# Business Case
# M028 Childers to Gayndah Aged Line Rebuild

ERGON. ENERGY NETWORK

# Executive Summary

M028 Childers to Gayndah line is single circuit 66kV line suppling over 5300 customers on the Upper Burnett sub-transmission ring. A condition assessment of M028 indicates the asset is 65 years old, and the line conductor and many of the poles have reached their end of life. This document provides options, analysis and a proposed approach for mitigating aged asset risks on the M028 Childers to Gayndah line.

The current risks associated with the M028 line are significant. The line experiences four times the disruption of average equivalent line supplies; leading to significant outage periods for residential, commercial and industrial customers. Both the community and Ergon Energy staff are exposed to safety risks from poor condition asset failure, particularly during operational maintenance and fault restoration. Network access restrictions for live-line works have been imposed on M028 to minimise harm until a permanent solution is implemented. Bushfire risk due to line failure is also high for M028; with a grass fire started near Biggenden in September 2019 due to M028 line failure.

Two network options were initially considered but rejected; rebuilding the M028 line to a dual circuit, and augmenting M049 line to include a new connection. Both were rejected due to initial cost estimates being an order of magnitude larger than the other options considered.

A further five options were evaluated as part of this business case to address the risks posed by the aged M028 Childers to Gayndah line. These included three network options and two non-network options. The two non-network options involved the installation of diesel generation system and were ruled out prior to NPV analysis due to significantly higher CAPEX and OPEX costs. They may be reconsidered as part of the RIT-D process. The three network options considered in the NPV analysis were:

**Option 1** – Rebuild entire M028 line as a single circuit, timber pole line using iodine as a conductor

**Option 2** – Rebuild entire M028 line as a single circuit, concrete pole line using iodine as a conductor

**Option 3** - Rebuild entire M028 line as a single circuit, concrete pole line using neon as a conductor

Ergon Energy aims to minimise expenditure in order to keep pressure off customer prices, however understands that this must be balanced against critical network performance objectives. These include network risk mitigation (e.g. safety, bushfire), regulatory obligations (e.g. safety), customer reliability and security and preparing the network for the ongoing adoption of new technology by customers (e.g. solar PV). In this business case both safety and customer reliability are strong drivers, due to the advanced age of the M028 line.

To this end the preferred option was Option 3, as it delivers the highest NPV result and a prudent approach to risk minimisation. This option has a total direct cost of $52.4M with works proposed from 2020 - 2023.

The direct cost of the project for each submission made to the AER is summarised in the table below. Note that all figures are expressed in 2019/20 dollars and apply only to costs incurred within the 2020-25 regulatory period for the preferred option.

| Regulatory Proposal | Draft Determination Allowance | Revised Regulatory Proposal |
|---|---|---|
| $38.1M | $0M | $52.4M |

# Contents

# 1. Introduction

M028 Childers to Gayndah line is an Ergon Energy 66kV asset which runs 92km from Childers to Gayndah. M028 line is part of the 66kV sub transmission ring supplying over 5300 customers with a peak load of 30.8MVA. The line supplies Degilbo (DEGI), Gayndah (GAYN), Mundubbera Town (MUTO) and Eidsvold (EIDS) and Mount Rawdon gold mine (MORW).

M028 line is 65 years old and has reached its end of life. The line conductor and poles are in extremely poor condition and pose significant customer supply risks, environmental risks and safety risks to both Ergon Energy employees and the community.

## 1.1 Purpose of document

This document provides options, analysis and a proposed approach for mitigating aged assets risks on M028 Childers to Gayndah line. This is a preliminary business case document and has been developed for the purposes of seeking funding for the required investment in coordination with the Energy Queensland Revised Regulatory Proposal to the Australian Energy Regulator (AER) for the 2020-25 regulatory control period. Prior to investment, further detail will be assessed in accordance with the established Energy Queensland (EQL) investment governance processes. The costs presented are in $2019/20 direct dollars.

## 1.2 Scope of document

The scope of this document is limited to the aged electricity supply infrastructure of M028 Childers to Gayndah line. The condition of parallel feeder M049 is also considered this business case, as the M028 line forms part of a sub transmission supply ring with M049.

## 1.3 Identified Need

Ergon Energy aims to minimise expenditure in order to keep pressure off customer prices, however understands that this must be balanced against critical network performance objectives. These include network risk mitigation (e.g. safety, bushfire), regulatory obligations (e.g. safety), customer reliability and security and preparing the network for the ongoing adoption of new technology by customers (e.g. solar PV). In this business case both safety and customer reliability are strong drivers, due to the advanced age of the M028 line.

M028 Childers to Gayndah line has reached its end of life. The M028 line is 65 years old with original conductor and 37% original untreated hardwood poles. Independent sample assessments of the conductor (detailed in Appendix H ) found all nine samples did not meet AS C41 -1968 minimum breaking and tensile strength requirements and showed significant annealing.

The M028 line has extremely poor customer reliability, with four times the disruption of an average of sub transmission feeder. The line currently has no overhead earth wire, making it highly susceptible to lightning strikes and damage. Eleven Dangerous Electrical Events (DEE[1]) have been recorded against M028 in the last seven years (1.57 DEEs per annum); 27% due to lightning strike. A ban for live-line works has also been imposed on M028 due to its condition; resulting in regular de-energisation for maintenance.

[1] A DEE is a notifiable event to the regulator, under the Electrical Safety Regulation 2013. DEEs involve unsafe electrical equipment and people who are electrically unsafe around high voltage electrical equipment (*Electrical Safety Act 2012*).

M028 also crosses bushfire prone areas, increasing the fire risk to the surrounding environment due to line failure. In September 2019 asset failure on M028, attributed to its aged nature, started a grass fire near Biggenden during a peak fire risk period.

Further, the low thermal rating of the M028 limits the peak loading of the 66kV sub transmission ring during contingency events on M049; leading to load shedding and operational losses for large-scale mining customer Mt Rawdon Gold Mine.

Left unaddressed, M028 line will continue to degrade; increasing negative customer impacts and operational safety risks for Ergon Energy workers through probable failure of the asset.

Replacement works are recommended to align with the CAPEX objectives and criteria from the National Electricity Rules as detailed in Appendix C .

## 1.4 Energy Queensland Strategic Alignment

Table 1 below details how M028 aged line rebuild contributes to EQL's corporate and asset management objectives. The linkages between these Asset Management Objectives and EQL's Corporate Objectives are shown in Appendix D .

**Table 1: Asset Function and Strategic Alignment**

| Objectives | Relationship of Initiative to Objectives |
|---|---|
| **Ensure network safety for staff contractors and the community** | Suitable electricity infrastructure development is critical to the safe operation of the electricity network. Without suitable replacement asset failures could occur resulting in unacceptable safety risks to the community. |
| **Meet customer and stakeholder expectations** | The provision of suitable electricity infrastructure is critical to a safe and reliable electricity supply. This infrastructure contributes to important electricity security and reliability outcomes expected by the community. |
| **Manage risk, performance standards and asset investments to deliver balanced commercial outcomes** | Without suitable ageing plant replacements, significant risks of supply interruptions and safety risks are likely to arise in coming years. Hence the most suitable economic development provides a balanced result in terms of investment to meet required safety and reliability obligations. |
| **Develop Asset Management capability & align practices to the global standard (ISO55000)** | Timely renewal of infrastructure using suitable asset standards aligns with the practices in ISO55000. |
| **Modernise the network and facilitate access to innovative energy technologies** | The proposed rebuild is in line with modern standards that support bringing aged assets up to modern standards. This proposal will be progressed through the Regulatory Investment Test for Distribution (RIT-D) process to ensure that demand-side and other innovative technologies are tested as alternatives to the network proposal. |

## 1.5 Applicable service levels

Corporate performance outcomes for this asset are rolled up into Asset Safety & Performance group objectives, principally the following Key Result Areas (KRA):

- Customer Index, relating to Customer satisfaction with respect to delivery of expected services
- Optimise investments to deliver affordable & sustainable asset solutions for our customers and communities

Corporate Policies relating to establishing the desired level of service are detailed in Appendix D

Under the Distribution Authorities, EQL is expected to operate with an 'economic' customer value-based approach to reliability, with "Safety Net measures" to mitigate risks. Safety Net measures are intended to mitigate against the risk of low probability, high consequence network outages. Safety

Net targets are described in terms of the number of times a benchmark volume of energy is undelivered for more than a specific time period. A table of safety net obligations can be found in Appendix F .

EQL is expected to employ all reasonable measures to ensure it does not exceed minimum service standards (MSS) for reliability, assessed by feeder types as

- System Average Interruption Duration Index (SAIDI), and;
- System Average Interruption Frequency Index (SAIFI).

Both Safety Net and MSS performance information are publicly reported annually in the Distribution Annual Planning Reports (DAPR). MSS performance is monitored and reported within EQL daily.

## 1.6 Compliance obligations

Table 2 shows the relevant compliance obligations for this proposal.

**Table 2: Compliance obligations related to this proposal**

| Legislation, Regulation, Code or Licence Condition | Obligations | Relevance to this investment |
|---|---|---|
| **QLD Electrical Safety Act 2002**<br>**QLD Electrical safety Regulation 2013** | We have a duty of care, ensuring so far as is reasonably practicable, the health and safety of our staff and other parties as follows:<br>• Pursuant to the Electrical Safety Act 2002, as a person in control of a business or undertaking (PCBU), EQL has an obligation to ensure that its works are electrically safe and are operated in a way that is electrically safe.[2] This duty also extends to ensuring the electrical safety of all persons and property likely to be affected by the electrical work.[3] | This proposal reduces safety risks through timely and suitable replacement of aged assets. |
| **Distribution Authority for Ergon Energy issued under section 195 of *Electricity Act 1994* (Queensland)** | Under its Distribution Authority:<br>• The distribution entity must plan and develop its supply network in accordance with good electricity industry practice, having regard to the value that end users of electricity place on the quality and reliability of electricity services.<br>• The distribution entity will ensure, to the extent reasonably practicable, that it achieves its safety net targets as specified.<br>• The distribution entity must use all reasonable endeavours to ensure that it does not exceed in a financial year the Minimum Service Standards (MSS) | This proposal reduces customer outages (and reduces SAIFI and SAIDI) caused by plant failures due to aged assets in poor condition. This improves Ergon Energy's ability to comply with MSS. |
| **National Electricity Rules, Chapter 5** | Schedule S5.1 of the National Electricity Rules, Chapter 5 provides a range of obligations on Network Services Providers relating to Network Performance Requirements. These include:<br>• Section S5.1.9 Protection systems and fault clearance times<br>• Section S5.1a.8 Fault Clearance Times<br>• Section S5.1.2 Credible Contingency Events | This proposal improves fault clearance times (currently extended due to the poor condition of the asset) and removes recovery limitations for credible contingency events. |

[2] Section 29, *Electrical Safety Act 2002*
[3] Section 30 *Electrical Safety Act 2002*

| Legislation, Regulation, Code or Licence Condition | Obligations | Relevance to this investment |
|---|---|---|
| **AS7000** | AS7000 defines terms of structural wind loading, load factors, strength reduction and reliability replacement or rebuild of a line. | This proposal recommends a solution compliant with AS7000. |
| **AS C41-1968** | AS C41-1968 outlines specifications for Hard-Drawn Copper Conductors for Overhead Power Transmission Purposes. | This standard is considered relevant to the time of commissioning of the M028 line and has been used in the condition assessment of the existing conductor. |

## 1.7 Limitation of existing assets

The primary driver for this investment is replacement capital expenditure (Repex). Condition assessments for M028 Childers to Gayndah line highlight aged and poor condition assets which present significant customer, safety, environmental, and business risks. Key issues associated with M028 line are detailed below.

### Reliability

M028 Childers to Gayndah line has accumulated almost two million customer minutes lost in the last four years. Degilbo being the most affected with over 1100 customers losing power every outage; on average six and a half hours of supply per year. M028 line reliability is around 6.4 faults/100km/year; four times worse than Ergon Energy's average outage rate for sub transmission wood pole feeders. For reliability comparison, a concrete pole feeder with an aerial earth wire has an average 0.25 faults /100km /year, 24 times better than disruption experienced by the customers on M028.

### Line Rating

The current low thermal rating of the M028 line (15.1MVA Summer Day Rating) limits the peak loading of the sub transmission ring during contingency events. M028 is unable to supply large-scale customer Mt Rawdon Gold Mine when an outage occurs on parallel feeder M049 during peak periods; leading to loss of supply and operational losses for the customer.

### Voltage Levels

Voltage modelling indicates the network is voltage constrained both in system normal and contingency scenarios; with most zone substation transformers at maximum boost tap and unable to supply further voltage. This leads to possible loss of supply during outages on either M028 or M049.

Modelling shows that an outage on M028 during summer peaks can cause low voltages at Mt Rawdon Gold Mine. Planned outages can be scheduled outside of these periods, however the network will be constrained by unplanned outages within peak periods. Voltage limitations also mean Mt Rawdon Gold Mine is unable to be supplied during a M049 outage and future large customer connections may not be possible or only be possible with restrictions e.g. limiting operation to off-peak times or utilising peak lopping generators.

## Value of Customer Reliability

Value of Customer Reliability (VCR) modelling shows the outage cost to customers (excluding Mt Rawdon Gold Mine) for both feeders (M028 and M049) was estimated at $1.3M per annum FY18/19 (excluding further asset degradation). With a further VCR impact for Mt Rawdon Gold Mine of up to $10.6M per annum. This cost is significant to customer supply and operations.

Detail about how the Australian Energy Market Operator (AEMO) 2014 VCR standard is applied in investment analysis is included in each DNSP's Distribution Annual Planning Report (DAPR) under section 6.4 on Network Planning Criteria.

## Feeder Condition

M028 Childers to Gayndah line was constructed in 1954 (65 years old) using untreated wood poles and strung with 7/0.104 Hard Drawn Bare Copper (HDBC) at 50$^{O}$C. 37% of the M028 line includes the original untreated wood poles.

Independent sample assessments of the aged conductor found it to be in poor condition and not meeting AS C41 -1968 minimum breaking and tensile strength requirements and showing significant annealing. An operational ban on live-line work has been imposed on this asset due to its poor condition; resulting in a greater volume of outages for maintenance. ALS Industrial's full report can be found in Appendix H .

The M028 line currently has no overhead earth wire, making it highly susceptible to lightning strikes and damage. Over ten Dangerous Electrical Events (DEE) have been recorded against M028 in the last seven years (see Appendix H ); 27% due to lightning strike. In the most recent four-yearly inspection cycle (2018), Ergon Energy spent approximately $390,000 on corrective maintenance for M028. Line degradation is expected to accelerate due to age, lightning damage to conductor and termite damage to poles.

Parallel feeder M049 Isis – Gayndah line is 31 years old with pesticide-treated wood poles and has a summer day rating of 45.6MVA. M049 has no overhead earth wire; making it susceptible to lightning strikes. It is not deemed to need immediate replacement; its end of life however has been considered in option analyses.

# 2 Counterfactual Analysis

## 2.1 Purpose of asset

Upper Burnett sub transmission ring infrastructure is essential to the reliable supply of electricity to over 5,300 residential, rural, and industrial customers in regional Queensland. This includes supply to the townships and substations of Degilbo (DEGI), Gayndah (GAYN), Mundubbera Town (MUTO) and Eidsvold (EIDS) and Mt Rawdon gold mine (MORW) – See Appendix H .

The following parameters are key to supply in the Upper Burnett region:

- Ensuring network safety for staff, contractors and the community.
- Ensuring outage frequency, duration and severity are minimised.
- Providing suitable network arrangements; prudently maximising the customer supply coverage under credible contingency events.

Mt Rawdon Gold Mine is a significant customer and the largest employer in the area - with 24hr production and authorised demand (AD) of 12MW. Several other large customer ventures also exist in the area, representing potential future growth requirements for M028 (described in Appendix H ).

## 2.2 Business-as-usual service costs

The business as usual (BAU) service costs for M028 Childers to Gayndah line are the maintenance costs and progressive conductor replacement costs. In addition to these costs, significant emergency response and replacement costs would be incurred for the counterfactual BAU case if failures occur. An estimate of risk monetisation for asset failure is provided in Section 2.4 below.

## 2.3 Key assumptions

The Counterfactual BAU case assumes a do-nothing case where routine maintenance continues and the asset is run to failure. This option has been costed and shown for comparative purposes only. This option is not appropriate due to the safety issues involved and is unviable as it is non-compliant with current regulations.

## 2.4 Risk assessment

The risks below reflect the Counterfactual BAU case. This risk assessment is in accordance with the EQL Network Risk Framework and the Risk Tolerability table from the framework is shown in Appendix E .

**Table 3: Counterfactual risk assessment**

| Risk Scenario | Risk Type | Consequence (C) | Likelihood (L) | Risk Score | Risk Year |
|---|---|---|---|---|---|
| Public Safety Impact - Conductor/pole failure in a public access area results in single fatality | Safety | 5 *(Single fatality / incurable fatal illness)* | 2 *(Very Unlikely)* | **10** ***(Low Risk)*** | 2019 |
| Worker Safety Impact – Failure of an aged copper conductor during re-tensioning results in loss of control of conductor striking a worker causing single serious injury | Safety | 4 *(Multiple serious injury / illness)* | 3 *(Unlikely)* | **12** ***(Moderate Risk)*** | 2019 |

| Risk Scenario | Risk Type | Consequence (C) | Likelihood (L) | Risk Score | Risk Year |
|---|---|---|---|---|---|
| Bushfire Impact – An energised conductor fails and falls to ground starting bushfire resulting in medium-term disruption to eco-system. Area surrounding M028 Feeder classified as bush fire prone with 'high' to 'very high' bushfire potential. | Safety & Environment | 4 *(Medium term disruption to eco-system)* | 3 *(Unlikely)* | **12** ***(Moderate Risk)*** | 2019 |
| Asset Impact – Interruption to a single large-scale business (Mt Rawdon Gold Mine) for >12 hours leads to shut down process and involves rolling load shedding at DEGI, GAYN, MUTO and EIDS while the line is repaired. | Customer | 3 *(Disruption to single large-scale business)* | 4 *(Likely)* | **12** ***(Moderate Risk)*** | 2019 |
| Asset Impact – Limitations on maintenance works program and potential load shedding at DEGI, GAYN, MUTO and EIDS due to ban on live line works. | Customer | 3 *(Interruption >12 hours)* | 4 *(Likely)* | **12** ***(Moderate Risk)*** | 2019 |
| Customer & Political Sensitivity - Continued inability to maintain M028 in accordance with EQL standards leads to ongoing interruption and adverse regional media attention. | Customer | **3** *(Adverse regional media attention)* | 3 *(Unlikely)* | **9** ***(Low Risk)*** | 2019 |

The conclusion from this risk assessment is that significant safety, fire and customer risks exist now given the state of M028 line. These risks need to be addressed to ensure the safety of Ergon Energy staff and members of the community in accordance with the principles of So Far as Is Reasonably Practicable (SFAIRP). Failure to address these risks by running assets to failure does not comply with Ergon Energy's safety compliance obligations under the *Electrical Safety Act 2002* and the associated *QLD Electrical Safety Regulation 2006*. Further details of the risk ratings and descriptions can be found in Energy Queensland's Network Risk Framework.

The monetary impact of the M028 line risk profile has been assessed in the Figure 1 below. This risk monetisation uses historical data for M028 and M049 to derive estimates for failure frequency, probability of consequence, outage periods, fault escalation and fault recovery times. These parameters are then multiplied by the estimated cost impact of various asset failure impacts to quantify the values shown below. Appendix G summarises the parameters and process used for this risk quantification.

Figure 1 shows an increasing inherent monetary risk exposure for M028 the as asset continues to degrade over time; with customer reliability, fire and safety risk costs at the forefront of this exposure.

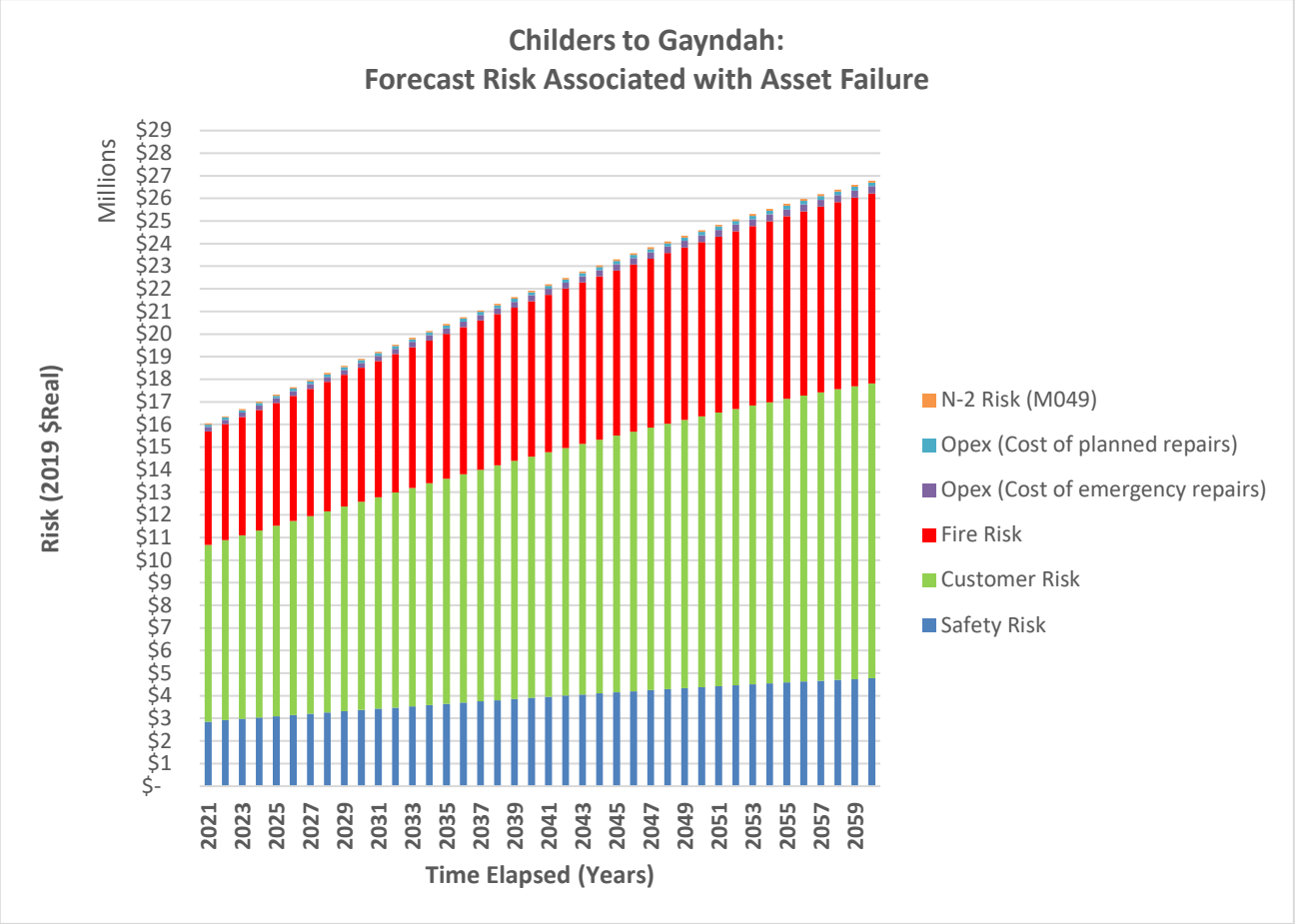



**Figure 1: M028 Risk Monetisation Assessment**

## 2.5 Retirement or de-rating decision

M028 line is vital to the reliable supply of electricity for over 5,300 residential, rural, and industrial customers in the Upper Burnett region of Queensland. Continued excessive failure of M028 Childers to Gayndah line will maintain a negative impact to EQL's objectives related to customer, safety and environmental outcomes. Continued failure also has reputation implications due to the importance of energy supply to local industries. The option to retire M028 Childers to Gayndah line (removing the safety risk), leaving M049 to service the regional loads of the existing 66kV ring, has been considered. This option is not viable however, due to voltage issues, large levels of load shedding for extended periods of the year, and the inability of this configuration to meet safety net standards.

Consequently, there is no suitable retirement or de-rating decision associated with this infrastructure due to its criticality to network operations.

# 3 Options Analysis

## 3.1 Options considered but rejected

The Counterfactual BAU case is presented below for comparison. It has however been rejected as it presents a low Net Present Value (NPV) verse other options and fails to address key safety and environmental risks for M028. This option would also not meet structural wind loading, load factors, strength reduction and reliability requirements required under AS7000.

The following options were also considered as part of the initial assessment of the M028 line, but were rejected due to lower NPV (higher cost) and higher VCR outcomes than the option variables considered under Section 3.2:

**Table 4: Options Considered but Rejected**

| Asset Solution | Circuit / Pole | Conductor | Route | Considerations |
|---|---|---|---|---|
| **Rebuild M028 to dual circuit and recover M049** | Dual Circuit Concrete | Neon at 60°C (19/3.75 AAAC 1120) with aerial earth wire 45.8MVA capacity 91.6MVA ring capacity | Isis Bulk Supply Point to Gayndah Zone Substation (99km) | • Enables removal of M049<br>• Includes tie-in points and remote isolation switches along M028 /M049 to minimise customer outages.<br>• Includes new 66kV feeder bay at Isis Bulk Supply Point (BSP) Substation |
| **Augment M049 to include connection to Dallanil to Degilbo and remove M028** | Single Circuit Concrete | Neon at 60°C (19/3.75 AAAC 1120) with aerial earth wire 45.6MVA capacity | Dallanil to Degilbo (12km) | • Tie in of new line to M049<br>• Operate M049 as single circuit radial<br>• 12MW of generation across Gayndah and Mundubbera for peak lopping and safety net compliance |

### Rebuild M028 to dual circuit and recover M049

This option provides abundant capacity to supply existing load and potential growth, sufficient capability to supply all loads during contingency events, and prudent expenditure against higher cost conductor materials.

All risks associated with the aged nature of M028 would be removed with the completion of this project by FY2024. The risks associated with the aging nature of M049 Feeder Isis to Gayndah (>30 years) are also removed under this option; providing the greatest improvement to network reliability. This is not the most cost-effective option however (40% higher CAPEX cost) as M049 infrastructure is replaced prior to its useful end-of-life. The significantly higher CAPEX expenditure results in this option presenting a lower NPV (higher project cost) than the proposed option.

### Augment M049 to include connection to Dallanil to Degilbo and remove M028

This option has a low CAPEX, but the highest VCR cost due a decline in network flexibility and customer reliability due to the radial operation of the 66KV network. During fault scenarios, this option requires generation support for over 4000 network customers and causes Mt Rawdon Gold Mine to incur ~$1M in operational costs and forgone profit.

While this option removes risks associated with the aged nature of M028, the significantly higher OPEX results in this option presenting a lower NPV (higher project cost) than the proposed option.

## 3.2 Identified options

### 3.2.1 Network options

The following refined network options have been considered:

**Table 5: Network Options Considered**

| Asset Solution | Circuit / Pole | Conductor | Route | Considerations |
|---|---|---|---|---|
| **Option 1 – Rebuild M028 Timber, Iodine** | Single Circuit Timber | Iodine at 75°C (7/4.75 AAAC 1120) with aerial earth wire 45 MVA capacity | Isis Bulk Supply Point to Gayndah Zone Substation (99km) | • Limited availability of >15m wooden poles with 20kN loading.<br>• Timber poles require replacement after 50 years<br>• Operate in parallel with M049<br>• No reliability improvement for Mt Rawdon Gold Mine reliability costs due to unacceptable voltages when connecting to a new Iodine feeder. |
| **Option 2 – Rebuild M028 Concrete, Iodine** | Single Circuit Concrete | Iodine at 75°C (7/4.75 AAAC 1120) with aerial earth wire 45 MVA capacity | Isis Bulk Supply Point to Gayndah Zone Substation (99km) | • Concrete pole life is 60 years<br>• Operate in parallel with M049<br>• No reliability improvement for Mt Rawdon Gold Mine reliability costs due to unacceptable voltages when connecting new Iodine line. |
| **Option 3 – Rebuild M028 Concrete, Neon (recommended)** | Single Circuit Concrete | Neon at 75°C (19/3.75 AAAC 1120) with aerial earth wire 62MVA capacity | Isis Bulk Supply Point to Gayndah Zone Substation (99km) | • Concrete pole life is 60 years<br>• Operate in parallel with M049<br>• Enables possible retirement of M049 at end of life (load dependant)<br>• Reliability improvement for Mt Rawdon Gold Mine reliability costs |

### 3.2.2 Non-network options

Two non-network options have also been considered. These solutions have been sized to meet a peak load of 35MW and average load of 26.25MW:

**Table 6: Non-network options considered**

| Asset Solution | Overview | Considerations |
|---|---|---|
| **Hybrid Generation Solution** | • 25MW AC Solar PV<br>• 14MW Battery Energy System Solution<br>• 45MW Diesel Genset (10 x 4.5MW) | • Very high capital cost $96.7M<br>• High non-fuel annual OPEX cost $4.3M<br>• No reduction in safety or environmental risks<br>• Effectively placement within the network to best minimise reliability impacts – unlikely to totally remove reliability risk. |

| Asset Solution | Overview | Considerations |
|---|---|---|
| **Diesel Generation Solution** | • 45MW Diesel Genset (10 x 4.5MW) | • Moderate capital cost $49.5M<br>• Very high OPEX fuel cost $58.7M<br>• No reduction in safety or environmental risks<br>• Effectively placement within the network to best minimise reliability impacts – unlikely to totally remove reliability risk. |

These options have not been analysed further due to the very high up-front cost of the hybrid solution ($96.7M) and excessive operational cost ($58.7M) of the diesel solution. This investment will also be subject to RIT-D as a mechanism for customer and market to explore further solutions (not considered here). The primary investment driver for this project is REPEX, addressing both asset safety and performance risks. A successful Non-Network Solution may be able to assist in reducing the scope required for the replacement project but will not be able to impact the project timing due to the aged equipment risk.

## 3.3 Economic analysis of identified options

### 3.3.1 Cost versus benefit assessment of each option

Cost inputs to the following analysis is based on bottom-up design estimates for each option; thereby providing a greater level of accuracy than the initial AER submission for this option. The Net Present Value (NPV) of each option has been determined by considering costs and benefits over the program lifetime from FY2020/21 to FY2039/40, using EQL's standard NPV analysis tool. The tool incorporates any residual value for assets at the end of the program lifetime into the NPV analysis.

#### Assumptions

- The scope of work was costed based on Asset Replacement; including costs and resources required for the installation of new infrastructure and removal of the existing assets. These activities are well known and established.
- The Net Present Value (NPV) of each option has been determined by considering costs and benefits over the program lifetime from FY2019/20 to FY2079/80 to correctly evaluation concrete vs timber poles variables, using the EQL standard NPV analysis tool.
- Value of Customer Reliability (VCR) is defined based on the cost of interruption to the customer. VCR is an economic value applied to customers' annual unserved energy and helps compare project options in a project business case where reliability is assessed to have a material impact. VCR assessment includes restoration time, repair time and mobile generation.

Table 7 outlines the Present Value (PV) of CAPEX and OPEX, and the NPV of costs over the lifetime of each option, discounted at the Regulated Real Pre-Tax Weighted Average Cost of Capital (WACC) rate of 2.62%. The table also outlines the annual VCR value associated with each option.

**Table 7: NPV comparison of options**

| Option | NPV ($M) | Up-Front CAPEX ($M) | Option CAPEX (PV $M) | Option OPEX (PV $M) | Avg. Risk Reduction p.a. ($M) | Residual VCR ($M/yr) |
|---|---|---|---|---|---|---|
| **Option 1 – Rebuild M028 (Timber, Iodine)** | 186.3 | 44.8 | -74.9 | -8.0 | 11.5 | 9.5 |

| Option | NPV ($M) | Up-Front CAPEX ($M) | Option CAPEX (PV $M) | Option OPEX (PV $M) | Avg. Risk Reduction p.a. ($M) | Residual VCR ($M/yr) |
|---|---|---|---|---|---|---|
| **Option 2 – Rebuild M028 (Concrete, Iodine)** | 195.4 | 51.6 | -77.4 | -6.4 | 11.9 | 9.2 |
| **Option 3 – Rebuild M028 (Concrete, Neon)** | 387.7 | 52.4 | -56.0 | -1.8 | 19.3 | 1.3 |

### Option 1: Rebuild M028 (Timber, Iodine)

Option 1 improves the reliability for M028 customers (SAIFI) by 75% and removes safety and environmental risks associated with the aged nature of M028. This option has the lowest up-front CAPEX cost however, the Iodine conductor provides unacceptable voltage levels when connected to Mt Rawdon Gold Mine and therefore fails to provide sufficient capacity to supply all loads during contingency events on M049 feeder and offers minimal VCR improvement.

Over the 60-year assessment period, this option has a higher cost due to the shorter asset life of wooden poles (requiring replacement after 50 years) and cost of replacement of M049 (like-for-like) at its end of life (2040). The NPV provided by this option is lower than Option 2 or 3.

### Option 2: Rebuild M028 (Concrete, Iodine)

Option 2 improves the reliability for M028 customers (SAIFI) by 96% and removes safety and environmental risks associated with the aged nature of M028. The Iodine conductor however, provides unacceptable voltage levels when connected to Mt Rawdon Gold Mine. This option therefore fails to provide sufficient capacity to supply all loads during contingency events on M049 feeder and offers minimal VCR improvement.

Option 2 has a high up-front CAPEX cost due to longer asset life concrete poles. Over the 60-year assessment period, this option also has a higher cost than Option 3 cost due to the cost for (like-for-like) M049 replacement at its end of life. The NPV provided by this option is lower than Option 3.

### Option 3: Preferred - Rebuild M028 (Concrete, Neon)

Option 3 improves the reliability for M028 customers (SAIFI) by 96% and removes safety and environmental risks associated with the aged nature of M028. Option 3 also provides sufficient capability to supply all loads during a contingency on M049 feeder. The scope includes Neon conductor and new remote switches along the M028 to provide greater network flexibility and safety net compliance for rural zone substations connected to M028 and M049. This will allow for the new M028 to supply Mt Rawdon Gold Mine during an outage to the first section of M049. Similarly, if there is a fault in the first section of the new M028, M049 can be back feed 18km to Degilbo, providing suitable voltages for Degilbo to operate during this particular contingency. Further, this option allows for (loads pending) the retirement of line M049 at its end of life; presenting a reduced total CAPEX cost across the assessment period.

All risks associated with the aged nature of M028 will be removed with the completion of this project. This option does not address current risks associated with the aging nature of M049 Feeder Isis to Gayndah (>30 years). These risks are manageable however, under safe work practices and future risks can be managed by the increased capacity of M028; enabling it to take on M049 loads.

Option 3 is preferred as it provides the highest NPV (lowest cost) and lowest VCR reliability cost of all the options. This option also allows for a level of future load growth and further large customer connections.

It should be noted that the cost of $52.4M for this proposed option is higher than the $38.1M submitted as part of Ergon's original regulatory proposal in January 2019. This is due to a complete re-estimation of the project that has been carried out. This additional replacement capex has been reported as a separate line item in Ergon's RIN.

## 3.4 Scenario Analysis

### 3.4.1 Sensitivities

Sensitivity analysis was conducted for capital costs, varying the estimates by +/- 20%. Table 8 below shows, based on Monte Carlo simulation, Option 3 was the preferred option for 100% of cases. The absolute nature of these results reflects the significant variance in reduction value between options across an extensive (60 year) analysis period. Based on the sensitivity analysis, Option 3 remains the preferred option.

**Table 8: Monte Carlo NPV Analysis**

| Option | Rank | Average NPV ($M) | Best NPV | Worst NPV |
|---|---|---|---|---|
| **Option 1 – Rebuild M028 (Timber, Iodine)** | **3** | **189.8** | 0% | 0% |
| **Option 2 – Rebuild M028 (Concrete, Iodine)** | **2** | **206.2** | 0% | 0% |
| **Option 3 – Rebuild M028 (Concrete, Neon)** | **1** | **397.6** | 100% | 0% |

### 3.4.2 Value of regret analysis

Option 3 presents a decision pathway of 'least regret' for the M028 Childers to Gayndah line. The largest value of regret for this asset is the risk of safety incidents, environmental incidents and cost of customer reliability. Option 3 prudently removes these risks and provides a significant improvement to customer outcomes on both M028 and M049; improving reliability for Mt Rawdon Gold Mine. Option 3 remains the preferred option as it offers the least value of regret through prudently eliminating the key risks using the highest NPV (lowest cost) option.

## 3.5 Qualitative comparison of identified options

### 3.5.1 Advantages and disadvantages of each option

Table 9 below details the advantages and disadvantages of each option considered.

**Table 9: Assessment of options**

| Options | Advantages | Disadvantages |
|---|---|---|
| Option 1 – Rebuild M028 (Timber, Iodine) | • Safety and environmental risks of aged equipment failure removed on M028<br>• Network flexibility of sub transmission ring maintained | • Network risks to M049 customers during contingency events are not addressed by this option<br>• Higher maintenance and shorter asset life for timber poles<br>• Limited supply of suitable timber poles (competing with asset maintenance suppliers) |

| Options | Advantages | Disadvantages |
|---|---|---|
| Option 2 – Rebuild M028 (Concrete, Iodine) | • Safety and environmental risks of aged equipment failure removed on M028<br>• Network flexibility of sub transmission ring maintained<br>• Lower maintenance cost and longer asset life for concrete poles | • Network risks to M049 customers during contingency events are not addressed by this option |
| Option 3 – Rebuild M028 (Concrete, Neon) | • Safety, network and environmental risks of aged equipment failure removed on M028<br>• Network flexibility of sub transmission ring maintained<br>• Customer reliability improved; particularly during contingency events<br>• Capacity for future growth or recovery of M049. | • Higher up-front cost. |
| Counterfactual - BAU Do Nothing | | • Unacceptable safety, network and environmental risk which increases as line further degrades |

The network (business) risk the organisation would be exposed to if the project was not undertaken is not deemed to be As Low as Reasonably Practicable (ALARP). Addressing the risks, as detailed above, through implementation of the preferred Option 3 will significantly reduce Ergon Energy's risk exposure.

The risk exposure of Option 3 is lower than Option 1 and 2 where the customer network risk, associated with M028 providing supply during contingency events on M049, is not addressed. The current risk associated with the aging nature of M049 is not addressed by any of the above options however is manageable under safe work practices. The adoption of higher risks (Counterfactual option) expose the business to unsatisfactory risks to Ergon Energy workers, the community and customers.

### 3.5.2 Alignment with network development plan

The proposed works outlined in this business case will enable Ergon Energy to proactively respond to changing network requirements. This will ensure that customer supply, network reliability and safety requirements continue to be met going forward.

### 3.5.3 Alignment with future technology strategy

This program of work does not contribute directly to Energy Queensland's transition to an Intelligent Grid, in line with the Future Grid Roadmap and Intelligent Grid Technology Plan. However, it does support Energy Queensland in maintaining affordability of the distribution network while also maintaining safety, security and reliability of the energy system, a key goal of the Roadmap, and represents prudent asset management and investment decision-making to support optimal customer outcomes and value across short, medium and long-term horizons.

### 3.5.4 Risk Assessment Following Implementation of Proposed Option

Table 10 outlines the risk assessment for the Ergon Energy network following implementation of the preferred option.

**Table 10: Risk assessment showing risks mitigated following Implementation**

| Risk Scenario | Risk Type | Consequence (C) | Likelihood (L) | Risk Score | Risk Year |
|---|---|---|---|---|---|
| Public Safety Impact - Conductor/pole failure in a public access area results in single fatality | Safety | (Original) | | | |
| | | 5 *(Single fatality / incurable fatal illness)* | 2 *(Very unlikely)* | **10** ***(Low Risk)*** | 2019 |
| | | (Mitigated) | | | |
| | | 5 *(Single fatality / incurable fatal illness)* | 1 *(Almost no likelihood)* | **5** ***(Very Low Risk)*** | 2024 |
| Worker Safety Impact – Failure of an aged copper conductor during re-tensioning results in loss of control of conductor striking a worker causing single serious injury | Safety | (Original) | | | |
| | | 4 *(Multiple serious injury / illness)* | 3 *(Unlikely)* | **12** ***(Moderate Risk)*** | 2019 |
| | | (Mitigated) | | | |
| | | 4 *(Single serious injury / illness)* | 1 *(Almost no likelihood)* | **4** ***(Very Low Risk)*** | 2024 |
| Bushfire Impact – An energised conductor fails and falls to ground starting bushfire resulting in medium-term disruption to eco-system. Area surrounding M028 Feeder classified as bush fire prone with 'high' to 'very high' bushfire potential. | Safety & Environment | (Original) | | | |
| | | 4 *(Multiple serious injuries / illnesses Medium term disruption to eco-system)* | 3 *(Unlikely)* | **12** ***(Moderate Risk)*** | 2019 |
| | | (Mitigated) | | | |
| | | 4 *(Multiple serious injuries / illnesses Medium term disruption to eco-system)* | 1 *(Almost no likelihood)* | **4** ***(Very Low Risk)*** | 2024 |
| Asset Impact – Interruption to a single large-scale business (Mt Rawdon Gold Mine) for >12 hours leads to shut down process and involves rolling load shedding at DEGI, GAYN, MUTO and EIDS while the line is repaired. | Customer | (Original) | | | |
| | | 3 *(Disruption to single large-scale business)* | 4 *(Likely)* | **12** ***(Moderate Risk)*** | 2019 |
| | | (Mitigated) | | | |
| | | 3 *(Disruption to single large-scale business)* | 2 *(Very unlikely)* | **6** ***(Low Risk)*** | 2024 |
| Customer & Political Sensitivity Continued inability to maintain this feeder in | Business | (Original) | | | |
| | | **3** *(Adverse regional media attention)* | 3 *(unlikely)* | **9** ***(Low Risk)*** | 2019 |

| Risk Scenario | Risk Type | Consequence (C) | Likelihood (L) | Risk Score | Risk Year |
|---|---|---|---|---|---|
| accordance with EQL standards leads to ongoing interruption and adverse regional media attention. | | (Mitigated)<br>**3**<br>*(Adverse regional media attention)* | 1<br>*(Almost no likelihood)* | **3**<br>***(Low Risk)*** | 2024 |

Figure 2 and Figure 3 show the risk reduction initiated by the rebuild of M028 line under Option 3. These figures show:

- Risk remains high until the end of construction in 2023
- Risk is significantly minimised from 2024 – 2040 as the new conductor and concrete poles almost completely removes all safety and fire risks, significantly improve the reliability of M028 and reduce the VCR cost for M049 contingency events; limiting it to the time it takes to switch Mt Rawdon Gold Mine to connect to M028.
- Risk is further reduced in 2040 when it is assumed M049 can be retired, connecting M049 customers directly to the more reliable M028 line.
- A manageable level of predominantly customer risk remains from 2041 onwards.

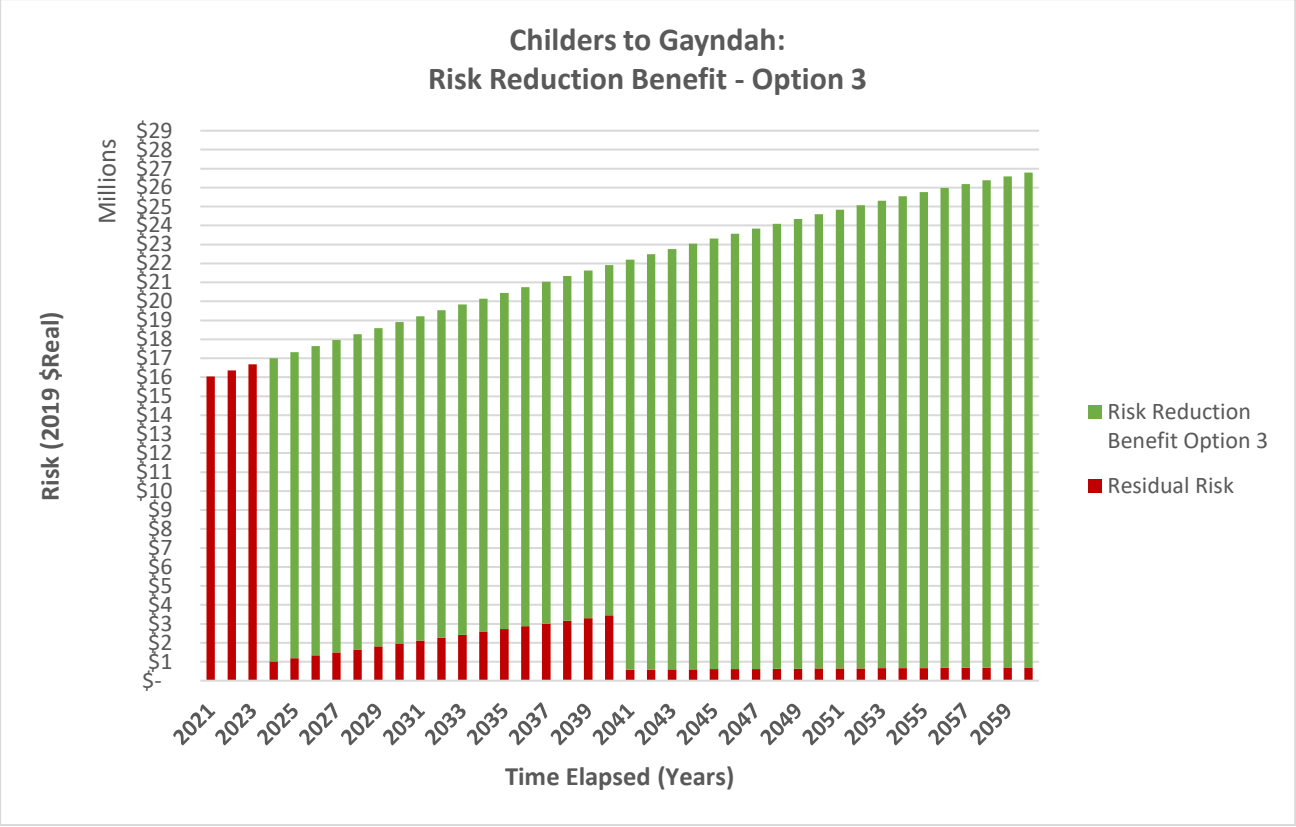



**Figure 2: Risk Reduction Monetary Impact – Option 3**

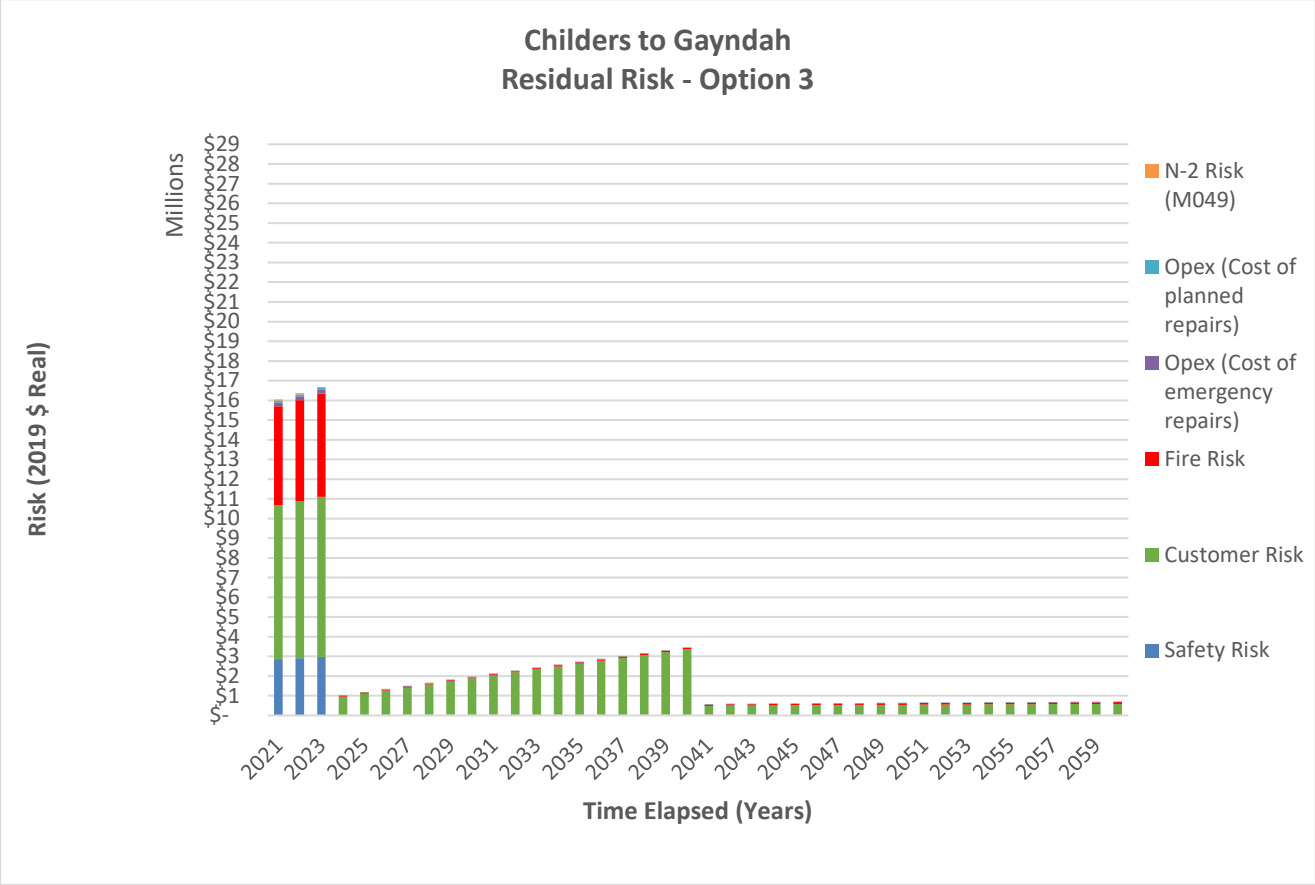



**Figure 3: M028 Residual Risk Monetisation – Option 3**

# 4 Recommendation

## 4.1 Preferred option

Option 3 to rebuild M028 as single circuit using concrete poles strung with Neon conductor is preferred option. Although this option has a higher up-front CAPEX, across the 60-year option analysis period, it prudently removes all risks associated with the aged nature of M028, provides sufficient capability to supply all loads during contingency events, and offers the highest NPV outcome. This option has a total capital cost of $52.4M with works proposed from 2020 - 2023.

It should be noted that the cost of $52.4M for this proposed option is higher than the $38.1M submitted as part of Ergon's original regulatory proposal in January 2019. This is due to a complete re-estimation of the project that has been carried out. This additional replacement capex has been reported as a separate line item in Ergon's RIN.

## 4.2 Scope of preferred option

- Rebuild M028 line from Gayndah to Isis Bulk Supply Point (99km) with Single Circuit Concrete Pole (SCCP) feeder strung with 19/3.75 AAAC 1120 (Neon) at 75°C with aerial earth wire (14mm Optical Ground wire (OPGW)) for a capacity of 62MVA. Accommodating areas of M028 currently underslung with 11kV and low voltage lines.
- Install 3 x 66kV motorised isolators to the east of Mt Rawdon tee to allow interconnection between M028 and M049 to enable supply to Mt Rawdon Gold Mine during an outage to the first section of M049 or fault on the first section of M028.
- Removal of the existing Childers - Degilbo - Gayndah (M028) line and recovery of assets as per Energy Qld asset recovery policies.
- Install a new 66kV feeder bay at Isis BSP substation to connect to the new 66kV line.

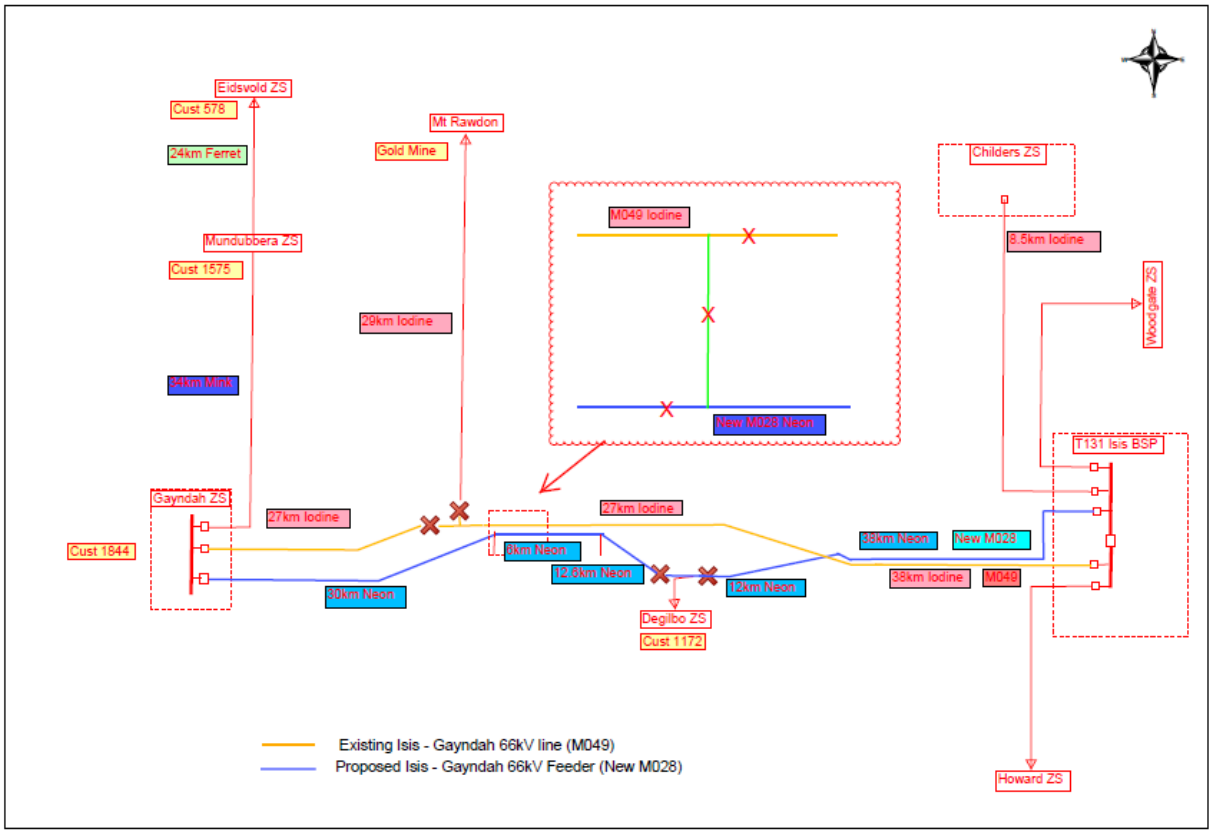



**Figure 4: Representative Geographic of the Upper Burnett River Supply, with the proposed new M028 Construction with Neon Conductor from Isis to Gayndah, with the inclusion of three remote control isolators to the east of Mt Rawdon tee.**

# Appendix A References

**Note:** Documents which were included in Energy Queensland's original regulatory submission to the AER in January 2019 have their submission reference number shown in square brackets, e.g. Energy Queensland, *Corporate Strategy [1.001], (31 January 2019).*


AEMO, *Value of Customer Reliability Review, Final Report,* (September 2014).

Energy Queensland, *Asset Management Overview, Risk and Optimisation Strategy [7.025]*, (31 January 2019).

Energy Queensland, *Corporate Strategy [1.001],* (31 January 2019).

Energy Queensland, *Future Grid Roadmap [7.054],* (31 January 2019).

Energy Queensland, *Intelligent Grid Technology Plan [7.056],* (31 January 2019).

Energy Queensland, *Network Risk Framework*, (October 2018).

Ergon Energy, *Distribution Annual Planning Report (2018-19 to 2022-23) [7.049]*, (21 December 2018).

# Appendix B Acronyms and Abbreviations

The following abbreviations and acronyms appear in this business case.

| Abbreviation or acronym | Definition |
|---|---|
| $M | Millions of dollars |
| $ nominal | These are nominal dollars of the day |
| $ real 2019-20 | These are dollar terms as at 30 June 2020 |
| 2020-25 regulatory control period | The regulatory control period commencing 1 July 2020 and ending 30 Jun 2025 |
| AD | Authorised Demand |
| AEMC | Australian Energy Market Commission |
| AEMO | Australian Energy Market Operator |
| AER | Australian Energy Regulator |
| ALARP | As Low as Reasonably Practicable |
| AMP | Asset Management Plan |
| Augex | Augmentation Capital Expenditure |
| BAU | Business as Usual |
| BSP | Bulk Supply Point |
| CAPEX | Capital expenditure |
| CoC | Cost of Consequence |
| Current regulatory control period or current period | Regulatory control period 1 July 2015 to 30 June 2020 |
| DAPR | Distribution Annual Planning Report |
| DC | Direct Current |
| DEE | Dangerous Electrical Event |
| DEGI | Degilbo |
| DNSP | Distribution Network Service Provider |
| DSDMIP | Department of State Development, Manufacturing, Infrastructure and Planning |
| EIDS | Eidsvold |
| EQL | Energy Queensland Ltd |
| GAYN | Gayndah |
| HDBC | Hard Drawn Bare Copper |
| ICR | Incident Conversion Rate |
| IT | Information Technology |
| kN | Kilonewton |
| KRA | Key Result Areas |

| Abbreviation or acronym | Definition |
|---|---|
| kV | Kilovolt |
| kW | Kilowatt |
| LoC | Likelihood of Consequence |
| MORW | Mount Rawdon Gold Mine |
| MSS | Minimum Service Standard |
| MUTO | Mundubbera Town |
| MVA | Megavolt Ampere |
| MW | Megawatt |
| NEL | National Electricity Law |
| NEM | National Electricity Market |
| NEO | National Electricity Objective |
| NER | National Electricity Rules (or Rules) |
| Next regulatory control period or forecast period | The regulatory control period commencing 1 July 2020 and ending 30 Jun 2025 |
| NPV | Net Present Value |
| OPEX | Operational Expenditure |
| PCBU | Person in Control of a Business or Undertaking |
| PoS | Probability of Severity |
| Previous regulatory control period or previous period | Regulatory control period 1 July 2010 to 30 June 2015 |
| PV | Present Value |
| Repex | Replacement Capital Expenditure |
| RIN | Regulatory Information Notice |
| RIT-D | Regulatory Investment Test – Distribution |
| RTS | Return to Service |
| SAIDI | System Average Interruption Duration Index |
| SAIFI | System Average Interruption Frequency Index |
| SAMP | Strategic Asset Management Plan |
| SCADA | Supervisory Control and Data Acquisition |
| SCCP | Single Circuit Concrete Pole |
| SFAIRP | So Far as Is Reasonably Practicable |
| VCR | Value of Customer Reliability |
| WACC | Weighted average cost of capital |
| ZS | Zone Substation |

# Appendix C Alignment with the National Electricity Rules (NER)

The table below details the alignment of this proposal with the NER capital expenditure requirements as set out in Clause 6.5.7 of the NER.

**Table 11: Alignment with NER**

| Capital Expenditure Requirements | Rationale |
|---|---|
| **6.5.7 (a) (2)**<br>**The forecast capital expenditure is required in order to comply with all applicable regulatory obligations or requirements associated with the provision of standard control services** | This proposal ensures that safety obligations and reliability obligations outlined in *Table 2: Compliance obligations related to this proposal*, are met by providing economically efficient project to ensure safety and reliability risks on M028 line are reduced and where possible, removed. Without this project, these obligations would be at significant risk of being breached. |
| **6.5.7 (a) (3)**<br>**The forecast capital expenditure is required in order to:**<br>**(iii) maintain the quality, reliability and security of supply of supply of standard control services**<br>**(iv) maintain the reliability and security of the distribution system through the supply of standard control services** | This project improves currently poor levels of customer reliability caused by end of life line assets. This project is critical to providing network reliability and safety net security and reliability targets. |
| **6.5.7 (a) (4)**<br>**The forecast capital expenditure is required in order to maintain the safety of the distribution system through the supply of standard control services.** | This project removes unacceptable safety risks to both the community, staff and the environment. Without this project, unacceptable levels of safety risk would increase as the asset further ages and deteriorates. |
| **6.5.7 (c) (1) (i)**<br>**The forecast capital expenditure reasonably reflects the efficient costs of achieving the capital expenditure objectives** | The Unit Cost Methodology and Estimation Approach sets out how the estimation system is used to develop project estimates based on specific material, labour and contract resources required to deliver a scope of work. The consistent use of the estimation system is essential in producing an efficient CAPEX forecast by enabling:<br>• Option analysis to determine preferred solutions to network constraints<br>• Strategic forecasting of material, labour and contract resources to ensure deliverability<br>• Effective management of project costs throughout the project lifecycle, and<br>The works included in the project are well known and familiar to the business. The unit costs that underpin our forecast have also been independently reviewed to ensure that they are efficient (Attachments 7.004 and 7.005 of our initial Regulatory Proposal). |
| **6.5.7 (c) (1) (ii)**<br>**The forecast capital expenditure reasonably reflects a realistic expectation of the demand forecast and cost inputs required to achieve the capital expenditure objectives** | The prudency of this proposal is demonstrated through the options analysis conducted and the quantification of risk and benefits of each option.<br>The prudency of our CAPEX forecast is demonstrated through the application of our common frameworks put in place to effectively manage investment, risk, optimisation and governance of the Network Program of Work. An overview of these frameworks is set out in our Asset Management Overview, Risk and Optimisation Strategy (Attachment 7.026 of our initial Regulatory Proposal). |

# Appendix D Mapping of Asset Management Objectives to Corporate Plan

This proposal has been developed in accordance with our Strategic Asset Management Plan. Our Strategic Asset Management Plan (SAMP) sets out how we apply the principles of Asset Management stated in our Asset Management Policy to achieve our Strategic Objectives.

Table 1: "Asset Function and Strategic Alignment" in Section 1.4 details how this proposal contributes to the Asset Management Objectives.

The Table below provides the linkage of the Asset Management Objectives to the Strategic Objectives as set out in our Corporate Plan (Supporting document 1.001 to our Regulatory Proposal as submitted in January 2019).

**Table 12: Alignment of Corporate and Asset Management objectives**

| Asset Management Objectives | Mapping to Corporate Plan Strategic Objectives |
|---|---|
| **Ensure network safety for staff contractors and the community** | **EFFICIENCY**<br>***Operate safely as an efficient and effective organisation***<br>Continue to build a strong safety culture across the business and empower and develop our people while delivering safe, reliable and efficient operations. |
| **Meet customer and stakeholder expectations** | **COMMUNITY AND CUSTOMERS**<br>***Be Community and customer focused***<br>Maintain and deepen our communities' trust by delivering on our promises, keeping the lights on and delivering an exceptional customer experience every time |
| **Manage risk, performance standards and asset investments to deliver balanced commercial outcomes** | **GROWTH**<br>***Strengthen and grow from our core***<br>Leverage our portfolio business, strive for continuous improvement and work together to shape energy use and improve the utilisation of our assets. |
| **Develop Asset Management capability & align practices to the global standard (ISO55000)** | **EFFICIENCY**<br>***Operate safely as an efficient and effective organisation***<br>Continue to build a strong safety culture across the business and empower and develop our people while delivering safe, reliable and efficient operations. |
| **Modernise the network and facilitate access to innovative energy technologies** | **INNOVATION**<br>***Create value through innovation***<br>Be bold and creative, willing to try new ways of working and deliver new energy services that fulfil the unique needs of our communities and customers. |

# Appendix E Risk Tolerability Table

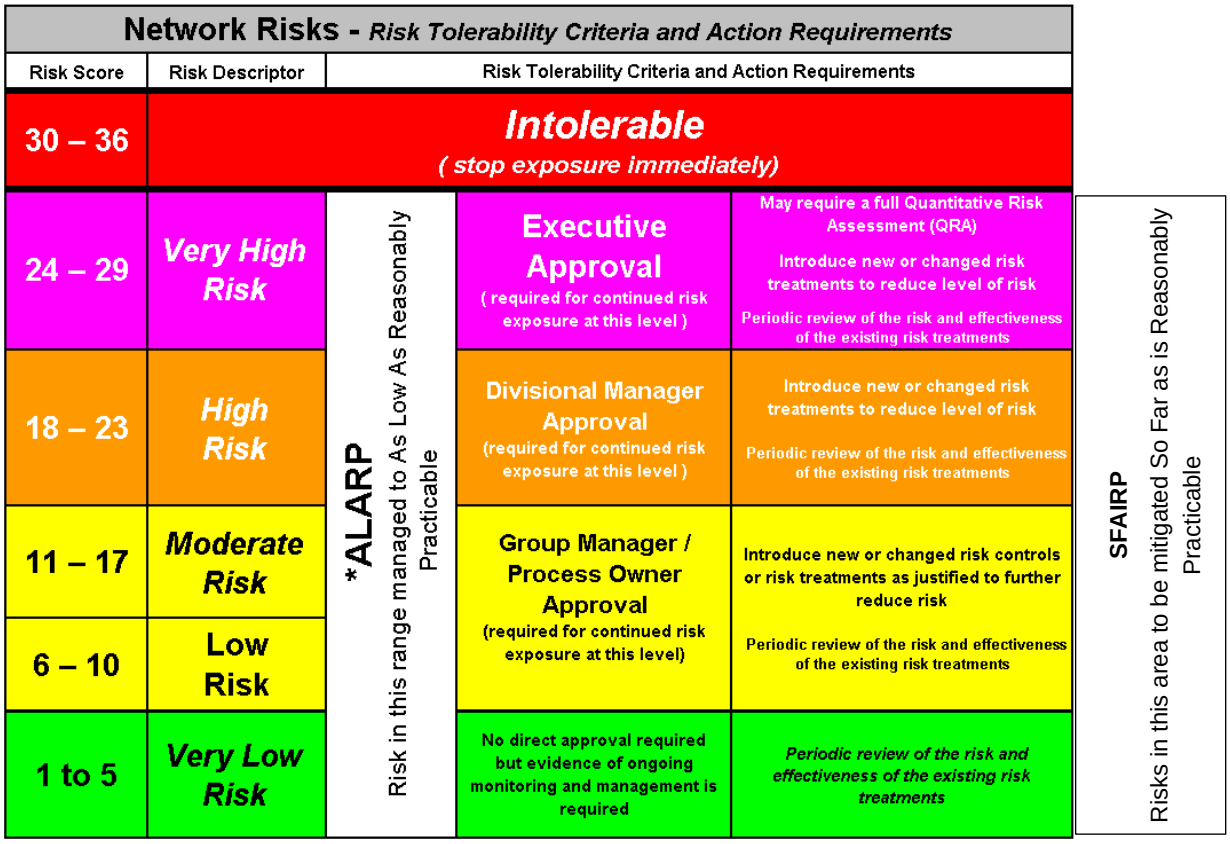



**Figure 5: A Risk Tolerability Scale for evaluating Semi-Quantitative risk score**

# Appendix F Safety Net Obligations

### Safety Net Criteria

Network planning criteria is a set of rules that guide how future network risk is to be managed for and under what conditions network augmentation or other related expenditure should be undertaken.

### Ergon

Ergon Energy is required under Distribution Authority No. D01/99 to adhere to the probabilistic planning approach where full consideration is given to the network risk at each location, including operational capability, plant condition and network meshing with load transfers.

The Safety Net requirements provide a backstop set of 'security criteria' that set an upper limit to the customer consequence (in terms of unsupplied load) for a credible contingency event on our network. Ergon Energy is required to meet the restoration targets defined in Schedule 4 of Ergon Energy's Distribution Authority "…*to the extent reasonably practicable."*

The safety net criteria are classified into Regional Centre and Rural Area, each with a different timeline as follows:

| Area | Targets |
|---|---|
| Regional Centre | Following an N-1 Event, load not supplied must be:<br>• Less than 20 MVA (5,000 customers) after 1 hour;<br>• Less than 15 MVA (3,600 customers) after 6 hours;<br>• Less than 5 MVA (1,200 customers) after 12 hours and<br>• Fully restored within 24 hours. |
| Rural Areas | Following an N-1 Event, load not supplied must be:<br>• Less than 20 MVA (7,700 customers) after 1 hour;<br>• Less than 15 MVA (5,800 customers) after 8 hours;<br>• Less than 5 MVA (2,000 customers) after 18 hours and<br>• Fully restored within 48 hours. |

**Table 4-1: Safety Net – Load not supplied and maximum restoration times following a credible contingency**

The zone substations connection to M028 and M049 are classified as rural areas. As Mt Rawdon Gold Mine is connected directly to the sub-transmission network, its loads do not count towards Safety Net load-at-risk calculations; on this basis, M028 is currently safety net compliant.

# Appendix G Quantitative Risk Assessment Details

## Key Assumptions for Childers to Gayndah Model:

**Failure rates for MO28 Childers to Gayndah:**

*Source: (As per EQ supplied historical outage management system data. Repair time is derived)*

| ***Failure Mode:*** | **Yearly Frequency (1 in *n* years)** | **Average repair time:** |
|---|---|---|
| Insulation Failure | 5.67 | 8 Hours |
| Lightning Strike | 1.42 | |
| Crossarm Failure | 17.00 | |
| Pole Failure | 8.50 | |
| Joint Failure | 8.50 | |
| Conductor Clashing | 17.00 | |
| Vegetation Contact | 17.00 | |
| Low Clearances | 17.00 | |
| Burned Bridges | 8.50 | |
| Broken Conductor | 2.13 | |
| Unknown cause | 0.30 | |

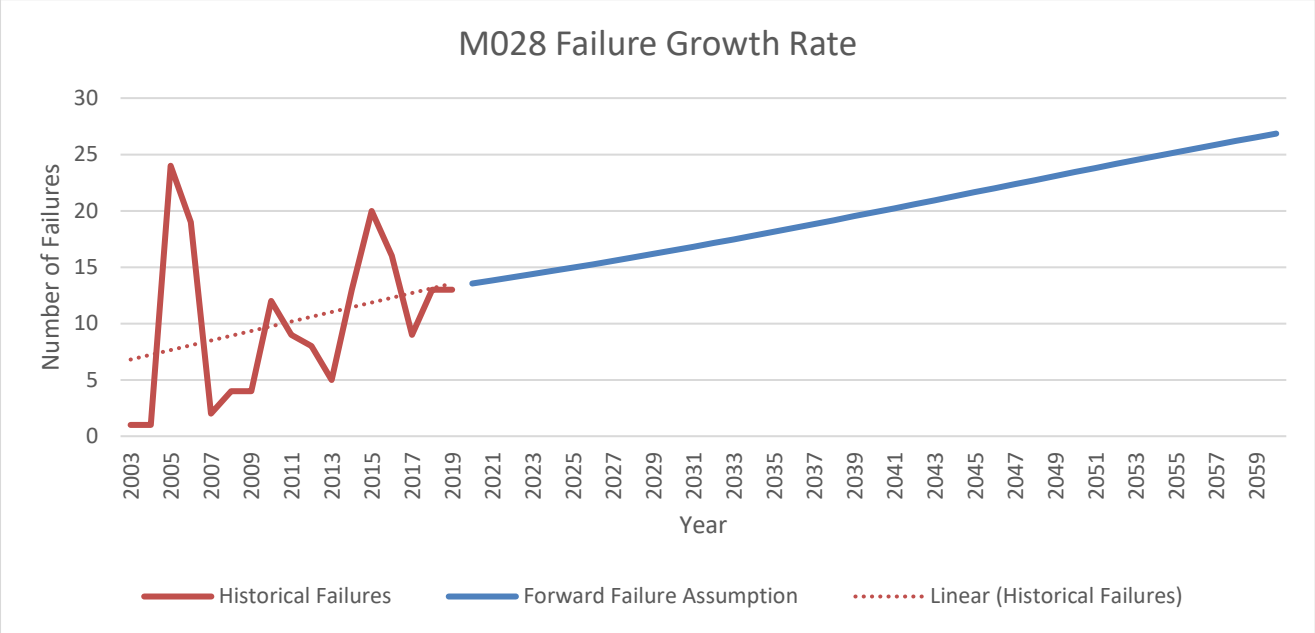
**Failure rates for MO49 Isis to Gayndah:**

*Source: (As per EQ supplied historical data. Repair time is derived from planning proposal)*

| ***Failure Mode:*** | **Yearly Frequency (1 in *n* years)** | **Average repair time:** |
|---|---|---|
| Asset Failure (generic) | 0.25 | 4 Hours |

**Failure growth rate:**

We have assumed a linear growth rate on failures of **2%** per annum in line with EQ supplied historical data.




**Value of customer reliability (M028 and M049):**

Value of Customer Reliability was used to calculate the cost of unserved energy associated with asset failure. VCR was calculated based on AEMO figures and assumptions.

(See AEMO Value of Customer Reliability Fact Sheet, available at: https://www.aemo.com.au/-/media/Files/PDF/AEMO_FactSheet_ValueOfCustomerReliability_2015.pdf)

| | | |
|---|---|---|
| VCR Residential | $ | 25,420 |
| VCR Commercial | $ | 44,390 |
| VCR Industrial | $ | 44,390 |

**Incident Conversion Rate (ICR):**

The Incident Conversion Rate is the ratio of a risk consequence type to total incidents, based on past data and converted to an annual %. This is used to calculate the Likelihood of Consequence.

ICR (67%) was calculated using Energy Queensland historical failure data for M028.

$ICR = n_{\text{incidents attributed to consequence}}/n_{\text{incidents per asset class}}$

| Incident Conversion Rate | | |
|---|---|---|
| **Consequence** | **Incidents Attr. to Cons. (p/a)** | **Total No. of Incidents (p/a)** |
| Safety - Single Fatality | 6.8 | 10.2 |
| Safety - Major Injury | 6.8 | |
| Fire | 6.8 | |

### Incident Probability of Severity (PoS):

The Probability of Severity is the potential that an incident will result in a particular risk consequence category.

| Risk Cons. Scale | Probability of Severity | |
|---|---|---|
| | Fire | Safety |
| 6 | 1.0% | 1.0% |
| 5 | 5.0% | 7.5% |
| 4 | 10.0% | 15.0% |
| 3 | 25.0% | 25.0% |
| 2 | 45.0% | 45.0% |
| 1 | 70.0% | 70.0% |

### Likelihood of Consequence (LoC)

Likelihood of Consequence is the likelihood of an asset failure resulting in a consequence.

Calculated from ICR and PoS

*LoC = ICR × PoS*

| Input | LoC | Source/Assumptions |
|---|---|---|
| Single fatality | 5.0% | =67% × 7.5% |
| Major injury | 16.8% | =67% × 25.0% |
| Fire | 6.7% | =67% × 10.0% |

### Cost of Consequence (CoC):

Cost of Consequence is the Monetisation of the consequence should it occur.

| Consequence | Safety Risk Inputs | |
|---|---|---|
| | Consequence Monetisation | Disp. Factor |
| **6 Multiple Fatalities** | $ 9,800,000 | Not Used |
| **5 Single Fatality** | $ 4,900,000 | 10 |
| **4 Multiple Serious Injuries** | $ 490,000 | 8 |
| **3 Single Serious Injury** | $ 49,000 | 6 |
| **2 Minor Injury** | $ 4,900 | 4 |
| **1 Very Low Injury** | $ 500 | 2 |

*Note: fire generally relates to property damage and legal action.*

| Consequence | Fire Risk Inputs | |
|---|---|---|
| | Consequence Monetisation | Disp. Factor |
| 6 | $ 20,000,000 | Not Used |
| 5 | $ 10,000,000 | 7.5 |
| 4 | $ 4,500,000 | 5 |
| 3 | $ 1,000,000 | 4 |
| 2 | $ 100,000 | 3 |
| 1 | $ 10,000 | 1 |

Calculated from LoC, Consequence Monetisation and Dispersion Factor

*CoC* = *LoC* × Consequence Monetisation × Dispersion Factor

**Maintenance Costs:**

Cost of maintenance – planned and emergency. Labour and materials. Source: estimated.

| OPEX Rates | Cost ($/hr) | Workers (number) | Total Cost ($/hr) |
|---|---|---|---|
| Planned | 200 | 6 | $ 1,200 |
| Emergency | 300 | 6 | $ 1,800 |
| Materials | $ 10,000 | | |

| | |
|---|---|
| **Average instances of planned maintenance (annually):** | 3.5 |
| **Average duration of planned maintenance per instance (hours):** | 21.4 |

**Demand forecasts and load characteristics:**

Source: Combination of Ergon 2018 DAPR and estimated values.

**Degilbo**

| Year | Degilbo Load Forecast (MVA) | Power Factor | Load Factor | % Load Residential | % Load Commercial | % Load Industrial |
|---|---|---|---|---|---|---|
| 2021 | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| 2022 | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| 2023 | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| 2024 | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| 2025 | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **2026** | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2027** | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2028** | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2029** | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2030** | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2031** | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2032** | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2033** | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2034** | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2035** | 2.50 | 0.8 | 0.6 | 80 | 10 | 10 |

| Year | Munduberra Load Forecast (MVA) | Power Factor | Load Factor | % Load Residential | % Load Commercial | % Load Industrial |
|---|---|---|---|---|---|---|
| **2021** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2022** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2023** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2024** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2025** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2026** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2027** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2028** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2029** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2030** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2031** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2032** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2033** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2034** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |
| **2035** | 6.00 | 0.8 | 0.6 | 63 | 18.5 | 18.5 |

| Year | Gayndah Load Forecast (MVA) | Power Factor | Load Factor | % Load Residential | % Load Commercial | % Load Industrial |
|---|---|---|---|---|---|---|
| **2021** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2022** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2023** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2024** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2025** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **2026** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2027** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2028** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2029** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2030** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2031** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2032** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2033** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2034** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |
| **2035** | 5.90 | 0.8 | 0.6 | 70 | 15 | 15 |

**Eidswold:**

| Year | Eidswold Load Forecast (MVA) | Power Factor | Load Factor | % Load Residential | % Load Commercial | % Load Industrial |
|---|---|---|---|---|---|---|
| **2021** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2022** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2023** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2024** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2025** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2026** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2027** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2028** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2029** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2030** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2031** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2032** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2033** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2034** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |
| **2035** | 1.60 | 0.8 | 0.6 | 80 | 10 | 10 |

**Mt Rawdon:**

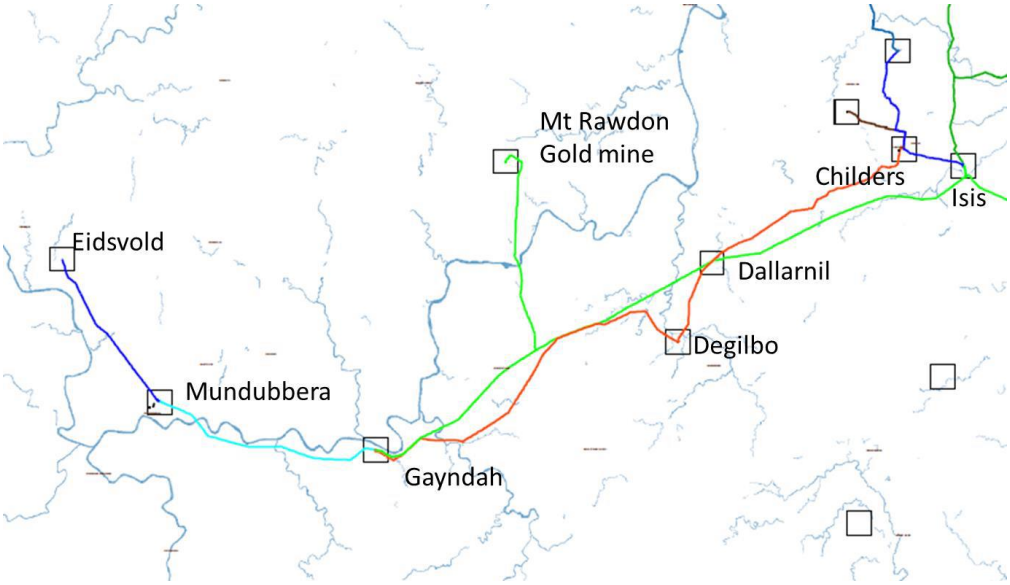
| Year | Mt Rawdon Gold Mine | Power Factor | Load Factor | % Load Residential | % Load Commercial | % Load Industrial |
|---|---|---|---|---|---|---|
| **2021** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **2022** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2023** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2024** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2025** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2026** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2027** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2028** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2029** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2030** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2031** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2032** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2033** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2034** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |
| **2035** | 12.00 | 1 | 0.9 | 0 | 0 | 100 |

# Appendix H Supporting Documents

### M028 Line Route

The figure below shows the supply area for the sub transmission ring; with M028 shown in red and M049 in green.




### M028 Condition Assessment

Condition Report.pdf

### M028 DEE Mapping

DEE.pdf

### M028 Bushfire Assessment

firerisk_new.pdf

### M028 Future Growth

The Southern Planning group works closely with the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP) and Ergon Energy's Major Customer group to determine future growth prospects in the area. These include Gayndah Region Irrigation Development project with water harvest at Reids Creek for 2660kW and Mt Lawless 770kW, Binjour Bauxite Mine 1000kW, and Wateranga project by High Titanium Resources and Technology Limited. The Gayndah Region Irrigation Development has only listed the water harvest pumping requirements. Individual customers including cane farmers, citrus farmers and beef producers will make applications when water licences and access is known. Whilst these are only enquiries at this stage, the ability to supply potential new loads should be considered when assessing options for M028 and the Upper Burnett network.

## M028 Risk Assessment

Risk Model for Childers to Gayndah 2

## M028 NPV Assessment

EE Business Case - Childers to Gayndah -