Business Case: Asset Monitoring

Directlink Joint Venture
2025-2030 Revenue Proposal

Energy
Infrastructure
Investments

Document control

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Table 1.1: Revision Record

Version	Date	Updated By	Changes Made
0.1	*13/11/2023*	*James Brandt*	*Initial draft*
0.2			*Feedback received from group discussions*

Table 1.2: Review and Distribution

Name	Role	Action	Sections
Noel Power	Senior HV Power Engineer	Input	All
James Brandt	Asset Performance and Lifecycle Specialist	Input	All
Eric Kocaj	Head of Infrastructure Projects	Input	All
Mark Allen	Regulatory Manager	Review	All

Table 4: Approvals

Name	Role	Approval	Date Approved
Annie Martyn	Asset Manager	*Approved*	*19/01/24*
Paul Alexander	GM Asset Management	*Approved*	*19/01/24*

Contents

1. Purpose

To present project recommendations and expenditure forecast for inclusion in the Directlink Regulatory Proposal for the FY26 to FY30.

This business case supports forecast capital expenditure of $1.28million on a portfolio of projects within the Asset Monitoring program of Directlink.

Cost estimates are provided in FY25 dollars unless stated otherwise.

2. Scope of the Business Case

The program of Asset Monitoring for Directlink is focussed on ensuring reliability of asset performance, safety and maintenance through improved monitoring of the asset's condition, given the criticality of accurate and timely asset information used to respond to and improve situational awareness.

This Business Case seeks to identify and evaluate a range of fit-for-purpose asset monitoring measures over the 2026-30 regulatory control period, with the view to uplift the current capabilities to monitor and manage asset integrity, reliability and the overall safe and effective operation of assets with the need to protect electricity consumers from inefficient investments.

All cost estimates project expenditure in the 2025-30 regulatory control period are provided in FY25 dollars unless stated otherwise.

3. Efficient Execution of Projects

When undertaking all projects in this business case APA will comply with the APA Group Procurement Standard. The APA procurement standard outlines the process by which all procurement of APA projects occurs. It defines the competitive procurement processes and provides efficient outcomes for the business. The capital expenditure is managed by the AMP, with its reference to Section 2.4 of the Asset Lifecycle and Performance Plan to support efficient execution of project.

4. Background and Context

4.1. Identification of Need

APA continues to make investments in its core systems and processes that support its array of gas and electricity assets across the country. There has been an increased focus in operational excellence activities and how assets are consistently integrated leading to improved results in performance, reliability and overall asset information management.

Directlink is positioned to take advantage of these programs, although has not yet funded the program of works required to leverage standardised 'ways of working'. APA owns 3 HVDC interconnectors across Australia and effectively maintained platforms across the asset base will help reduce operational risks associated with bespoke platforms for each site.

Secure, structured, accurate and reliable asset information is essential for enhanced asset monitoring with engineering teams empowered to make data-driven decision from remote locations with robust system controls and protection in place. These uplifts span Maintenance Management

Systems, Records Management and Historian platforms in-line with APA's system and business process architecture.

4.2. Risk assessment framework for Safety and Protection Program

Major maintenance is required for Directlink to minimise the risk of outages and faults given the age of the asset. Major maintenance carried out in the regulatory period 2025-2030 will also ensure ongoing maintenance costs are optimised and efficient up to the end of its economic life in 2042.

Section 2.4 of the Asset Performance and Lifecycle Plan outlines the governance and high-level risk framework in which these projects are assessed. This process includes assessment of the likelihood and consequence consistent with APA's Risk Matrix.

4.3. Regulatory context

The Asset Monitoring program for Directlink is designed to meet the following capital expenditure objectives set out in clause 6A.6.7(a) of the National Electricity Rules:

- maintain the quality, reliability, and security of supply of prescribed transmission services (6A.6.7(a)(3)(iii)); and
- maintain the reliability, safety, and security of the transmission system through the supply of prescribed transmission services (6A.6.7(a)(3)(iv)).

The Asset monitoring capital expenditure associated is consistent with the requirements of (6A.6.7(a)(3)(iii)) because it will maintain the quality, reliability, and security of supply of prescribed transmission services. Asset monitoring is required to maintain the aging asset to the end of its economic life in 2042, to maintain supply and reduce the risk of outages. To the extent that Directlink is associated with providing services to the transmission system (6A.6.7(a)(3)(iv)).

5. Proposed Projects

The proposed schedule of expenditure for **Asset Monitoring** for the regulatory period FY26-FY30 is;

Table 5.1 – Asset Monitoring capital expenditure ($FY25)

Program	FY26	FY27	FY28	FY29	FY30	Total
Asset Integration - Asset Information	0.25	-	-	-	-	0.25
Asset Maintenance Management Uplift and Maintenance Strategy	0.39	0.14	-	-	-	0.52
Master Controller- FEED	-	-	-	-	0.14	0.14
Operations Asset Integration	0.09	0.09	0.09	0.09	-	0.37
Total	0.73	0.37	0.09	0.09	0.14	1.28

Real 2025$ with project management fee, APA margin, and labour escalation.

5.1. Asset Information Management

Background

APA uses Enterprise Content Management (ECM) as its controlled document management system. This is used to store all critical asset information, including all asset drawings and documents for the asset.

Issue

Directlink's asset drawings and documentation are stored and managed through various platforms, with knowledge of information sources retained by key site support personnel.

Lack of access to verified and validated asset information impacts the ability to troubleshoot issues or deliver maintenance. This can also result in inefficient use of projects resourcing, revalidating technical data to proceed with technical assurance and project delivery.

Risk Assessment

The most credible consequence is delayed return to service due to ineffective troubleshooting. This has occurred in the past and is expected to continue in the next revenue period as engineering authorities needing to attend site to obtain the correct data.

There are additional risks such as inefficient work practises in assuring accurate data for maintenance and projects and poor change impact assessment resulting in faults and reliability issues.

The Risk Score associated with the current state is a consequence of 2 and a likelihood of 5.

Untreated Asset Risk Score: 2(Minor) x 5 (Frequent) = Moderate

Preferred Option

The recommendation is to use APA-wide systems for managing critical asset information. The objective is to migrate asset drawings and documentation across multiple sources into ECM, whilst ensuring the latest revision of drawings and documentation are available for use. The process includes validating accuracy of key documents / drawings being migrated as a single source of truth.

5.2. Asset Maintenance Management Uplift and Maintenance Strategy

Background

Maximo is APA's Computerised Maintenance Management System (CMMS) and is used to maintain a comprehensive record of the asset, equipment and facilities including details such as location, specifications, maintenance history and other key asset information. Maximo is the key tool used to plan, schedule and execute efficient maintenance across APA's assets.

Issue

The current configuration of the asset hierarchy and associated maintenance processes at Directlink is sub-optimal. As a result, the reactive and preventative maintenance activities require significant manual intervention, risking quality and consistency. This also risks incorrect or adequate data collection relating to the results of proactive testing, use of spare parts etc.

With the current gaps in the maintenance system; there are a number of possible consequences:

- Reliability review of failure data is manual and changes in performance, failure rates may not be appropriately recognised. If leading indicators of hardware issues are not identified, continual performance deterioration will occur unchecked; ultimately resulting in declining reliability and increasing reactive maintenance costs. As this technology that was relatively new at the time of commissioning and is now reaching mid-life, further reliability issues not

yet known by industry experts may arrive. As such, monitoring for leading indication of hardware issues is increasingly critical to ongoing reliable operation.

- If maintenance work is not sufficient detailed in the CMMS system, it is dependent on individuals conducting works to a consistent quality and to track the planned and actual spare parts required to perform tasks. This may result on maintenance performed in a way that is not compliant or of a poor quality resulting in premature hardware failure and premature stock out of spare parts.

Risk Assessment

If maintenance planning and execution gaps remain, it is likely that reliability issues are not addressed proactively; resulting in more frequent, longer duration outages for the remainder of Directlink's life.

The Risk Score associated with the current state is a consequence of 3 and a likelihood of 3.

Untreated Asset Risk Score: 3 (significant) x 3 (unlikely) = Moderate

Preferred Option

This proposal targets uplifting the CMMS to address integrity and safety risks through the implementation of a robust maintenance strategy and works management process aligned with CMMS capability uplift programs in place at APA.

5.3. Master Controller Front-End Engineering and Design (FEED) Study

Background

To meet AEMO dispatch targets, all 3 x 60MW stations are usually dispatched concurrently to meet the required target, for example if a total of 90MW is required, each system transfers 30MW each.

Issue

When all three parallel systems operate under low load conditions, this requires parallel running of cooling systems and other plant such as phase reactor fans, incurring unnecessary load, maintenance and emissions.

The Original Equipment Manufacturer (OEM) has recommended to operate with less systems online at any given time to deliver the required power. The OEM has indicated this may deliver improved reliability of critical components as they are not operating 24/7.

APA wish to understand the optimal dispatch for running three systems and the impact of switching on components, energy savings and more broadly assess any market benefits offered through secondary capabilities such as voltage support or primary frequency response services.

Risk Assessment

The opportunity is to optimise the running of the converter stations when the load requirements are low, therefore preserving asset life and maximising energy efficiency in delivery of expected demand and grid solutions for prescribed transmission services into the future.

If this assessment is not conducted; it will to be possible to determine the viability of this project, resulting in ongoing sub-optimal reliability.

The Risk Score associated with not undertaking this assessment is a consequence of 3 and likelihood of 4.

Untreated Asset Risk Score: 3 (Significant) x 4 (Occasional) = High

Preferred Option

The recommendation is to undertake a feasibility study to refine the design scoping of a master controller system to assess whether it delivers net benefits to customers through the management of optimal dispatch.

5.4. Operations Asset Integration

Background

Directlink is remotely monitored by APA's Integrated Operational Control (IOC) team and has on-going OT related requirements to manage servers, software and asset insight solutions.

Currently, Directlink is remotely monitored by APA's Integrated Operational Control (IOC) team with ongoing OT related requirements to manage servers, software and asset insight solutions. Although general alarms are able to be monitored 24/7 from the IOC, it is not possible to identify specific faults without site access. In addition, some of the connection functions with the distributors are not able to be remotely monitored, resulting in incomplete fault data. These is also no redundancy in the current OT monitoring systems.

Issue

The asset has not been fully integrated into APA's operating systems, resulting in potential cybersecurity, operability, and reliability monitoring risks. As well, alarm and security (both physical and cyber) response are not as timely as possible.

Without improved integration, there is a risk of a security or reliability incident being inadequately addressed.

Risk Assessment

A delayed response may result in asset damage. For example, failure to respond to an alarm in a timely manner may result in electrical component destructive failure; impacting associated equipment and resulting in an extended outage (over one month) while a repair is executed.

The Risk Score associated with not undertaking this assessment is a consequence of 4 and likelihood of 2.

Untreated Asset Risk Score: 4 (Major) x 2 (Remote) = Moderate

Preferred Option

The recommendation is to fully integrate Directlink into APA's IT/OT operational protocols which addresses OT risks and enables increased site operability and remote operational efficiency. Initiatives to improve high-resolution data management, cyber security, IT/OT connectivity enhances future asset monitoring requirements by APA's IOC and engineering teams.

6. Project Options Analysis

For each project, APA has explored an appropriate range of credible options seeking to balance cost, benefits and risk, including scope to defer investment. In some instances, project needs and the means of addressing them are limited, in which case only a "Do-nothing" base case (Option 0) and a single credible option was investigated.

The table below sets out the options evaluated for each project, the preferred option and the overall justification for the preferred option.

Table 6.1 - Project Options Analysis

Project	Alternatives considered	Analysis	Asset Risk Score	Estimated cost
Asset Information	**A) Do nothing** Continue to maintain multiple information repository systems.	Risk: Asset compromised with inaccurate information hindering the ability to maintain the asset and assess the impact of any modifications. Risk: Outages due to faults are extended for days to weeks, negatively impacting the market and risking reliability of supply to customers. This is not the preferred option as this does not reduce the unacceptable residual risk to the market and reliability of supply to customers.	Untreated risk: Consequence: 2 Likelihood: 5 Risk: Moderate	Approx. $50,000 OPEX and CAPEX in inefficient data assurance activities for maintenance and projects.
	B) Migration of asset data into ECM Collate asset data stored across multiple repository systems, validate its accuracy and migrate into ECM	Benefit: Reduces the impact of making incorrect decisions using unvalidated information Benefits: More timely decision-making with efficiencies gained through timely access to required asset information This is the preferred option as this reduces the residual risk to an acceptable level, providing long term data integrity for the lowest cost.	Consequence: 2 Likelihood: 2 Risk: Negligible	$250,168

Project	Alternatives considered	Analysis	Asset Risk Score	Estimated cost
Asset Maintenance Management Uplift and Maintenance Strategy	A) Do nothing No changes to the level of consolidation of Directlink assets into the CMMS.	Risk: Poor maintenance practises and reliability assessments resulting in increased frequency and extended duration unplanned outages as the asset ages. This will negatively impact the market and risk reliability of supply to customers. Risk: Sub-optimal spares and materials management impacting the ability to maintain the asset. Risk: Inability to optimise maintenance efficiency and robustness by drawing on HVDC asset systems (i.e. cannot utilise common spares across assets and implement reliability improvements from Murraylink). This is not the preferred option as this does not reduce the unacceptable residual risk to the market and reliability of supply to customers.	Consequence: 3 Likelihood: 3 Risk: Moderate	0
	B) Partial uplift of CMMS A focus on preventative maintenance tasks and job plans without correct system configuration to manage maintenance strategies.	Benefit: Marginally improved maintenance practises, delivering consistent maintenance under current reliability strategies. Risk: Poor reliability assessments resulting in increased frequency and extended duration unplanned outages as the asset ages. This will negatively impact the market and risk reliability of supply to customers. Risk: Sub-optimal spares and materials management impacting the ability to maintain the asset. Risk: Inability to optimise maintenance efficiency and robustness by drawing on HVDC asset systems (i.e. cannot utilise common spares across assets and implement reliability improvements from Murraylink).	Consequence: 3 Likelihood: 3 Risk: Moderate	$280,000

Project	Alternatives considered	Analysis	Asset Risk Score	Estimated cost
		This is not the preferred option as this does not sufficiently reduce the unacceptable residual risk to the market and reliability of supply to customers.		
	C) Full uplift of CMMS End-to-end uplift program ensuring a system-wide view of maintenance is considered. This includes: • Review of the Maintenance Strategy • Review and update the asset hierarchy • Configuration of the CMMS and implementation of revised Maintenance Strategy • Undertake change management	Benefit: Reliability improvements and improved productivity resulting from; • Effective and transferable maintenance management practices • Critical and strategic sparing strategies fulfilled with access to the right parts when required • Enhanced asset lifecycle management aligned to individual asset componentry technical life. This is the preferred option as this reduces the residual risk to an acceptable level, providing long term data integrity for the lowest cost.	Consequence: 2 Likelihood: 2 Risk: Negligible	409,365
Master Controller FEED Study	A) Do nothing	Risk: Continue to operate three systems under low load conditions, without full knowledge of whether an optimised operating regime is possible. If optimisation is possible and not implemented, significant reliability and efficiency improvement opportunity will not be recognised. This will result in increased maintenance costs, spares use and reliability impacts; ultimately resulting in higher frequency, longer outages comparatively. This will have a negative impact on the market and reliability of supply to customers. This is not the preferred option as it doesn't adequately assess the significant opportunity that may be offered by a master controller.	Consequence: 3 Likelihood: 4 Risk: High	0

Project	Alternatives considered	Analysis	Asset Risk Score	Estimated cost
	B) Conduct a feasibility assessment Study to scope the requirements and cost/benefit of a Master Controller to manage Directlink under low load conditions To resolve, the following is proposed; • Scoping study • Engineering assessment study	Risk: Operational performance efficiency losses and asset life impacts under low load operation unidentified. Benefits: A design scope for low load operation understood with clear cost/benefit outcomes outlining; • Energy and emissions savings from reduced system loading • Maintenance impacts based on changed operational regime This is the preferred option as it will ensure the opportunity for master control is adequately assessed and planned for in a future revenue period.	Consequence: 3 Likelihood: 2 Risk: High	$136,455
Operations Asset Integration	A) Do nothing Directlink remains partially integrated into APA's IT/OT operational protocols	Risk: Cybersecurity, IT/OT obsolescence and asset performance insights not progressed leading to availability issues based on emerging operational opportunities and threats used to develop mitigation strategies. This will result in unplanned outages due to faults and/or deliberate security breaches. Outages may exceed 3 months, resulting in major negative market impacts and risk reliability of supply to customers. This is not the preferred option as it does not reduce the unacceptable residual risk associated with these outages.	Consequence: 4 Likelihood: 2 Risk: Moderate	0
	B) Develop standalone IT/OT solution for Directlink, separate from APA's systems	Benefit: Anticiplated to reduce residual risk to IT and OT systems to accetable level. Risk: Execution costs are an estimate and may grow further. Risk: will require additional operating costs to run and maintain.	Consequence: 3 Likelihood: 2 Risk: Low	More than $1.5million

Project	Alternatives considered	Analysis	Asset Risk Score	Estimated cost
	C) Fully integrate Directlink into APA's IT/OT operational protocols	Benefit: IT/OT risks/opportunities clarified with improvement programs addressing; • Data management (incl. security) • Cybersecurity • Remote/local connectivity • Asset insights, e.g. condition monitoring, advanced warning, etc. This is not the preferred option as it reduces both the likelihood and the consequence of IT/OT related outages. This reduces the residual risk to an acceptable level in the most cost-effective way.	Consequence: 3 Likelihood: 1 Risk: Negligible	$370,000

7. Recommendation

The recommended approach is to undertake adequate and fit-for-purpose Asset Monitoring activities through investing in the identified project options listed in Table 5.1.

The cost to complete the Asset Monitoring measures is $1.28 over the FY26 – 30 period.

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Noel Power	Senior HV Power Engineer	*Input*	*All*
James Brandt	Asset Performance & Lifecycle Specialist	*Input*	*All*
Eric Kocaj	Head of Infrastructure Projects	*Input*	*All*
Mark Allen	Regulatory Manager	*Review*	*All*

Table 4: Approvals

Name	Role	Approval	Date Approved
Annie Martyn	Asset Manager	Approved	*19/01/24*
Paul Alexander	GM Asset Management	Approved	*19/01/24*

Contents

1. Purpose

To present the business case for Directlink's Safety and Protection program that is comprise of 10 projects.

This business case supports forecast capital expenditure of $5.03 million[1] on Safety and Protection projects over the regulatory period 2025 to 2030.

Cost estimates are provided in FY25 dollars unless stated otherwise.

2. Scope of the Business Case

The program of Safety and Protection seeks to maintain Directlink's reliability by maintaining the integrity of the asset, including the site facilities, equipment storage and protection systems. These activities take into consideration the criticality of the asset, employee and contractor health and safety, as well as protecting the public from risks associated with High Voltage Direct Current (HVDC) plant and ensuring ongoing operational reliability.

This Business Case seeks to identify and evaluate a range of fit-for-purpose safety and protection measures over the 2025-30 regulatory control period, with the view to balance critical safety imperatives with the need to protect electricity consumers from inefficient investments.

3. Efficient execution of projects

When undertaking all projects in this business case APA will comply with the APA Group Procurement Standard. The APA procurement standard outlines the process by which all procurement of APA projects occurs. It defines the competitive procurement processes and provides efficient outcomes for the business. The capital expenditure is managed by the AMP, with its reference to Section 2.4 of the Asset Lifecycle and Performance Plan to support efficient execution of project.

4. Background and Context

4.1. Identified Need

The safety, health and well-being of all stakeholders who operate Directlink's HV infrastructure is paramount to APA as Operator and Maintainer of the asset. All APA employees and contractors require assurance safeguards and identified improvements are implemented.

The protection component of this justifications extends to public safety, where further initiatives intend to protect the public from inadvertent consequences.

4.2. Risk assessment framework for Safety and Protection Program

Major maintenance is required for Directlink to minimise the risk of outages and faults given the age of the asset. Major maintenance carried out in the regulatory period 2025-2030 will also ensure ongoing maintenance costs are optimised and efficient up to the end of its economic life in 2042.

Section 2.4 of the Asset Performance and Lifecycle Plan outlines the governance and high-level risk framework in which these projects are assessed. This process includes assessment of the likelihood and consequence consistent with APA's Risk Matrix.

4.3. Regulatory context

The Safety and Protection program for Directlink is designed to meet the following capital expenditure objectives set out in clause 6A.6.7(a) of the National Electricity Rules:

- comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services (6A.6.7(a)(2)).
- maintain the quality, reliability, and security of supply of prescribed transmission services (6A.6.7(a)(3)(iii)); and
- maintain the reliability, safety, and security of the transmission system through the supply of prescribed transmission services (6A.6.7(a)(3)(iv)).
- The projects in the major maintenance program of works meet these capital expenditure objectives as set out in clause 6A 6.7(a).

Safety and Protection works expenditure associated is consistent with the requirements of (6A.6.7(a)(2)) to meet health, safety and environmental obligations. It is also necessary to ensure the ongoing reliable operation of Directlink consistent with (6A.6.7(a)(3)(iii)) and to the extent that Directlink is associated with providing services to the transmission system (6A.6.7(a)(3)(iv)).

5. Proposed Projects

The proposed schedule of expenditure for **Safety and Protection** for the regulatory period FY26-FY30 is set out in *Table 5*;

Table 5.1: Safety and Protection capital expenditure ($FY25)

Program	FY26	FY27	FY28	FY29	FY30	Total
AC Isolators / Earth Switches	0.26	-	-	-	-	0.26
Bungalora Facilities Improvementsgene	0.13	-	-	-	-	0.13
Bungalora Storage Facilities	0.34	-	-	-	-	0.34
Cameras for Inspections	-	-	0.09	-	-	0.09
DC disconnectors	0.45	-	-	-	-	0.45
Environmental Damage from Landslips	0.18	-	-	-	-	0.18
Physical Site Security and Public Protection	2.13	1.09	0.06	-	-	3.28
Reposition Nitrogen Tanks	0.23	-	-	-	-	0.23
Sound Wall Earthing	-	-	0.06	-	-	0.06
Remote easement access	0.03	-	-	-	-	0.03
Total	3.73	1.09	0.21	-	-	5.03

5.1. Bungalora Facilities Improvements

Background

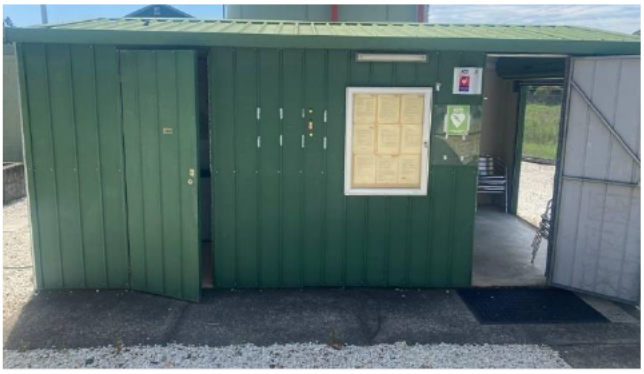
There are facilities at Bungalora for employees and contractors to congregate out of the weather and consists of a lunch table, kitchenette and unisex bathroom.

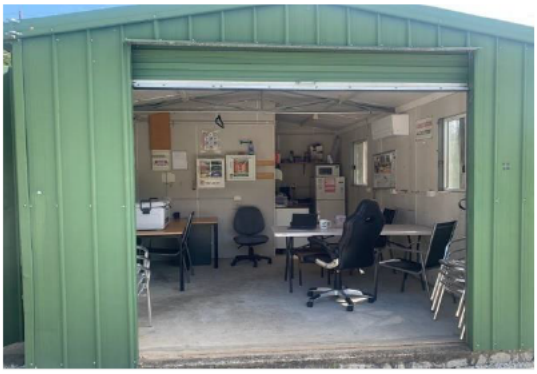
Issue

The facilities are inadequate for housing the number of employees and contractors attending site, especially during long shifts associated with major maintenance, shutdowns and projects. There is limited room to move, inadequate food preparation space and impractical bathroom facilities given the increasing number of female employees. The weather conditions can vary throughout the seasons with employees and contractors requiring adequate protection from the elements.

Due to the increasing technical and maintenance resource requirements to support frequency planned outages and upgrade projects, these facilities have become increasingly problematic for the workgroup.

Figure 1: Current Bungalora Facilities





Risk Assessment

The site support personnel require a safe and comfortable workplace environment to maintain the reliability, safety, and security of the asset, whilst ensuring APA continue to attract and retain the specialised expertise needed to supply transmission services. The consequence of continued operation with the current facilities is inefficient and impractical working arrangements. This space conflict is heightened during outages or project and hence occurs multiple time per annum.

The Risk Score associated with the current state is a consequence of 2 and likelihood of 5.

Untreated Asset Risk Score: 2 (Minor) x 5 (Frequent) = Moderate

Preferred Option

The preferred option is to install a basic multi-purpose room, with extra bathroom facilities.

5.2. Bungalora Storage Facilities

Background

The storage facilities for spares consists of a single shed at the site entrance, with other essential equipment stored in an off-site storage facility in the Brisbane outer suburbs.

Issue

Storage facilities off-site make inventory management difficult and quick access to spare parts is not possible. An increase in on-site storage capacity is required to manage spares for accessing at short notice.

Continued storage of spare part at an off-site facility may result in damage to critical spare parts and this damage may not be immediately realised. This could be caused by poor temperature control, poor handling practises or theft. The consequence is that a critical spare part assumed to be available may not be in working order and Directlink is not able to operate until the spare is sourced.

Risk Assessment

Lead times for many critical spares already procured vary from six months to many years, so the consequence could be multiple years of no operation.

The Risk Score associated with the current state is a consequence of 5 and likelihood of 2.

Untreated Asset Risk Score: 5 (Catastrophic) x 2 (Remote) = High

Preferred Option

This proposal seeks a dedicated storage shed on-site to manage spares and meet the expected demand for transmission services when unforeseen equipment failure occurs.

5.3. Environmental Damage from Landslips

Background

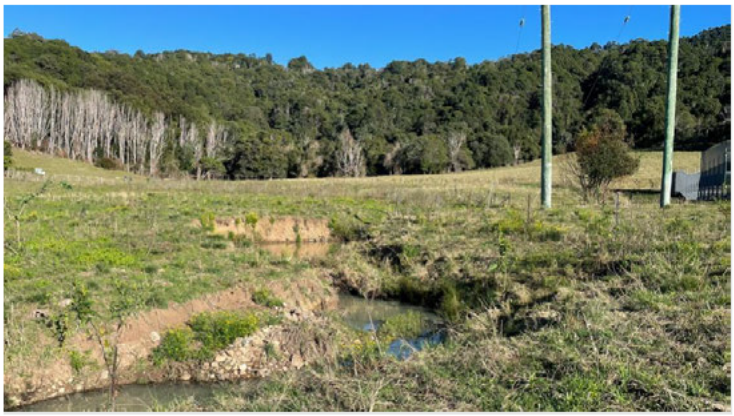
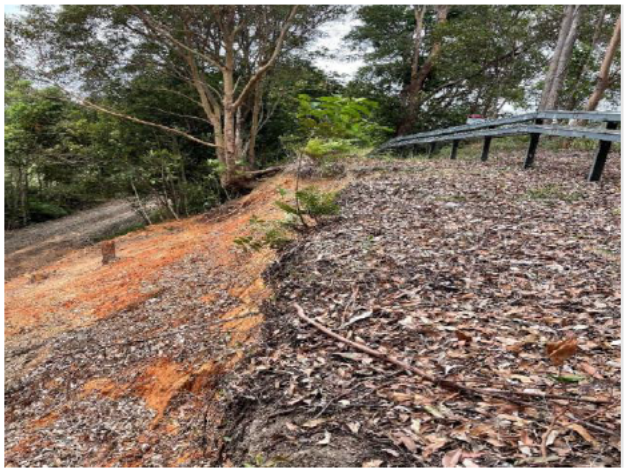
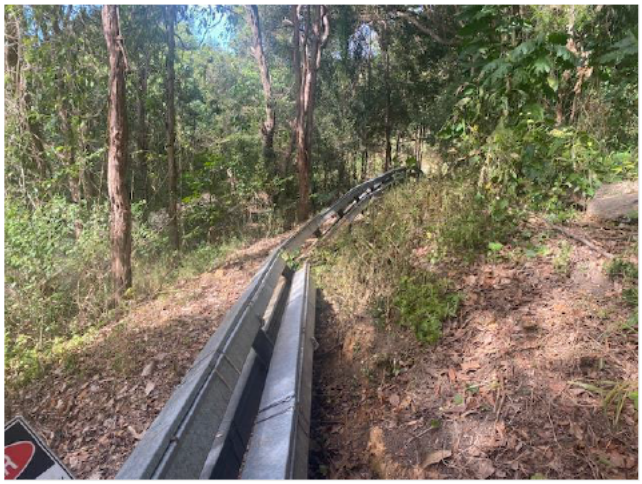
APA has identified six (6) significant areas within the easement corridor that have become prone to erosion during inclement weather events. The three highest risk sites are being rectified in the current revenue determination as emergency works with the remaining comparatively lower risk sites proposed to be prioritised and addressed in FY26 – 30.

Issue

The 2022 flood event in the Northern NSW region has eroded alluvial watercourse banks and caused landslips along the cable run.

The remaining three sites are outlined in *Table 5.2*

Table 5.2: Remaining erosion sites.

Bungalora *Erosion of the existing overland flow path has extended towards the electrical poles & the stays*	
Mooball *Erosion of land bank at Mooball that supports HVDC cabling.*	
Crabbes Creek *Erosion of pushing against and threatening to topple HVDC cabling.*	

Risk Assessment

The consequence of failing to remediate and stabilise these sites of erosion is that further erosion will occur until the cable is unsupported and fails. This will result in an approximately 3-month outage to replace the section of cable suspended above the water course and reinstate the foundation. This will result in all of Directlink being offline for 3-month. Given the observed rate of erosion, it is

estimated that a support will be fully eroded due to rainfall events by the end of this 2026 to 2030 regulatory period; however, this is uncertain given the unpredictability of rainfall events.

The Risk Score associated with the current state is a consequence of 4 and likelihood of 4.

Untreated Asset Risk Score: 4 (Significant) x 4 (Occasional) = High

Preferred Option

The recommendation is to maintain the reliability, safety and security of the transmission system through permanent remediation works to address the erosional damages on flood-affected sites and re-evaluate the priority based on risk assessing any changing circumstances as a result of future weather events.

5.4. Physical Site Security and Public Protection

Background

Break-ins at APA operated sites have increased in recent years. There has been increasing frequency of intruders at electrical generation and transmission facilities; in some cases, not detected until the intruder has departed and the possible damage is unknown. Directlink needs to be protected from an unauthorised access and potential interference.

Issue

The site needs to mitigate potential interference that compromises the asset's safe operation and security against physical threats such as inadvertent electrocution from unlawful entry and more extreme incidents such as violent protest, sabotage, terrorism, and espionage.

Risk Assessment

[redacted]

Preferred Option

The proposed work includes improved deterrence and installation of detection to respond to unauthorised access and protect the public from associated HVDC risks.

5.5. Reposition Nitrogen Tanks

Background

Nitrogen is stored at both Directlink sites in pressurised cylinders which are located inside of the enclosed rooms. Nitrogen is used as buffer gas and is preferable to air as it will prevent corrosion within the cooling system.

This is part of the original design from the Original Equipment Manufacturer (OEM), however the safety risk associated with this system was not previously recognised.

Issue

The enclosed space and the current position of the storage cylinders creates an asphyxiation risk within the room. The process of replenishing the cylinders is challenging due to the position and physical space constraints. This operational risk was previously unrecognised by the site operations and maintenance team; however internal technical APA resources have identified this unacceptable risk during a site visit.

Risk Assessment

In the event of a large or continuous release of nitrogen into the enclosed space, the nitrogen gas levels will be sufficient to asphyxiate an individual. There is no motive force to circulate the air and one or more people may enter the space and immediately be overcome, resulting in a fatality. Dangerous good guidelines provided by NSW and Queensland safety regulators suggest nitrogen cylinders are stored outdoors in well-ventilated locations.

Leaks in such a system have occurred in the past, however not at a rate to pose an asphyxiate risk. Interim measures to improve air quality monitoring have been employed to mitigate this risk.

The Risk Score associated with the current state is a consequence of 5 and likelihood of 2.

Untreated Asset Risk Score: 5(Catastrophic) x 2 (Remote) = High

Preferred Option

The recommendation is to reposition the nitrogen cylinders to a position outside of the valve room to mitigate the asphyxiation residual risk and comply with Safe Work guidelines. An added benefit is improved access for maintenance and replenishment of the cylinders.

5.6. Sound Wall Earthing

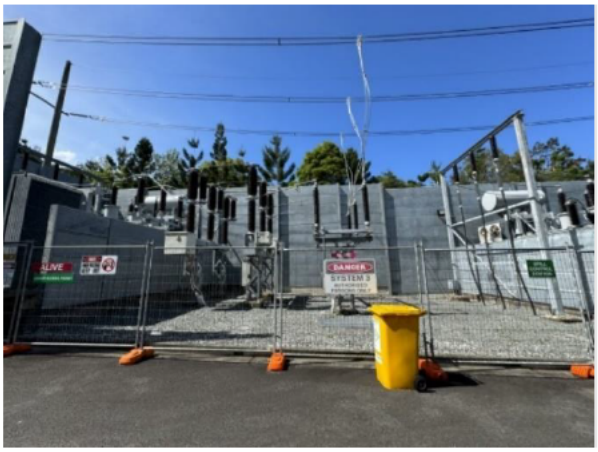
Background

The earthing connections around the sound walls and existing fencing in the transformer yard need to be effectively bonded to earth in accordance with the required standards. Protective earthing is required to mitigate the risk of electrocution should someone contact the unearthed electrical current.

Issue

Earthing connections with the minimum requirement established are required between the panels in the sound walls to prevent possible equipment damage and mitigate the risk of a fatality. A recent earth grid audit identified inadequate earthing testing facilities with regulatory obligations requiring a testable earth link on these structures.

Figure 2: Sound Wall Earthing



Risk Assessment

The consequence of not addressing this in the upcoming regulatory period will be non-compliance, which may require Directlink to be shut down while the non-compliance is rectified, this may take up to one month to address in an unplanned way. This is expected to occur if this issue is not addressed; this state of operation will not be accepted indefinitely.

The Risk score associated with the current state is a consequence of 4 and a likelihood of 3.

Untreated Asset Risk Score: 4(Major) x 3 (Unlikely) = Moderate

Preferred Option

The recommendation is to internally connect the fence to earth from inside the sound wall fencing perimeter in accordance with Australian electrical safety standards AS/NZS 2067.

5.7. AC Isolators

Background

An isolator provides separation between different sections of a power system. It is used to de-energise equipment for maintenance or repair work. There are two types of AC isolators installed at Directlink, the centre break type (Figure 1) and double break type (Figure 2).

They also provide a visual confirmation the circuit is broken as a visible gap between the contacts indicate the circuit is de-energised.

Figure 3: Types of AC Isolators

Figure 1

Figure 2

Issue

There are three pairs of the centre break style isolators installed at each asset site (Bungalora and Mullumbimby), with these isolators having known faults and consequently no longer supported by the Original Equipment Manufacturer (OEM). There are no spares stored at Directlink and no like for like spares can be purchased. These isolators are common component and do not need to be sourced from the OEM; modern equivalent isolators with like for like functionality can be procured more cost effectively.

Risk Assessment

If the isolators fail, it is not possible to maintain the reliability and security of the system with all three stations experiencing an outage while new isolators are sourced and installed. This would likely take a number of months to execute. Due to the age of these isolators and visual assessment of their condition as well as industry data on performance, these isolators are reaching end of life now and are anticipated to fail in the next regulatory period.

The Risk Score associated with the current state is a consequence of 5 and a likelihood of 3.

Untreated Asset Risk Score: 5 (Catastrophic) x 3 (unlikely) = High

Preferred Option

The recommendation is to replace three (half) of the centre break isolators with similar rating isolators and procure one additional double break isolator. This would allow the two new isolators to be installed with the remaining spares for used as back-up for remaining centre break isolators at both sites.

5.8. Asset Operational Inspections

Background

The converter buildings (barns) are 'live' High Voltage (HV) areas and cannot be entered by personnel safely unless the system is de-energised and made safe given the fatal safety risk associated with the energised high voltage equipment.

Issue

To undertake unplanned inspections and investigations, the operations team needs to de-energise the barn prior to visually inspecting the equipment condition for damage.

Risk Assessment

The converter barns currently have no online monitoring of converter system operation. These barns contain critical filtering and conversion electrical systems that are prone to failure. The consequence of the current arrangement is unrevealed failures arise and are not detected until the failure escalates to an unplanned outage of approximately one week. This has occurred with overheating of a termination in recent years that may have been identified prior to failure with thermal monitoring of the barn.

There is an additional safety risk associated with minimising manual function checks. These checks require access to the high voltage area. Although there are controls in place to de-energise and isolate sources, there is still greater inherent safety risk associated with accessing this area.

The Risk Score associated with the current state is a consequence of 3 and a likelihood of 4.

Untreated Asset Risk Score: 3 (Significant) x 4(Occasional) = High

Preferred Option

It is proposed to install a camera system to all the converter stations to allow detailed inspection of equipment whilst the converter building remains energised. This will expedite internal inspection of the buildings in response to faults, without requiring an outage and reduce the frequency and duration of outages. Further, this reduces the frequency the personnel are required to enter a potentially hazardous area, given inspections can't occur until inside the building. Two cameras per barn have been proposed to ensure the adequate field of view coverage is obtained.

5.9. DC Disconnectors

Background

Disconnectors are designed for making and breaking unloaded circuits. They are used to physically disconnect equipment or sections of a circuit for maintenance purposes when the circuit is not carrying current.

DC disconnectors inside the barns are used to isolate the DC cables. The disconnectors use a centre break style. The disconnectors are usually taken out of service by using a redundant disconnector with the old one refurbished for later use when next needed.

Issue

The spares for the DC disconnectors are depleted and the Original Equipment Manufacturer (OEM) no longer provides support; that is, it is not possible to purchase like for like spares. Although like for like spares cannot be sourced, modern equivalent disconnectors are available from the OEM and other suppliers to perform the required function. It is not anticipated that these modern equivalents will become unsupported in the near term.

The lack of spares means should another DC disconnectors fail, the section of the plant would suffer an extended outage until alternative solution is identified and implemented.

Risk Assessment

If the disconnectors fail, this will result in a Directlink outage until the disconnector is replaced. It is expected that this outage more than one month. Given the rate of failure; it is expected that the like for like disconnector spares will be depleted in the upcoming revenue period.

The Risk Score associated with the current state is a consequence of 4 and a likelihood of 3.

Untreated Asset Risk Score: 4 (Major) x 3 (unlikely) = High

Preferred Option

The recommendation is to replace six of the DC disconnectors (and procure one additional for redundancy) of the double break style disconnectors of similar rating to maintain availability in case of failure as the spares are depleted.

5.10. Remote Easement Access

Background

Specific sections on the cable route are not accessible by standard road vehicles and many sections are not connected by established roads.

Issue

The cable route runs for 59km with APA employees currently having to cover large distances on foot, often carrying bulky equipment in slippery conditions.

Risk Assessment

Without access to a UTV, it is challenging to efficiently and effectively monitor the full 59km of the cable route as frequently as possible. This results in increased labour costs to continue to conduct inspections. As well, the consequence is defects may not be identified prior to escalation result in cable damage and system outages.

The Risk Score associated with the current state is a consequence of 3 and a likelihood of 3.

Untreated Asset Risk Score: 3 (significant) x 3 (unlikely) = Moderate

Preferred Option

The recommendation is to procure a UTV and trailer. This provides more effective cable route access for undertaking cable inspections and repairs. It also improves the frequency and coverage of land erosion / landslip inspections with employees better equipped to deploy essential equipment to hard to access remote locations more easily.6.

6. Project Options Analysis

For each project, APA has explored an appropriate range of credible options seeking to balance cost, benefits and risk, including scope to defer investment. In some instances, project needs and the means of addressing so limited, only a "Do-nothing" base case (Option A) and a single credible option was investigated.

The table below sets out the options evaluated for each project, the preferred option and the overall justification for the preferred option.

Table 6.1 - Project Options Analysis

Project	Alternatives considered	Analysis	Asset RIsk Score	Estimated Cost
Bungalora Facilities	**A) Do nothing** Undertake no improvements to the current facility.	Risk: Directlink would continue current operation of site with inadequate facilities for the site team. This is not the preferred option as this does not adequately resolve the issue of substandard working facilities.	Consequence: 2 Likelihood: 5 Risk: Moderate	0
	B) Install temporary facilities Install temporary facilities during every planned system outage (3 per annum) to house additional workforce	Risk: Does not support other major maintenance, projects or unplanned activities. Risk: over 5-year period, will cost more OPEX than proposed CAPEX Benefit: Will provide satisfactory workspace when installed. This is not the preferred option as this delivers the required risk reduction at a greater cost to consumers than the preferred option.	Consequence: 2 Likelihood: 2 Risk: Moderate	$40,000 per use = $120,000 p.a.
	C) Upgrade and repurpose current Bungalora facility	Risk: Not all practical concerns associated with working and break facilities are addressed.	Consequence: 2 Likelihood: 4	$60,000 to $95,000

	Modification of the existing facility for additional weather protection, no additional space or toilet facilities added.	Benefits: Partially improved worker satisfaction, with remaining requirements unaddressed. This is not the preferred option as this does not adequately resolve the issue of substandard working facilities.	Risk: Moderate	
PREFERRED OPTION	**D) Replace the Bungalora facility** This option replaces the current facilities to meet industry WHS requirements (incl furnishings). This includes costs to remove existing shed, install new modular facility, including foundations, installation of new bathroom facilities and connection to existing electrical and water infrastructure.	Benefit: Facilities installed in-line with WHS requirements, improved employee working conditions with increased workspace capacity throughout shut-downs/projects. This is the preferred option as it increases the working facilities to an acceptable standard, delivering the required risk reduction for the lowest cost.	Consequence: 2 Likelihood: 2 Risk: Negligible	$125,285
Bungalora Storage Facilities	**A) Do nothing** Continue to store spare parts at an offsite facility in Geebung.	Risk: Current third-party rental overhead with uncontrolled storage practices and stocktake. Risk: Less reactive to unplanned outages. Risk: Spare parts damaged or stored incorrectly resulting in critical spares not being available in the event of a failure. This may result in outages greater than 12 months. This would cause significant and sustained negative market impact and risk reliability of supply to customers.	Consequence: 5 Likelihood: 2 Risk: Hight	$40,000 p.a. OPEX

		Benefit: Facilities maintained by external resource. This is not the preferred option as it does not reduce the residual risk to customers to an acceptable level.		
	B) Increase frequency Continue to store parts at an offsite facility but increase the frequency of stocktake and function testing at offsite facility	Risk: Current third-party rental overhead at $21k p.a. with uncontrolled storage practises. Risk: increased OPEX to mobilise resources to external facility at high frequency. Risk: Less reactive to unplanned outages. Benefit: Facilites maintained by external resource Benefit: Marginally reduces the risk of misplaced parts and damage not being identified but still far less robust than site storage. Likelihood of damaged missing parts still treated as remote (2). This is not the preferred option as this does not adequately reduce the risk of extended outages to an acceptable level.	Consequence: 5 Likelihood: 2 Risk: Moderate	$120,000 OPEX for storage and to undertake quarterly stocktakes.

PREFERRED OPTION	**C) Construct a Storage Shed and Shelter** This option protects all spares on-site and provides a simple shelter structure to preserve the larger cable rolls.	Benefit: Improved reliability supporting Directlink Spares Management strategy with spares available to reduced down-time. This is the preferred option as this reduces the residual risk to customers resulting from damaged/missing spare parts to an acceptable level.	Consequence: 2 Likelihood: 2 Risk: Negligible	$337,726
Environmental Damage from Landslips	**A) Do nothing** No mitigation plan to remedy rain-affected landslips and wash-outs along the cable tray.	Risk: Public safety issues associated with cable tray on unstable land. Risk: Cable reliability issues with cable trays exposed to further weather events. This will result in extended (>3 month) outages, negatively impacting the market and risking reliability of supply to customers. This is not the preferred option as this does not reduce the residual risk of an outage nor the and risk to public safety to an acceptable level	Consequence: 4 Likelihood: 4 Risk: High	0*
PREFERRED OPTION	**B) Remediate erosion** Provide permanent stabilisation of the creek bank at the remaining sites not covered under Emergency Works in the current revenue determination period.	Benefits: Reduced risk of outage on Directlink assets and public safety risk. This is the preferred option as this addresses the unacceptable risk to customers and the public resulting from landslip events.	Consequence: 3 Likelihood: 2 Risk: Low	$179,325
	C) Relocate cable Move the cable, and where necessary, galvanised steel tray to a new location further from the creek.	Benefits: Further reduces the risk of losing assets through land slips.	Consequence: 3 Likelihood: 2 Risk: Low	Between $5 and 10M

		Risk: Major project to install new cable in appropriately route given terrain and nearby rail trail and properties. This is not the preferred option is this reduced the risk associated with land slips in line with the preferred option, but at a far greater cost.		
Physical Site Security and Public Protection	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

	- [redacted]	[redacted]		
Nitrogen Tanks	**A) Do nothing** Leave nitrogen cylinders in position	Risk: Asphyxiation may occur in the event of nitrogen cylinder or regulator failure in the enclosed space. This is not the preferred option as this does manage the risk to personnel of asphyxiation.	Untreated risk: Consequence: 5 Likelihood: 2 Risk: High	0
PREFERRED OPTION	**B) Reposition the nitrogen cylinders** Move cylinders outside, augment piping, regulators and improve monitoring.	Benefit: Asphyxiation risk reduced to as low as reasonably practical and in line with industry guidelines Benefit: Reduce manual handling risk associated with access for maintenance and replenishment of cylinders. This is the preferred option as it reduces the risk of asphyxiation of personnel to an acceptable level.	Untreated risk: Consequence: 3 Likelihood: 2 Risk: Low	$228,265
Sound Wall Earthing	**A) Do nothing** AC transformer fencing is unbonded to the earth resulting in non-compliance.	Risk: Non-compliance to standards requiring Directlink to be taken offline until rectified. This will result in an unplanned outage of approximately 2 weeks, negatively impacting the market and risking reliability of supply to customers. This is not the preferred option as it does not adequately reduce the residual the risk of non-compliance.	Untreated risk: Consequence: 4 Likelihood: 3 Risk: High	0*

PREFERRED OPTION	**B) Internally connect sound wall and fencing to earth** Earth from inside the sound wall fencing perimeter in accordance with Australian electrical safety standards AS/NZS 2067.	Benefit: Reduced risk of death and/or injury to workers due to electrocution. Benefit: Compliance to relevant standards. This is the preferred option as it reduces the residual risk of harm and non-compliance to an acceptable level for the lowest cost.	Consequence: 2 Likelihood: 2 Risk: Negligible	$63,321
AC Isolators	**A) Do nothing** Operate with the current isolators and perform limited maintenance, with limited access to spares in event of failure.	Risk: Isolator fails resulting in Directlink offline for 3 months while replacement isolators are sourced and installed. This will result in negative market impacts and risk reliability of supply to customers. This is not the preferred option as this does not r the unacceptable risk to the market and customers.	Consequence: 5 Likelihood: 3 Risk: High	0*
PREFERRED OPTION	**B) Replace some AC isolators** Replace 3 isolators and procure 1 spare isolator.	Benefits: Addresses maintenance required on aged isolators and reduces the duration of an outage to repair further isolators. This is the preferred option as this reduces the residual risk to an acceptable level for the lowest cost.	Consequence: 2 Likelihood: 2 Risk: Negligible	$255,171
	C) Replace all AC isolators Replace all 6 isolators with similar rating double break isolator and longer OEM support life.	Benefits: Addresses of maintenance required on aged isolators. This is not the preferred option as this provides equivalent risk reduction to the preferred option for greater cost.	Consequence: 2 Likelihood: 2 Risk: Negligible	$620,000

Asset Operational Inspections	**A) Do nothing** Continue operations unchanged without surveillance and detailed inspection of network assets.	Risk: Additional maintenance cost associated with isolation and physical inspection Risk: Extended duration outages not supported by AEMO, requiring extended or night shifts. Risk: Defects are not identified proactively until significant failure occurs; resulting in unplanned outages. This is not the preferred option as the overall costs will be higher without facilitating camera inspections. There is also an associated risk reduction with executing on-line inspections.	Untreated risk: Consequence: 3 Likelihood: 4 Risk: High	+$50,000 p.a. OPEX cost for higher frequency inspections executed with traditional isolations
PREFERRED OPTION	**B) Install cameras inside the HVDC barns** Procure and install thermal cameras inside both HVDC barns at Mullumbimby and Bungalora for remote monitoring 24/7 APA's Inegrated Operations Control and site.	Benefit: Allows inspection without physically inspecting assets and needing to de-energise equipment. This improves plant condition monitoring with early detection of deteriorating equipment, allowing for better outage planning (duration and frequency). Benefit: Improve safety by reducing worker exposure to HV electrical risk by assessing conditions prior to entering the barns. This is the preferred option as it offers reliability improvement with lower costs overall.	Consequence: 2 Likelihood: 2 Risk: Negligible	$88,169
DC Disconnectors	**A) Do nothing**	Risk: Unplanned outage due to DC Disconnector failure. A one-month outage will result in a negative market	Untreated risk:	0*

	Perform minor maintenance to attempt to keep the current DC disconnectors operational.	impact and risk to reliability of supply to customers.	Consequence: 4 Likelihood: 3 Risk: High	
PREFERRED OPTION	**B) Replace some of the DC disconnectors** Replace 6 of the DC disconnectors and procure 1 spare of double break style disconnectors of similar rating.	Benefits: Reduced risk of disconnectors failing, resulting in improved availability when unplanned maintenance required. This option is the preferred option to reduce the residual risk to an acceptable level in the most cost-effective way. This is done by balancing the risk of disconnector failure with limited spares for backup against the cost of replacing all 12 disconnectors. The six used disconnectors removed would be used as spares.	Consequence: 2 Likelihood: 2 Risk: Negligible	$446,549
	C) Replace all the DC disconnectors. Replace all 12 centre break disconnectors with similar double break disconnectors.	Benefits: Reduced risk of disconnectors failing, resulting in improved availability when unplanned maintenance required. This is not the preferred option as it achieves comparable risk reduction to the preferred option at a greater cost.	Consequence: 2 Likelihood: 2 Risk: Negligible	$1,1500,000 to $1,400,000
Remote easement access	**A) Do nothing** Continue to use standard road vehicles to transport material, with manual handling of bulky cable handling material to remote locations. More frequent closure of the rail trail bike path required for vehicle access.	Risk: Inefficient monitoring and maintenance of cable route. Risk: Unplanned outages due to preventable defects along cable route (e.g. damaged signage, supports, cable trays due to weather events). Any cable damage will result in an outage, negatively impacting the market and risking reliability of supply to customers. This is not the preferred option as this mode of inspection is increasingly	Untreated risk Consequence: 3 Likelihood: 3 Risk: Moderate	$30,000 p.a. in additional labour costs to monitor cable route

		inefficient and time consuming to conduct safely and consistently, resulting in increased OPEX costs. In addition, this does not adequately reduce the residual risk associated with cable failure.		
PREFERRED OPTION	**B) Acquire UTV and trailer** Acquire UTV and trailer. Commission and operationalise safety requirements	Benefits: Minimises manual handing safety risks lifting equipment through dense bush land. Benefits: More effective approach to inspecting and repairing the cable, monitoring the easement, whilst minimising the impact on public access to the bike trail. This is the preferred option as there is a reduction in reliability risk as well as a prevention of OPEX cost escalation.	Consequence: 2 Likelihood: 2 Risk: Negligible	$27,564
*These options will have OPEX maintenance costs associated due to the inevitable reactive maintenance that will be required with any run to failure option.				

7. Recommendation

It is proposed to undertake the portfolio of 11 Safety and Protection projects consistent with the identification, evaluation and justification of project options presented in Table 5.1, at a total cost to complete of $5.03million over the 2025-30 regulatory control period.

Business Case: Spares Management

Directlink Joint Venture
2025-2030 Revenue Proposal

Energy
Infrastructure
Investments

Document control

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Table 1.1: Revision Record

Version	Date	Updated By	Changes Made
0.1	*10/11/2023*	*James Brandt*	*Initial draft*
0.2			*Feedback received from group discussions*

Table 1.2: Review and Distribution

Name	Role	Action	Sections
Noel Power	Senior HV Power Engineer	*Input*	*All*
James Brandt	Asset Performance & Lifecycle Specialist	*Input*	*All*
Eric Kocaj	Head of Infrastructure Projects	*Input*	*All*
Mark Allen	Regulatory Manager	*Review*	*All*

Table 4: Approvals

Name	Role	Approval	Date Approved
Annie Martyn	Asset Manager	Approved	*19/01/24*
Paul Alexander	GM Asset Management	Approved	*19/01/24*

Contents

1. Purpose

To present project recommendations and expenditure forecast for inclusion in the Directlink Regulatory Proposal for FY26 to FY30.

This business case includes an estimate for forecast capital expenditure of $12.5 million on a portfolio of projects within the Strategic Spares Management program for Directlink.

2. Scope of the Business Case

The Strategic Spares Management project will:

- Identify all assets critical to the ongoing safe and reliable operation of the Directlink Interconnector (Asset criticality assessment)
- Analyse the nature of any spares that could be held for those assets (Spares Assessment)
- Assess what is the optimal spares strategy for each of those assets that minimises the cost to customers for operating Directlink in the longer term (Economic assessment)
- Procure the efficient level of spares (Procurement)

The spare parts inventory covers all Directlink sub-systems.

This Business Case includes a high-level estimate of the cost of acquiring all the spares. All cost estimates of project expenditure in the 2025-30 regulatory control period are provided in FY25 dollars unless stated otherwise.

Note the strategic spares management does not include the acquisition of generation one IGBTs as they are no longer available to Directlink in the forthcoming regulatory period.

2.1. Regulatory context

The Spares Management program for Directlink is designed to meet the following capital expenditure objectives set out in clause 6A.6.7(a) of the National Electricity Rules:

- maintain the quality, reliability and security of supply of prescribed transmission services; and
- maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The Spares Management Program will maintain the reliability of Directlink over the life of the asset. It will utilise an assessment system to ensure the expenditure incurred would reflect a prudent service provider acting efficiently and represent a realistic expectation of the costs to achieve the requirement.

The delivery of this project will be consistent with APA's project management policies and procurement standard (see Attachments 04b and 04c).

3. Strategic Spares Management Program

Spares management is a critical component of Directlink's operational resilience and efficiency. Spares management is essential for minimising downtime, optimising costs, and ensuring the continuity of operations.

The objective of the strategic spares management project is to design a spares management program that ensures the ongoing reliable operation of Directlink at the lowest long-term cost to customers.

The spares management strategy involves the systematic identification, procurement, storage, and utilisation of spare parts to support equipment maintenance and address unforeseen breakdowns.

As the key functions of the converter system are manufactured by Hitachi, it is not possible to source many spares from an alternative supplier. Due to factors beyond Hitachi's control, such as global supply chain constraints; there have been occasions where notification of the withdrawal of support has been issued with very limited notice.

These challenges have resulted in Directlink reconsidering the most prudent and efficient strategy for spares management over the long term to the expected end of economic life, to ensure that the Directlink interconnector will achieve its life expectancy at the lowest cost.

3.1. Framework and Methodology for Spares Management

As noted above the framework for developing the spares management strategy is structured around three components:

- Identify all assets critical to the ongoing safe and reliable operation of the Directlink Interconnector (Asset criticality assessment)
- Analyse the nature of any spares that could be held for those assets (Spares Assessment)
- Assess what is the optimal spares strategy for each of those assets that minimises the cost to customers for operating Directlink in the longer term (Economic assessment)

3.2. Asset criticality assessment

Refreshing the critical assets assessment is a critical step in developing the spares management strategy for Directlink. This requires refreshing due to the age of Directlink and the transfer of asset OEM from ABB to Hitachi resulting in changing OEM support. Critical assets are defined as those that have a significant impact on operations and performance.

Directlink has commenced a criticality assessment. This will involve an assessment of each sub system and each asset within the subsystem to determine its criticality to the operational capability of Directlink. The criteria for determining the criticality of sub-assets / components are as follows:

- failure of the sub-asset / component would result in an outage of the Directlink Interconnector or a Directlink Interconnector System (Directlink is made up of 3 x 60MW systems)
- failure of the sub-asset / component poses a high risk of an outage of the Directlink Interconnector or a Directlink Interconnector System due to limited redundancy. That is, assets with limited redundancy for continued operation; such as IGBTs.

This assessment is currently underway with an expected completion date in Q1 2024. The output of this assessment will be a list of assets deemed to be critical to the ongoing reliable operation of Directlink. Input from the Manufacturer of Directlink (Hitachi) will be critical to the completion of this process in a timely manner.

3.3. Spares Assessment

For each of the critical assets, the failure and replacement characteristics for each will be considered. The failure and replacement characteristics considered are:

- Expected failure rates
- Cost of acquisition of spares
- Shelf life
- Risk of obsolescence
- Procurement lead times
- Cost of storage
- Procurement limitations
- Replacement cost for operating system

The following table provides a description of each of the characteristics being considered.

Characteristic	Description
Expected Failure Rate	The estimated frequency at which failures are expected to occur under normal operating conditions. This is a forecast of failure rates.
Cost of acquisition of spares	Cost of the spares including any costs associated with procurement, contracting, legal advice etc.
Shelf Life	Period that a spare can be stored, under suitable conditions, and retain its quality. If the spare has a limited shelf life, then Directlink will maintain a sufficient quantity of the subcomponent at all times to ensure the ongoing operation of the Directlink Interconnector System, whilst minimising wastage based on forecast of failure rates.
Risk of Obsolescence	The risk that a subcomponent will become unobtainable in the future. If there is no material risk of obsolescence, then the approach will be to acquire the prudent and efficient number of spares in the most prudent and efficient profile. If there is a risk of obsolescence then the procure the number of spares that maximises the NPV to customers, recognising the cost of the spare, cost of storage and the cost of replacing the operating equipment based on a range of realistic forecast failure rates.
Procurement Lead times	The lead time is the length of time from putting in a purchase to having the spare in storage. The procurement lead times can be expected to influence the prudent purchase quantity. The longer the lead time the harder it is to adjust for unexpected failures. This would require a higher level of spares in the first order to behave as insurance for all subsequent orders. Where

	part of the contingency is utilised, it would need to be rebuilt at the earliest opportunity (next order).
Cost of Storage	This is the cost of building (or acquiring) additional storage that meets the necessary conditions to store spares and the cost of maintaining that storage for the duration of the Directlink Interconnector.
Procurement Conditions	Manufacturers of some items like cable and IGBTs require minimum purchases. In some cases, this minimum may be above the efficient procurement for Directlink but on PV (present value) analysis may still be prudent (if the counterfactual is operating system replacement). There are also costs associated with the project of procurement (project management, contract negotiation etc) that could influence the frequency of purchases.
Replacement cost for operating system	Cost of replacing the operating system as spares cannot be acquired.

This data collection and assessment will be conducted following the Asset criticality assessment and is expected to take two months to collect all the relevant data.

3.4. Economic Assessment

The data is then analysed for each category of critical spares to determine the frequency and quantity of purchases. This analysis is expected to be complete by the end of April 2024.

The spares will fall into one of three categories.

1) Business as usual
2) Long lead times
3) Obsolescence risk

Business as usual

This is for critical spares where there are multiple sources for the asset, obsolescence risk is low and lead times are short.

The procurement approach will be to forecast failure rates and optimise procurement volumes. This will optimise for:

- costs of procurement;
- limitations placed by vendors;
- Storage costs; and
- Time value of money

Long or growing lead times

This is for those critical spares with multiyear lead times that have forecast failure rates of multiple failures per year.

The approach for these assets is similar to “business as usual” spares except the long lead times carry a risk that the failure rate of the asset can change within the lead time and the spares can be

exhausted. Given the long lead times, even when higher failure rates are identified, it could take over 5 years to increase sparing, resulting in exhaustion of the available spares before more can be sourced.

However, in the first procurement an additional number of spares would be acquired to act as an insurance against the possibility that failure rates could rise before the procurement approach could be adjusted.

In some circumstances a probability could be associated with the likelihood of an increase in failure rates based on the age profile of the asset and historic experience with the asset in other networks. However, where the asset is unique to Directlink, proxies for the likelihood of asset failure will have to be derived.

Obsolescence Risk

Where a sub-system contains assets that are provided by a sole source supplier then there is a risk of obsolescence of the sub-system created by having one of those assets fail and having no replacement.

The analysis determining the scope and scale of spares acquisitions should reflect the following:

- Obsolescence can happen at short notice;
- The present value of the cost of spares vs the present value cost of sub-system replacement;
- The forecast of failure rate for the assets.

Customers are better off acquiring the relevant number of spares where the present value of the cost of spares to ensure that there are sufficient spares available to enable the sub system to reach the end of Directlink's economic life is less than the present value of the replacement cost of the sub-system.

3.5. Overall Risk

If the above issues are not addressed there are two key impacts on the future operability of Directlink;

a) If insufficient spares are procured and stored (due to long lead times, obsolescence or increase failure rates), extended outages to Directlink will occur whilst spares are sourced. This is likely to lead to outages of greater than 12 months and based on current sparing challenges. Outages of this duration will have a significant negative market impact and risk reliability of supply to customers.

   Consequence: 5, Likelihood 3. Untreated Risk: Extreme

b) If insufficient spares are procured before parts become obsolete; major capital upgrades will be required to Directlink to facilitate continued operation. This will result in significant capital cost and extended (>1 month) outages to implement upgrades. These outages will have a negative impact on the market and risk reliability of supply to customers. As these have already been multiple cases of parts becoming obsolete, this is viewed as a likely outcome.

   Consequence: 4, Likelihood 4 Untreated Risk: Extreme.

3.6. Procurement

Procurement will take place in line with the identified strategy for the asset and will be undertaken in accordance with the APA procurement standard.

This approach will address immediate procurement needs for Directlink for the 2025-2030 regulatory period and contribute to the long-term reliability and performance of the asset.

This will be a multi-year procurement strategy.

4. Proposed Project Expenditure

The forecast expenditure for Spares Management for the 2025-30 regulatory period comprises of all spares for critical equipment to support the asset until end of life in 2042.

The amount included is the best available forecast which is an estimate based on the expected cost of some components that could be expected to be incurred. An updated cost estimate based on the procurement approach adopted for each critical asset following the completion of the criticality assessment will be complete at the end of April 2024.

The forecast of expenditure is as below for the regulatory period FY26-FY30 ($m).

Project	FY26	FY27	FY28	FY29	FY30	Total
Spares Management	$1.8	$1.2	$1.7	$1.5	$6.2	$12.5

The proposed expenditure is based on information available at time of proposal. Final expenditures over the regulatory period will ultimately be shaped by stock availability and any restrictions and conditions imposed by vendors, such as minimum purchasing requirements.

5. Recommendation

The proposed solution is to maintain the inventory of spare equipment. The capital cost to complete the spares management program is $12.5 million over the FY26 – 30 period.

Business Case: Major Maintenance

Directlink Joint Venture
2025-2030 Revenue Proposal

Energy
Infrastructure
Investments

Document control

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Table 1-1: Revision Record

Version	Date	Updated By	Changes Made
0.1	*10/11/2023*	*James Brandt*	*Initial draft*
0.2			*Feedback received from group discussions*

Table 1-2: Review and Distribution

Name	Role	Action	Sections
Noel Power	Senior HV Power Engineer	*Input*	*All*
James Brandt	Asset Performance & Lifecycle Specialist	*Input*	*All*
Eric Kocaj	Head of Infrastructure Projects	*Input*	*All*
Mark Allen	Regulatory Manager	*Review*	*All*

Table 4: Approvals

Name	Role	Approval	Date Approved
Annie Martyn	Asset Manager	Approved	*19/01/24*
Paul Alexander	GM Asset Management	Approved	*19/01/24*

Contents

1. Purpose

To present the business case for Directlink's Major Maintenance program that is comprised of 10 projects.

This business case supports forecast capital expenditure of $8.6 million[1] on Major Maintenance projects over the regulatory period 2025 to 2030.

Cost estimates are provided in FY25 dollars unless stated otherwise.

2. Scope of the Business Case

The program of Major Maintenance for Directlink is focused on maintaining reliability and the economic life of the asset to 2042 through the refurbishment, replacement or management of major equipment, plant components and site up-keep.

This Business Case seeks to identify and evaluate a range of fit-for-purpose major maintenance measures over the 2025-30 regulatory control period, with the view to balance critical safety imperatives with the need to protect electricity consumers from inefficient investments.

3. Efficient execution of projects

When undertaking all projects in this business case APA will comply with the APA Group Procurement Standard. The APA procurement standard outlines the process by which all procurement of APA projects occurs. It defines the competitive procurement processes and provides efficient outcomes for the business. The capital expenditure is managed by the AMP, with its reference to Section 2.4 of the Asset Lifecycle and Performance Plan to support efficient execution of project.

4. Background and Context

4.1. Identified Need

APA is required to maintain the reliability, efficiency, and safety of Directlink assets through to the end of their economic life. A key aspect of addressing these requirements involves periodically replacing or refurbishing critical major equipment and plant components based on their condition and likelihood of failure.

Major maintenance is considered capital expenditure as it provides the economic benefit of extending the life of the asset to its full economic life.

Major Maintenance relates to expenditure on the capital components of the asset to maintain reliability and continued operation to deliver the prescribed transmission service. It also maintains the operational value of Directlink as an asset until the end of its economic life in 2042.

[1] All cost estimates are provided in FY25 dollars unless stated otherwise.

Major Maintenance has some fundamental points of differentiation with routine maintenance, in that it:

- Primarily involves activities to replace or refurbish asset components.
- Is based on proactive planning.
- Involves specific and focused objectives designed around known issues. And
- Focuses on discrete initiatives rather than recurrent activities.

4.2. Risk assessment framework for Major Maintenance

Major maintenance is required for Directlink to minimise the risk of outages and faults given the age of the asset. Major maintenance carried out in the regulatory period 2025-2030 will also ensure ongoing maintenance costs are optimised and efficient up to the end of its economic life in 2042.

Section 2.4 of the Asset Performance and Lifecycle Plan outlines the governance and high-level risk framework in which these projects are assessed. This process includes assessment of the likelihood and consequence consistent with APA's Risk Matrix.

4.3. Regulatory context

The Major Maintenance program for Directlink is designed to meet the following capital expenditure objectives set out in clause 6A.6.7(a) of the National Electricity Rules:

- comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services (6A.6.7(a)(2)).
- maintain the quality, reliability, and security of supply of prescribed transmission services (6A.6.7(a)(3)(iii)); and
- maintain the reliability, safety, and security of the transmission system through the supply of prescribed transmission services (6A.6.7(a)(3)(iv)).

By avoiding outages associated with equipment failure the expenditure is consistent with the requirements of (6A.6.7(a)(3)(iii)) and to the extent that Directlink is associated with providing services to the transmission system (6A.6.7(a)(3)(iv)).

5. Proposed Projects

The proposed schedule of expenditure for Major Maintenance is as below for the regulatory period FY26-FY30.

Table 5.1: Forecast Capital Expenditure for Major Maintenance ($m FY25)

Program	FY26	FY27	FY28	FY29	FY30	Total
Cable Modification (Transitions)	0.55	-	-	-	-	0.55
Facility Cable Tray Install and Cable Relocation	-	0.34	-	-	-	0.34
Circulating Cooling Water System	0.19	0.19	0.28	1.59	0.19	2.43
Reactor Cooling Reliability Improvement	0.36	0.85	0.85	-	-	2.06
Circuit Breakers	0.14	0.41	0.68	0.14	0.29	1.66
Fire System Updates	-	-	0.21	0.21	0.21	0.64
Land Grading	0.03	0.03	-	-	-	0.07
Major Capital Maintenance	0.17	0.17	0.17	0.17	0.17	0.85
Total	1.43	2.00	2.20	2.11	0.87	8.60

The proposed expenditure for Major Maintenance 2025-30 is comprised of ten projects that each have their own specific contexts driving the need for investment. Broadly, the projects relate to the replacement or refurbishment of key components to extend asset life and ensure the reliability and safety of the asset. A summary of the need and key details for each project is provided below.

5.1. Cable Modification

Background

A cable transition refers to the area(s) where the cable moves from underground to above ground or below ground to above ground. The undergrounding of cable requires modification in some areas due to land slips, temperature variations, and flooding that can cause cable faults.

In the current regulatory period, 2020-2025, $1,100,000 was forecast to be spent to conduct a detailed failure analysis and develop and implement a cost-effective solution. $130,000 has been spent and a further $400,000 is planned to be spent in FY24 and 25.

This spend has been delayed as initial investigation found there were a number of different causes to transition faults; including water ingress at poorly sealed locations and thermal stress. As a result, an industry expert consultant was engaged to undertake analysis of multiple fault samples to develop the most prudent mitigation plan.

The outcome of the analysis in September 2023 was an engineered solution to prevent thermal stress failures as this was the leading cause of transition failure. It is planned to mitigate half the locations identified in this revenue period and remaining half in the following revenue period. This campaign approach over an extended period is the most efficient way to execute these works, based

on geographic location of the faults as there will be less mobilisation and project management costs. It is also expected to deliver a higher quality, consistent result with a small, skilled team delivering the scope.

Figure 1: Cable Transition

Issue

An investigation into the Directlink cable faults indicated approximately 60% of the 195 faults that have occurred on the Directlink DC cable have occurred at cable transitions along the 59km route between Bungalora and Mullumbimby. Localised sharp changes in temperature occur at the transition point causing thermal stress of the cable, ultimately resulting in cable failures.

Risk Assessment

The consequence of a cable failure is the associated system (1 of 3) immediately trips offline. It takes approximately 2 weeks to locate the fault and execute the repair. Each repair requires a full Directlink (all 3 system) outage for 1 to 2 days to affect the repair.

The likelihood of a cable fault at a transition is expected to be more than one per annum based on history.

The Risk Score associated with the current state is a consequence of 2 and likelihood of 5.

There are also significant maintenance costs associated with affecting each repair as long lengths of cable are required and 3rd party cable joining experts must be mobilised to conduct the joining activity.

Untreated Asset Risk Score: 3 (Significant) x 5 (Frequent) = High

Preferred Option

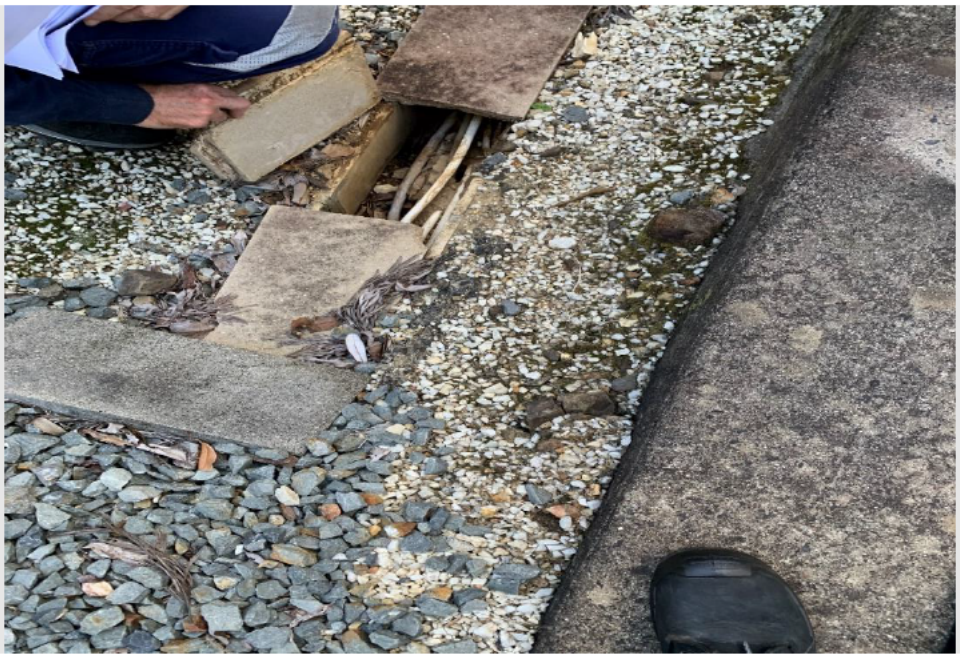
The cable transitions are the sections where the cable moves from above ground to below ground. The Cable Transition Modification proposed is to reduce the localised thermal stress at these transition points though installation of shade/insulation. This is the preferred option for resolving the issue of repeated faults at these locations as this is a substantially lower cost alternative that will successfully reduce the residual risk.

5.2. Facility Cable Tray Install and Cable Relocation

Background

The monitoring and control wiring at the converter stations runs between the control rooms and the external transformers. The control wiring is located on wiring trays to protect them from degrading. At the converter stations, the monitoring and control wiring runs between the control rooms and the external transformers.

Figure 2: Facility Cable Tray



Issue

The wiring is exposed and has been water and rodent damaged in the past. Due to their critical function, damage to these cables can lead to false control operations and outages. Installation of new ducts at a higher level (at or above ground level) would assist with water ingress issues and underground conduits (with cable pits) to protect from external factors and provide clear division of wiring. This would allow easier maintenance and troubleshooting and outweighs the costs of the project.

Risk assessment

The consequence of a failure of the facility monitoring and control cables is an unplanned full Directlink outage for at least one month. These cables cannot be joined or partially repaired and as such, a large replacement activity will be required. An unplanned outage of this duration will have a market impact and poses a reliability of supply risk to some customers.

A fault is anticipated in the coming years based on visual assessment of the cables.

The Risk Score associated with the current state is a consequence of 3 and likelihood of 3.

Untreated Asset Risk Score: 3 (Significant) x 3 (Unlikely) = Moderate

Preferred option

The recommendation is to replace the wiring with armoured wiring to provide additional mechanical protection, install new ducts at a higher level (at or above ground level). Relocation and provision of additional protection for wiring can be achieved via a combination of solutions for the cables and ducts. These solutions include, removing the existing cables and replacing with armoured wiring to provide additional mechanical protection. Installing new ducts at a higher level (at or above ground level) which would assist with water ingress residual risk.

5.3. Circulating Cooling Water (CCW) System Preventative Maintenance

Background

The cooling system provides cooling to the critical electrical components in the valve rooms and adjacent facilities. These electrical components generate heat proportional to the power capacity being transferred and this heat needs to be dispersed to ensure these critical components operate within their design parameters for temperature. The circulating water system is used to remove heat from the valve room. The water is then cooled at cooling towers using air driven by cooling fans.

Issue

There are three key issues that may arise from a poorly maintained circulating water system:

a) Cooling Tower Fans and motors:
The cooling tower fans and motors are recommended for overhaul on a regular basis and are due in the next regulatory period according to the Original Equipment Manufacturer (OEM) recommendations. If these overhauls are not completed, unpredictable and catastrophic failures are anticipated, impacting overall reliability and cooling system performance.

b) Water Leaks
Water leaks resulting in secondary asset damage; resulting in unplanned Directlink outages to repair and increased maintenance/sparing costs due to asset damage. Isolation valves, sealing joints and bellows have been in service for 25 years. There are visual indications of minor weeps that need to be addressed before catastrophic failure occurs.

c) Structural Degradation:
Structural components in this system such as the cooling towers and the cooling tower sound enclosures are prone to corrosion due to the high rainfall, humid environment. Failure to address isolated corrosion will result in more extensive damage and significant structural rework being required prior to the end of Directlink's operating life.

Risk Assessment

Three separate risk assessments have been conducted, each relating to one of the 3 issues identified:

a) Cooling Tower Fans and Motors:

If cooling tower fans are not proactively maintained, unplanned failures will occur. Proactive overhaul of the fans and motors will ensure any bearing defects, impellor alignment issues or motor winding issues will be identified prior to catastrophic failure. If unaddressed, these failures escalate. For example, fan alignment issues and excessive vibration will damage bearings, damage the fan blades and shaft. This will result in costly unplanned reactive maintenance. These failures will be unrevealed until the fan is required for operation. As

such, these failures will result in unplanned outages to repair failed fans. Proactive overhaul of the fans and motors on a regular basis is common industry practise and it is expected that failures will occur in the next regulatory period if no proactive maintenance is undertaken.

The Risk Score associated with the current state of the fans is a consequence of 3 and a likelihood of 4.

Untreated Asset Risk Score (Cooling Tower Fans and Motors): 3 (significant) x 4 (occasional) = Moderate

b) Water Leaks

If the current water leaks and associated high risk leak locations are not addressed, water leaks will escalate. These water leaks will impact the electrical components in the vicinity; causing significant asset damage, maintenance cost and unplanned outages.

The Risk Score associated with the current state of the water system is a consequence of 4 and a likelihood of 4.

Untreated Asset Risk Score (Water Leaks): 4 (Major) x 4 (Occasional) = High

c) Structural Degradation:

If the current corrosion observed on the structure is not addressed and further proactive activities undertaken to manage corrosion, structural damage will escalate. This structural damage will eventually lead to a significant collapse. This may result in injury or fatality if personnel are in the vicinity of a collapse. This will also result in an extended (1 to 2 month) duration Directlink outage to affect a repair. Due to the corrosive nature of the Directlink environment, this is seen as a credible scenario in the remaining life of Directlink (to 2042)

The Risk Score associated with the current state of the structural components of the cooling system is a consequence of 4 and a likelihood of 3.

Untreated Asset Risk Score (Structural Degradation): 4 (Major) x 3 (Unlikely) = High

Preferred Option

It is recommended to undertake the most cost-efficient capital expenditure option in each case that will reduce the residual risk to an acceptable level. That is;

a) For Fans and Motors, it is recommended to refurbish the existing motors to ensure ongoing reliable operation

b) For Water Leaks, it is recommended to replace the leak prone component with like for like modern equivalent to prevent leaks for the remainder of the asset life

c) For Structural Degradation: it is recommended to proactively repair observable corrosion and continue preventative corrosion spraying.

5.4. Reactor Cooling Reliability Improvement

Background

The phase reactor provides a large reactance that allows the valves to control the active and reactive power flow with AC network. In operation, phase reactors heat up, and must be cooled. The current control for the reactor cooling fans has no duty cycle, no fire system cut off and the relay logic is complex and aging. The motors on the phase reactors currently run only in on/off mode.

There are 18 reactors and procurement of each replacement is estimated at $3.5m (excluding installation costs).

Issue

When the temperature rises above the recommended operating temperatures the phase reactor cooling switches on at maximum capacity. This temperature cycling creates additional stress on the phase reactors shortening their operating life. This temperature cycling creates additional wear and tear on the phase reactors shortening their operation life. A phase reactor can cost $3.5m to replace. A recent function test of a phase reactor has indicated performance degradation.

Risk Assessment

If the current degradation is not addressed; it is expected that the phase reactors will fail performance tests prior to the end of life of Directlink. This will require the phase reactors to be replaced at significant expense. The replacement activity will also require a dedicated outage to execute.

The Risk Score associated with the current state is a consequence of 3 and likelihood of 4.

Untreated Asset Risk Score: 3 (Significant) x 4 (Occasional) = High

Preferred option

This scope of works has been previously proposed by APA. At the time of the previous submission, the decline in reactor performance was not yet observed, but had been predicted. In 2023, a separate reactor was removed for recoating and testing. The test results indicated a performance decline. A cause of reactor performance deterioration is the thermal cycling associated with this cooling control system. APA is again proposing this improvement to arrest this degradation and extend the life of the reactors.

A variable speed drive provides greater flexibility to the temperature control function, increasing and decreasing cooling air flow to manage phase reactor temperatures. This has the impact of reducing temperature cycling on the phase reactor.

5.5. Circuit Breakers

Background

The circuit breakers allow for the High Voltage AC connection between Directlink and the supply authorities. If the circuit breakers fail to operate (i.e. don't break the circuit) it creates operational risk and/or potential for more frequent or longer duration unplanned outages.

There are currently only 3 spare units between the 2 breaker types. An acceleration in failure could result in a spare not being available to return a system back to service. The circuit breakers allow for the High Voltage AC connection between Directlink and the supply authorities. There are currently 13 circuit breaker sets (39 individual breaker poles) installed at Directlink, 6 sets have the single pole type BLK222 mechanism (18 units in total) and 7 have the 3-pole mechanism of type BLK82 (21 units in total).

Issue

Since 2018, 7 circuit breakers pole have been replaced due to SF6 leaks and it is inevitable that the remaining circuit breakers will fail in the same manner. Each failure will take a system offline for a minimum of one week while the circuit breaker is replaced. A 3-system outage is also required to lift the circuit breaker into place. Failure to operate the circuit breakers creates operational risk and/or potential for more frequent or longer duration unplanned outages.

All of these have been manufactured by Hitachi. These specific circuit breakers are no longer manufactured, with Hitachi advising APA that they are no longer supporting the servicing and repair of the crank housing driving the circuit breaker mechanisms.

There is no safety risk associated with this as the arrangement is fail safe.

Risk assessment

The consequence of a circuit breaker failure is that a system is required to be taken offline while the circuit breaker is replaced. However, it is anticipated there will be no like for like replacements available in the next revenue determination, as such any failure is like to result in an extended (3 to 4 month) unplanned outage while a project to upgrade the failed circuit breaker is implemented.

The Risk Score associated with the current state is a consequence of 4 and likelihood of 4.

Untreated Asset Risk Score: 4 (Major) x 4 (Occasional) = High

Preferred option

The proposed recommended approach requires replacing 2 sets of each type of breaker between the two sites (12 poles). This can be done by replacing four circuit breakers sets at one site or two circuit breakers sets at each site. The replacement would ensure the new breakers are supported by the original equipment manufacturer. Additionally, the breakers that are removed can be refurbished and serve as additional spares for the older circuit breakers (9 sets or 27 CB poles remaining) that are still in service. This will reduce the residual risk to an acceptable level.

5.6. Fire System Updates

Background

Adequate fire system protections are a regulatory requirement, critical for early detection and suppression of fires, as well as necessary for asset insurance coverage. The NSW technical regulator requires adherence to AS1851. It is also critical for ensuring the validity of business insurance. As such, as fire system equipment reaches its end of life, timely replacement of with modern equivalent equipment is required.

Issue

All Honeywell UDC 2800 model fire panels at Bungalora and Mullumbimby are reaching their end of life. The CPU and main termination boards are no longer available. The Honeywell UDC 3030 model is available and can be used as a direct replacement. Other components of the fire system are obsolete such as the fire-eater bottles together with the Novec fire suppression systems which are also due for replacement.

Risk Assessment

If no action was taken in the next regulator period to conduct capital maintenance of the fire system, DirectLink would become non-compliant with fire regulatory standards. The consequence of non-compliance is that operation of Directlink would need to cease until this non-compliance is remediated; this would take approximately one month. This is a likely outcome as this is a current regulatory requirement.

The Risk Score associated with the current state is a consequence of 3 and likelihood of 5.

Untreated Asset Risk Score: 3 (Significant) x 5 (Frequent) = High

Preferred option

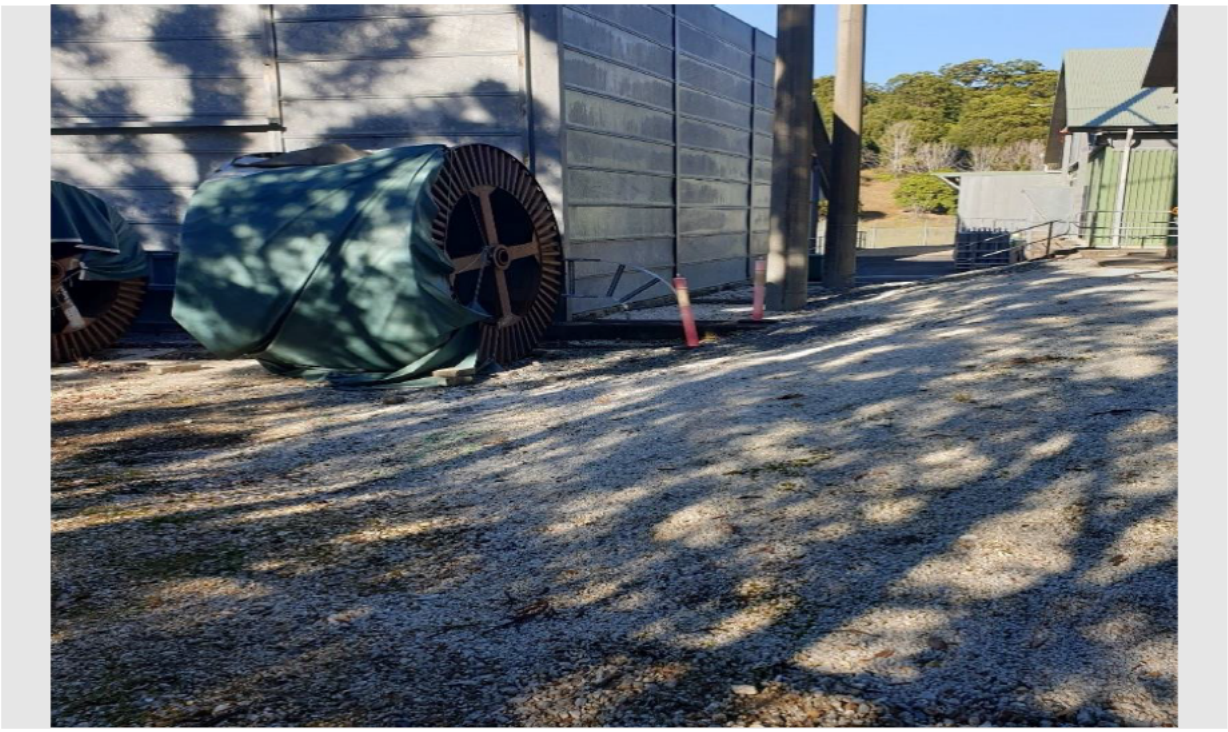
The recommendation is to proactively replace fire system components approaching their end of life to manage the residual risk of non-compliance.

5.7. Land Grading

Background

Improper stormwater drainage could have both long and short-term consequences e.g. foundation damage from pooling water. At Bungalora it has been noted that there is stormwater wash up against and through the soundwalls and into the cable trays.

Figure 3: Current land grading/water run off path with no dedicated drainage.



Issue

The stormwater currently flows towards the converter station, inundating the cable trays and infiltrating sound walls leading into the transformer yard. This creates a potential risk to the electrical infrastructure and in the long term to the foundations of the soundwalls.

Additionally, the top layer gravel washing away with the stormwater impacts on the site earthing design parameters.

Risk assessment

If no action was taken to improve the land grading, water ingress into the cable trays and sound walls would cause significant damage and require significant capital expenditure to replace. In addition, the sound wall could completely fail, resulting in an unplanned outage for at least one month to repair and may injure nearby personnel. Based on visual assessment of deterioration to date, this is a likely outcome in the next regulatory period.

The Risk Score associated with the current state is a consequence of 4 and likelihood of 4.

Untreated Asset Risk Score: 4 (Major) x 4 (occasional) = High

Preferred option

The proposal is to grade the current land area and direct storm water sufficiently away from the site.

5.8. Major capital maintenance

Background

This project comprises a targeted program of major maintenance activities to ensure reliable and safe operation. This includes a number of like for like replacements and major inspections overhauls. These activities have limited project management requirements when compared to the technical management of the upgrades listed in the programs above.

Issue

Due to the age of Directlink, a number of major overhauls are required to ensure ongoing performance of auxiliary mechanical systems and facilities that ensure the electrical conversion components operate reliably.

This program of works involves overhauling, refurbishing and replacing components of the systems required to operate Directlink:

- Fire water pump and generator major overhauls in-line with manufacturer recommendations (this is treated separately to refurbishment of the fire pump system as it requires limited engineering and project management expertise)
- General facility major maintenance (gutter replacements, roof sections etc.) maintenance
- Pressure vessel inspections and repairs in-line with Australian Standard requirements.
- Dehumidifier major overhaul; in-line with manufacturer recommendations
- Major remediation of converter site vegetation management.
- Vehicle capital repairs are also included in major capital maintenance given the location of Directlink and the requirement for physical inspections.

Risk assessment

If ongoing major capital maintenance is not completed, auxiliary systems are expected to fail and result in frequent, short unplanned shutdowns and significant reactive maintenance costs.

The Risk Score associated with the current state is a consequence of 2 and likelihood of 5.

The costs associated with the reactive maintenance required if systems are not proactively maintained as per manufacturer's recommendations is expected to exceed the preventative maintenance costs.

Untreated Asset Risk Score: 2 (minor) x 5 (Frequent) = Moderate

Preferred option

Complete Major Capital Maintenance to ensure ongoing reliability of critical auxiliary systems to reduce the residual risk to negligible and minimise operating cost escalations.

6. Project Options Analysis

For each project, APA has explored an appropriate range of credible options seeking to balance cost, benefits, and risk, including scope to defer investment. In some instances, project needs and the means of addressing them are limited to the extent that only a "Do-nothing" base case (Option 0) and a single credible option are the only reasonable and feasible options.

Error! Reference source not found. table below sets out the options evaluated for each project, the preferred option, and the overall justification for the preferred option.

Table 6.1- Project Options Analysis

Project	Alternatives considered	Analysis	Asset RIsk Score**	Estimated Cost
Cable Transitions	**A) Do Nothing** Not undertake any modification to the cable	Risk: If no modifications are undertaken, multiple failures each year are expected, resulting in repeated Directlink outages. Regular outages to Directlink will result in negative market impacts and risk reliability of supply to customers. Risk: This will result in costs to execute repairs to cable transitions when failures occur. These costs are comparable to the costs to implement the modification, and likely even greater. This is not the preferred option as it is expected to result in higher operating costs and the high frequency failures impacting the market and reliability of supply to customers is an unacceptable risk.	Untreated risk: Consequence: 3 Likelihood: 5 Risk: Moderate	$290,000 p.a. OPEX for fault repairs
	B) Cable Undergrounding Underground the above ground cable lengths to remove all transition points.	Benefit: Less repairs due to cable transition faults and above ground cable faults from external interference. Risk: Increased repairs to accidental interference and fauna. Fault finding is more challenging; resulting in increased repair durations. Although there are benefits to undergrounding, the cost to execute is prohibitive and does not offer sufficient benefit beyond the preferred solution. It offers the same risk reduction as the preferred option for far greater cost.	Consequence: 3 Likelihood: 2 Risk: Low	Over $150m

PREFERRED OPTION	**C) Cable Transition Modification** Modify the cable transitions to minimise the localised sharp step changes in temperatures	Benefit: Cost avoidance as less repairs are required. Benefit: Reduction in unplanned outages resulting from cable faults at transitions. This is the preferred option as it is the lowest cost option to reduce the risk to an acceptable risk.	Consequence: 2 Likelihood: 3 Risk: Low	$545,820
Facility Cable Trays	**A) Do Nothing** Not undertake any proactive replacement and replace failed cables reactively.	Risk: Unplanned cable faults will result in an extended (estimated one month) outage for Directlink whilst repairs are undertaken. Prolonged outage would have a negative impact on the market and risk reliability of supply to customers. This option is not preferred as there is an unacceptable risk to customers by impacting the market and reliability of supply for a month. In addition, should the cables fail, it is anticipated that the cable tray will require replacement, incurring similar costs to the preferred option.	Untreated risk: Consequence: 3 Likelihood: 3 Risk: Moderate	Approx. $430,000 repair cost for each occurrence. Loss of market benefits are in addition to repair costs.
	B) Replace cable tray like for like Replace the cable trays and the current trench like for like.	Risk: Will impact require extended outage to implement Risk: Will not address root cause of degradation Risk: Estimated to cost more than above ground cable tray installation This option is not preferred as it is an equivalent cost to the preferred option and does not adequately reduce the likelihood of failure.	Consequence: 3 Likelihood: 3 Risk: Moderate.	Approx. $350,000
PREFERRED OPTION	**C) Relocation of cable trays** Replace existing cables with armoured cables. Install ducts at higher level. This will require new armoured cables, tray relocation and installation, modification of cable pits.	Benefit: This will significantly reduce the likelihood of cable failure and unplanned outages and avoidance of repair costs due to failure.	Consequence: 3 Likelihood: 2 Risk: Low	$341,138
CCW Preventative Maintenance	**A) Do nothing** Conduct no proactive maintenance and repair motors, fans as they fail.	Risk: Unplanned outages when fans fail on demand resulting in high frequency impacts to market and supply reliability risk to customers.	Untreated risk: Consequence: 4 Likelihood: 3	0*

a) Fans and Motors		Risk: Increased OPEX costs due to catastrophic failures for unmaintained fans and motors This is not the preferred option as it poses unacceptable risk to customers and is anticipates to increase OPEX costs associated with unplanned, reactive maintenance.	Risk: High	
PREFERRED OPTION	**B) Refurbishment of existing fan motors and fans.** Proactive refurbish fans and motors in groups at low fan usage period. This utilizes a known and reasonable cost compared to international importation and redesigns for local products.	Benefit: Allows for continued operation and avoids unplanned outages due to failures Benefit: Lower cost than a modification project or purchase of new like for like motors. This is selected as the preferred option as it is the lowest cost option to reduce the risk of customer impacts to an acceptable level.	Consequence: 3 Likelihood: 2 Risk: Low	$608,000
	C) Importing new motors Replace motors of similar capacity from international suppliers.	Benefit: Allows for continued operation and avoids unplanned outages due to failures Risk: Long lead times to source new like for like motors This is not the preferred option as it is higher cost as the preferred option for equivalent risk reduction.	Consequence: 3 Likelihood: 2 Risk: Low	$1,530,000
	D) Alteration of the motor mounting Alter motor housings to accommodate standard motor size and replace motors with locally available new motors	Benefit: Availability of supply as motors and housings are standard size Benefit: Reduced risk of failure and outages for unplanned repairs. This is not the preferred option as it is higher cost as the preferred option for equivalent risk reduction.	Consequence: 3 Likelihood: 2 Risk: Low	$1,560,000
CCW Preventative Maintenance **b) Water Leaks**	**A) Do Nothing** Undertake no proactive maintenance and address leaks reactively.	Risk: Frequent short duration outages to Directlink will arise to affect repairs. These repairs cannot be conducted with Directlink online. These frequent outages will negatively impact the market and risk reliability of supply to customes. Risk: This option will incur additional and increasing OPEX costs to reactively maintain water system and replace assets impacted by water leaks. Reactive	Consequence: 4 Likelihood: 4 Risk: High	Between $100,000 and $1,000,000 p.a. OPEX

		maintenance OPEX costs could be between $100,000 p.a. and $1,000,000 p.a., depending on secondary damage caused to IGBTs, capacitors and other critical electrical components. This is not the preferred option as the risk to customers is unacceptable and the cost to conduct reactive repairs are expected to exceed to costs for preventative maintenance projects.		for reactive work
	B) Material Upgrades Upgrade materials of o-rings, valves, bellows to extend life	Benefit: Prevents water leaks for the longer term This is not the preferred option as the current material selection has been acceptable for the first half of the asset life. As such, the cost associated with this option is higher whilst achieving the equivalent risk reduction to the preferred option.	Consequence: 4 Likelihood: 2 Risk: Low	$1,600,000
PREFERRED OPTION	**C) Replace with like for like modern equivalent** Replace leak prone joints and fittings with like for like equivalent new components	Benefit: Prevents water leaks for remaining life of the asset. Benefit: Lower cost and achieves risk reduction for remainder of asset life This is the preferred option as the like for like materials are expected to provide reliable operation for the remaining lift of the asset at the lowest cost.	Consequence: 4 Likelihood: 2 Risk: Low	$788,600
CCW Preventative Maintenance **c) Structural degradation**	**A) Do Nothing** Undertake no proactive maintenance to prevent escalation of current corrosion and prevent initiation of corrosion.	Risk: This option would lead to eventual breakdown of structures causing unsafe conditions for personnel and an approximately one month outage for Directlink. This will result in a negative market impact and supply reliability risk to customers.	Untreated risk: Consequence: 3 Likelihood: 4 Risk: High	0*
PREFERRED OPTION	**B) Routine maintenance** Includes standard, low-cost measures such as annual spraying to mitigate visible corrosion of the cooling tower	Benefit: Low-cost solution Benefit: Mitigation of external visible cooling tower corrosion Benefit: Addresses safety hazard and reduces risk of impact to reliability. This is the preferred option as this will address the unacceptable safety and reliability risks for the lowest cost.	Consequence: 2 Likelihood: 3 Risk: Low	$950,00

	C) Extensive maintenance Involves removal of the Bungalora cooling tower roof to enable corrosion mitigation treatment on the sound panels and the roof, as well as to undertake annual spraying	Benefit: More extensive scope to address risk of unknown corrosion damaging sound enclosure. Benefit: Addresses safety hazard and reduces risk of impact to reliability. This is not the preferred option as it delivers comparable risk reduction to the preferred option for a greater cost.	Consequence: 2 Likelihood: 2 Risk: Negligible	$1,750,000
	D) Full replacement Full replacement of roof and all other parts of the cooling tower affected by corrosion	Benefit: Complete mitigation of any active corrosion Risk: Higher cost for comparable risk reduction. Risk: Does not address costs for ongoing corrosion risk. This is not the preferred option as it delivers comparable risk reduction to the preferred option for a greater cost.	Consequence: 2 Likelihood: 2 Risk: Negligible	More than $5m
Reactor Cooling Reliability	**A) Do Nothing** Continue current cooling fan operation and associated control system	Risk: Premature degradation of at least 1 of the 18 phase reactors, requiring replacement (at $3.5m) This is not the preferred option as this does not address the unacceptable risk of asset damage and replacement cost.	Consequence: 3 Likelihood: 4 Risk: High	$5m to $80m
PREFERRED OPTION	**B) Install variable speed drive (VSD) and modernise control system** The proposed enhancements consists of two components: - Replace and reposition reactor cooling fans. This allows for significant air flow in between the reactor cages. There are 6 fans per building, making a total of 12 fans required.	Benefit: Extend the life of the phase reactors to avoid replacement. VSDs provide greater flexibility to the temperature control function, increasing and decreasing cooling air flow to manage phase reactor temperatures. This is the preferred option to prevent deterioration of 18 reactors (at $3.5m each). This reduces the risk to an acceptable level for the lowest cost.	Consequence: 3 Likelihood: 2 Risk: Low	$2,061,835

	- Upgrade the cooling fan control using Variable Speed Drives (VSDs) to improve reliability with less cycling and less extreme temperature changes improving mechanical and electrical component reliability.			
Circuit Breakers	**A) Do Nothing** Conduct no proactive replacement of circuit breakers	Risk: Circuit breakers continue to fail until no spares are available; resulting in an approximately one-month outage at each failure (and unplanned costs). An outage of one month will negatively impact the market and reliability of supply to customers. This is not the preferred option as the ongoing risk of failure is unacceptable.	Consequence: 4 Likelihood: 4 Risk: High	0*
PREFERRED OPTION	**B) Replace all circuit breakers** Replacing all 13 circuit breakers at each facility/end with modern equivalent circuit breakers with like for like functionality.	Benefit: Shorter duration planned outages to deliver long term safe operability of facility. This is the preferred option as this addresses the risk in the most cost effective way.	Consequence: 2 Likelihood: 2 Risk: High	$2,200,000
Fire System	**A) Do Nothing** Fail to undertake capital upgrades to fire system where like for like replacement is no longer possible.	Risk: This would result in non-compliance with regulatory standards and hence is unacceptable.	Consequence: 3 Likelihood: 5 Risk: HIgh	0*
	B) Replace end-of-life components This includes replacing Honeywell UDC 2800 fire panels with Honeywell UDC 3030 panels; replace fire-eater bottles; and replace Novec fire suppression systems.	Benefit: Compliance with standards and avoidance of safety, reliability risks that could arise from non-functional fire system This is the preferred option to maintain fire system compliance for the lowest cost.	Consequence: 3 Likelihood: 1 Risk: Negligible	$644,750
Land Grading	**A) Do Nothing** Continue to allow water drainage path towards sound enclosure foundation and cable trays.	Risk: Unplanned significant repair costs resulting from water damage to Bungalora site assets. Risk: Sound enclosure damage cannot be repaired with Directlink online, resulting in a onemonth outage. This would result in a negative market impact and supply reliability risk to customers.	Consequence: 4 Likelihood: 4 Risk: High	$100,000 to $1,000,000

		This is not the preferred option as this risk of outages impacting the market and reliability of supply to customers is unacceptable.		
PREFERRED OPTION	**B) Construct Boundary Drainage** Involves alteration of site boundary drainage ditch	Benefit: Reduces amount of flooding from site boundary, thereby reducing reliability risks This is the preferred option as it addresses the unacceptable risk for the lowest cost.	Consequence: 3 Likelihood: 2 Risk: Low	$65,498
Major Capital Maintenance	**A) Do Nothing** Address auxiliary system failures reactively.	Risk: Frequent unplanned outages due to auxiliary system failures, requiring repair. Regular outages will have a negative impact on the market and reliability of supply for customers. This is not the preferred option as it does not address this unacceptable risk.	Consequence: 2 Likelihood: 5 Risk: Moderate	0*
PREFERRED OPTION	**B) Implement preventative maintenance program of works** Implement major preventative maintenance and overhauls in line with manufacturer recommendations. NOTE: Equipment upgrades were not considered credible as reliability performance has been acceptable for the first half of Directlink's life.	Benefit: Improved reliability of auxiliary systems supporting Directlink operation. Benefit: Reduced risk of operational performance issues or outages. This is the preferred option as it addresses the unacceptable risk in the most cost-effective way.	Consequence: 2 Likelihood: 2	$852,844
*These options will have OPEX maintenance costs associated due to the inevitable reactive maintenance that will be required with any run to failure option.				

7. Recommendation

It is proposed to undertake the portfolio of 10 Major Maintenance projects consistent with the identification, evaluation and justification of project options presented in Table 5.1, at a total cost to complete of $8.60 million over the 2025-30 regulatory control period.