design of feeders on Power and Water's network. This feeder design was achieved by increasing the conductor tension which has several implications:

- High conductor failure rate (discussed above) as excess tension leads to reduction in asset life due to mechanical stress.
- Routine maintenance and repairs are very challenging for the field crews to perform as specialised equipment and training is required for filed crews who work on this asset so that all the maintenance work carried out on this feeder can be done in a safe manner.
- Any repairs carried out on this feeder have long restoration times due to the feeder location and terrain, the conductor tension and large span length, and access to the appropriately trained crews and equipment. All these factors make it difficult to complete repairs and cause delays in restoring the power supply to affected customers.

These factors contribute towards the higher cost of maintenance associated with this feeder and higher economic impact to our customers when there is an asset failure.

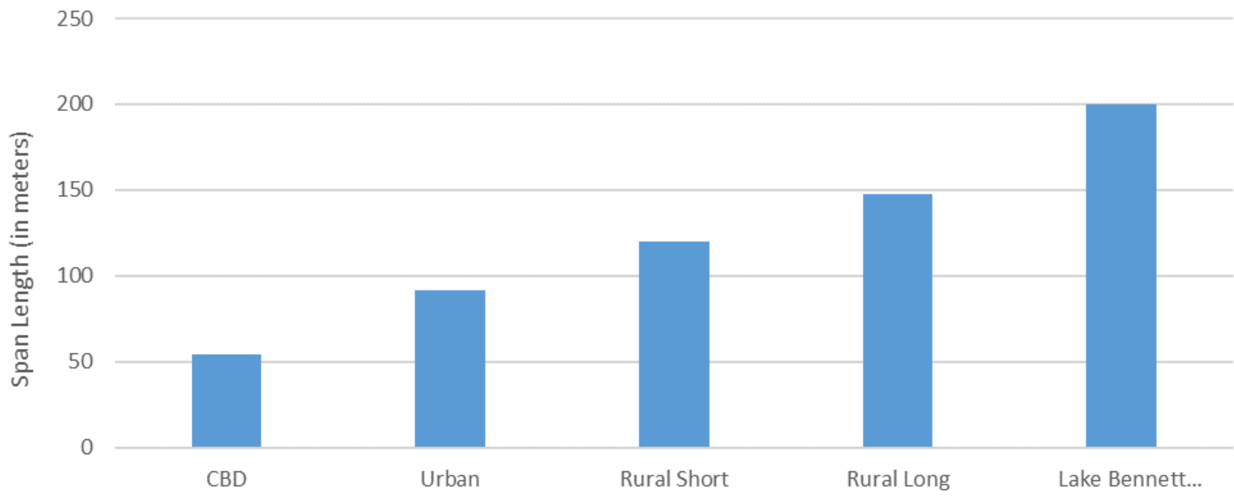


Figure 7 Average span length comparison

2.3.5 Safety clearances

An investigation was undertaken in August 2017 to determine the asset health of the conductors along the 31.8 km of route length of the 22kV Lake Bennett overhead feeder. It was found that 66.7% of the conductor spans over road crossings and 39.6% of conductor spans for other areas (excluding road crossings) did not meet the minimum ground clearances as per the Electricity Reform (Safety and Technical) Regulations and the AS7000:2016 Standard.

As stated above, the combination of the long spans and deteriorated condition such as broken strands contribute to the increased sag of the conductor and breaching of clearances.

Table 4 below provides a summary of the investigation outcomes identifying the clearance issues. Depending upon the relevant category, different kinds of infringements are applicable as per Schedule 4 of the Electricity Reform (Safety and Technical) Regulations[1] if there are safety clearance breeches posing health and safety issues for public.

Table 4 Lake Bennett – Ground Clearance inspection results

Ground clearance inspection results	Clearance over carriageway roads (m)	Clearance over land other than carriageway of roads (m)
Ground clearance standard[2]	6.7	5.5
Largest breach	2.3	1.9
Smallest breach	1.7	0.05
Volume of breaches (%)	**66.7**	**39.6**

[1] Legislation Database (nt.gov.au)

[2] Power and Water internal standards for conductor clearance are 7.5m (Roads) and 6m (other areas)

2.4 Consequences of failure

There are three key consequences of conductor failure that are aligned to Risk Quantification Procedure. These are:

- **Health and Safety**
  All the Power and Water's high voltage network needs to be operated and managed in a manner that it meets its safety obligations towards its employees, contractors, and the members of public at all times. The insufficient ground clearance poses a safety risk to public and Power and Water's workforce involved in working on or near the proximity of the asset. A conductor failure or low clearance will have significant health and safety consequence for anyone coming in contact with the conductor. Additionally, working with the heavy conductor pose as OHS risk to workers.
- **Reliability/Serviceability**
  Due to radial feeder network configuration, an asset failure will result in supply outages for customers and, as described above, for this asset there is an extended restoration time. Due to unique feeder design and existing asset condition issues, the cockatoo conductor feeders have lower reliability and lower maintainability. As these are radial feeders, customers will be without power until the fault is rectified. This is impeding Power and Water to meet its reliability performance objectives. Long outages for customers will lead to loss of reputation for the utility and will also affect the reliability targets. In view of this, Power and Water should be prioritising the remediation of conductors with defects/issues to meet both customer expectations and reliability targets.
- **Compliance**
  A fundamental business driver for Power and Water is compliance to Electricity Reform (Safety and Technical) Regulations and to the AS7000:2016 Standard statutory requirements. This is encapsulated in the objective of providing safe and reliable power supply at a minimal cost as expressed through the Network Technical Code and Network Planning Criteria. Presently the Lake Bennett overhead feeder is non-compliant and the other feeders that are constructed with high tension cockatoo conductor are expected to have similar clearance issues.

2.5 Risk assessment

The risk posed by Cockatoo overhead conductor due to the identified issues has been quantified by applying Power and Water Risk-Quantification Procedure[3]. This procedure has been developed based on good electricity industry practice and taking into account the recent guidelines and determinations made by the AER, the ISO 31000 Risk Management Standard, and other professional publications.

This assessment has been undertaken based on the counterfactual case, that is, on the basis that Power and Water does not undertake any mitigation measures to address the risk and only addresses faults reactively as the base case scenario. Figure 8 shows the increasing level of risk that would be carried by Power and Water in the absences of any mitigating actions.

[3] CONTROL0932, Power and Water Corporation, Risk Quantification Procedure

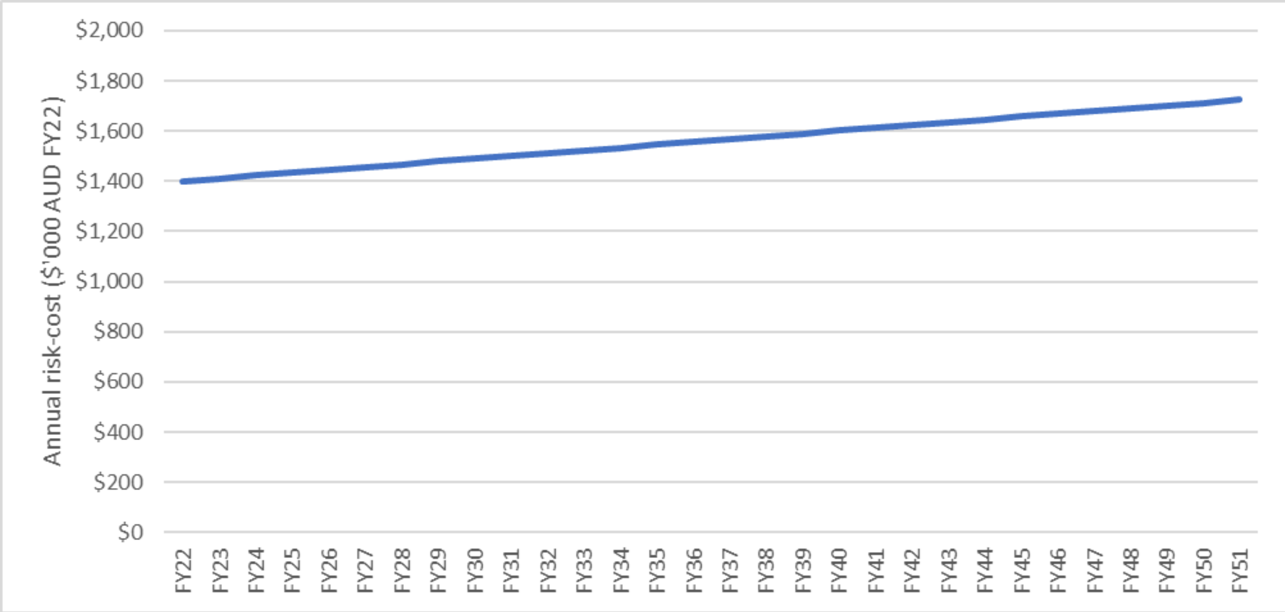


Figure 8 Annual risk cost applying the Values and Model Framework if only replacing at failure

The dominant components of this increasing level of risk are the economic impacts of outages which are calculated based on the Value of Customer Reliability (VCR) and the risk of penalties for non-compliance with clearance (distance from the ground to the conductor) requirements. While the consequence of health and safety impacts are significant, the probability of them materialising is very low as the feeder is in a rural area and offset from the road with few spans that cross over roads or driveways.

The risk assessment demonstrates that there is an increasing risk across the cockatoo conductor fleet. The reduction in risk that is achieved by different credible mitigation options, along with the cost of those options and any other direct financial cost savings, is used to identify the preferred option in Section 3.

2.6 Summary

Power and Water has identified that the cockatoo type conductors are demonstrating the deterioration modes and operational issues that indicate the conductor has reached the end of its serviceable life:

- The conductor is a non-standard imperial gauge type that was installed using non-standard high-tension techniques. Hence, it is difficult to maintain as specialist equipment, tools and field crew training is required. This results in extended outage durations when there is an asset failure.
- The high tension installation means that when it fails, the force of the conductor failure can create secondary assets to fail such as poles and pole tops, as well as being a significant safety hazard to field crews.
- The conductor is over 45 years old and is displaying signs of having reached end of its serviceable life, including broken strands, corrosion and conductor damage due to burning.
- The reliability of the asset is decreasing and there is an average of four outages due to asset failure per year. The poor asset condition and the conductor performance is the worst in the Power and Water network with respect to outages caused by asset failure. There is a decline in performance and extended time required for repair of Cockatoo conductor resulting in increasing cost to customers.
- There are a significant number of spans that do not comply with the minimum clearance requirements as a result of broken strands and creep as the conductor ages. This creates the risk of penalties for non-compliance and also pose a risk to safety.

The overall assessment demonstrates that there is disproportionate risk-cost associated with this asset. Section 3 discusses the options that will efficiently manage these risks.

At the end of the current regulatory period, there will be an additional 24 km of Cockatoo conductor replacement around the Manton Zone Substation that is comprised of:

- 5 km of Cockatoo conductor on the Acacia feeder (purple line in Figure 1).
- 3 km of Cockatoo conductor on the Lake Bennett feeder (orange line in Figure 1)., and
- 16 km of Cockatoo conductor on the Lake Bennett feeder (red line in Figure 1).

Options to address this condition issue are set out in section 3.

3. Options analysis

This section describes the various options that were analysed to address the increasing risk to identify the recommended option. The options are analysed based on ability to address the identified needs, prudency and efficiency, commercial and technical feasibility, deliverability, benefits and an optimal balance between long term asset risk and short-term asset performance.

3.1 Comparison of credible options

Credible options are identified as options that address the identified need, are technically feasible and can be implemented within the required timeframe. The following options have been identified:

- **Option 1** – Replace on failure (counter factual scenario). This option would involve continuing to replace or repair the faulted section of the overhead cockatoo conductor upon failure.
- **Option 2** – Mid-span pole installation and re-conductoring. Implement a program of works to install mid span poles, replace pole tops, and replace the sections of overhead Cockatoo conductor which needs replacement based on defects identified during routine inspection and maintenance.
- **Option 3** – Complete line rebuild. Implement a program of works to rebuild the existing line which includes replacing existing overhead cockatoo conductors with a new conductor and all the associated hardware.

Options 2 and 3 both involve a modern equivalent like-for-like asset replacement but with differing asset management strategies. Accordingly, each credible option is suitable for differing risk appetite levels, has different residual risk projections and investment requirements.

A comparison of the three identified credible options and the issues they address in the identified need is depicted in Table 5. These options are described and assessed in detail in the sections below.

Table 5 Summary of options analysis outcomes relative to the base case (Option 1)

Assessment metrics	Option 1	Option 2	Option 3
NPV ($'000, real FY22)	-	8,325	6,384
BCR	-	2.97	2.17
Capex ($'000, real FY22)	-	4,738	6,348
Meets customer expectations	○	●	●
Aligns with Asset Objectives	○	●	●
Technical Viability	◑	●	◑
Deliverability	●	◕	○
Preferred	✗	✓	✗

● Fully addressed the issue ◕ Adequately addressed the issue ◑ Partially addressed the issue ○ Did not address the issue

3.1.1 Option 1 – Replace on failure

This option proposes to only repair the Cockatoo conductors in a reactive manner post failure. This means incurring the cost of the outages and accepting the risk to public and worker safety. In addition, the cost per unit of emergency replacement or repair of conductor post failure is higher than a planned outage and programmed replacement work.

The Risk Quantification Procedure was applied to assess the risk posed by this asset. The resultant quantified risk-cost is shown in Figure 9 below. This option was assessed to result in the highest residual risk cost of the three credible options, indicating the worst network performance and highest risk to health and safety. The decrease in risk up to FY24 represents the benefit achieved from the current project that is forecast to continue until FY24 based on the currently approve scope and budget.

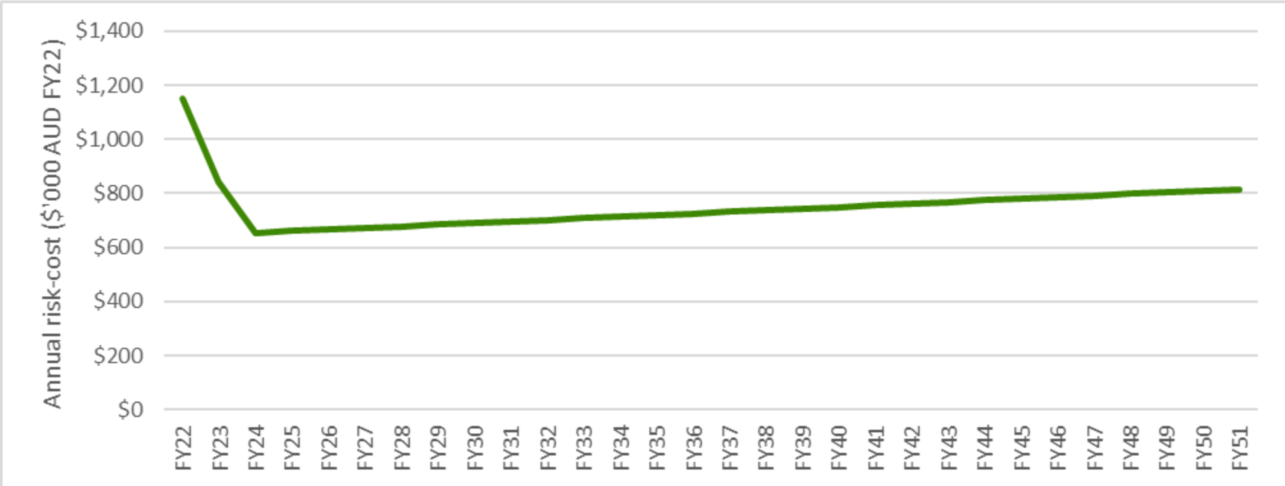


Figure 9 Risk profile achieved through Option 1

While this option is deliverable and technically feasible (it is a reactive activity), it results in deteriorating network performance and increasing safety risk to both the public and workers.

The residual risk of this option is high. This approach does not directly address the underlying need which is the large volume of conductors that is known to be in poor condition, performing poorly with respect to reliability and at end of their serviceable life. Therefore, it does not align with the Asset Objectives of maintaining reliability and safety of the network.

There is no capex associated with this option for the next 2024-29 regulatory period. However, it has the highest risk, with an increasing annual risk-cost (as shown in Figure 9 Risk profile achieved through Option 1), and does not address the underlying need that was identified in section 2.3.

This option is not recommended.

3.1.2 Option 2 – Mid-span pole installation and re-conductoring

This option proposes to reconductor the overhead feeders currently comprised of cockatoo conductor. The approach is to build the new assets underneath the existing line so that the existing easement and alignment will be retained to minimise the additional costs and time delay for obtaining permits and approvals from the Aboriginal Areas Protection Authority (AAPA).

The route will be designed so that the maximum number of existing poles can be reused and the average span length will be reduced to 150 metres. From experience with the completed sections, approximately 70% of the required poles will need to be new and all cross arms on the existing poles will be replaced.

A total route length of 24 km of cockatoo conductor overhead feeder will be replaced as well as an additional 2 km of feeder on the 22MT07 Acacia feeder, as summarised in Table 6.

Table 6 Length of cockatoo conductors by feeder to be replaced

Feeder name	Route length (km)	Year
22MT06 Lake Bennett (Stapleton and Adelaide River localities)	16 km	FY26 / FY27
22MT07 Acacia	5 km	FY27
22MT07 Acacia (upgrade/replace some sections and install OPGW)	2 km	FY27
22MT06 Lake Bennett (Coomalie creek locality, difficult terrain)	3 km	FY25
Total to be installed	26 km	

The residual quantified risk-cost of this option is shown in the Figure 10 below. This analysis have been completed on the basis that the scope of works planned for the current regulatory period will proceed.

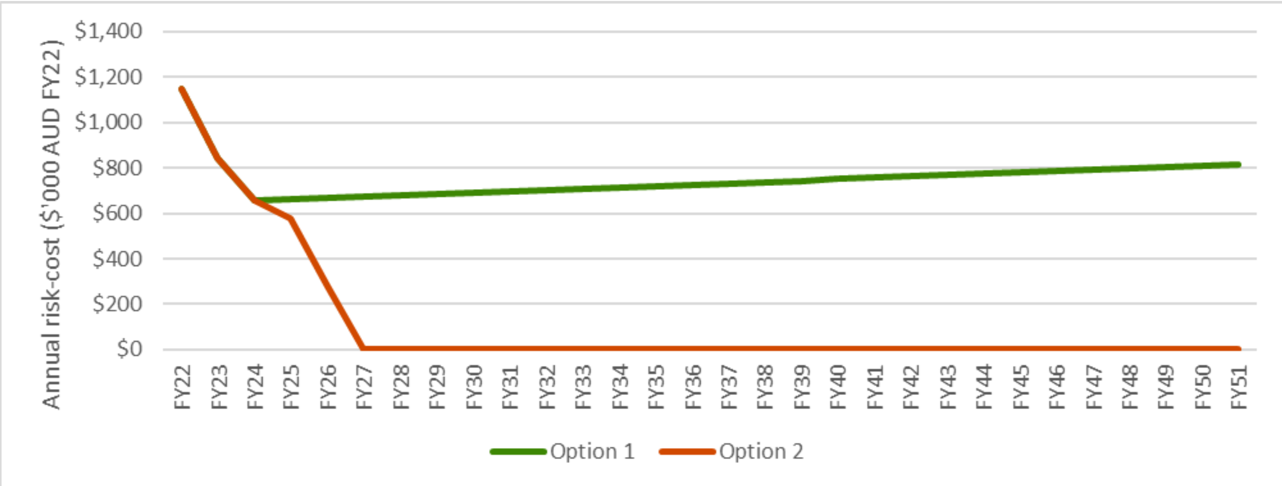


Figure 10 Risk reduction achieved through Option 2

This option proposes to replace all sections of cockatoo conductor along with the installation of mid span poles and pole tops. It involves standard conductor installation with ready availability of suitable equipment and training which operational crews are already familiar with. This option can be delivered within time and budget. It has the following benefits:

- It will contribute towards achieving the Asset Objectives of maintaining reliability and safety of the network. As the poorer sections of conductor are removed from the network, reliability will improve.

- Removes a non-standard type of conductor from the network which is difficult for the crew to work with and has a dangerous failure mode with respect to health and safety of the field crew and damage to associated assets.
- it will enable Power and Water to achieve and maintain compliance with minimum ground clearance requirements.
- Will improve reliability through shorter restoration times for future failures.

The scope of this option is expected to involve the replacement of 24 km of route length in the 2024-2029 regulatory period.

The total capex for this option is estimated to be $4.74 million with a present value of $4.2 million. The NPV of Option 2, relative to the Option 1 base case, is $8,325 million. The BCR of Option 2, relative to the Option 1 base case, is 2.97.

3.1.3 Option 3 – Complete line re-build

This option proposes to implement a complete line rebuild program that will progressively replace the entire fleet of 1975 cockatoo conductors.

A complete line rebuild will involve constructing a new feeder parallel to the existing feeder which involves installation of poles, installation of new overhead conductor and also involves decommissioning and disposal of existing poles, pole tops and existing overhead conductor.

The resultant residual quantified risk-cost of this option is shown in the following Figure 11. This option was assessed to result in the second highest risk cost of the three options, indicating an improved network performance.

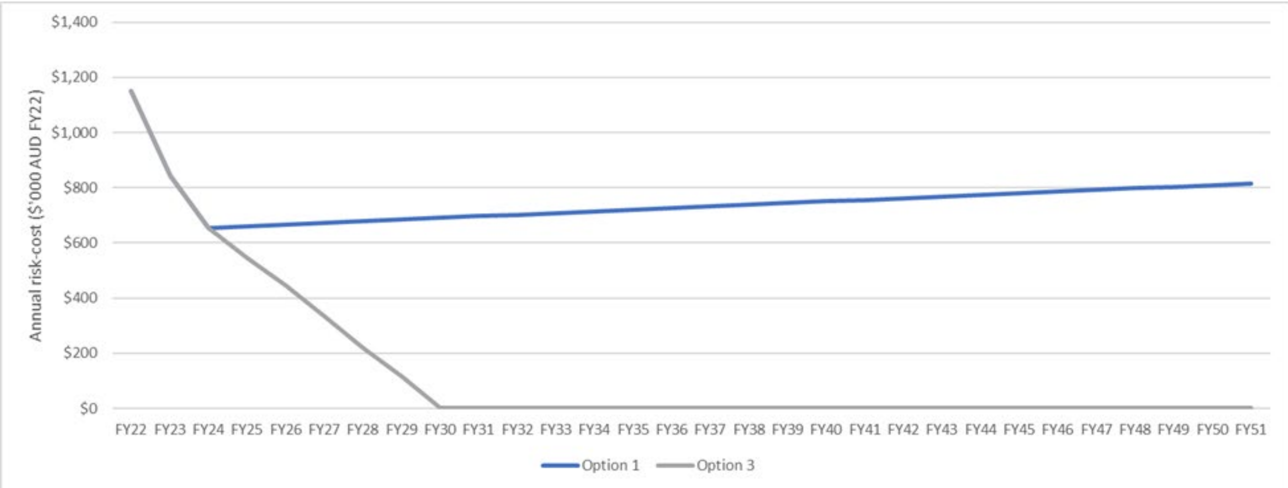


Figure 11 Risk reduction achieved through Option 3

This option proposes to rebuild a new section of line parallel to the existing feeder. This approach will achieve the same benefits as Option 2 however with the following additional considerations:

- This is a significant change to the current approach being undertaken.
- An additional 30% of new poles will required as the existing poles will note be able to be re-used. This will increase the cost of this option. This is estimated to result in an additional 2 poles per kilometre compared to Option 2

- There is expected to be additional delay and cost due to the additional permitting requirement from the government and AAPA to secure a new easement. This is expected to result in delay, estimated at an extension of an additional 50% (completion in FY30 rather than FY27) and an additional cost to AAPA, conservatively estimated to double to $200,000.
- There will be additional costs to establish new access tracks rather than repair/remediation of the existing tracks. This is estimated to be an additional 20%.

In total, the unit rate is expected to increase to $210,000 per kilometre plus the AAPA fees and delivery has been delayed. However, Power and Water does not consider that this option is feasible due to the constraints that are likely to be applied by AAPA and the unnecessary delay to address the issues compared to Option 2.

The total capex for this option for the 2024-29 regulatory period is estimated to be $6.3 million (real 2021/22) with a net present value of $5.5 million. The NPV of Option 3, relative to the Option 1 base case, is $6.384 million. The BCR of Option 3, relative to the Option 1 base case, is 2.17.

3.2 Non-credible options

Our analysis also identified a number of options found to be non-credible. These options are described below and were not taken through to detailed analysis for the reasons provided.

3.2.1 Retire or de-rate assets to extend life – does not address the need

Total retirement of the assets is not a credible option as the conductor is required for safe and reliable distribution of the electricity network. De-rating the conductor will not have any impact as it will directly impact customer's load or maximum demand supplied through the conductor which will increase customer dissatisfaction. However, when a conductor is identified to require full replacement, it will be assessed as part of planned replacement that will result in a lower overall cost.

3.2.2 Non-Network alternatives – does not address the need

Due to the type and function of these assets, there are no non-network alternatives or solutions that can be implemented in place of direct asset replacement with like for like (modern equivalent) assets. When a conductor is identified for replacement, Power and Water undertakes an assessment of whether the size or type can be changed to reduce cost or to meet future demand most efficiently.

3.2.3 Capex/Opex Substitution – does not address the need

Since the driver of this investment is significant deterioration across a fleet of assets caused by the same design deficiency and environmental conditions, it is not feasible to substitute capital expenditure with operational expenditure to resolve the risk. Only capital expenditure to replace part or all the conductor will address all the underlying issues.

3.2.4 Standalone Power Systems (SPS) – excessive cost and does not address the need

An option to implement a SPS was also considered. It involves removing section(s) of poles and wires supplying these customers and instead supplying them via a SPS comprised of solar PV, batteries and diesel generator. Based on recent projects, the following costs of operating a SPS has been calculated:

- A 1MVA system with diesel generator, Solar PV and BESS will cost an estimated $7.8m. With an Equivalent Annual Cost (based on 20 year life) of $470k.

- Annual fuel consumption is estimated at $2.4m based on the generator operating at an average of 50% capacity (consistent with the load profile at Manton ZSS).
- A simple discounted cashflow using the capital cost and annual fuel costs over a 20 year period shows that an SPS is significantly more expensive than a network solution, even considering full benefits of improved reliability (approximately $220k per annum saving due to reduced outages, refer to section 2.3).
- Maximum demand of 1MVA has been assumed, to match the system size of the available SPS cost data with the load duration curve of Manton ZSS, to calculate the total energy supplied of 4,6385MWh per year.
- This results in a cost to customers of $0.62 per kWh. In comparison, the pricing order[4] caps the highest rate for residential customers at $0.31 per kWh and $0.39 per kWh for commercial customers.

This high-level analysis indicates that the installation of an SPS is likely to be uneconomic.

The feasibility of SPS is also questionable as it may not be deliverable within the required timeframe. This is because of the need to obtain significant land area for installation of solar panels and generation, requiring consultation and approval involving local landholders and communities. In addition, there are high initial costs for the installation of generation, ongoing operational costs for fuel and maintenance.

[4] Electricity Pricing Order 1 July 2021 - 30 June 2022, available at: https://utilicom.nt.gov.au/publications/correspondence-directions-and-notices/electricity-pricing-order-1-july-2021-30-june-2022

4. Recommendation

The recommended option is Option 2 – Mid-span pole installation and re-conductoring, to be most prudent and cost effective to meet the identified needs. This option has an estimated capex of $4.74 million (real 2021/22) for the 202429 regulatory period. Option 2 has a NPV of $24.5 million relative to the Option 1 base case.

While Options 2 and 3 had the same resultant risk profile and both result in a new compliant distribution line, the cost benefit analysis found that Option 2 was the most efficient with a lower capital cost and higher NPV compared to Option 2. Therefore, Option 2 is the preferred option.

The proposed program is consistent with the National Electricity Rules Capital Expenditure Objectives as the expenditure is required to maintain the quality, reliability and security of supply of standard control services and maintain the safety of the distribution system.

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4.1 Strategic alignment

The “Power and Water Corporation Strategic Direction” is to meet the changing needs of the business, our customers and is aligned with the market and future economic conditions of the Northern Territory projected out to 2030.

This proposal aligns with Asset Management System Policies, Strategies and Plans that contributes to the D2021/260606 “Power and Water Strategic Direction” as indicated in the table below.

Table 7 Strategic alignment

	Strategic direction focus area	Strategic direction priority
1	Customer and the community at the centre	Improve Public Health and Safety
2	Always Safe	Cost Prudency

4.2 Dependent projects

The scope of this project relies on the successful replacement of 27km of cockatoo conductor on the Lake Bennett Feeder by June 2024, under the existing program.

Historically, cockatoo conductor replacement had been included in the Poor Performing Feeder (NMF) program. However, since a dedicated replacement program has been implemented, cockatoo conductor has been excluded from the NMF program to ensure there is no double counting of expenditure.

4.3 Deliverability

This project will replace 24 km of Cockatoo conductor over the next regulatory period based on identified defects and replacement volumes. It will also deliver a total of 182 distribution poles either as replacements or new mid-span poles. The annual volumes are based on the existing project and are comparable to the actuals in 2021-22 and budgeted for 2022-23 through to 2023-24. This improves certainty regarding the deliverability of the program.

4.4 Customer considerations

As required by the AER's Better Resets Handbook[5], in developing this program Power and Water has taken into consideration feedback from its customers.

Feedback received through customer consultation undertaken at the time of writing this PBC, has demonstrated strong support amongst the community for appropriate expenditure to enable long term maintenance of the network to ensure improved reliability, maintainability and safety of supply[6].

The scope of the existing project was changed from the scope originally proposed in the business case in response to customer consultation regarding outages and managing customer expectations.

4.5 Expenditure profile

This business case proposes $4.74 million (real 2021/22) of capex for the scope of work to be completed between July 2024 and June 2029 (2024-29 regulatory period) which will replace the remaining 24 km of the Cockatoo conductor in the Manton, Batchelor and Adelaide River areas and install additional poles to the relevant sections of line.

Table 8 shows a summary of the expenditure requirements of the for the 2024-29 regulatory period.

Table 8 Annual capital and operational expenditure ($'000, real FY22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	1,019	1,786	1,933	0	0	4,738
Opex	-	-	-	-	-	0
Total	**1,019**	**1,786**	**1,933**	**0**	**0**	**4,738**

4.6 High-level scope

The scope of this project is to replace 24 km of Cockatoo conductor and install mid-span poles, over the next regulatory period, based on identified defects and replacement volumes. The indicative length of Cockatoo conductor replacement, numbers of distribution poles and poletops to be replaced (are covered under Table 9 below.

The volumes are based on 150 metre average spans, 70% of the poles required being new and 30% of the required poles covered by the existing poles. All poles require new pole tops.

[5] Better Resets Handbook – Towards Customer Centric Network Proposals, Australian Energy Regulator, Dec 2021
[6] Darwin Peoples Panel, 2nd and 3rd April 2022

Table 9 Indicative list of proposed conductor replacements during the 2024-29 regulatory period

Feeder name	Conductor length (km)	New distribution Poles (#)	New Poletops (#)
Acacia	57 Note 2	24	34
Manton Note 1	3	20	30
Lake Bennett	16	75	107
Total	**26**	**119**	**171**

Note 1: The terrain in the Coomalie Creek area of the Lake Bennett feeder is difficult and therefore the expected cost is approximately twice the unit rate as for the other section of the feeder. Allowance for 50% more poles included.

Note 2: the 7 km is comprised of 5 km of the cockatoo conductor plus 2 km of short sections that have been replaced on failure and will be brough up to current standard and the installation of OPGW for the full 2 km route.

The final project definition will be provided in the Project Investment Delivery Business Case supporting the next project phase gateway.

Appendix A. Cost estimation

The forecast is based on the most recent actual costs incurred by Power and Water for works completed so far, as summarised in Table 10.

Table 10 Actual incurred costs up to FY22

Stage	Length (km)	Total cost (real FY22)	Unit rate (per km)
Stage 1	5	$794,432	$158,886
Stage 2	8	$1,284,649	$160,581
Total	13	$2,079,081	$159,929

The following additional considerations regarding cost have also been included in the cost estimate:

- For the 3 km section of 22MT06 Lake Bennett feeder in the Coomalie Creek locality, the estimate for construction is double the cost of the rest of the line. This is due to:
    - Expected impacts of permitting restrictions by AAPA that may force alternative line routes or limitations on site work.
    - Difficult terrain that will be more difficult and time consuming to string the conductors.
    - The need to build or refurbish access tracks to be able to undertake the works.
    - Expected requirement for more poles (shorter spans) due to the terrain and corners in the existing easement.
- For the 22MT07 Acacia feeder, a total line length of 7km will need to be built. This is comprised of:
    - The existing 5km of the line comprised of cockatoo conductor will be replaced using the same method as done for the competed Stage 1 and Stage 2.
    - An addition 2 km has been identified to require partial rebuild due to sections that were previously replaced due to failure of cockatoo and will be brought to the same standard and construction as the rest of the feeder. This will minimise the joints in the line and provide a better long term outcome for the asset. In addition, for the entire 2 km section requires installation of OPGW.
- An allowance has also been made for permitting and approvals from AAPA:
    - While there is an existing line and easement, Power and Water does not currently hold a permit from AAPA (legacy issue from when the line was first built), so a permit will be required for the full line length and can only be done once the full detailed design is completed.
    - The route passes through a number of areas that have been identified by Power and Water as potentially sensitive areas, hence Power and Water expects additional costs for permitting.
    - Power and Water must also work with multiple traditional owners in different sections of the route.

The total costs are summarised in Table 11.

Table 11 Estimated costs for 2024-29 regulatory period

Stage	Length (km)	Unit rate (per km)	Total cost (real FY22)
Acacia feeder (purple line in Figure 1).	5	$160,000	$800,000
Acacia feeder (purple line in Figure 1). Section of a 2 km of overhead line to be replaced plus installation of OPGW.	2	$160,000	$320,000
Lake Bennett feeder (orange line in Figure 1). This section is expected to be twice as expensive due to the difficult terrain increasing the effort (and therefore labour cost) to complete this work , and	3	$320,000	$960,000
Lake Bennett feeder (red line in Figure 1).	16	$160,000	$2,560,000
AAPA permit cost estimate		$100,000	$100,000
Total	**24**		**$4,740,000**

Appendix B. Key assumptions

The risk analysis for each option is nominally based on a calculated model where the forecast number of annual failures is estimated using the age profile and probability curves. The HV OH conductor asset is taken to have a Weibull type survival curve with a life of 60 years and a slope of 2.0.

There are no planned replacements for Option 1. Both Options 2 and 3 have the same risk model profile of replacing 24 km of line during FY25 to FY29. This is in addition to 27 km of line modelled as replaced in FY23 to FY24. This results in these options having the same network risk profile at completion of the project.

The risk models for all the options have a custom profile for compliance breaches, which is only used in the compliance value dimension of risk modelling. This results in Option 1 having a continuing (constant) number of compliance breaches (as there are no replacements), While Options 2 and 3 have no compliance breaches beyond FY28.

Energy not supplied is based on historical data for the Lake Bennett feeder.

There is nil capex in the Option 1 financial model as it is repaired upon failure.

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