Business Case
Cloncurry Supply Reinforcement

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NETWORK

Executive Summary

Two sites currently supply the Cloncurry district located around 110 km east of Mount Isa; Cloncurry 66/11 kV Zone Substation (CLON ZS) and North Cloncurry 66/11 kV Zone Substation (NOCL ZS). These sites have two sources of supply – via either a 220kV or 66kV feeder, both from Mt Isa. The 220kV feeder runs from Mica Creek (near Mt Isa) to Chumvale (CHUM ZS) where a single 220/66kV transformer feeds the Cloncurry 66kV system. An alternate 66kV supply stems from the Duchess Rd (DURO) substation near Mt Isa via a roughly 110km 66kV feeder to CHUM ZS. This 66kV feeder also supplies small loads en route at Mary Kathleen (MAKA) and Corella River (CORI).

As the energy demand for the Cloncurry district reaches over 7.5 MVA during peak times, the Service Safety Net Targets apply for certain outages. Several asset conditions have been identified resulting in the local network no longer meeting the Service Safety Net Targets under peak load conditions. Relying on mobile generation for support at short notice is infeasible due to the distance of this area from the required mobile generation assets and the complex logistics involved. Thus, some capital investment is required to ensure compliance going forward. In addition, the 66kV line from DURO to CHUM ZS has various statutory clearance and other condition issues that need to be addressed.

An option to re-build the existing feeder was considered but rejected, as the initial estimate of capital expenditure was anticipated to be significantly larger than the other options considered. Four network options were evaluated in this business case, in addition to a counterfactual ‘Do nothing’ case. These options were:

Option 1 - Interpoling: Interpole sections of DR-CC-1 66 kV circuit and replace 66 kV assets to increase rating

Option 2 - 2nd transformer at CHUM: Install new 220kV assets to enable duplicate supply at CHUM and allow removal of part of the DURO to CHUM 66kV line

Option 3 - Permanent Generation: Install full capacity permanent standby generation assets in Cloncurry to replace existing 66kV Feeder supply configuration to provide backup in the event of failure of the 220/66kV transformer at CHUM.

Option 4 - Mixed Generation: Install limited capacity permanent standby generation (5MVA) with additional deployable back-up generation (2MVA) to replace existing supply configuration

Counterfactual – The 66kV line is retired, and temporary generation is used in contingency events.

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 case security and reliability are strong drivers, as the Service Safety Net Target will no longer be met as demand in the Cloncurry district grows.

To this end the preferred option is Option 1, as it has the least negative NPV result (-$1.4M) of the options considered while still ensuring the Service Safety Net Targets are met under the forecast peak load conditions.

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 2018/19 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
$5.8M	$0	$5.8M

Contents

1 Introduction

Presently there are two sites supplying the Cloncurry district, located approximately 110 km east of Mount Isa; Cloncurry 66/11 kV Zone Substation (CLON ZS) and North Cloncurry 66/11 kV Zone Substation (NOCL ZS). Chumvale 220/66 kV Zone Substation (CHUM ZS) supplies electricity to approximately 1,427 connections in the Cloncurry township and surrounding areas via the Cloncurry and North Cloncurry Zone Substations. These sites have two sources of supply – via a 220kV feeder from Mt Isa and via a 66kV feeder also from Mt Isa, as shown in Appendix I. The 220kV feeder runs from Mica Ck (MICC) (near Mt Isa) to Chumvale (CHUM ZS) where there is a single 220/66kV transformer that feeds the Cloncurry 66kV system. An alternate 66kV supply emanates from the Duchess Rd (DURO) substation near Mt Isa via a long (approx. 110km) 66kV feeder to CHUM ZS. This 66kV feeder also supplies small loads en route at Mary Kathleen and Corella River. The existing network schematic is shown in Figure 1.

As the energy demand for the Cloncurry district reaches over 7.5 MVA during peak times, the Service Safety Net Targets apply for certain outages. A number of asset conditions have been identified which mean that the local network no longer meets the Service Safety Net Targets under peak load conditions. The safety Net Contingency management Plan can be found in Appendix G. In addition, the 66kV line from DURO to CHUM ZS has a range of statutory clearance and other condition issues that need to be addressed.

1.1 Purpose of document

This document recommends the optimal capital investment necessary for maintaining Ergon Energy's Service Safety Net Targets in the Cloncurry district, located in north western Queensland. This is necessary as the existing assets require significant remediation to reduce the risk of non-supply under a credible contingency.

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 Ergon Energy 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 $2018/19 direct dollars.

1.2 Scope of document

This document outlines the asset limitations, proposed works, other options considered, and the risk reductions achieved through the proposed works.

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 case security and reliability are strong drivers, as the Service Safety Net Target will no longer be met as demand in the Cloncurry district grows.

The intent of this approval is to provide adequate network capability to meet the obligations of the Safety Net and to provide an acceptable level of reliability to the Cloncurry and surrounding community.

Approximately 184 spans of the Duchess Road to Cloncurry DR-CC-1 66kV feeder have been identified as having insufficient ground clearance to meet minimum statutory requirements under the designed operating temperature. In addition, the summer day thermal rating of this feeder is not sufficient to supply Cloncurry under peak load conditions. This thermal constraint also applies to the step-up transformer and 11kV transformer cable at the Duchess Road substation.

This proposal aligns with the CAPEX objectives and criteria from the National Electricity Rules as detailed in Appendix C.

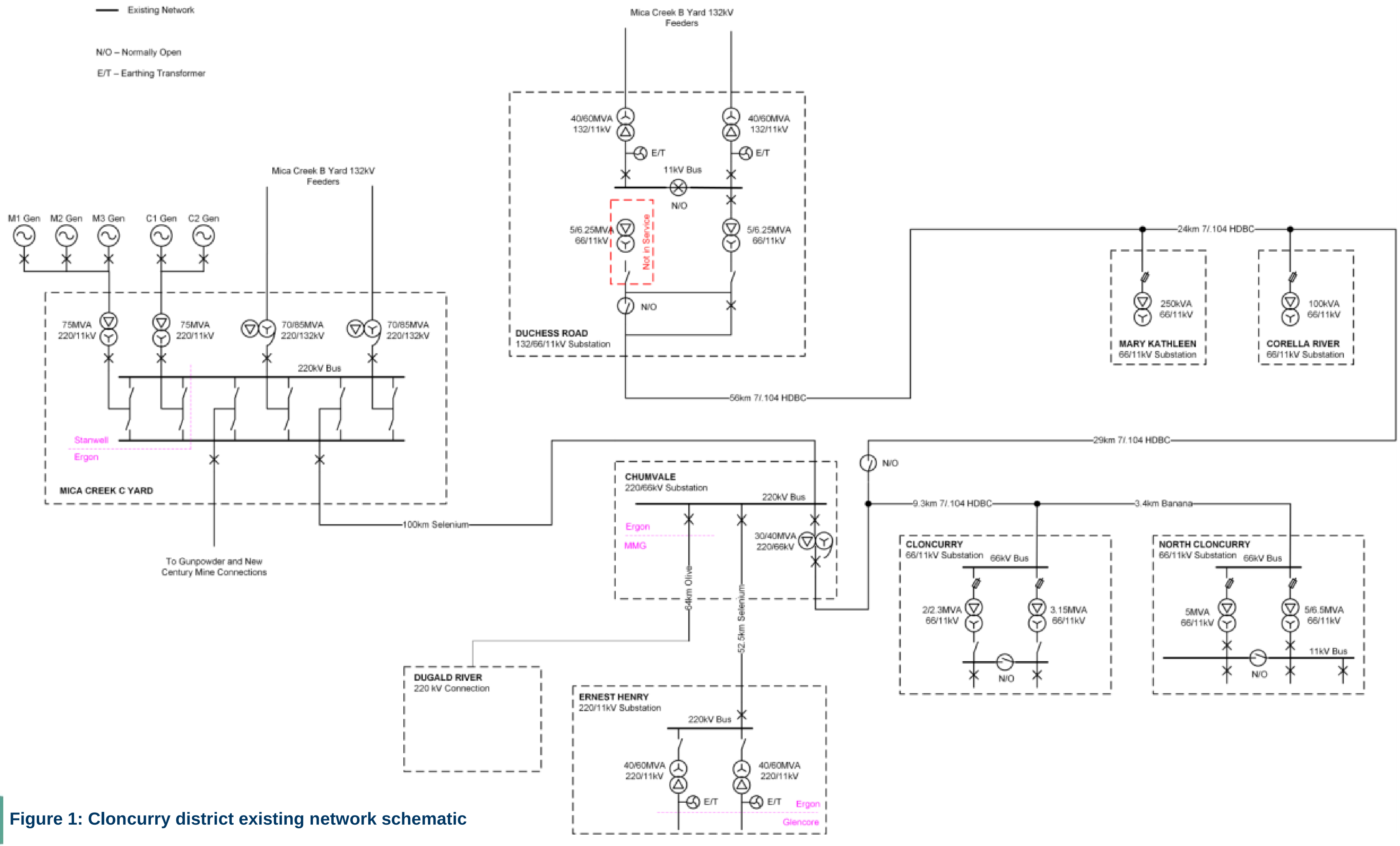


Figure 1: Cloncurry district existing network schematic

1.4 Energy Queensland Strategic Alignment

Table 1 details how Cloncurry Supply Reinforcement contributes to Energy Queensland'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	By increasing the ground clearance to meet statutory requirements, the risk to the public and site workers of making contact with the 66kV line will be significantly reduced.
Meet customer and stakeholder expectations	Through reinforcing the Cloncurry supply, Ergon Energy will be able to meet Service Safety Net Targets' restoration times, increasing the reliability for customers and reducing the risk of extended outages.
Manage risk, performance standards and asset investments to deliver balanced commercial outcomes	The proposed works will ensure Ergon Energy meets the Service Safety Net Targets and, in the process, reduce the risk of extended outages and public contact with the 66kV line.
Develop Asset Management capability & align practices to the global standard (ISO55000)	The proposed works have been developed in accordance with established planning standards and systems to align with the asset management standards.
Modernise the network and facilitate access to innovative energy technologies	This project will be subject to consideration through the RIT-D process to ensure that suitable non-network innovative solutions are considered.

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" for extreme circumstances. Safety Net measures are intended to mitigate against the risk of low probability vs 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 Service Safety Targets 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.

Cloncurry is considered a ‘Rural Area’. As per Schedule 4 of the Ergon Energy Distribution Authority, restoration of supply for rural areas following a single contingency event (N-1) must be less than 5 MVA after 18 hours, with the remaining load fully restored after 48 hours.

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 **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: • 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.[1] This duty also extends to ensuring the electrical safety of all persons and property likely to be affected by the electrical work.[2]	This proposal remediates ground clearance issues in areas where the 66kV conductor does not meet season design requirements, reducing the likelihood to staff and the public of coming into contact with a live conductor, which could result in a single fatality
Distribution Authority for Ergon Energy issued under section 195 of *Electricity Act 1994* (Queensland)	Under its Distribution Authority: • 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. • The distribution entity will ensure, to the extent reasonably practicable, that it achieves its Service Safety Net Targets as specified. • 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 addresses issues with meeting the Service Safety Net Targets in credible contingency scenarios, under peak load, by re-configuring supply to the Cloncurry district.

1.7 Limitation of existing assets

Substation Limitations

Assessments of the zone substations in the area have identified the following limitations.

Table 3: Substation Limitations

Substation	Limitations
Chumvale (CHUM ZS)	• Recently underwent a significant yard extension, with the connection of the Dugald River Mine 220 kV private line in 2017. This included the installation of a “stub” for a future 220kV bay to allow capacity expansion. • Currently supplies both Cloncurry and North Cloncurry zone substations.
Cloncurry (CLON ZS)	• The long-term strategic plan is to retire this zone substation so it is anticipated that the existing configuration will be maintained until the end of life. • When retired, all network connections will be transferred to North Cloncurry.

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

North Cloncurry (NOCL ZS)	• Future capacity increases will be required to facilitate the transfer of connections from CLON ZS when that substation is retired. This is likely to align with end-of-life replacement of the existing transformers.
Duchess Road (DURO ZS)	• Currently supplies both NOCL ZS and CLON ZS via a 66kV feeder in a contingency scenario only. • Supplies Mary Kathleen (MAKA ZS) and Corella River (CORI ZS) in normal operating conditions. • Investigations have identified the Buchholz protection device on TF4 causes the transformer to trip when there is a feeder fault. Further analysis is necessary to understand the root cause of this issue and identify appropriate remediation. • Previous testing of TF3 in 2013 determined problems with both insulation resistance and winding resistance. Insulation resistance has been remediated but it is not believed at the time of writing that the winding resistance has been remediated to meet Maintenance Acceptance Criteria (MAC) testing.

Subtransmission Limitations

The following subtransmission limitations are based on standard Ergon Energy Subtransmission feeder ratings.

Table 4: Feeder design ratings for subtransmission feeders

Operational Number	Feeder Name	Limiting Conductor	SD	SE	SNM
			Rating (A)	Rating (A)	Rating (A)
CH-CC-1	CHUMVALE-CLONCURRY 66kV	7/.104 HDBC	83	136	141
DR-CC-1	DUCHESS RD-CLONCURRY 66kV	7/.104 HDBC	83	136	141
MICB-DURO 1	MICA CK B-DUCHESS RD NO.01 132 kV	Grape	384	491	462
MICB-DURO 2	MICA CK B-DUCHESS RD NO.02 132 kV	19/.111 HDBC	279	345	336
CHUM	MICC-CHUM 220KV FDR 7018 220 kV	Selenium	855	930	872

Table 4 shows the summer thermal ratings for the subtransmission feeders that supply the Duchess Road and Cloncurry substations from the Mica Creek Switchyards. The limiting feeder rating on the DR-CC-1 feeder provides a SD equivalent limit of approximately 9.5MVA. Note that the transfer capacity of the DR-CC-1 feeder would also be limited by the rating of DURO TF4 and the associated 11 kV transformer cable. The DURO T4 has a limited tapping range, resulting in voltage limitations for demand above 6.25MVA. The 11kV cables on this transformer are also limited to a rating of 7.5MVA.

Ground Clearance Limitations

The majority of the DURO-CLON 66 kV feeder does not have an overhead earth wire (OHEW). The construction is a mix of steel lattice towers and concrete poles. An investigation was completed in March 2017 from ROAMES (Remote Observation Automated Modelling Economic Simulation) data to ascertain what condition this line was in, compared with the original design parameters. The study has confirmed that a high percentage of spans on this feeder do not meet their original design parameters and as such require detailed assessment. A total of 564 spans were analysed with 195 of these spans showing as being in violation of the 6.1m clearance requirement at the 50^{0}C original design temperature. 3 of these spans were identified as high risk and remediation works have been completed on these spans. 8 of these spans were identified as a medium risk and are planned to be rectified by November 2019. The remaining 184 spans have been classified as a lower risk due to locality and the ground clearance.

A ground survey was conducted on a 12km section of this feeder to confirm the accuracy of the ROAMES data and the results were generally within 100-200mm between the two datasets. The ROAMES Survey identified 195 line clearance defects for a 50^0C operating temperature.

Based on preliminary advice the conductor on this feeder is considered to generally be in a reasonable condition (i.e. no corrosion). Over the years some sections of conductor (approx. 4km) have been annealed by bush fires and these have been replaced.

Asset Life-cycle Limitations

The available asset lifecycle information for each substation at the time of this report has been collated in Table 5. Only assets that have an estimated retirement year within the next AER regulatory period window have been shown. The summary of assets to be included for replacement are listed under the preferred option. The full register for assets identified for replacement until 2027 is located in Appendix J.

Table 5: Summary of assets due for retirement before 2027

Substation	Key Assets for Retirement before 2027
Chumvale (CHUM ZS)	• From provided asset lifecycle data, all identified assets reaching end-of-life within the next AER regulatory window at CHUM ZS are protection relays. • As the preferred option does not include works in CHUM ZS, these assets will need to be assessed for replacement in another project.
Cloncurry (CLON ZS)	• Assets for retirement include voltage transformers and protection relays
North Cloncurry (NOCL ZS)	• The available asset lifecycle information suggests there are no assets with an estimated retirement year within the next AER regulatory period.
Duchess Road (DURO ZS)	• assets include the A197 66 kV voltage transformers which will be replaced as part of project WR1214920 and the old Duoroll ABS's, D429, A129C and C429 • These type of ABS's have been causing many issues over the years and should be replaced. • It is also recommended that the segmented insulators on the 66kV bus are replaced.

If the identified limitations are not addressed, the risks outlined in this proposal are considered to be an unacceptable level of risk, specifically:

- Unacceptable public safety risks due to inadequate clearance to ground on a large number (195) of line sections. Such a risk scenario could result in a single fatality.
- Inability to supply Mary Kathleen ZS and Corella River ZS in system abnormal network operation due to constraints at DURO ZS,
- Inability to meet Service Safety Net Targets' timeframes in Cloncurry District in a contingency where the 220kV network or the 220/66kV transformer at CHUM ZS is unavailable.

2 Counterfactual Analysis

2.1 Purpose of asset

The assets addressed by this proposal supply the Cloncurry district and are required to be compliant with the Service Safety Net Targets.

2.2 Business-as-usual service costs

Service costs for the counterfactual are maintenance cost for the 220kV line and running costs associated with temporary generation in contingency events, which is estimated to be $62,900 per day for fuel and maintenance in the event of failure of the 220kV or 220/66kV transformer at CHUM ZS.

2.3 Key assumptions

Since continuing to operate the 66kV line with so many statutory clearance to ground breaches is untenable, the counterfactual case assumes that the 66kV line is removed while the 220kV line is retained, with temporary generation deployed for contingency events. Since there is no spare 220/66kV transformer, recovery times are expected to be of long duration (up to 6 months). Such a scenario is expected to occur once in 15 years, with a short outage (2 weeks) due to a bay failure also possible and expected to occur once in 5 years.

With up to 7MW of temporary generation to fully serve the area, all 6 mobile step-up transformers and 1MW generation units available to Ergon across the state would be required. The likelihood of all 6 sets being available at the time of a contingency event is low. In addition, the closest stored mobile generation set to Cloncurry is in Townsville, around 800km away. It is important to consider safe working practices when driving such long distances, and the road conditions in regional Queensland and it is anticipated that such a distance would take at least 12 hours to be completed.

Once on site, each set takes around 4 hours to commission and be operational. This means that the first 1MW of temporary generation is only able to be supplied after ~16 hours, provided there is an established footprint for the temporary generation. This would leave up to 7MVA unserved after 12 hours, which meets the rural Service Safety Net Target for that timeframe. However, in order to meet <5MVA unserved after 18 hours, and fully restored within 48 hours, another generation set will need to be operational within 2 hours of the first and the remaining 4 sets in the state will need to be available and operational within another 30 hours.

It is not possible to meet full restoration within 48 hours even if all temporary generation sets in the state are available at the time of contingency due to the travel and set-up times required for such a large temporary generation site (expected to be 3-4 days to achieve full operational capacity).

2.4 Risk assessment

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 6: Counterfactual risk assessment

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
Failure of CHUM 220/66kV TF supplying CLON and NOCL and existing alternate supply from DURO is unavailable, resulting in sustained customer outages >12 hours.	Customer	3 *(interruption to 5,000 customers, >12 hours, three times in a week)*	3 *(Unlikely)*	**9** ***(Low)***	2019-25

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
Failure of CHUM 220/66kV TF supplying NOCL and CLON, requiring generation to meet shortfall in supply due to lack of capacity from DURO line, resulting in additional business costs of >$1million	Business	4 *(equates to business cost of >$1million or equivalent)*	3 *(Unlikely)*	**12** ***(Moderate)***	2019-25
Failure of CHUM 220/66kV TF supplying CLON and NOCL and existing alternate supply from DURO unavailable, resulting in a notifiable Service Safety Net Targets breach and an improvement notice issued by the regulator	Legislated	4 *(Improvement notice issued by the regulator)*	3 *(Unlikely)*	**12** ***(Moderate)***	2019-25
EQL identifies clearance defects in accordance with electrical safety regulations resulting in regulator involvement and an enforceable undertaking being issued.	Legislated	4 *(Improvement notice issued by the regulator)*	6 *(Almost Certain)*	**24** ***(Very High)***	2019-25
Inadvertent contact with 66kV OH line due to non-compliant clearance to ground, resulting in a single fatality	Safety	5 *(single fatality/ incurable fatal illness)*	3 *(Unlikely)*	**15** ***(Moderate)***	2019

Further details of the risk ratings and descriptions can be found in Energy Queensland's Network Risk Framework.

The safety risk that the public and staff would be exposed to if no work was undertaken, specifically around the likelihood of a single fatality due to insufficient ground clearance, is not acceptable. Under the counterfactual case, the safety risk is significantly reduced once the 66kV line is removed, anticipated in 2020.

In addition, the network (business) risks the organisation would be exposed to if the project was not undertaken (Inherent Risk) are not deemed to be as low as reasonably practicable (ALARP). Addressing the risks, as detailed above, through implementation of the preferred option will reduce Energy Queensland's risk exposure.

2.5 Retirement or de-rating decision

Retirement of the CHUM 220/66kV TF and 66kV feeders from CHUM which supply Cloncurry would leave Cloncurry only with the alternate supply from DURO. DURO ZS does not have capacity to supply CLON and NOCL in addition to its normal supply to MAKA and CORI under peak loads. Therefore, retirement of the assets would result in significantly reduced reliability in the Cloncurry district and leave CLON and NOCL with no alternate supply in the event of a credible contingency. This would breach the Service Safety Net Targets and as a result, this is not considered to be a viable option. The retirement of the 66kV feeder from DURO to CHUM has been considered in this analysis. Removal of the CORI substation has also been considered as part of this analysis.

3 Options Analysis

3.1 Options considered but rejected

The option to re-build the existing 110 km DR-CC-1 66 kV feeder was considered. This option included:

- New single circuit concrete pole (SCCP) 66kV line to achieve a minimum design rating of 130 A (approximately 15 MVA);
- Replace existing TF3 and TF4 at DURO, connecting both to boost transfer capability on the 66kV line ;
- Replace existing 66 kV voltage transformers (VTs) (condition-based replacement).

This option was not considered feasible due to the significant capital cost to provide this solution.

3.2 Identified options

3.2.1 Network options

Option 1 - Interpoling: Interpole sections of DR-CC-1 66 kV circuit and replace 66 kV assets to increase rating

Scope:

- Interpole (insert intermediate poles) the necessary sections of the existing line (approximately 184 spans);
- Replace the existing step-up DURO ZS 66/11 kV TF4 (rating) and 66kV bay VT set (condition-based replacement)
- Replace the DURO 66 kV Duoroll ABS's (condition-based replacement)
- Replace the segmented insulators on the DURO 66 kV bus (condition-based replacement)

Key Assumptions:

- Interpole of feeder does not create additional requirement to replace existing conductor for every span;
- Interpole of feeder does not create the need for additional changes to restore asset to original design condition.

Option 2 – 2nd transformer at CHUM: Install new 220kV assets to enable duplicate supply at CHUM and allow removal of part of the DURO to CHUM 66kV line

Scope:

- Extend the CHUM ZS yard and install new 220/66 kV transformer bay with protection relays
- Interpole the necessary sections of the existing lines (approximately 28 spans)
- Update Safety Net Plans for all sites in question.
- Install new 220 kV circuit-breaker (CB) bay in MICC 'C' yard, connected to existing MICC-CHUM-1 circuit exit;
- Remove approximately 53km of the DR-CC-1 66 kV line, between MAKA ZS and CHUM ZS;
- Terminate 66 kV DR-CC-1 line using a recloser;
- Install 2 x 50 A OD (Open Delta) Voltage Regulators at location of previous MAKA ZS 66/11 kV TF
- Recover CORI ZS 66/11 kV TF and supply single customer via non-network option;

Key Assumptions:

- Partial conversion of 66 kV DR-CC-1 line to 11 kV and removal of 53 km section alleviates all existing statutory clearance problems;
- Voltage regulation of new 11 kV line is sufficient to maintain voltage levels within the system performance standard;
- Transmission network tower structure failure is considered non-credible.

Option 3 – Permanent Generation: Install full capacity permanent standby generation assets in Cloncurry to replace existing 66kV Feeder supply configuration to provide backup in the event of failure of the 220/66kV transformer at CHUM.

Scope:

This option proposes to install permanent generation (5MVA), build new 11 kV bay at NOCL ZS, purchase land for generation installation, split DR-CC-1 and energise MAKA at 11 kV, distribution works and complete Safety Net plans.

- Purchase suitable land plot next to existing NOCL ZS to install permanent generation;
- Interpole the necessary sections of the existing lines (approximately 28 spans)
- Update Safety Net Plans for all sites in question.
- Deploy permanent generation units to NOCL ZS, or establish contract with local suppliers
- Install new 11 kV bay at CLON ZS to support connection of generation;
- Remove approximately 53km of the DR-CC-1 66 kV line, between MAKA ZS and CHUM ZS;
- Terminate 66 kV DR-CC-1 line using a recloser;
- Install 2 x 50 A (OD) Voltage Regulators at location of previous MAKA ZS 66/11 kV TF
- Recover CORI ZS 66/11 kV TF and supply single customer via non-network option;

Key Assumptions:

- Partial conversion of 66 kV DR-CC-1 line to 11 kV and removal of 53 km section alleviates all existing statutory clearance problems;
- Voltage regulation of new 11 kV line is sufficient to maintain voltage levels within the system performance standard;
- Transmission network tower structure failure is considered non-credible.

Option 4 – Mixed Generation: Install limited capacity permanent standby generation (5MVA) with additional deployable back-up generation (2MVA) to replace existing supply configuration

Scope:

This option proposes to install 2.5MVA permanent generation, build new 11 kV bay at NOCL ZS, purchase land for generation installation, split DR-CC-1 and energise MAKA at 11 kV, distribution works, deploy 2.5MVA temporary generation when required and complete Safety Net plans.

- Purchase suitable land plot next to existing NOCL ZS to install permanent generation;
- Interpole the necessary sections of the existing lines (approximately 28 spans)
- Update Safety Net Plans for all sites in question.
- Deploy permanent generation units to NOCL ZS, or establish contract with local suppliers
- Install new 11 kV bay at CLON ZS to support connection of generation;

- Remove approximately 53km of the DR-CC-1 66 kV line, between MAKA ZS and CHUM ZS;
- Terminate 66 kV DR-CC-1 line using a recloser;
- Install 2 x 50 A (OD) Voltage Regulators at location of previous MAKA ZS 66/11 kV TF
- Recover CORI ZS 66/11 kV TF and supply single customer via non-network option;

3.2.2 Non-network options

Energy Queensland is committed to the implementation of Non-Network Solutions to reduce the scope or need for traditional network investments. Our approach to Demand Management is listed in Chapter 7 of our Distribution Annual Planning Report but involves early market engagement around emerging constraints as well as effective use of existing mechanisms such as the Demand Side Engagement Strategy and Regulatory Investment Test for Distribution (RIT-D). We see that the increasing penetration and improving functionality of customer energy technology, such as embedded generation, Battery Storage Systems and Energy Management Systems, have the potential to present a range of new non-network options into the future.

The primary investment driver for this project is Augex, supporting customer growth and network security. A successful Non-Network Solution may be able to assist in reducing the scope or timing for this project. As the cost of options considered as part of this report is greater than $6M this investment will be subject to RIT-D as a mechanism for customer and market engagement on solutions to explore further opportunities.

The customer base in the study area is predominantly rural residential and has a medium opportunity to reduce demand or provide economic non-network solutions. There is potential for future load growth resulting from new customer connections in this area if significant economic and/or population growth is experienced. As this network is not connected to the National Electricity Market, it is possible any third-party proposals may require negotiation with the North West Power System committee.

Expenditure for the proposed project has been modelled as CAPEX and included in the forecast for the current regulatory control period. Funding of any successfully identified Non-Network solutions will be treated as an efficient OPEX/CAPEX trade-off, consistent with existing regulatory arrangements.

3.3 Economic analysis of identified options

3.3.1 Cost versus benefit assessment of each 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 FY2038/39, using EQL's standard NPV analysis tool.

Capital Costs

The yearly direct costs, expressed in real 2018/19 dollars, for each option across the 2020-25 regulatory period are summarised in Table 7. A detailed breakdown of the cost items used to construct the yearly costs is provided in the NPV model.

Table 7: Yearly direct costs for each option

Options	2020-21	2021-22	2022-23	2023-24	2024-25	Total
1	$80,212	$256,694	$376,957	$3,335,276	$1,758,680	$5,807,819
2	$148,872	$514,809	$719,619	$7,523,424	$3,933,273	$12,839,997
3	$141,372	$480,313	$691,563	$7,138,571	$4,032,552	$12,484,371

Options	2020-21	2021-22	2022-23	2023-24	2024-25	Total
4	$84,176	$289,134	$406,690	$4,204,959	$2,499,413	$7,484,372
Counterfactual	$23,040	$84,789	$102,196	$1,069,295	$560,678	$1,839,998

Results

The net present value comparison is shown in Table 8. The Regulated Real Pre-Tax Weighted Average Cost of Capital (WACC) rate of 2.62% has been applied as the discount rate for this analysis (as per EQL's Standard NPV Tool). The NPV analysis demonstrates that Option 1 represents the lowest cost network option.

Table 8: Net present value of options

Option Name	Rank	Net NPV	CAPEX NPV	OPEX NPV	Benefits NPV
Option 1 - Interpoling	1	**-1,363**	-5,329	-16	3,982
Option 2 - 2nd transformer at CHUM	4	**-7,863**	-11,839	-6	3,982
Option 3 - Permanent generation	5	**-8,923**	-11,508	-1,397	3,982
Option 4 - Mixed generation	3	**-5,949**	-6,897	-3,034	3,982
Counterfactual	2	**-8,894**	-1,698	-7,196	0

The key regret scenarios in this analysis are a fatality from inadequate line clearance on the DURO to CHUM 66kV line or the failure of the CHUM 220/66kV transformer resulting in long duration outages at Cloncurry. A significant outage event on the 220/66kV transformer occurring once in 15 years is modelled, in addition to a 1-5-year occurrence of a bay failure resulting in a 2-week outage. In both scenarios the cost of deploying temporary generation in the counterfactual case is modelled.

The VCR value used represents a 2-day outage caused by a bay failure with approximately 150MWh unserved energy, once temporary generation is deployed, resulting in a VCR event of ($4,650,000). In the business as usual case, this scenario is considered likely. The proposed option 1 deals with both key regret risk scenarios and is the lowest NPV cost.

3.4 Scenario Analysis

3.4.1 Sensitivities

Energy Queensland utilises the AEMO 2014 Value of Customer Reliability (VCR) values as part of its investment and project planning process. VCR is an economic value applied to customers' unserved energy for any particular year and is intended to represent customers' willingness to pay for their reliability of electricity supply.

3.4.2 Value of regret analysis

In terms of selecting a decision pathway of 'least regret', Option 1 presents an economically efficient and balanced approach. Option 1 allows for the utilisation profile of existing assets and avoids high upfront costs involved in changing present network configuration (Option 2) and very low utilisation from new assets of significant cost (Option 3).

In addition to VCR value, the NPV benefit from undertaking the Option 1 scope of works is ~$4.5M. As such, Option 1 is considered the least regret option.

3.5 Qualitative comparison of identified options

3.5.1 Advantages and disadvantages of each option

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

Table 9: Assessment of options

Option	Advantages	Disadvantages
Counterfactual	• Reduces planned resource requirements in capital program	• Condition of assets may cause catastrophic failure during high demand • Ground clearances are insufficient and present risk to public • May cause increased incurred capital investment from early failure • More resources required to attempt expedited repairs from asset failures, pushing out scheduled works plan • May expose Ergon Energy and EQL as being unable to meet Service Safety Net targets under Distribution Authority requirements
Option 1 - Interpoling	• Rectifies clearance breaches and replaces plant at risk of failure, mitigating safety hazards to the staff and public • Maintains utilisation profile of existing assets • Allows Ergon Energy and EQL to meet Safety Net requirements under Distribution Authority	• Cost involved in maintaining present network configuration • Large scale project will require significant resource hours • Premature failure of CHUM ZS 22/66kV TF will require long lead time replacement, relying solely on this supply configuration for several months
Option 2 – 2nd Transformer at CHUM	• Rectifies clearance breaches by energising assets at lower voltage • Removes some at risk assets from being energised in the network, removing safety hazards to the staff and public	• Asset condition of line may still require capital expenditure to remove safety non-conformances • Increased 66kV bus fault level at CHUM ZS may require rectification earthing works in ZS, including downstream considerations • High cost involved in changing present network configuration • Large scale project will require significant resource hours • Very low utilisation from new assets of significant cost • May expose Ergon Energy and EQL to not being able to meet Service Safety Net Targets in some contingencies

Option	Advantages	Disadvantages
Option 3 – Permanent Generation	• Rectifies clearance breaches by energising assets at lower voltage • Removes some at risk assets from being energised in the network, removing safety hazards to the staff and public	• Asset condition of line may still require capital expenditure to remove safety non-conformances • Increased site hazards to be managed due to storage of flammable fuel etc. • Increased local fault levels will require rectification earthing works in ZS, including downstream considerations • High capital expense plus high running costs during operation • Exposure to price fluctuations of fuel • Large scale project will require significant resource hours • Very low utilisation from new assets of significant cost • Premature failure of CHUM ZS 22/66kV TF will require long lead time replacement, relying on this supply configuration for several months
Option 4 – Mixed Generation	• Rectifies clearance breaches by energising assets at lower voltage • Removes some at risk assets from being energised in the network, removing safety hazards to the staff and public	• Asset condition of line may still require capital expenditure to remove safety non-conformances • Increased site hazards to be managed due to storage of flammable fuel etc. • Increased local fault levels will require rectification earthing works in ZS, including downstream considerations • High running costs during operation of standby and mobile generation • Exposure to price fluctuations of fuel • Large scale project will require significant resource hours • Very low utilisation from new assets of significant cost • Premature failure of CHUM ZS 22/66kV TF will require long lead time replacement, relying on this supply configuration for several months • Mobile generation will have to be sourced from across the state and will take more than 12hrs to deploy

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.

The proposed works would ensure that Ergon Energy meets its Service Safety Net Targets going forward, which is an important point of compliance. In addition, it takes into account the long-term strategic decision to retire Cloncurry Zone Substation, ensuring that work undertaken will have a lasting impact on the network in line with future development.

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: Risk assessment showing risks mitigated following Implementation

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
Failure of CHUM 220/66kV TF supplying CLON and NOCL and existing alternate supply from DURO is unavailable, resulting in sustained customer outages >12 hours.	Customer	*(Original)* *3* *(interruption to 5,000 customers, >12 hours, three times in a week)* (Mitigated) 3 *(interruption to 5,000 customers, >12 hours, three times in a week)*	 *3* *(Unlikely)* 1 *(Almost No Likelihood)*	 ***9*** *(Low)* **3** *(Very Low)*	2019
Failure of CHUM 220/66kV TF supplying NOCL and CLON, requiring generation to meet shortfall in supply due to lack of capacity from DURO line, resulting in additional business costs of > $1 million	Business	*(Original)* *4* *(equates to business cost of >$1million or equivalent)* (Mitigated) 4 *(equates to business cost of >$1million or equivalent)*	 *3* *(Unlikely)* 1 *(Almost No Likelihood)*	 ***12*** *(Moderate)* **4** *(Very Low)*	2019
Failure of CHUM 220/66kV TF supplying CLON and NOCL and existing alternate supply from DURO unavailable, resulting in a notifiable Service Safety Net Targets breach and an improvement notice issued by the regulator	Legislated	*(Original)* *4* *(Improvement notice issued by the regulator)* (Mitigated) 4 *(Improvement notice issued by the regulator)*	 *3* *(Unlikely)* 1 *(Almost No Likelihood)*	 ***12*** *(Moderate)* **4** *(Very Low)*	2019

Risk Scenario	Risk Type	Consequence (C)	Likelihood (L)	Risk Score	Risk Year
EQL identifies clearance defects in accordance with electrical safety regulations resulting in regulator involvement and an enforceable undertaking being issued.	Legislated	*(Original)* *4* *(Improvement notice issued by the regulator)*	*6* *(Very likely)*	*24* *(Very high)*	2019-25
		(Mitigated) 4 *(Improvement notice issued by the regulator)*	2 (Very unlikely)	**8** **(Low)**	
Inadvertent contact with 66kV OH line due to non-compliant clearance to ground, resulting in a single fatality	Safety	*(Original)* *5* *(single fatality /incurable fatal illness)*	*3* *(Unlikely)*	***15*** *(Moderate)*	2019
		(Mitigated) 5 *(single fatality /incurable fatal illness)*	2 *(Very Unlikely)*	**10** *(Low)*	

4 Recommendation

4.1 Preferred option

This planning proposal recommends that Ergon Energy conduct remedial work, as per Option 1, on the DURO-CLON-1 66 kV sub-transmission line by interpoling spans, replacing the existing 66/11 kV step-up transformer and undertaking 66 kV refurbishment at DURO. This is to be constructed for a target capacity available date in 2023. The total estimated NPV cost (2018/19) for the recommended works is $5,085,187.

4.2 Scope of preferred option

The scope of the recommended works is as follows:

- Interpole the necessary sections of the existing line to remove clearance-to-ground non-conformances at the 50degC designed operating temperature, including line re-tensioning;
- Replace the existing step-up 66/11 kV TF4 and upgrade the transformer cable;
- Replace the existing 66 kV bay VT set. (project WR1214920);
- Replace the 66 kV Duoroll ABS's. D429, A129C and C429;
- Replace the segmented insulators on the DURO 66 kV bus

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, *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
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AMP	Asset Management Plan
Augex	Augmentation Capital Expenditure
BAU	Business As Usual
CAPEX	Capital expenditure
CB	Circuit-Breaker
CHUM ZS	Chumvale Zone Substation
CLON ZS	Cloncurry 66/11 kV Zone Substation
CORI	Corella River Substation
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
DNSP	Distribution Network Service Provider
DURO	Duchess Road Substation
EQL	Energy Queensland Ltd
IT	Information Technology
KRA	Key Result Areas
kV	Kilovolt
MAC	Maintenance Acceptance Criteria
MAKA	Marky Kathleen Substation
MICC	Mica Creek
MSS	Minimum Service Standard
MVA	Megavolt Amperes
MVAR	Megavolt Amperes Reactive
MW	Megawatt

Abbreviation or acronym	Definition
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
NOCL ZS	North Cloncurry 66/11 kV Zone Substation
NPV	Net Present Value
OD	Open Delta
OHEW	Overhead Earth Wire
OPEX	Operational Expenditure
PCBU	Person in Control of a Business or Undertaking
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 for 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
TF	Transformer
VCR	Value of Customer Reliability
VT	Voltage Transformer
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) **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**	Under QLD Electrical Safety Act 2002 and QLD Electrical safety Regulation 2013, Ergon Energy is required to operate its assets in an electrically safe manner. This proposal sets out works which address clearance to ground breaches in the Cloncurry area which would otherwise represent a moderate risk to staff and the public.
6.5.7 (a) (3) **The forecast capital expenditure is required in order to:** **(iii) maintain the quality, reliability and security of supply of supply of standard control services** **(iv) maintain the reliability and security of the distribution system through the supply of standard control services**	This proposal addresses works required in order to ensure Ergon Energy meets its Service Safety Net Targets going forward in the Cloncurry area.
6.5.7 (a) (4) **The forecast capital expenditure is required in order to maintain the safety of the distribution system through the supply of standard control services.**	This proposal addresses numerous clearance to ground issues with live conductors which present a moderate risk to the public and staff.
6.5.7 (c) (1) (i) **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 and program 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: • Option analysis to determine preferred solutions to network constraints • Strategic forecasting of material, labour and contract resources to ensure deliverability • Effective management of project costs throughout the program and project lifecycle, and • Effective performance monitoring to ensure the program of work is being delivered effectively. 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) **The forecast capital expenditure reasonably reflects a realistic expectation of the demand forecast and cost inputs required to achieve the capital expenditure objective**	The prudency of this proposal is demonstrated through the options analysis conducted and the quantification of risk and benefits of each option. 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 ***Operate safely as an efficient and effective organisation*** 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 ***Be Community and customer focused*** 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 ***Strengthen and grow from our core*** 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 ***Operate safely as an efficient and effective organisation*** 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 ***Create value through innovation*** 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

<table>
<tr><th colspan="6">Network Risks - Risk Tolerability Criteria and Action Requirements</th></tr>
<tr><th>Risk Score</th><th>Risk Descriptor</th><th colspan="3">Risk Tolerability Criteria and Action Requirements</th><th></th></tr>
<tr><td>30 – 36</td><td colspan="4">Intolerable
(stop exposure immediately)</td><td></td></tr>
<tr><td>24 – 29</td><td>Very High Risk</td><td rowspan="5">*ALARP
Risk in this range managed to As Low As Reasonably Practicable</td><td>Executive Approval
(required for continued risk exposure at this level)</td><td>May require a full Quantitative Risk Assessment (QRA)
Introduce new or changed risk treatments to reduce level of risk
Periodic review of the risk and effectiveness of the existing risk treatments</td><td rowspan="5">SFAIRP
Risks in this area to be mitigated So Far as is Reasonably Practicable</td></tr>
<tr><td>18 – 23</td><td>High Risk</td><td>Divisional Manager Approval
(required for continued risk exposure at this level)</td><td>Introduce new or changed risk treatments to reduce level of risk
Periodic review of the risk and effectiveness of the existing risk treatments</td></tr>
<tr><td>11 – 17</td><td>Moderate Risk</td><td rowspan="2">Group Manager / Process Owner Approval
(required for continued risk exposure at this level)</td><td rowspan="2">Introduce new or changed risk controls or risk treatments as justified to further reduce risk
Periodic review of the risk and effectiveness of the existing risk treatments</td></tr>
<tr><td>6 – 10</td><td>Low Risk</td></tr>
<tr><td>1 to 5</td><td>Very Low Risk</td><td>No direct approval required but evidence of ongoing monitoring and management is required</td><td>Periodic review of the risk and effectiveness of the existing risk treatments</td></tr>
</table>

Figure 2: 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."*

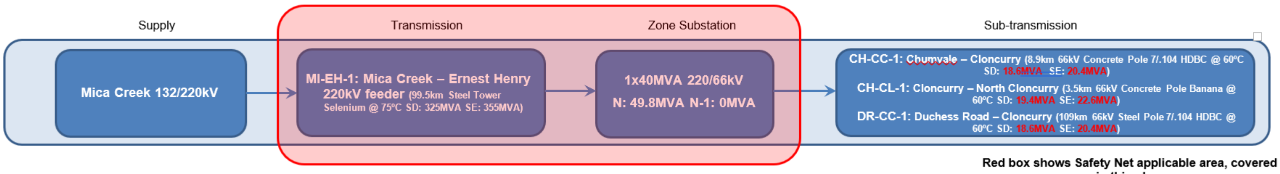
The safety net criteria are classified into Regional Centre and Rural Area, each with a different timeline as follows:

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

Table D1: Safety Net – Load not supplied and maximum restoration times following a credible contingency

Appendix G. Safety Net Contingency Management Plan

CHUMVALE BULK SUPPY SUBSTATION



Red box shows Safety Net applicable area, covered in this plan

Safety Net Contingency Plan

Note: This plan was developed to ensure Safety Net *compliance* for a *credible* event occurring on the day of (forecast) maximum demand for a normal (POE50) year. It does not necessarily represent the "best" contingency (i.e. the plan that results in the smallest number of lost customer minutes/ unsupplied load). Most events will occur when demand is less than the forecast MD. In these cases, some actions such as shedding large customers, deploying Nomads/Pegasus units, etc. will not be necessary to achieve SN *compliance* and it will be up to the co-ordinator to decide on what is best. Where the event occurs on a day where demand is higher than the forecast MD, SN compliance may not be possible – in which case, best endeavours is all that is required.

Scenario	Failure	Consequence	Actions	SN Minimum Timeline	Assessed Time	Safety Net Compliance
1.	Transformer Failure (T1) at Chumvale	Loss of 66kV Supply to CLON ZS and NOCL ZS, up to 7.5MVA lost (1497 customers)	1. Initial Fault OCC Diagnosis & Dispatch (1hr)			
			2. Cloncurry first response crews attend & diagnose on site (2hrs)			
			3. Install 1.5MVA of LV generation (4-6 LV sets between 100kVA and 500kVA) from Mt Isa, Cloncurry & Western Depots[1] (6hr stand up, 2hr loading, 2hr transport & 8hr phase in) following the completion of steps 1 & 2 as per Gantt Chart in Appendix A	18 hours	21 hours	NO
			4. Dispatch test & sub ops via charter flight (4hr crew stand up & 6hr concurrent charter flight stand up + 2hr flight)[2]			
			5. Preliminary testing to inform response plane action (12hrs)			
			6. Deploy 2MVA of HV & LV generation from Townsville[3] (4hr stand up, 2hr loading, 19hr 800km transport with fatigue management & 4hr phase in) in parallel with steps 3, 4 & 5 as per Gantt Chart in Appendix A	18 hours	32 hours	NO
			7. Deploy 1MVA of HV generation from Cairns[3] (4hr stand up, 2hr loading, 24hr 1100km transport with fatigue management & 4hr phase in) in parallel with steps 3, 4, 5 & 6 as per Gantt Chart in Appendix A		36 hours	
			8. Deploy 1MVA of HV generation from Mackay[3] (4hr stand up, 2hr loading, 24hr 1200km transport with fatigue management & 4hr phase in) in parallel with steps 3, 4, 5, 6 & 7 as per Gantt Chart in Appendix A		37 hours	
			9. Deploy 1MVA of HV generation from Maryborough[3] (4hr stand up, 2hr loading, 29hr 1600km transport with fatigue management & 4hr phase in) following the completion of step 5 as per Gantt Chart in Appendix A		60 hours	
			10. Deploy 1MVA of HV generation from Toowoomba[3] (4hr stand up, 2hr loading, 29hr 1600km transport with fatigue management & 4hr phase in) in parallel with step 9 as per Gantt Chart in Appendix A	48 hours	60 hours	NO
			There is also an option to hire 2MVA of LV generation sets from Townsville, Cairns or Mackay (4-6 LV sets between 350kVA and 500kVA) instead of deploying HV generation from Maryborough & Toowoomba following the completion of step 5. Deployment timeframe would be 6hr stand up, 2hr loading, 19hr transport with fatigue management & 8hr phase in. Phase in for this option would be more time consuming as all existing LV generation connection points would be in use.			
			Full supply restored:	48 hours	60 hours	NO
2.	Fault on the MI-EH Transmission line	Loss of 220kV supply to CHUM, up to 7.5MVA lost (1497 customers)	1. Controllers detect fault (<1hr)	18 hours	< 1 hour	YES
			2. Dispatch local crews from Cloncurry to attend and conduct an aerial patrol to locate the fault (8hrs)	18 hours	8 hours	YES
			3. Isolate the fault, repair the line (pole, hardware and/or conductor replacement) and restore supply (8hrs)	18 hours	< 18 hours	YES
			Full supply restored:	48 hours	< 18 hours	YES
3.	Fault on the CH-CC 66kV line	Loss of 66kV supply to CLON ZS and NOCL ZS, up to 7.5MVA lost, (1497 customers)	1. Controllers detect fault (<1hr)	18 hours	< 1 hour	YES
			2. Dispatch local crews from Cloncurry to attend and conduct an ground patrol to locate the fault (3hrs)	18 hours	3 hours	YES
			3. Isolate the fault, repair the line (pole, hardware and/or conductor replacement) and restore supply (8hrs)	18 hours	< 18 hours	YES
			Full supply restored:	48 hours	< 18 hours	YES

Safety Net Restoration Targets
RURAL/REMOTE
1. Less than 20MVA after 1 hour
2. Less than 15MVA after 8 hours
3. Less than 5MVA after 18 hours
4. Fully restored within 48 hours

Important Notes

The assessed time for each action is based on the standard response times outlined in the Safety Net Application Manual in conjunction with input from local network operations and field delivery staff.

Refer to Gantt Chart in Appendix A for more detail on the response plan

[1] Hire generation is dependent upon what is available in Cloncurry and Mt Isa at the time.

[2] This plan does not rely on Test section confirming a transformer failure prior to the implementation of restoration actions.

[3] Assuming that HV generation units are not tied up in long rural deployments or planned work

Approximately 184 spans on the DR-CC-1 66 kV feeder have been identified as having insufficient ground clearance to meet minimum statutory requirements at the 50°C designed operating temperature.

The step-up 66/11 kV transformer (T4) and associated 11 kV transformer cable at DURO have insufficient thermal rating to supply the Cloncurry summer peak load.

Large Customers on "N" Connection Agreements (Whose Load is **Not** Counted Against Safety Net Targets)

NMI	Name	Address	Auth. Demand	Transformer
N/A	N/A	N/A	N/A	N/A

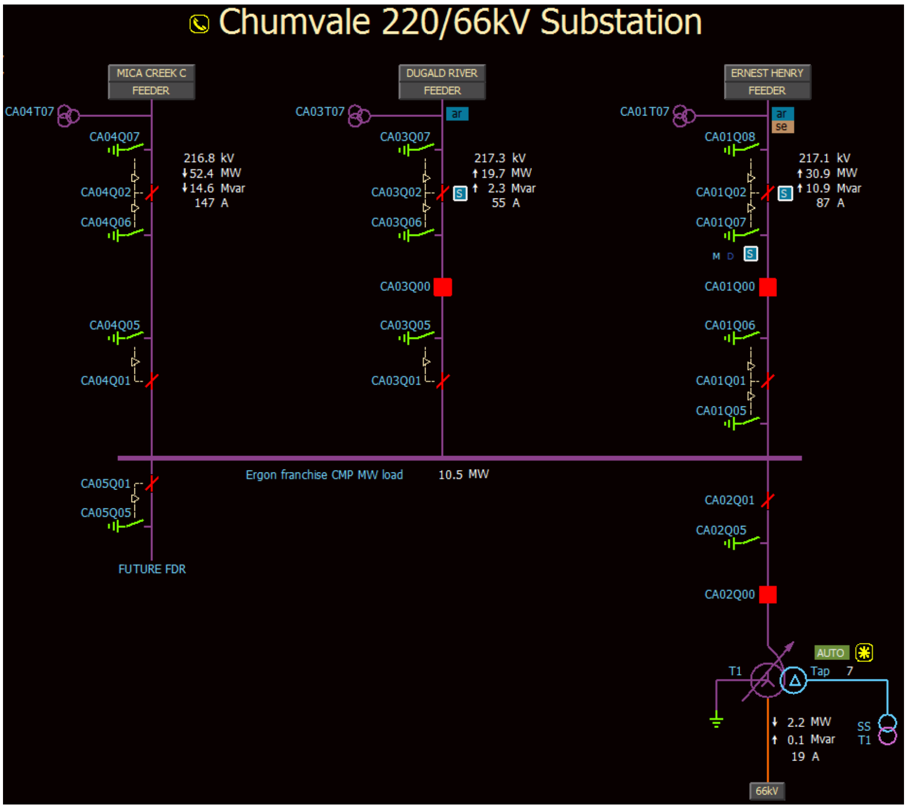


Figure 3: Substation Single Line Diagram

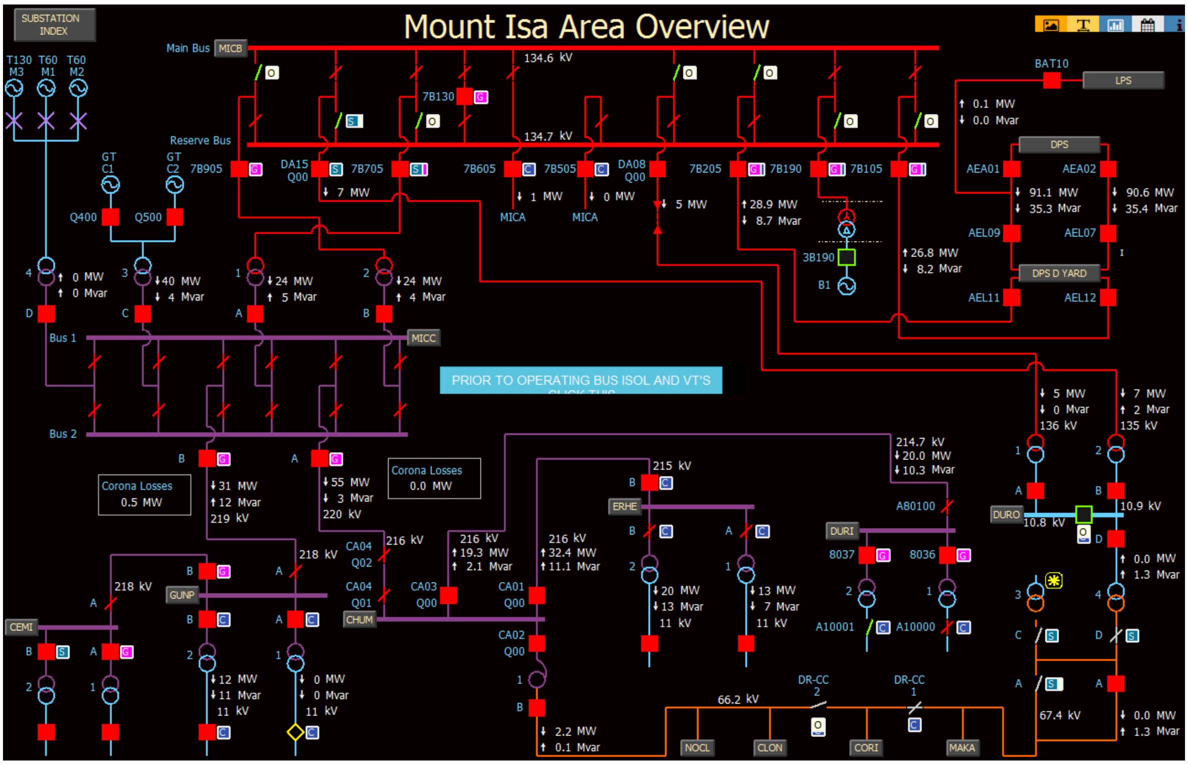
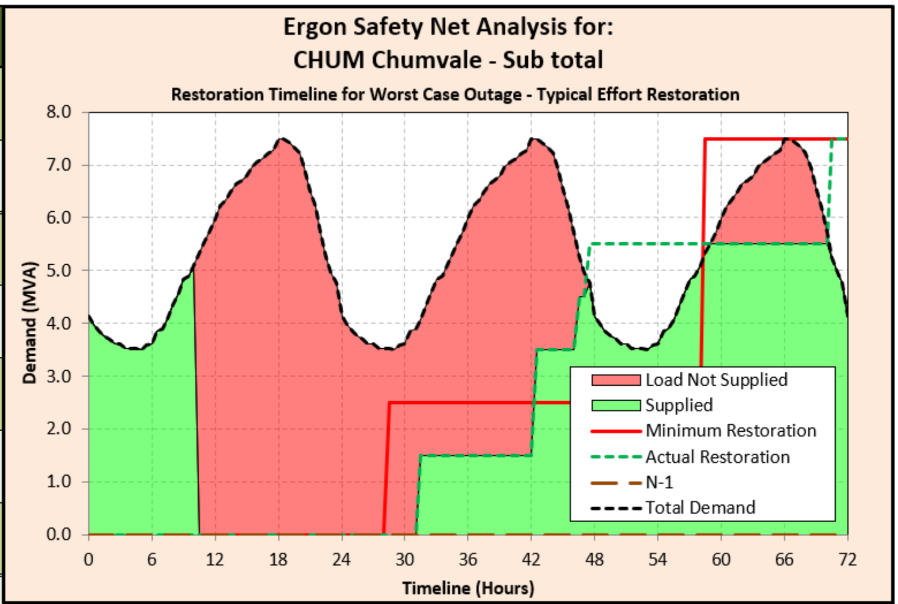


Figure 4: ST Single Line Diagram

	Load (MVA)	Time
N-1	0.0 MVA	
Sheddable Load	0.0 MVA	
Install LV gen from Mt Isa, Cloncurry & Western Depots	1.5	21.0 hr
Install HV & LV generation from Townsville	2.0	32.0 hr
Install HV generation from Cairns	1.0	36.0 hr
Install HV generation from Mackay	1.0	37.0 hr
Install HV generation from Maryborough & Toowoomba	2.0	60.0 hr
Replace 220/66 kV TF	4320 hr	



Safety Net Compliance: NOT COMPLIANT

Figure 5: Substation Safety net Analysis

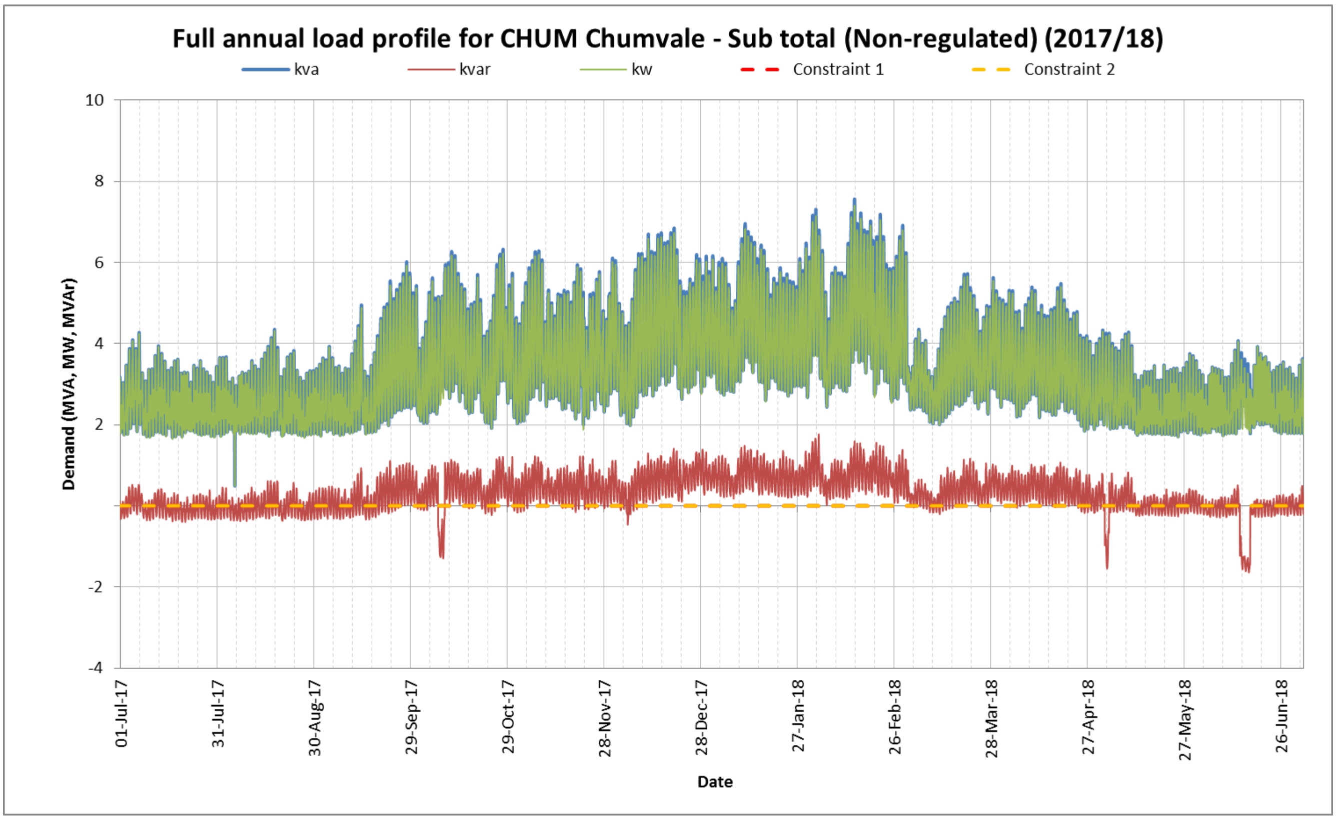


Figure 6: Load Profile showing capability

Table 13: Forecast and capability

	Annual Maximum Demand (MVA)										
	Actual	POE50 Forecast									
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
POE50	7.6	7.6	7.5	7.6	7.7	7.6	7.6	7.6	7.7	7.7	7.7
POE10		8.1	8.0	8.1	8.2	8.1	8.1	8.1	8.2	8.2	8.2
Substation N-1	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Substation N	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8
Subtransmission N-1	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Subtransmission N	325.0	325.0	325.0	325.0	325.0	325.0	325.0	325.0	325.0	325.0	325.0

Cloncurry Safety Net
Gantt Chart.pdf

Appendix H. Reconciliation Table

Reconciliation Table Conversion from $18/19 to $2020	
Business Case Value	
(M$18/19)	$5.80
Business Case Value	
(M$2020)	$6.00

Appendix I. Cloncurry District Layout

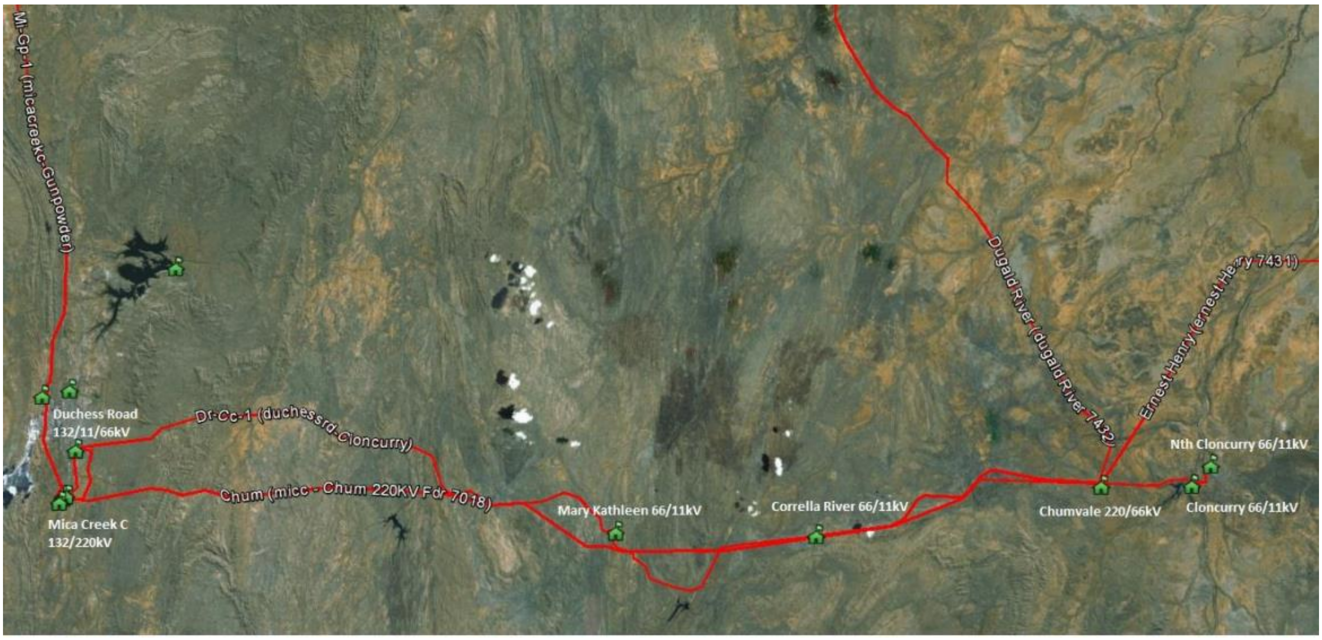


Figure 7: Cloncurry district geographical layout

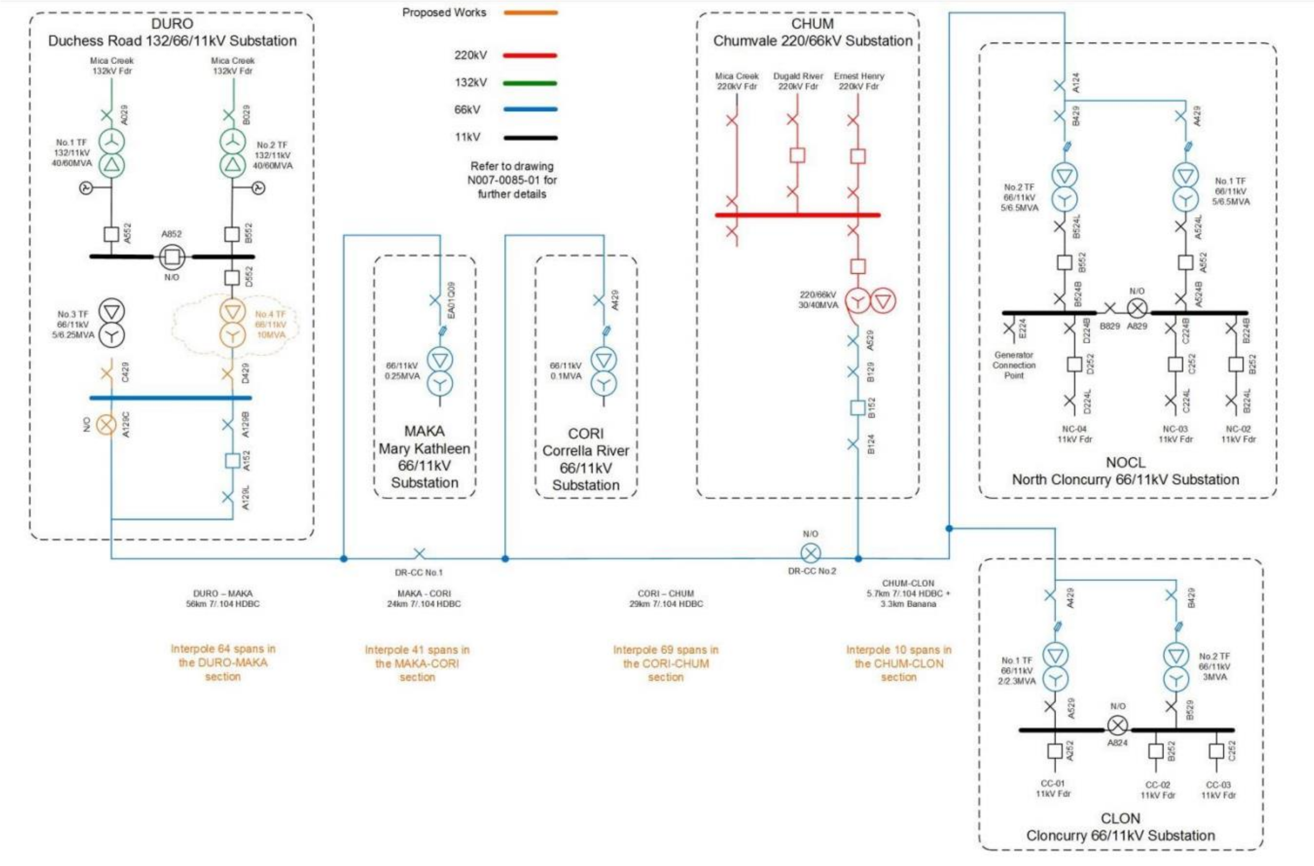


Figure 8: Single Line Diagram for Option 1

Appendix J. Supporting Documents

Table 14: Full register of assets with retirement year to 2027

Asset Class	Ellipse ID	SPN	Sub	Concat Name	Plant Type	YOM/ Inferred YOM	Age (yrs)	Estimated Retirement Year	WR No	WR Planned Yr
PR	1792542	PR93215195	CHUM	NQ CHUM - PR93215195 1998 - ALSTOM GEC > KCGG142 - EA51 - 66kV Feeder (Main Y: CBF)	Static	1998	19	2023		
PR		PR93218468	CHUM	NQ CHUM - PR93218468 1998 - SIEMENS > DUOBIAS M - TX51 - 220kV Transformer (Main X: DIFF)	Static	2009	19	2023		
PR	8217584	PR93219083	CHUM	NQ CHUM - PR93219083 1998 - SCHWEITZER > SEL321-1 - EA51 - 66kV Feeder (Main X: DIST)	Numeric	1997	19	2018		
PR	1792599	PR93219491	CHUM	NQ CHUM - PR93219491 1998 - ALSTOM GEC > KCGG142 - EA51 - 66kV Feeder (OC, EF, CBF)	Static	1998	19	2023		
PR	778736	PR93220842	CHUM	NQ CHUM - PR93220842 1998 - EA51 - 66kV Feeder (AR)	Unknown	1986	19	2023		
PR	5535567	PR93224924	CHUM	NQ CHUM - PR93224924 1998 - ALSTOM GEC > KCEG142 - CA51 (DOC, DEF)	Static	2009	19	2023		
PR	718567	PR93227184	CHUM	NQ CHUM - PR93227184 1998 - ALSTOM GEC > MCGG22 - TX51 - 220kV Transformer (NEF)	Static		19	2023		
PR	5802051	PR93231966	CHUM	NQ CHUM - PR93231966 1998 - ALSTOM GEC > MCGG82 - TX51 - 220kV Transformer (OC, EF)	Static		19	2023		
PR		PR93232380	CHUM	NQ CHUM - PR93232380 1998 - ALSTOM GEC > KCGG142 - TX51 - 220kV Transformer (Main Y: CBF)	Static	1998	19	2023		
PR	715020	PR93233882	CHUM	NQ CHUM - PR93233882 1998 - ALSTOM GEC > KCGG142 - TX51 - 220kV Transformer (OC, EF, CBF)	Static	1981	19	2023		
IS	00000062 9892	IS91854559	CLON	NQ CLON A529 - IS91854559 1976 11kV 400A SWITCHGEAR > GPD-3R (11935045)		1976	41	2026		
IS	00000062 9754	IS91718447	CLON	NQ CLON B529 - IS91718447 1976 11kV 400A SWITCHGEAR > GPD-3R (11935046)		1976	41	2026		
TR	00000066 0397	TR91619840	CLON	NQ CLON T1 - TR91619840 1976 66/11/0.415 kV 2.3MVA TYREE (110636)	On Load Tap Changer	1976	41	2025		
VT	00000191 5395	VT93216093	CLON	NQ CLON T1 # ph - VT93216093 1976 11kV TYREE > ### (1329/1)	Oil	1976	41	2021		

Asset Class	Ellipse ID	SPN	Sub	Concat Name	Plant Type	YOM/ Inferred YOM	Age (yrs)	Estimated Retirement Year	WR No	WR Planned Yr
VT	000008319346	VT94573720	CLON	NQ CLON T2 # ph - VT94573720 1975 11kV ### > ### (###)	Oil	1975	42	2020		
PR	716653	PR93219630	CLON	NQ CLON - PR93219630 1998 - COOPER > KFME - FB03 - 11kV Feeder	Static	1972	19	2023		
PR	714356	PR93219874	CLON	NQ CLON - PR93219874 1998 - COOPER > KFME - FB06 - 11kV Feeder	Static	1972	19	2023		
CB	000000410146	CB91545663	DURO	NQ DURO A152 - CB91545663 1977 66kV - SPRECHER AND SHUH > HPFA 409H (77/2181341-2)	Outdoor	1977	40	2017	1246354	2019
CT	000000630390	CT92875808	DURO	NQ DURO A196 A ph - CT92875808 1977 66kV EMIL PFIFFNER > JOF72 (82546)	Oil	1977	40	2022	1214920	2019
CT	000000570497	CT91896986	DURO	NQ DURO A196 B ph - CT91896986 1977 66kV EMIL PFIFFNER > JOF72 (82547)	Oil	1977	40	2022	1214920	2019
CT	000000457442	CT91928010	DURO	NQ DURO A196 C ph - CT91928010 1977 66kV EMIL PFIFFNER > JOF72 (82548)	Oil	1977	40	2022	1214920	2019
VT	000000550912	VT93219209	DURO	NQ DURO A197 A ph - VT93219209 1977 66kV ASEA > EMFC (6597154)	Oil	1977	40	2022	1214920	2019
VT	000000583597	VT93224424	DURO	NQ DURO A197 B ph - VT93224424 1977 66kV ASEA > EMFC (6597155)	Oil	1977	40	2022	1214920	2019
VT	000000604717	VT93217710	DURO	NQ DURO A197 C ph - VT93217710 1977 66kV ASEA > EMFC (6597156)	Oil	1977	40	2022	1214920	2019
PR		PR93206877	DURO	NQ DURO - PR93206877 2007 - ALSTOM AREVA SCHNEIDER > MICOM P142 - FB57 - 11kV Feeder	Numeric	1975	10	2027		
PR	774237	PR93207152	DURO	NQ DURO - PR93207152 2005 - ALSTOM AREVA SCHNEIDER > MICOM P142 - FB51 - 11kV Feeder	Numeric	1985	12	2025		
PR	716331	PR93207255	DURO	NQ DURO - PR93207255 2007 - ALSTOM AREVA SCHNEIDER >MICOM P141 - TX02 - 11kV Transformer (OC)	Numeric	1985	10	2027		
PR		PR93207281	DURO	NQ DURO - PR93207281 2007 - ALSTOM AREVA SCHNEIDER > MICOM P142 - FB59 - 11kV Feeder	Numeric	1960	10	2027		
PR	716336	PR93207313	DURO	NQ DURO - PR93207313 2007 - ALSTOM AREVA SCHNEIDER >MICOM P141 - TX01 - 11kV Transformer (OC)	Numeric	1985	10	2027		
PR	7723784	PR93207398	DURO	NQ DURO - PR93207398 2007 - ALSTOM AREVA SCHNEIDER > MICOM P141 - TX04 - 66kV Transformer (OC, EF, SEF, CBF)	Numeric		10	2027		

Asset Class	Ellipse ID	SPN	Sub	Concat Name	Plant Type	YOM/ Inferred YOM	Age (yrs)	Estimated Retirement Year	WR No	WR Planned Yr
PR		PR93207602	DURO	NQ DURO - PR93207602 2007 - ALSTOM AREVA SCHNEIDER > MICOM P142 - FB56 - 11kV Feeder	Numeric	2008	10	2027		
PR		PR93207659	DURO	NQ DURO - PR93207659 2007 - ALSTOM AREVA SCHNEIDER > MICOM P142 - FB55 - 11kV Feeder	Numeric	1987	10	2027		
PR		PR93207673	DURO	NQ DURO - PR93207673 2007 - ALSTOM AREVA SCHNEIDER > MICOM P142 - FB53 - 11kV Feeder	Numeric	2010	10	2027		
PR	718385	PR93207697	DURO	NQ DURO - PR93207697 2007 - ALSTOM AREVA SCHNEIDER > MICOM P141 - FB61 - 11kV Bus (CBF)	Numeric	2001	10	2027		
PR	717254	PR93207808	DURO	NQ DURO - PR93207808 2007 - ALSTOM AREVA SCHNEIDER > MICOM P142 - FB58 - 11kV Feeder	Numeric	1960	10	2027		
PR	8423419	PR93208040	DURO	NQ DURO - PR93208040 2006 - ALSTOM AREVA SCHNEIDER > MICOM P543 - DA52 - Feeder (DIFF, AR)	Numeric	1998	11	2026		
PR	716156	PR93208231	DURO	NQ DURO - PR93208231 2006 - ALSTOM AREVA SCHNEIDER > MICOM P142 - LX01 - 11kV Load Control (OC, EF, SEF, AR, CBF)	Numeric	1979	11	2026		
PR	8204664	PR93224412	DURO	NQ DURO - PR93224412 2002 - SCHWEITZER > SEL311-C - DA52 - Feeder (DIST)	Numeric	1993	15	2022		
PR	5783762	PR93230607	DURO	NQ DURO - PR93230607 2002 - TX52 - 11kV Load Control (OC, EF)	Unknown	1997	15	2027		
PR		PR93431037	DURO	NQ DURO - PR93431037 2007 - ALSTOM AREVA SCHNEIDER > MICOM P142 - FB60 - 11kV Feeder (OC, EF, SEF, AR, CBF, UF)	Numeric	2009	10	2027		