

Sadadeen to Lovegrove fibre optic upgrade

Regulatory Business Case (RBC) 2024-29

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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 investment 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 risks to network security and functionality of the current topology of the fibre optic cables in Alice Springs.

1.1 Business need

Fibre optic cable is used for fast and reliable communications between critical services for greater Alice Springs including protection, Scada and Territory Generation (TGEN) devices. Standard practice is to have N-1 redundancy with full separation between the independent communications paths so that a single incident doesn't disrupt the communications, and therefore SCADA and protection schemes. Full N-1 redundancy requires installing two separate cables taking separate routes so that failure of, or damage to, of one cable does not affect the other.

The current topology of the fibre optic cables in Alice Springs has the following key issues that pose significant risk to network security and functionality:

- Visible physical wear and tear on most of the fibre optic cable pole joints has been identified but cannot be addressed in the current configuration as it would require simultaneous outages on both paths in the communications network.



- The fibre optic cable topology is currently installed as a 'folded loop' with some sections of the fibre owned by third parties. This means that the two communications routes between each location are provided by separate cores within the same cable, hence these are not a fully independent path and damaging a single cable could disrupt all communications.
- This arrangement does not meet the requirements of the Network Technical Code (Clause 3.2.3.2, 2.9.2.2 and 2.9.5) which specify fully independent protection schemes, which includes the communication paths.

A qualitative risk analysis was carried out and demonstrates that the risk posed by the current fibre optic network topology is Very High and not acceptable to Power and Water.

The analysis above demonstrates there is a strong network need to mitigate the risks posed by the existing installation. Section 3 assesses the most prudent approach to mitigate the risks.

1.2 Options analysis

A program has been initiated to address the identified need and will be conducted in two stages. Stage 1 is underway and will be completed during the current regulatory period. It will address the connection from Owen Springs Power station to Lovegrove Zone Substation.

Stage 2 of the program is proposed to correct the connection from Sadadeen Zone Substation to Lovegrove Zone Substation and is proposed for the 2024-29 regulatory period.

In light of the existing program, two options were considered as described in Table 1.

Table 1 Summary of credible options

Option No.	Description	Recommended
1	Do not proceed with Stage 2 and retain the current topology	No
2	Continue with Stage 2 of the fibre optic cable upgrade	Yes

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.

1.3 Recommendation

The recommended option is Option 2 - Continue with Stage 2 of the fibre optic cable upgrade, at an estimated cost of \$1.5 million (real 2021/22), to be most prudent and cost effective to meet the identified needs. Table 2 shows a summary of the expenditure requirements for the 2024-29 regulatory period.

Table 2 Annual capital and operational expenditure (\$'000, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	-	-	1,200	250	-	1,450
Opex	-	-	-	-	-	-
Total	-	-	1,200	250	-	1,450

2. Identified need

This section provides the background and context to 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 Asset profile

Fibre optic cable is used for fast and reliable communications between critical services for greater Alice Springs including protection, Scada and TGEN devices.

SCADA and protection devices at Sadadeen and Lovegrove zone substations (ZSS) rely on the fibre optic network and are critical for network stability, safety and security. The types of protection that rely on these cables are typically differential protection and intertrips that will detect a fault and cause circuit breakers to open within milliseconds. This is required to minimise the fault current and avoid damaging assets or harming people.

Figure 1 shows the current topology of the fibre optic cables in Alice Springs. It highlights the following key issues that pose significant risk to network security and functionality:

- Visible physical wear and tear on most of the fibre optic cable pole joints has been identified, however with the folded loop topology, preventative maintenance or upgrade work is not able to be performed as this would require both paths in the communications network being removed from service simultaneously. The Alice Springs network cannot ensure safe and secure supply if both communication paths are removed from service concurrently.



- The fibre optic cable topology is currently installed as a 'folded loop' with some sections of the fibre owned by third parties. This means that the two communications routes between each location are provided by separate cores within the same cable, hence these are not a fully independent path and damaging a single cable could disrupt all communications.
- Some protection schemes between Sadadeen ZSS and Lovegrove ZSS are implemented through a pilot wire (the blue line in Figure 1). A pilot wire is a copper wire and has significantly limited bandwidth and functionality compared to fibre optic.
- This arrangement does not meet the requirements of the Network Technical Code (described in section 2.2)

Standard practice is to have N-1 redundancy with full separation between the independent communications paths so that a single incident doesn't disrupt the communications, and therefore SCADA and protection schemes. Full N-1 redundancy requires installing two separate cables taking separate routes so that failure of, or damage to, of one cable does not affect the other.

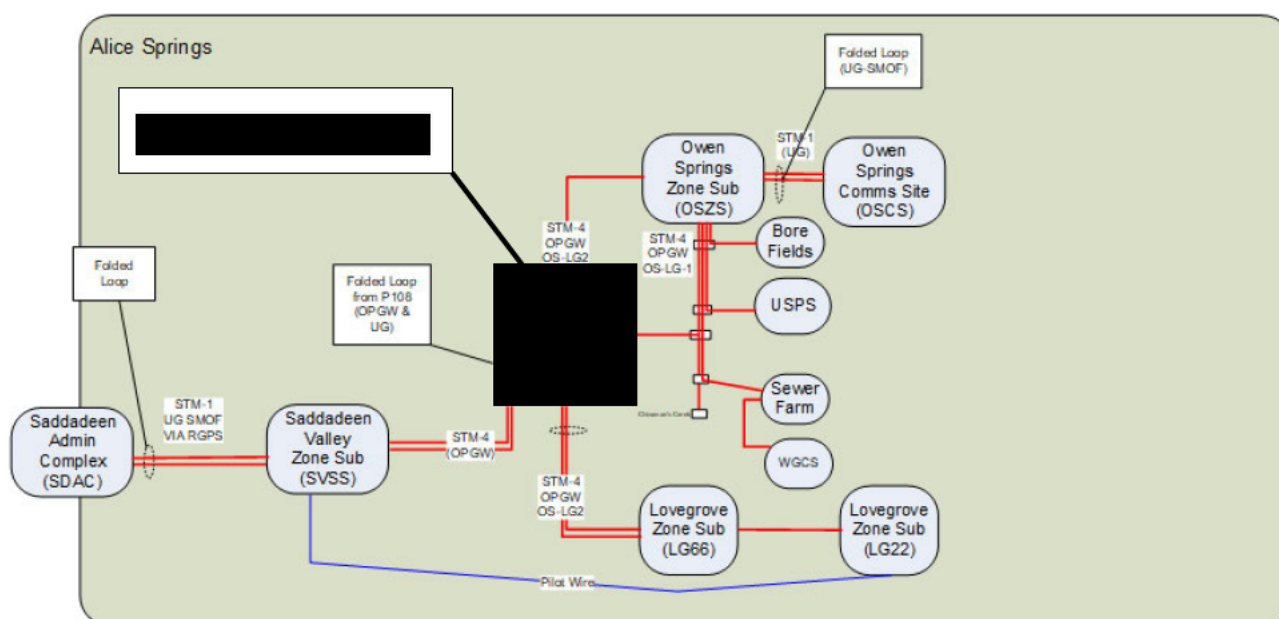


Figure 1 Current topology of the optic fibre cables

2.2 Regulatory and code compliance requirements

Power and Water is required to maintain compliance with the Network Technical Code and Network Planning Criteria (Technical Code) including for the maintenance of communication paths and protection systems. The nature of protection and communication requirements reflects the specific network design and configuration as nominated in the Technical Code. In this case, the Saddadeen ZSS is supplied from Lovegrove ZSS via two 22 kV 'express ties', also known as interconnectors.

The Technical Code at section 2.9.2 requires that primary equipment connected at voltages of less than 66kV shall be protected by two independent protection systems.

Section 3.2.3.2 of the Technical Code requires for interconnectors operated at 33kV and below:

- Protection shall be by two fully independent protection schemes as set out in clause 2.9.2.2.
- The protection arrangements shall be capable of clearing a fault within the clearance times set out in clause 2.9.5.

Clauses 2.9.2.2 and 2.9.5 provide further guidance on this requirement, most importantly to be able to clear a fault within the Critical Clearance Time. A fibre optic based differential protection scheme is more effective at achieving the clearance speeds over the distance between the two zone substations.

Further details of the compliance requirements relevant to this business case are provided in Appendix B.

2.3 Current management programs

The current risks and issues with the condition and topology of the fibre optic cables is being addressed through a staged process to remove the folded loop arrangement and ensure full N-1 redundancy is provided as required by the Technical Code.

There are two proposed stages from the original business case (PRA34589 under NMSC4):

- Stage 1 – separation of fibre paths from Owen Springs Power station (OSPS) to Lovegrove Zone Substation (LG ZSS). This is currently being planned and constructed and will be completed during the current regulatory period, prior to July 2024.
- Stage 2 is the proposed separation of fibre between Sadadeen Zone Substation (SD ZSS) and Lovegrove Zone substation (LG ZSS) through the city. Stage 2 is complex and the planning and design will be completed this regulatory period with construction completed next regulatory period (FY2024 to 2029).

Stage 1 is being completed as part of the new [REDACTED] zone substation as the improved communications security was required by a customer. The expected cost for the stage 1 scope of works is [REDACTED]

2.4 Risk assessment

Power and Water has developed the Risk Quantification Procedure to enable consistent quantification of risk from their assets into dollar terms. The procedure is applicable to most assets where there is a direct link between an asset failure and the impact of that failure on the defined consequence categories.

However, there is insufficient data to undertake a quantitative analysis on the impact of loss of the fibre optic cable network in Alice Springs, a qualitative assessment of the risk has been undertaken using the relevant key consequence areas set out in the Risk Quantification Procedure.

The fibre optic cable network is critical for control of the network for protection systems, to undertake network switching operations and to have visibility of the network status.

[REDACTED]

Further, due to the current topology, maintenance and repair of the deteriorated parts of the network is not possible. Without adequate reliability there is a high risk of loss of communications, contributing to issues in Alice Springs including:

- **Health and Safety:** Loss of visibility of the network could endanger Power and Water's field crews and the public through failure to manage the network configuration to isolate faults, incorrect operation of protection systems, or through operation of switches that could energise faulted sections of the network.
- **Service delivery:** Loss of visibility of the network could result in delayed response times, extending outages and therefore result in poor service to our customers.

The risk assessment is shown in Figure 2 in the matrix format as specified in the Enterprise Risk Management Standard. It shows the current risk ranking and the target risk ranking.

	Insignificant	Minor	Moderate	Major	Severe
Almost certain	Medium	High	Very High	Extreme	Extreme
Likely	Low	Medium	High	Very High	Extreme
Possible	Low	Low	Medium	High	Very High
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Low	Medium	Medium

Figure 2 Qualitative risk assessment

2.5 Summary

The existing topology of the fibre optic cable in Alice Springs is showing visible physical wear and tear, currently not installed according to Power and Water standards or the Technical Code, has a critical single point of failure and is not able to be adequately maintained.

A program has been initiated to correct the installation and will be conducted in two stages:

- Stage 1 will correct the connection from Owen Springs Power station to Lovegrove Zone Substation and will be completed in the current regulatory period (2019-24).
- Stage 2 will correct the connection from Sadadeen Zone Substation to Lovegrove Zone Substation and is planned for the next regulatory period (2024-29).

There is a strong network need to mitigate the risks posed by the existing installation. Section 3 assesses the most prudent approach to mitigate the risks.

3. Options analysis

This section describes the various options that were analysed to address the increasing risk to identify the recommended option.

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 - Do not proceed with Stage 2 and retain current topology.
- Option 2 - Continue with Stage 2 of the fibre optic cable upgrade.

A comparison of the two identified credible options and the issues they address in the identified need is depicted in Table 3.

These options are described and assessed in detail in the sections below.

Table 3 Summary of options analysis outcomes

Assessment metrics	Option 1	Option 2
NPC (\$'000, real FY22)	-	1,324
BCR	NA	NA
Capex (\$'000, real FY22)	0	1,450
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 - Do not proceed with Stage 2 and retain the current topology

This option proposes to retain the current topology and not complete Stage 2 of the proposed works. This option will not enable Power and Water to:

- Address remaining identified condition issues.
- Achieve compliance with the Technical Code.
- Undertake adequate maintenance on the network and hence result in increasing risk as the pole top joints continue to deteriorate.



This option is not recommended.

3.1.2 Option 2 - Continue with Stage 2 of the fibre optic cable upgrade

This option proposes to continue to implement Stage 2 of the proposed works. This option will enable Power and Water to:

- Address remaining identified condition issues.
- Achieve compliance with the Technical Code.
- Undertake adequate maintenance on the network and hence result in increasing risk as the pole top joints continue to deteriorate.



The total cost of this option is estimated to be \$1.5 million (real 2021/22) based on the initial analysis and quotes received for the Stage 1 works. This project (stage 2) is proposed to be implemented in 2026/27 and 2027/28. The timing has been determined based on the completion date of Stage 1, allowing for the complexity of detailed design and planning for implementation and managing within the resourcing constraints of the team.

This option is recommended.

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 detail analysis for the reasons provided.

3.2.1 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.

4. Recommendation

The recommended option is Option 2 – Continue with Stage 2 of the fibre optic cable upgrade, at an estimated cost of \$1.5 million (real 2021/22), to be most prudent and cost effective to meet the identified needs.

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.

This option mitigates the risks arising from identified condition and topology of the existing installation. The two key risks are a single point of failure and the current inability to maintain and repair the deteriorating asset as due to the folded loop topology, the fibre cannot be removed from service without loss of communications on the network.

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 “PWC Strategic Direction” as indicated in the table below.

Table 4 Alignment with corporate strategic focus areas

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

4.2 Dependent projects

There are no known projects or other network issues that are dependent on the resolution of this network issue.

4.3 Deliverability

This is a low-cost project that relies on standard skills and business as usual tasks. No delivery risks have been identified.

4.4 Customer considerations

As required by the AER’s Better Resets Handbook, in developing this program Power Services 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 continued reliability, maintainability and safety of supply.

4.5 Expenditure profile

Table 5 shows a summary of the expenditure requirements for the 2024-29 regulatory period.

Table 5 Annual capital and operational expenditure (\$'000, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	-	-	1,200	250	-	1,450
Opex	-	-	-	-	-	-
Total	-	-	1,200	250	-	1,450

4.6 High-level scope

The scope for this works remains at the concept stage. It will involve part of the route being completed using overhead Optical fibre Ground Wire (OPGW) installed on the overhead network and part of the route being completed using cables installed underground. The route will span a total length of about 3km through the city centre. Some route options through the city have been considered but have not progressed to a detailed duct/trench study, which will be completed closer to implementation.

Appendix A. Cost estimation

The cost estimate for the proposed option is based on the initial high level/concept scoping study and quotes and costs received when tendering for the Stage 1 works. Since this is based on recent market rates, the cost is considered to reflect an efficient cost estimate.

The market-based quote for the Stage 1 [REDACTED] based on existing trenches, conduits and pits that would be used for installation.

Stage 2 has an extended underground section through the CBD with trenches, conduit and pits needing to be installed. It will also include overhead fibre optic (OPGW) sections with transitions between overhead and underground. Overall, this will increase the cost compared to Stage 1. The cost for Stage 2 is estimated to be \$1.5 million (real 2021/22).

Appendix B. Compliance requirements

Power and Water is required to maintain the communications network to ensure compliance with a number of legislative requirements. This is consistent with the principles of the Risk Quantification Procedure, and while there are legislated penalties for non-compliance, compliance has been considered in a qualitative manner.

The relevant Legislation, Regulation and Codes include:

- Electricity Reform Act 2000
- Network Licence (varied 15 May 2020)
- National Electricity (NT) Rules (NT NER)
- Network Technical Code and Network Planning Criteria (Network Technical Code)
- System Control Technical Code

The key clauses that relate to the provision of communications systems are:

- The System Control Technical Code Clause 6.18(a) requires System Participants (the definition includes Power and Water as the network operator) to provide control and monitoring, alarms and measurements to the Power System Controller's SCADA system via communication links.
- The Network Technical Code Clauses 3.2.6 and 3.3.6.2 define the communications links between a User (generator or load) and the control centre (System Control) to be the responsibility of the Network Operator.
- The Network Licence Clause 10 requires Power and Water to comply with all applicable provisions of the System Control Technical Code and the Network Technical Code.
- The Electricity Reform Act 2000 Clause 31 provides a maximum penalty of 2,500 penalty units for contravening the licence conditions. A penalty unit is worth \$157 in 2021/22¹, providing a maximum penalty of \$392,500 per contravention.

There are clear legislative and government requirements for Power and Water to maintain a modern communications system and that the requirements are expected to become more stringent within the next few years with the introduction of the proposed Critical Infrastructure Bill. Decisions made on the technology and asset types installed now must provide real options² for providing the cyber security capability and technology compatibility required in the near future.

¹ <https://justice.nt.gov.au/attorney-general-and-justice/units-and-amounts/penalty-units>

² Regulatory Investment Test for Distribution, Application Guidelines, December 2018, Australian Energy Regulator, Section 3.2.3

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