2023-27
POWERLINK QUEENSLAND REVENUE PROPOSAL

Project Pack – PUBLIC

CP.01656
Calliope River to Larcom Creek 275kV Transmission Line Refit

CP.01656 – Calliope River to Larcom Creek 275kV Transmission Line Refit

Project Status: Not Approved

1. Network Need

The Calliope River to Larcom Creek transmission line is over 43 years old (commissioned in 1977) and is located immediately adjacent to Gladstone's industrial area. The feeder plays a vital role in maintaining the reliability of supply to Larcom Creek, Yarwun and Raglan. An outage of this feeder would leave up to 160MW and up to 3200MWh of customer load per day at risk[2].

A Condition Assessment (CA) carried out in October 2019 identified many of the line's tower bolts, members, tension strings and insulator hardware are exhibiting Grade 2 (Low) to Grade 4 (High) corrosion which is expected to decline further[1]. Approximately 20% of bolts and 3% of members are expected to reach Grade 3 (Medium) corrosion by 2022. This decline in asset condition increases the risk of structural failure that may cause safety incidents, network outages and additional network costs to replace assets under emergency conditions. Enhanced inspection and maintenance is to be implemented in the short term on three structures to manage their condition and align refit works for the entire built section in June 2024.

Energy Queensland forecasts confirm there is an enduring need to maintain electricity supply to the Gladstone area. The removal of the Calliope River to Larcom Creek transmission line would violate Powerlink's Transmission Authority reliability obligations (for N-1-50MW/600MWh). Failure to address the condition of this asset is likely to result in non-compliance with Powerlink's reliability and safety obligations[6].

2. Recommended Option

As this project is currently 'Not Approved', project need and options will undergo a public Regulatory Investment Test for Transmission (RIT-T) consultation process to identify the preferred option closer to the time of investment. Through this process, feasible non-network options will be sought and assessed.

The current recommended option is to refit poor condition components of the 275kV Calliope River to Larcom Creek line by June 2024[2].

The following options have been considered to address the condition of the line:

- Do Nothing – rejected due to non-compliance with reliability standards and safety obligations.
- Rebuild new 275kV feeders – to be reviewed via the RIT-T process.
- Non Network Option parameters identified – at present, no viable non network option identified.

Figure 2-1 below shows the current recommended option eliminates the forecast risk monetisation profile of the Calliope to Larcom Creek line in 2025.

Where a 'Do Nothing' scenario is adopted, the forecast level of risk associated with the asset escalates to over $7m p.a. in 2030 and continues to escalate. This is predominantly due to safety risks associated with the failure of overhead line structures, followed by network risks due to unserved energy[3].

The enhanced inspection and targeted maintenance approach reduces the risk profile in the near term compared to the "do nothing" scenario. This is only considered a feasible approach until 2024, when the extent of the components requiring intervention is expected to exceed the capability of maintenance resources to manage the condition through maintenance alone. The residual risk is reduced to less than $50k per annum when the refit works are completed.

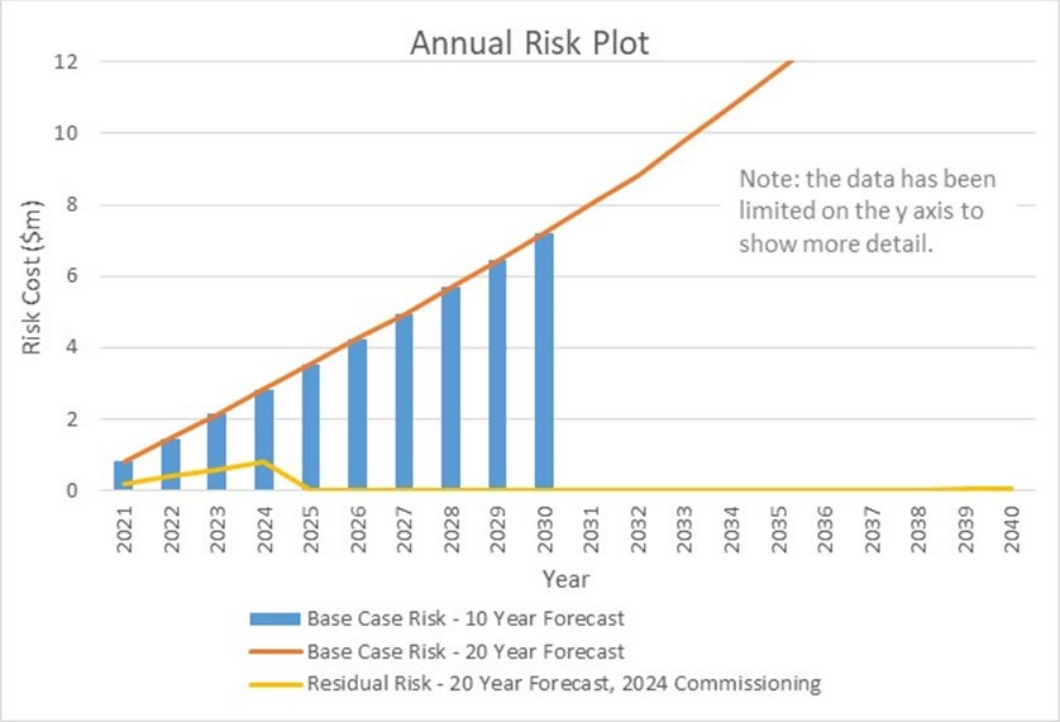

Figure 2-1 Annual Risk Monetisation Profile (Nominal)

3. Cost and Timing

The estimated cost to refit the Calliope River to Larcom Creek 275kV line feeder is $10.2m ($2020/21 Base)[5].

Target Commissioning Date: November 2023

4. Documents in CP.01656 Project Pack

Public Documents

1. Transmission Line Condition Assessment – Report BS1515 Mt Miller (STR-0012) to Larcom Ck 275kV
2. CP.01656 Calliope River to Larcom Creek 275kV Transmission Line Refit – Planning Statement
3. Base Case Risk and Maintenance Costs Summary Report CP.01656 Mt Miller - Larcom Creek 275kV TL Refit
4. Project Scope Report CP.01656 Calliope River to Larcom Creek 275kV Transmission Line Refit
5. Concept Estimate for CP.01656 - Calliope River to Larcom Creek 275kV Transmission Line Refit

Supporting Documents

6. Asset Reinvestment Criteria - Framework
7. Asset Management Plan 2021

Transmission Line Condition Assessment – Report

BS1515

Mt Miller (STR-0012) to Larcom Ck 275kV

Record ID	A3188366	
Team	Delivery & Technical Solutions – Technology & Planning – Asset Strategies – Transmission Lines	
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Approved by	Asset Strategies Manager	[redacted]

Version history

Version	Date	Section(s)	Summary of amendment	Author	Approver
1	28/10/2019		Original	[redacted]	[redacted]

Note: *Where indicator symbol ☼# is used (# referring to version number) it indicates a change/addition was introduced to that specific point in the document. If the indicator symbol ☼# is used in a section heading, it means the whole section was added / changed.*

IMPORTANT: - This Condition Assessment Report provides an overview of the SAP built section meters outlined in the Report's Scope. As it is snapshot in time based upon available data and the accuracy of the prediction methodology, any estimates of remaining life are valid for 3 years only from the date of the report's approval.

1. Executive Summary

BS1515 consists of 21 steel lattice structures commissioned in 1977 under contract number 277/74.

An estimated 36% of tower nuts and bolts are exhibiting grade 2 corrosions with 12% grade 3 and some grade 4 corrosions present. An estimated 13% of steel members are also showing grade 2 corrosions with 3% members having progressed to grade 3.

The insulator hardware appears to be in a very poor state with overwhelming photographic evidence of extensive grade 3 corrosion scattered throughout the built section. All bridging and suspension insulators appeared to be serviceable, however 50% of tension strings exhibiting grade 2 corrosion and 25% are showing low grade 3 corrosion.

The line sits in an average rainfall area with an average 60% humidity. Exposed carbon steel in this environment (C4: including tropical with low pollution) will corrode at between 50-80 micrometres per annum, which is 25-40 times faster than galvanised coatings. This could potentially result in the loss of 0.5mm of steel within 6-10 years.

As a result, particularly in the more exposed locations, an unusually high percentage of galvanised tower members are exhibiting evidence of grade 2 (13%) and grade 3 (3%) corrosion, and while few have yet suffered a total loss of their galvanised coatings, it is necessary to consider when and how to maintain the structures in order to avoid reaching the point where extensive replacement of steelwork is necessary. Insulator hardware similarly show a variety of corrosion levels, depending on location, and a large amount of insulator hardware has high grade 3 corrosion.

The ACSR/GZ conductors are in sound condition and are considered to have at least another 38 years remaining life.

Based upon the data presented in this report and measurement documents for 28% of structures, this line will required additional maintenance to keep it in a serviceable condition. A maximum health index of 8.7 was calculated for 15% of towers which equates to about 3 towers. As the maintenance resources required to keep the line in service are low it is recommended to perform additional maintenance to delay a refurbishment or rebuild in the short term. In 2022 it is estimated that on average across the built section 20% of bolts would have reached grade 3 and 6% of members would have reached grade 3 if no maintenance is performed.

It is considered that enhanced inspection together with targeted maintenance activities will allow the emerging condition risks to be managed across the entire built section, such that all works in the medium term can be undertaken together. The limit to which this approach is considered feasible is 2024.

NOTE: This estimate is valid for a maximum of 3 years, after which new evidence will need to be collected and analysed.

Predicted end of life summary table

Cond	Dampers	Spacers	EW	OPGW	Earthing	Foundation Bored	Foundation Grillage	Structures	Bridging.Strings	Suspension Strings	Tension.Strings
2057	2019	N/A	2068	2068	2024	2057	N/A	2014*	2026	2022	2022

Note: The predicted EOL years are based on a maximum health index of 7 for 95% of the sample data.

* This relates to the 3 structures in the worst condition.

2. Purpose

This report outlines the assessed condition of Built Section 1515 which spans between Mt Miller (near Calliope Substation) and Larcom Ck substation and has been produced to assist in developing a future asset management strategy for the line.

The report examines the condition of the line's major component groups, using field data and maintenance records, and assigns them a corrosion grade based upon existing Asset Management classifications.

3. Scope

SAP "Built Section Meters" have been used as the basis of categorising the transmission line components in this Condition Assessment Report.

Built Section Meters			
1	Foundations	8	Earthwire Hardware
2	Structure	9	Earthwire Mid-span Joints
3	Earthing	10	Suspension Insulators
4	Conductor	11	Suspension Insulator Hardware
5	Conductor Hardware	12	Tension Insulators
6	Conductor Mid-span Joints	13	Tension Insulator hardware
7	Earthwire	14	Signage

In addition to the built section meters the bridging insulators, bridging insulator hardware, and easement condition has also been assessed.

The Corrosion Grade assigned to each Built Section component is based on the corrosion/deterioration classifications used in Powerlink's existing Visual Guides.

3.1 Component Condition Summary:

The table below summarises the average condition of each major component group. Based on visual assessment and past experience the estimated remaining service life has also been provided.

Average Observed Corrosion Grades are based upon existing Powerlink Visual Inspection Guides, as applied to photographic evidence and extracted from SAP.

Built Section Meter	Average Level of Corrosion (%)				Sample Size	Installed Year	Health Index (95%)	Estimated Remaining Service Life (years)
Structure								
Foundations	G1	G2	G3	G4		1977	0	
Legs	100	0	0	0	4			
Structure Overall	G1	G2	G3	G4	6	1977	8.7	-5
Fasteners	51.4	35.8	12.5	0.3	6			
Members	84.7	12.5	2.8	0	6			
Climbing Aids	G1	G2	G3	G4				
Fasteners	45.8	31.7	23	0	6			
Tower Base	G1	G2	G3	G4				
Fasteners	52.5	35	11.7	0.8	6			
Members	89.2	10.8	0	0	6			
Tower Body	G1	G2	G3	G4				
Fasteners	57.5	33.3	9.2	0	6			
Members	79.2	15.8	5	0	6			
Superstructure	G1	G2	G3	G4				
Fasteners	44.7	40	15	0.3	4			
Members	82.5	12.5	5	0	4			
Cross Arms	G1	G2	G3	G4				
Fasteners	47.5	38.3	14.2	0	6			
Members	90	10	0	0	6			
Conductor Attachment Plate	G1	G2	G3	G4				
Fasteners	48.3	36.7	15	0	6			
EW Peak	G1	G2	G3	G4	6			
Fasteners	54.1	34.2	11.7	0	6			
Members	84.2	15.8	0	0	6			
	Min	Max	Avg					
Structure Earthing Resistance	0	0			0			

The health index is either the maximum value or the 95% value based on a normal distribution of the data sample.

The OHEW was replaced in 2008 when an OPGW was installed. There are no condition drivers to report at this early stage.

Built Section Meter	Corrosion Grade / Condition (%)								Sample Size	Installed Year	Health Index (95%)	Estimated Remaining Service Life (years)
Suspension - Side A										1977	6	3
Insulators	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	50	0	0	50	0	0	0	0	2			
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	66.7	0	0	33.3	0	0	3			
Hanger Brackets	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	100	0	0	0	0	0	2			
Hanger Bkt Fasteners	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	100	0	0	0	0	0	2			
Clamp Fasteners	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	33.3	33.3	33.3	0	0	0	3			
Clamps	Ok	Worn Rubber	Aged									
	66.7	0	33.3						3			
Insulator Shed	OK	Polluted	Dust	Moss	Fungi	Disc-cracked	Disc-chipped					
	100	0	0	0	0	0	0		2			
Tension - Side A										1977	6	3
Insulators	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	25	0	50	0	25	0	0	0	4			
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	25	50	0	25	0	0	4			
Deadend	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	50	0	50	0	0	0	4			
Insulator Shed	OK	Polluted	Dust	Moss	Fungi	Disc-cracked	Disc-chipped					
	100	0	0	0	0	0	0		4			
Bridging - Side A										1977	5	7
Insulators	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	50	0	50	0	0	0	0	0	2			
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	50	50	0	0	0	0	2			
Clamp Fasteners	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	50	0	50	0	0	0	2			
Insulator Shed	OK	Polluted	Dust	Moss	Fungi	Disc-cracked	Disc-chipped					
	100	0	0	0	0	0	0		2			

The health index is either the maximum value or the 95% value based on a normal distribution of the data sample.

Built Section Meter	Installation Date	Corrosion Grade/Comment	Estimated Remaining Service Life (years)
Earthing	1977	Str 27 & 31 had broken straps repaired, otherwise general aging.	5
Conductor	1977	No visible deterioration	38
Conductor Hardware	1977	Instances of damper corrosion and aging	0
Conductor Mid-Span Joints	1977	None visible	
Signage	1977	Ok	20

Notes:

Grade 2 (G2) corrosion observed should continue to be ***Monitored and Reviewed.***

Grade 3 (G3) corrosion represents a loss of greater than 50% of the galvanising layer and in the worst cases unprotected carbon steel corrosion is about to commence.

Grade 4 (G4) corrosion represents the total loss of galvanising and the onset of unprotected carbon steel corrosion. ***Estimated time until loss of 0.5mm of carbon steel in this environment is within 6-10years.***

4. Transmission Line Parameters

4.1 Overview

Built Section 1515 is 11.19km in length and consists of 10 Steel Lattice Tension Towers and 11 Steel Lattice Suspension Tower.

Figure 1: Built Secion 1515 geographical overview

4.2 Summary Table

Commissioning Date	01.08.1977
Voltage	275kV
Contract Number	277/74
No. of Circuits	1
Circuits	8859
Route Length (km)	11.19 km
No. of Towers	10 Tension 11 Suspension
Type	Galvanised Steel Lattice Tower
Foundations	Standard steel reinforced concrete
Conductor	ACSR/GZ PAW PAW, Normal 54/3.75 19/2.25
Sub-Conductor /Phase	1
Conductor Line Clamps	AGSU
Conductor Vibration Dampers Conductor	Dogbone / Stockbridge
No. of OHEW	1
Earthwire	PEARL 19/3.75 VOLLEYBALL 8/3.6 7/2
OHEW Line Clamps	AGSU
OHEW Vibration Dampers	Stockbridge D4
No. of OPGW	1
OPGW	ALCOA_FUJI_48FIB_OPGW_14.0
OPGW Line Clamps	AGSU
OPGW Vibration Dampers	Stockbridge D4
AVG Easement width	100m

4.2.1 Insulators

Insulator Function	Strs	Material	Rating	Type	Discs	Installed
Suspension	10	Porcelain	125kN	Fog	21	2008
	1	Porcelain	125kN	Normal	17	2008
Bridging	6	Porcelain	125kN	Fog	21	2015
	4	Porcelain	125kN	Fog	18	2015
	No hardware was changed in 2015					
Tension	6	Porcelain	125kN	Fog	22	1977
	1	Porcelain	125kN	Fog	18	2015
	3	Porcelain	160kN	Normal	18	1977
	The tension insulator strings are double strings.					

The quantity and type of insulator change at structure 28.

5. Location and Environment

5.1 General Location

The transmission line is located in Central Queensland immediately adjacent to Gladstone industrial area. This built section covers the distance between Calliope River and Larcom Ck via Yarwun. A proportion of the transmission line traverses tidal marine environment and large scale industrial areas, and there are a few major and minor road crossings.

	Rail	Distribution	Highway	Minor & Major Roads	Pipelines	Urban Property (<10m from easement)
Spans undercrosss	3	1	1	3	1	nil

Table 1: BS1515 Span undercrosss information

5.2 Land Use

The line lies just outside the Gladstone city precinct. Due to its' proximity to Gladstone industrial area and the coast, it's constantly exposed to high levels of salt laden air and industrial pollutants.

Figure 2: BS1515 land use area

5.3 Atmospheric Corrosion

Built Section 1515 is located between 2.7km and 9km from the coast and experiences an average rainfall of 880mm. Mean annual humidity is approximately 60%. The area around Calliope is also susceptible to localised industrial pollution and is therefore considered to be located in a C4 corrosion region.

The highest rates of galvanised steel corrosion normally occur on sheltered or partially sheltered steel members, nuts, bolts and joint interfaces. Reduced exposure to cleansing rains and drying winds creates a microenvironment where the accumulation of air-borne pollutants and trapped moisture accelerates the corrosion process.

The thickness of the original coating also determines the subsequent service life of the coating as the rate of zinc loss is constant for a given geographical area.

This increased potential for corrosion based upon microclimatic conditions and coating thickness is, as a general rule, consistent with the observed condition of Powerlink's galvanised steel lattice towers, with spot rusting of major members accompanied by more advanced rusting of nuts, bolts and joint nodes.

The structures in BS1515 are exhibiting high levels of grade 2 corrosion across both fasteners and structure members, some bolts and members are also showing signs of grade 3. These observations are consistent with past Powerlink experience.

Once the galvanised coating has been damaged or deteriorated to the point where visible corrosion is evident, the steel has effectively begun to break down (***AS/NZS 2312-2002 – Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings***). This point has been adopted as Level 2 corrosion in Powerlink's Visual Grading Guides and triggers corrective action to prevent deterioration of the underlying steel component

The Galvanizers' Association of Australia (refer Section 7) estimates the service life of nuts, bolts and members in this location as follows.

Component	Minimum coating thickness µm	Estimated life to First Service in Years *(First Appearance of Grade 2)*
Bolts & nuts	45	11
Members ≤ 6mm	70	17
Members > 6mm	85	20

The final stages of G3 Corrosion represent a total loss of galvanising and the onset of unprotected carbon steel corrosion. Rates of carbon steel corrosion can be between 10-300 times the rates of galvanised corrosion, depending upon the atmospheric conditions.

6. Condition Assessment

NOTE: Unless otherwise stated any Expected Remaining Life estimates are based upon the condition of the asset at the time the data was collected in 2017-2019.

Based on the photographs taken, there is extensive G2, G3 and G4 corrosion on BS1515 structures and insulator hardware.

Figure 36 in the appendix shows the spread of G2, G3 and G4 corrosion observed from the sampled structures.

6.1 Structure – Overview

The following table outlines the type and numbers of towers that make up Built Section 1515. Body extensions vary between -6 and +9 meters.

Tower Types	Number	Body Extensions
PSAM (Tension)	5	-6 to +6
PSSH/7 (Suspension)	7	+0 to +9
PSAL/S (Suspension)	4	+0 to +9
PSAL (Tension)	5	-6 to +9
TOTAL	**21**	

6.2 Foundation Condition

Structures utilise a standard steel reinforce concrete foundation as shown in Figure 3 below. No foundation issues have been identified on this built section

Figure 3: 1515-STR-0019 Tower Leg Condition

6.3 Structure Condition

6.3.1 Climbing Aids

G2 and G3 corrosion has been observed on some step bolts (seen in Figure 4).

This step bolts do not meet our current standards for climbing aids which incorporate a climbing attachment point.

Figure 4: G2 & G3 corrosion shown on step bolts 1515-STR-0012

The towers also have ladders to aid climbing and they also show signs of G2 and G3 corrosion.

Figure 5: G2 & G3 Corrosion on ladder 1515-STR-0012

6.3.2 Anti-Climbing Barriers

These towers don't have the standard barb wire installed and only have "crown of thorns" as anti-climbing barrier see Figure 6 below. Grade 2 corrosion was observed on some steelwork.

Figure 6: 1515-STR-0017 ACB Crown of Thorns

6.3.3 Tower Base

G2 and G3 corrosion has been observed on 45% of nuts and bolts and some G4 bolts were also present. Members are showing 11% G2 level of corrosion.

Figure 7: 1515-STR-0013 Tower Base Corrosion

6.3.4 Tower Body

A high percentage of G2 (33%) and G3 (9%) bolt corrosion was observed. Members showed about 16% with G2 corrosion. Figure 8 shows the general condition of the tower body and the large percentage of corroded bolts.

Figure 8: 1515-STR-0021 Tower Body corrosion

6.3.5 Superstructure

Surface rust has been observed on 13% of members with a high percentage (40%) of G2 nuts and bolts. A high percentage (15%) of G3 bolts are present with some instances of G4 bolts and G3 members.

Figure 9: 1515-STR-0017 with G2 and G3 bolts

Figure 10: 1515-STR-0028 Superstructure G3 bolts and G2 members

6.3.6 Conductor Attachment Plate Bolts

Most bolts on attachment plate show signs of corrosion with about 15% bolts reaching G3.

Figure 11: 1515-STR-05021 Attachment Zone - G2/G3 bolts

Figure 12: 1515-STR-0012 Attachment Plate bolt corrosion

6.3.7 Cross-arms

Surface rust has been observed on most cross arm nuts and bolts, with some bolts very close to grade 4. The cross arm bolts on structure 0021 and 0028 are displaying advanced grade 3 corrosion with 14% on average.

Figure 13: 1515-STR-0028 cross arm corrosion

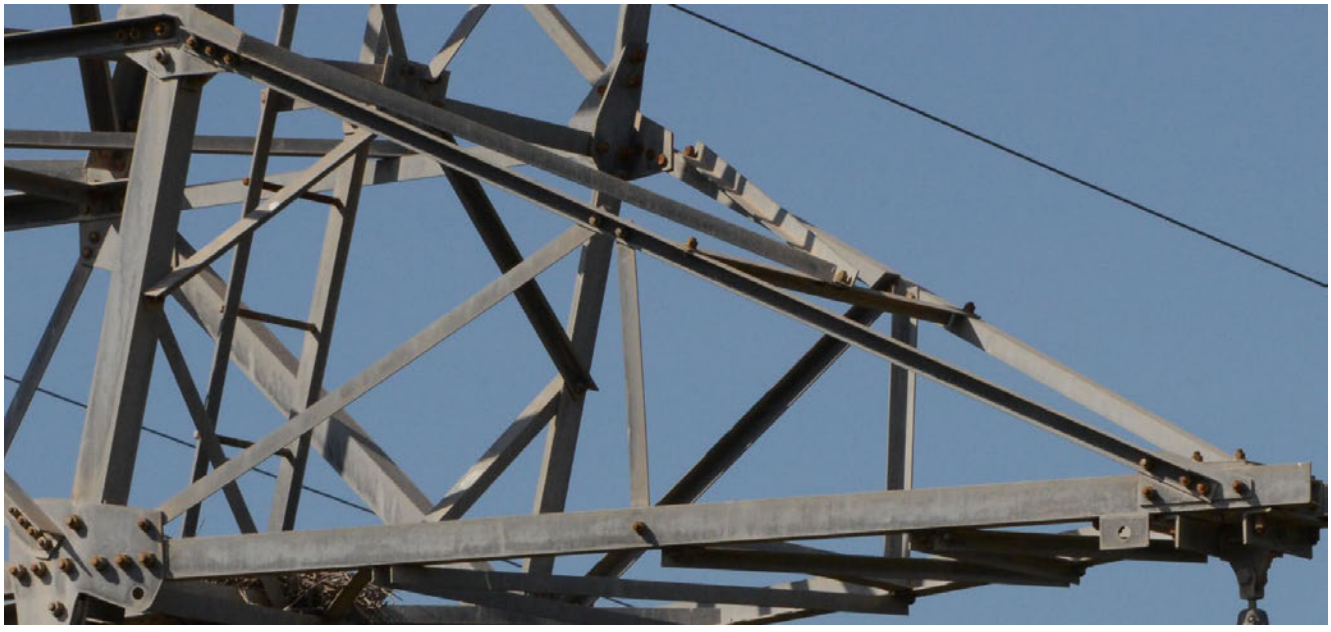


Figure 14: 1515-STR-0021 cross arm corrosion

6.3.8 Earthwire Peak

A high percentage of G3 rust has been observed on nuts and bolts as well as advanced surface corrosion on members as shown in the figures below of tower 0028.

Figure 15: 1515-STR-0028 G2/G3 corroded bolts and member on earth wire peak

Figure 16: 1515-STR-0028 Earth wire peak with G3 corroded bolts and G2 member

6.4 Earthing

Generally the earthing is ok with some instances of earth straps not connected.

Figure 17: 1515-STR-0019 Earth strap not connected

6.5 Conductor

The transmission line is strung with Single ACSR/GZ Paw Paw, Normal 54/3.75/19/3.25 conductor, containing a galvanised and greased central steel core.

Experience on ACSR conductors overseas has shown that the grease can harden after 35 to 45 years, resulting in moisture ingress and accelerated core corrosion. Previous testing of conductors on other lines has identified a small amount of corrosion in conductors of this age. Powerlink's oldest ACSR/GZ conductor (built in 1948 and removed in 2013) was installed in the Belmont area and was in a sound condition when inspected. Visual examination of the conductor has not indicated any major defects which could be attributable to aluminium or steel core corrosion or overloading.

No issues have been identified with the conductor

The Paw Paw ACSR/GZ conductor is terminated with a compressed dead end fitting. The end fittings are showing signs of Grade 2 corrosion.

Figure 18: 1515-STR-0028 Compression Fitting Corrosion

6.6 Conductor Hardware

Damper age varies and some are showing signs of aging and corrosion, these should be replaced when insulators are changed on the structure.

Figure 19: 1515-STR-0028 Damper showing signs of aging and corrosion

6.7 Conductor Mid-Span Joints

No mid-span joints are recorded in SAP.

6.8 Earthwire and Optical Ground wire

The OHEW was replaced in 2008 when the OPGW was installed.

Figure 20: 1515-STR-0021 OHEW & OHEW Hardware

6.9 Earthwire and Optical ground wire Hardware

The OHEW & OPGW is contained within a standard wedge tension set. All hardware was replaced in 2008 when the OPGW and OHEW was installed.

6.10 Suspension Insulators

Insulators were changed in 2008, however hardware was not changed. All suspension insulators are in good condition.

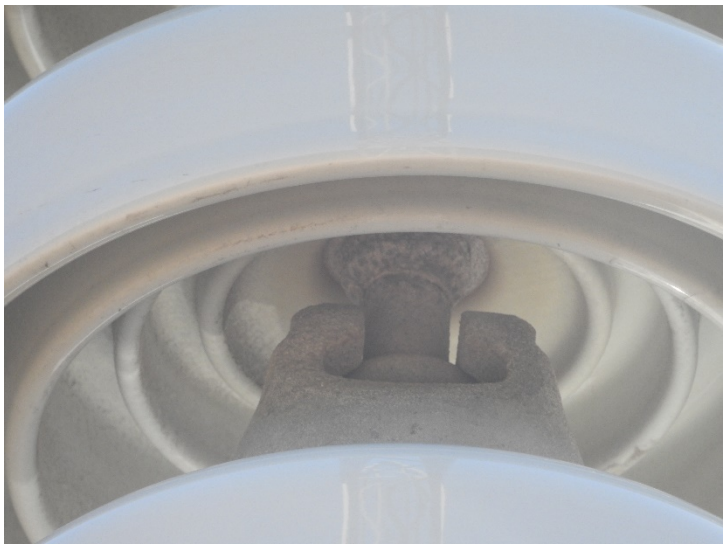


Figure 21: 1515-STR-0013 Suspension Insulator

6.11 Suspension Insulator Hardware

Hardware is displaying high G3 rust at the hot and G2 rust at the cold end.

Insulators were changed in 2008, however hardware was not changed. 30% of suspension strings are showing high G3 on hardware.

Figure 22: 1515-STR-0013 – Suspension Hardware Hot End

Figure 23: 1515-STR-0015 – Suspension Hardware Cold End

6.12 Tension Insulators

The tension Insulators are still original (except on STR-0028 replace in 2014) with 25% showing low G3 corrosion. The replacement on STR-0028 suggests they were G4 insulators.

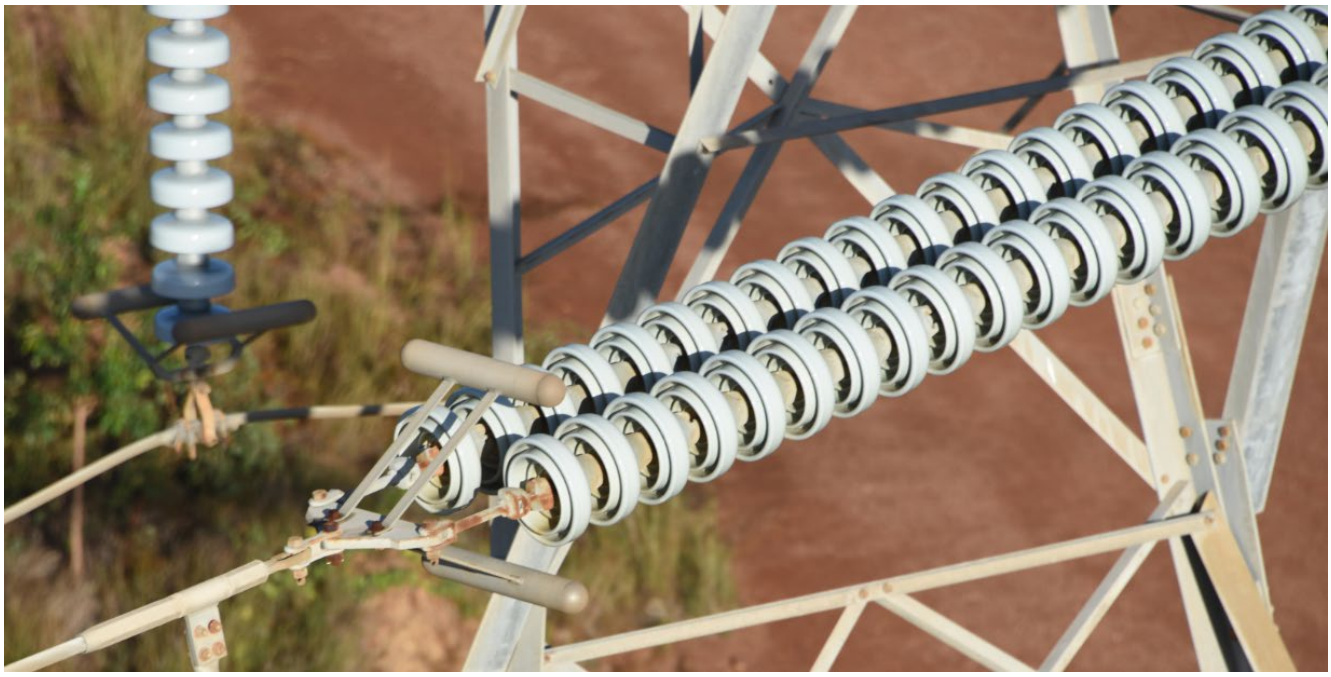


Figure 24: 1515-STR-0012 Tension Insulator String

Figure 25: 1515-STR-0017 Tension Insulator G3L

6.13 Tension Insulator Hardware

Tension insulator hardware is displaying extensive G2 and G3 corrosion which should be replaced when the insulators are changed.

Figure 26: 1515-STR-0017 Tension Insulator Hardware – Cold End

Figure 27: 1515-STR-0017 Tension Insulator Hardware – Hot End

Possibly one of the worst towers on the line is STR-0028 which had the tension insulators replaced in 2014 and the below photo was taken in 2018. High G3 hardware is of concern and should be addressed in the short term.

Figure 28: 1515-STR-0028 Tension Tower Attachment Location

6.14 Bridging Insulators

The bridging insulators were changed in 2015, however no hardware was changed.

6.15 Bridging Insulators Hardware

Figure 29: 1515-STR-0017 Bridging Insulator Hardware - Cold End

Figure 30: 1515-STR-0012 Bridging Insulator Hardware - Hot End

6.16 Signage

Signage was audited in August 2018 and no issues were recorded in SAP Built Section Meters.

6.17 Easement

The easement is in good condition with no outstanding notifications. The following two photos are examples of the easement. The easement is reasonably flat with one hilly section between towers 28 to 32.

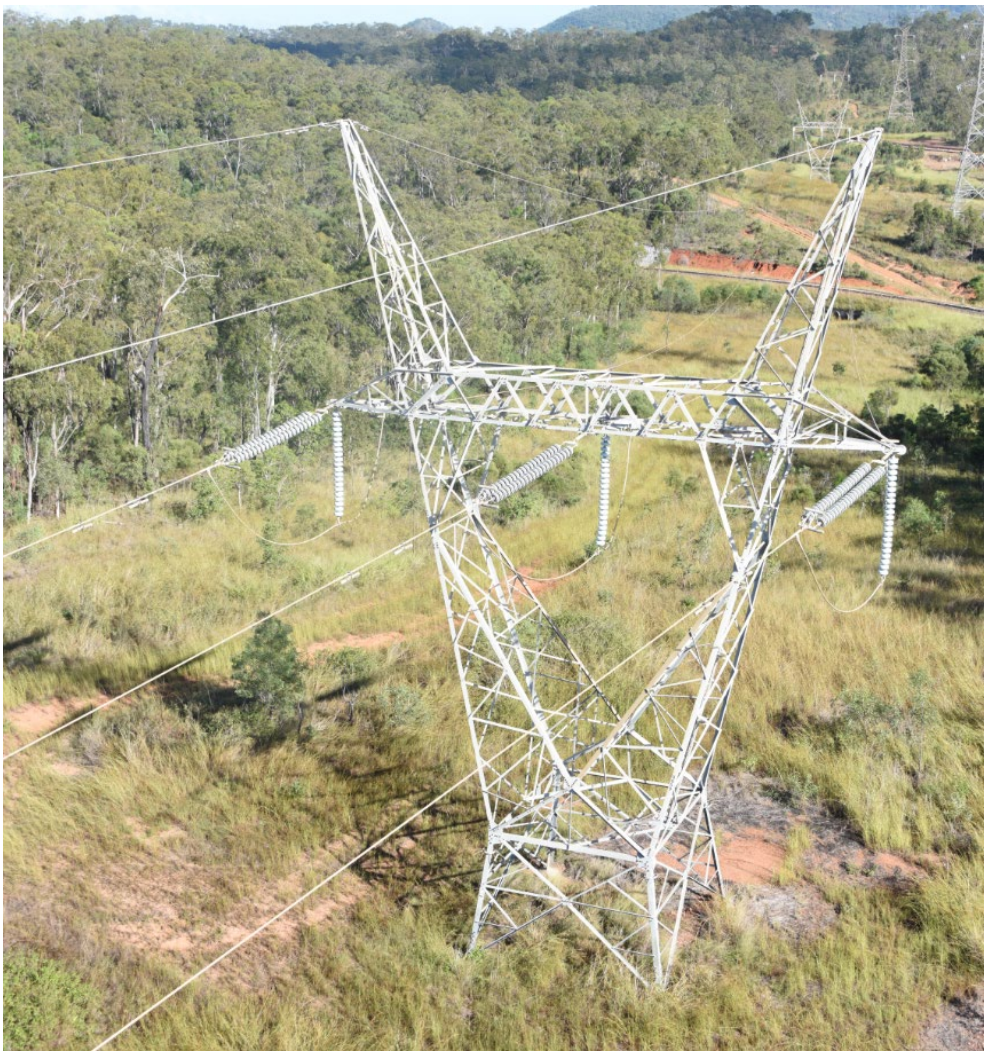


Figure 31: 1515-STR-0017 to 0018 Easement Conditions

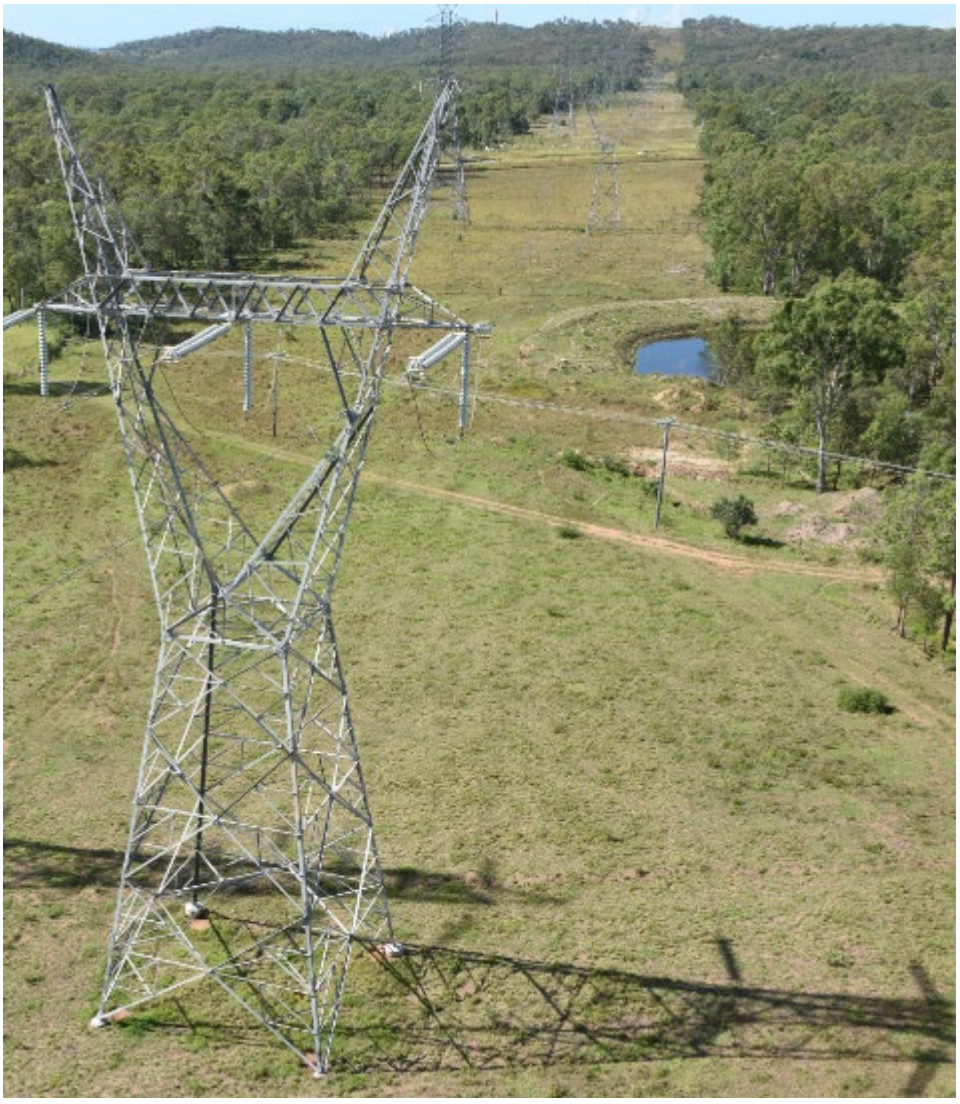


Figure 32: 1515-STR-0027 to 0026 Easement

Appendices

6.18 SAP Notifications Graph

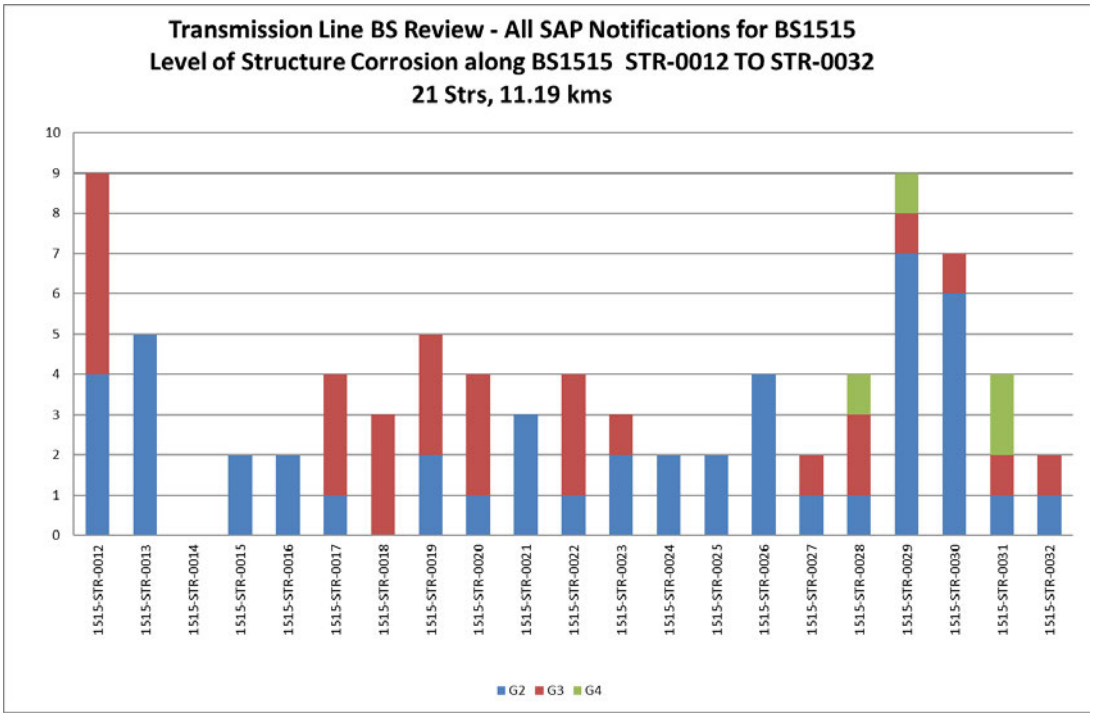


Figure 33: Graph of SAP all Notifications for Corrosion on Structures

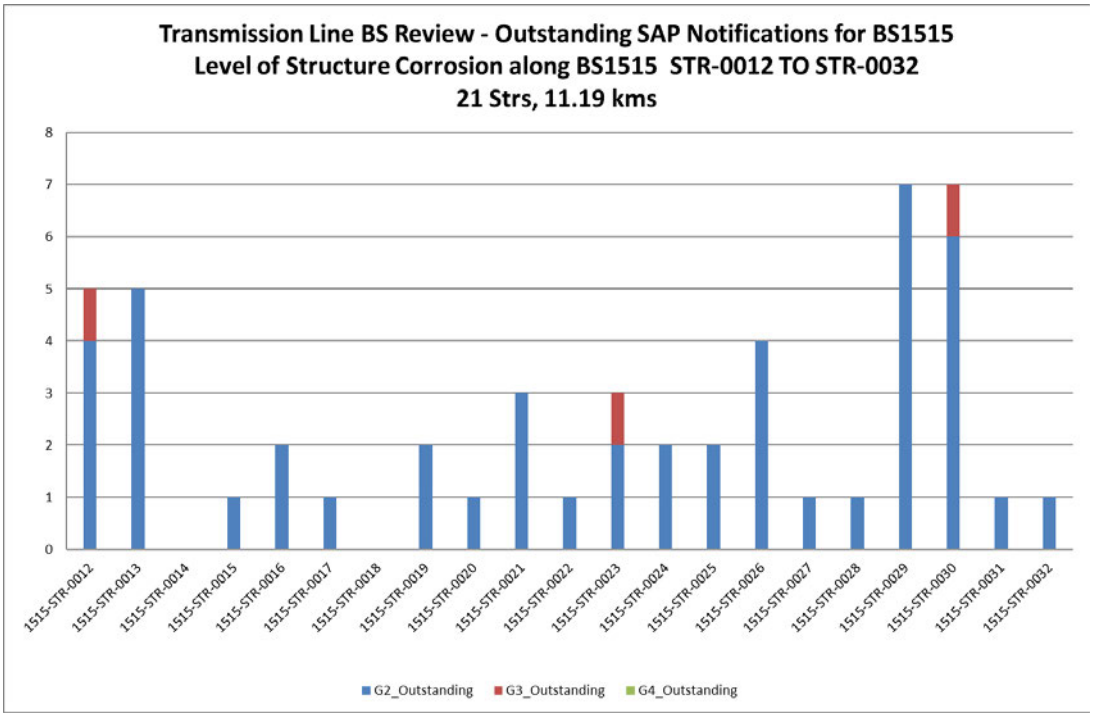
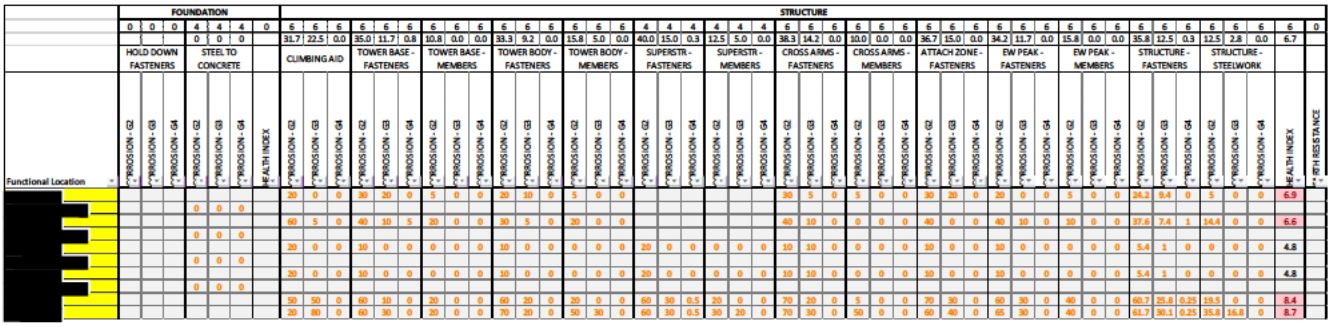


Figure 34: Graph of SAP Outstanding Notifications for Corrosion on Structures

6.19 Percentage of Structure Corrosion



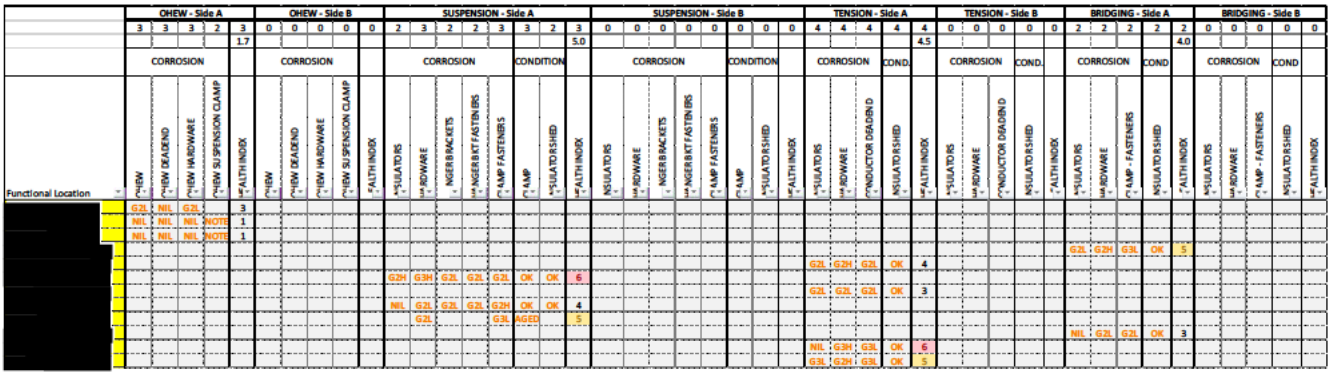


Figure 35: Condition Summary using MDs Spreadsheet

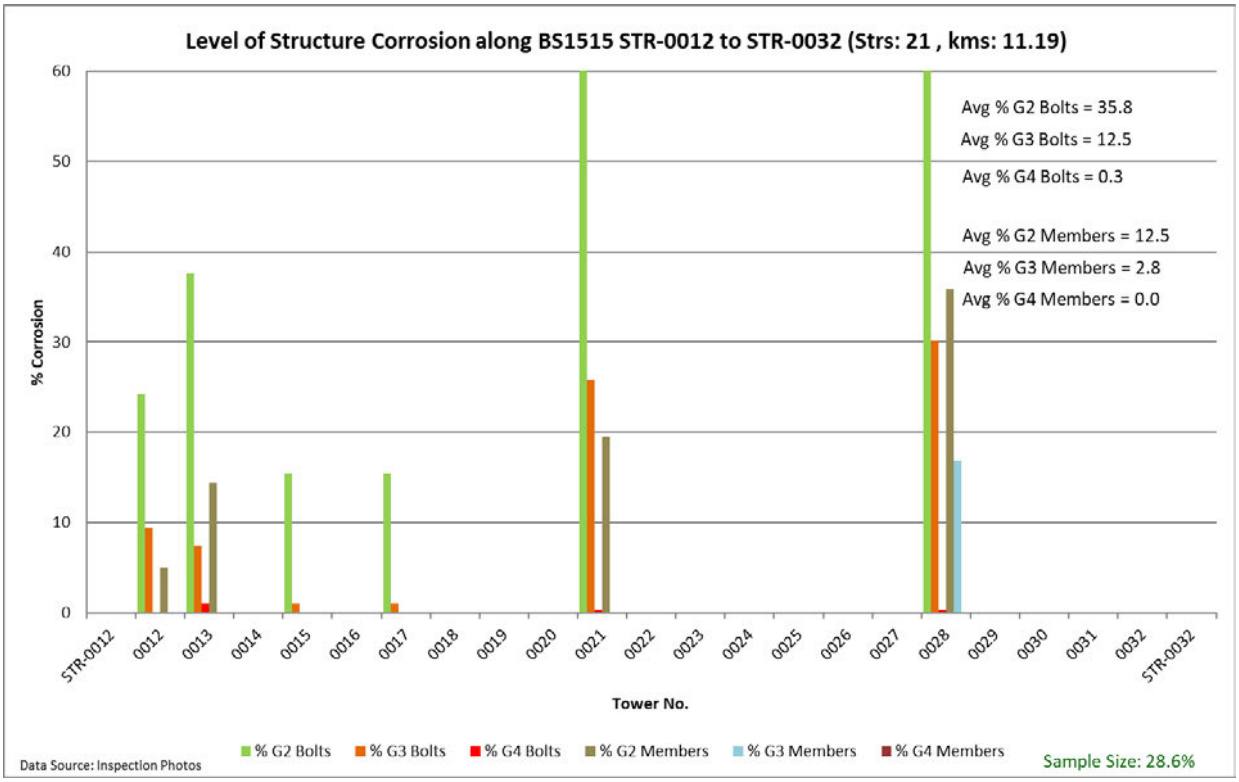


Figure 36: Percentage of Structure Corrosion

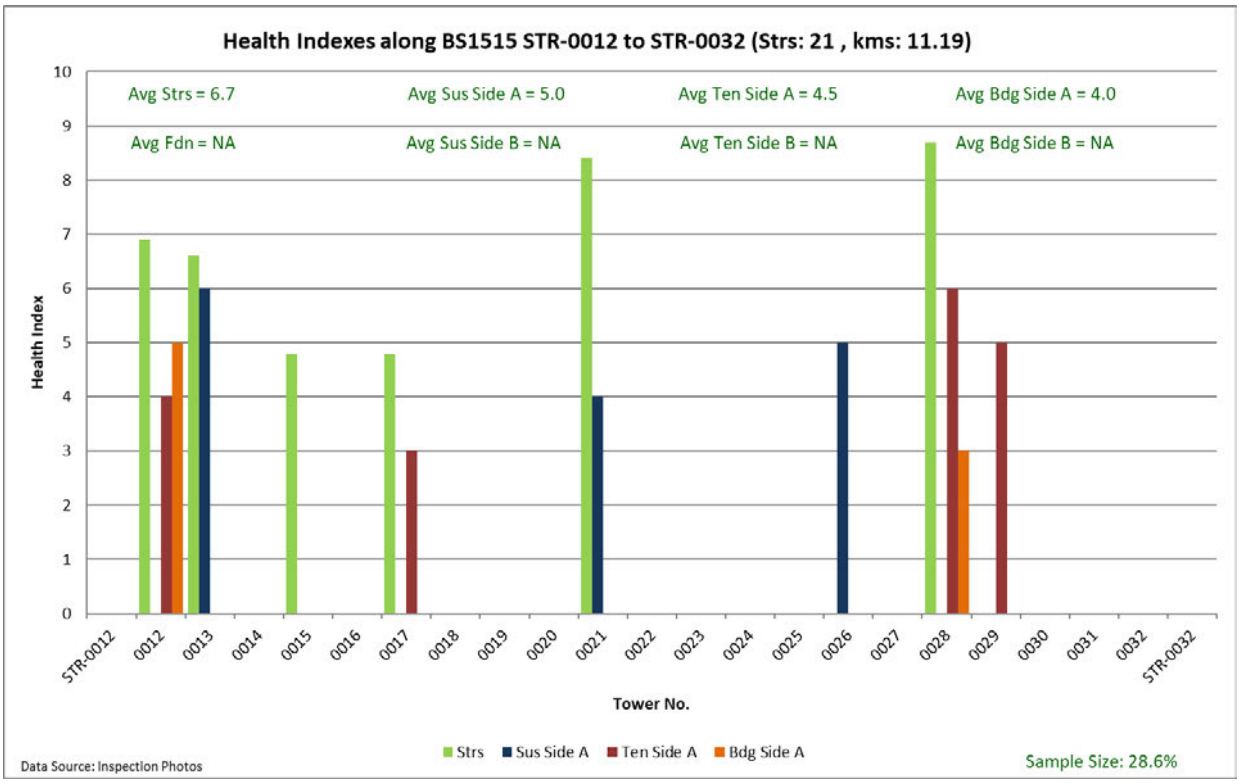


Figure 37: Health Index of Components along Line

6.20 Built Section Meters

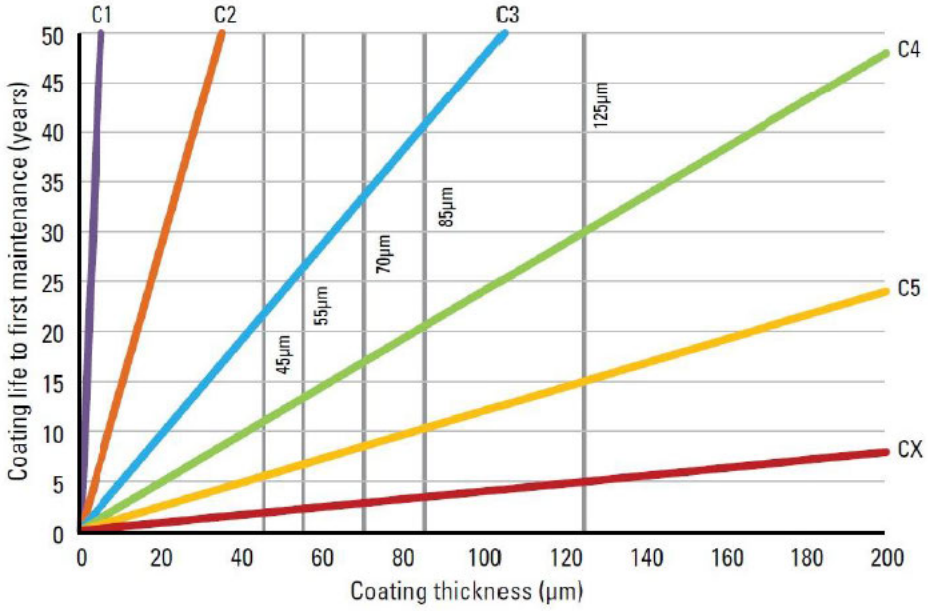
Functional Loc.	Meas Document	Measuring point	Date	Description	Read by	Coding code txt	Text
1515-SPN	18735649	857418	15/10/2018	CONDUCTORS	LINES CA	INVESTIGATED OK	
1515-SPN	18735650	857419	15/10/2018	CONDUCTORS MIDSPAN JOINTS	LINES CA	NO INVESTIGATION	
1515-SPN	18735651	857420	15/10/2018	CONDUCTOR HARDWARE (DAMPERS. SPACERS)	LINES CA	INVESTIGATED FOLLOWUP REQD	Damper replacement required
1515-SPN	18735652	857421	15/10/2018	OHEW/OPGW	LINES CA	INVESTIGATED OK	
1515-SPN	18735653	857422	15/10/2018	OHEW/OPGW MIDSPAN JOINTS	LINES CA	INVESTIGATED OK	
1515-STR	18735654	857142	15/10/2018	EARTHING (GRADING RING ETC)	LINES CA	INVESTIGATED OK	
1515-STR	18735655	857143	15/10/2018	FOUNDATIONS	LINES CA	NO INVESTIGATION	
1515-STR	18735656	857144	15/10/2018	STRUCTURE (ABOVE K-POINT.ANTICLIMB.OPGW)	LINES CA	INVESTIGATED FOLLOWUP REQD	G3-4 Fasteners and members
1515-STR	18735657	857145	15/10/2018	SUSPENSION INSULATORS	LINES CA	INVESTIGATED OK	
1515-STR	18735658	857146	15/10/2018	SUSP H'WARE (HANGERS. SUSP UNIT)	LINES CA	INVESTIGATED FOLLOWUP REQD	G3-4 Hardware
1515-STR	18735659	857147	15/10/2018	TENSION INSULATORS	LINES CA	INVESTIGATED FOLLOWUP REQD	G2-3 Stems
1515-STR	18735660	857148	15/10/2018	TENSION H'WARE(H'WARE.DEADEND.GRAD TUBE)	LINES CA	INVESTIGATED FOLLOWUP REQD	G3-4 Hardware
1515-STR	18735661	857149	15/10/2018	OHEW H'WARE(DEADEND.H'WARE.CLAMP.DAMPER)	LINES CA	INVESTIGATED FOLLOWUP REQD	G2-3 Hardware
1515-STR	18735662	857150	15/10/2018	SIGNAGE (CIRCUIT ID. WARNING PLATES)	LINES CA	INVESTIGATED OK	

Figure 38 - Latest Built Section Meters Measurement Document List

6.21 Estimated Service Life of Galvanised Steel

Corrosivity Category	Corrosivity	Example
C4 (D)	High	Moderate corrosion environment, such as in low density urban development or high activity rural areas, inland coastal regions, moderate to high humidity and rainfall, and/or moderate to heavy vegetation encroachment into the easement.

Chart 1: Life to First Maintenance of Hot Dip Galvanized Steel



The LFM range for a particular hot dip galvanizing coating thickness and each corrosivity zone can be read from the chart. For example, the LFM range for a hot dip galvanized article with an 85 µm thickness and located in the C4 (High) corrosivity zone is 20 to 40 years.

This chart is supported by case history evidence in Australia, where service life records of 50 years are common and up to 110 years are recorded.

The Life to First Maintenance chart is available as a standalone document directly from the Galvanizers Association of Australia.

Figure 39 - Time to First Maintenance of Galvanised Steel

Region	Rate	Bolts & Nuts (45µm)		Members <= 6mm (70µm)		Members > 6mm (85µm)	
		Min Yrs	Max Yrs	Min Yrs	Max Yrs	Min Yrs	Max Yrs
C4 (D)	4.2	11	21	17	33	20	40

6.22 Estimated Service Life of Carbon Steel

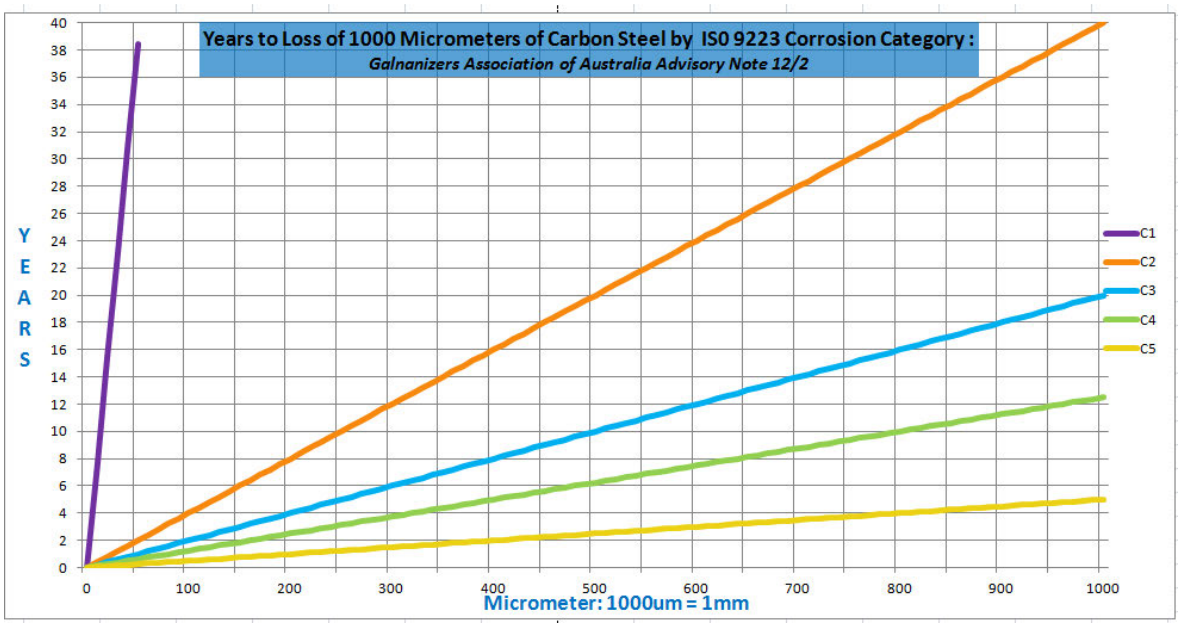


Figure 40 - Rate of Carbon Steel Loss

Source: Extrapolated from Table 2: Corrosion Rates for Steel and Zinc for the first year of exposure for different corrosivity categories. Galvanizers Association of Australia – Advisory Note GEN12/2 April 2012

6.23 References

Inspection Guides and Corrosion Models

- A2628257 Asset Strategies – Line Maintenance Principles – Specification
- A2791823 OSD – Transmission Line Patrol and Inspection – Guideline
- Galvanizers Association of Australia – Advisory Note GEN12/2 *"Atmospheric Corrosion Resistance of Hot Dipped Galvanized Coatings"* April 2012.

Built Section Configuration

- SAP Reports

Condition Assessment Data

- M Drive Photos
- SAP IK17 Measurement Documents

Planning Statement	**11/03/2020**
Title	CP.01656 Calliope River to Larcom Creek 275kV Transmission Line Refit - Planning Statement[1]
Zone	Gladstone
Need Driver	Condition assessment of the Calliope River – Larcom Creek 275kV transmission line, June 2020. Recommended refit by 2024 to maintain ongoing compliance with requirements of the Electricity Act 1994, Electrical Safety Act 2002 and Electricity Safety Regulation 2013[2].
Network Limitation	Feeder 8859 is required to maintain power transfer capability between Central West and North Queensland into Gladstone load centre, and to meet Powerlink Queensland's N-1-50MW/600MWh reliability obligations for Raglan, Larcom Creek and Yarwun.
Pre-requisites	None

Executive Summary

The Calliope River to Larcom Creek 275kV SCST transmission line (Feeder 8859), was commissioned in 1977. The condition of the transmission line has deteriorated, with end of life estimated by 2024

Energy Queensland forecasts have shown there is an enduring need to maintain electricity supply into the Gladstone zone. Removal of the line to address emerging safety issues arising from the ageing asset would result in Powerlink breaching its N-1-50MW/600MWh Transmission Authority reliability obligations.

The preferred option is to refit the existing 275kV SCST line (F8859) between Calliope River and Larcom Creek by June 2024.

[1] *This report contains confidential information which is the property of Powerlink and the Registered Participant mentioned in the report, and has commercial value. It qualifies as Confidential Information under the National Electricity Rules (NER). The NER provides that Confidential Information:*

- *must not be disclosed to any person except as permitted by the NER;*
- *must only be used or copied for the purpose intended in this report;*
- ***must not be made available to unauthorised persons***

[2] Electrical Safety Act 2002, section 29. Electrical Safety Regulation 2013, section 198(a). Electrical Safety Regulation 2013, section 198(d).

Table of Contents

1 Introduction

The Calliope River to Larcom Creek 275kV single circuit steel tower (SCST) transmission line (Feeder 8859), was commissioned in 1977 on built section BS1515. This feeder is located in Central Queensland immediately adjacent to the Gladstone industrial area and the coast. As such, it is constantly exposed to high levels of salt laden air and industrial pollutants.

A condition assessment for Feeder 8859 has confirmed that this feeder is approaching the end of its technical life and will require reinvestment by June 2024.

Figure 1 shows the geographical map of BS1515.

Figure 1: Geographical map of Feeder 8859

This report assesses the impact that removal of the ageing line would have on the performance of the network and Powerlink's statutory obligations. It also establishes the indicative requirements of any potential alternative solutions to the current services supported by the line.

2 Yarwun and Raglan Forecast

Figure 2 shows the existing connection configuration of the Larcom Creek & Raglan supply. There are two sources of supply; one from Bouldercombe Substation via Feeder 811 and the other from Calliope River via Feeder 8859. Therefore, Feeder 8859 plays an important role in maintaining the reliability of supply to Larcom Creek, Yarwun and Raglan.

Figure 2: Larcom Creek and Raglan Supply area

Figure 3 shows the duration curve for all loads connected to Yarwun and Raglan substations over the 2014-2019 period. Figure 4 presents the historical and forecast of peak load at Yarwun and Raglan in the next 10 years.

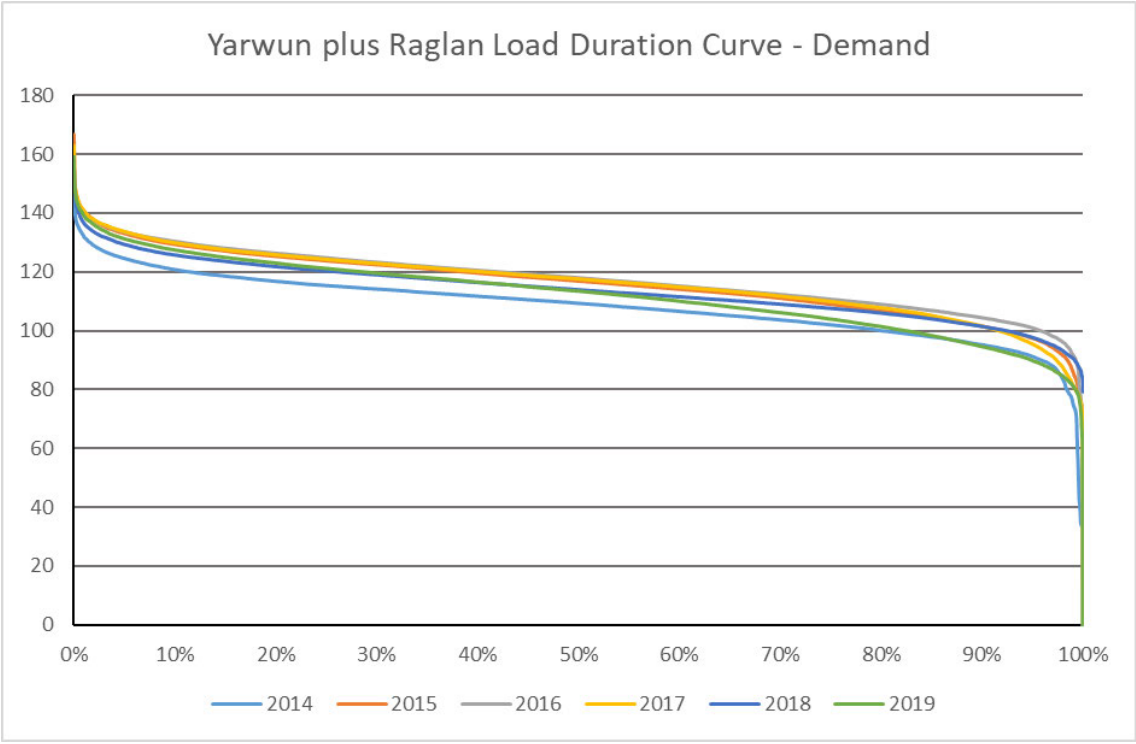


Figure 3: Load Curve for Yarwun and Raglan 132kV

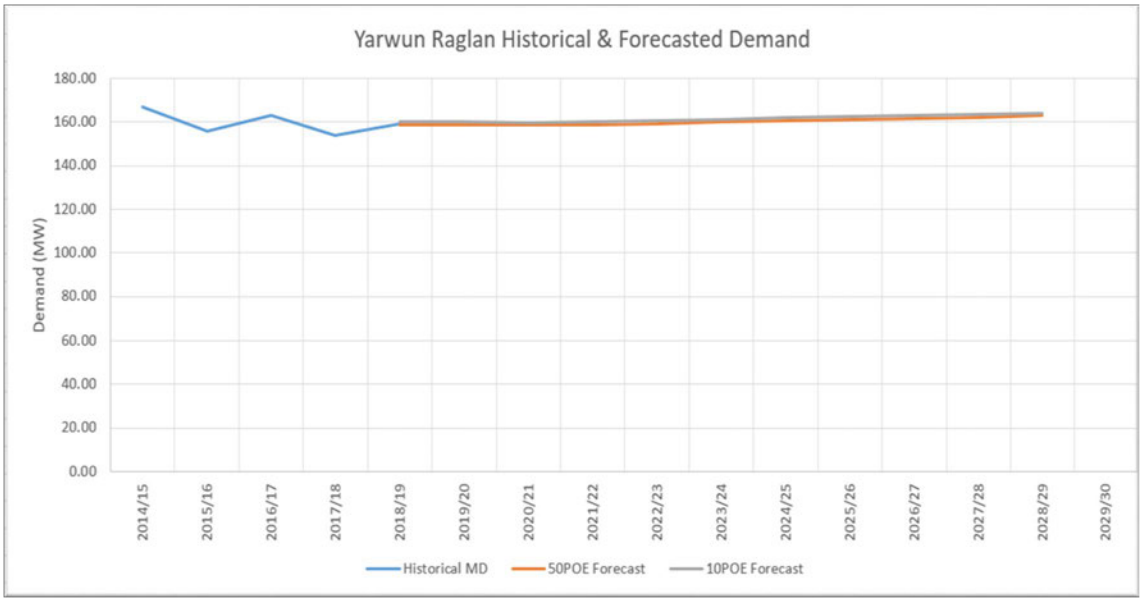


Figure 4: Historical and forecast Demand for Yarwun and Raglan 132kV

3 Statement of Investment Need

The removal of the functionality of Feeder 8859 would have a major impact on the reliability to loads supplied from the Larcom Creek and Raglan substations. Removal of this feeder would violate Powerlink's N-1-50MW/600MWh reliability standard.

There would also be significant impact on the power transfer capacity of the Gladstone grid section with associated market impacts.

Powerlink must therefore preserve the functionality of the Calliope River to Larcom Creek transmission line to ensure ongoing compliance with its Transmission Authority reliability obligations.

4 Network Risk

Feeder 8859 is one of the 275kV supplies to Raglan and Larcom Creek substations. Table 1 presents the historical load and energy at risk if Feeder 8859 was not replaced.

Table 1: Load at Risk

Load at Risk	Contingency	Qunatity	2014	2019
Yarwun and Boat Creek Load	Outage of Feeders 8859 and 8875	Max (MW)	132	133
		Average (MW)	107	108
		24h Energy Unserved Max (MWh)	3051	3109
		24h Energy Unserved Average (MWh)	2572	2601
Yarwun, Boat Creek and Raglan Load	Outage of Feeders 8859 and 811	Max (MW)	156	159
		Average (MW)	108	112
		24h Energy Unserved Max (MWh)	3121	3212
		24h Energy Unserved Average (MWh)	2599	2693

An outage of Feeder 8859 would also limit the power transfer capacity from Central West and North Queensland zones to the Gladstone zone and consequently to the CQ-SQ grid section. This would have a significant market impact. Table 2 shows the potential materiality of this market impact. Historical cases were played back with 8859 removed from service and the quantum of the overload on the parallel 275kV feeder between Bouldercombe and Calliope River substations (Feeder 812) noted in the table.

Table 2: Market Impacts of taking F8859 out-of-service

Load at Risk	Contingency	Quantity	2014	2019
CWQ - Gladstone	Calvale - Wurdong F871	Max (MW)	876	908
		Average (MW)	86	241
		24h Energy Unserved Max (MWh)	12952	12652
		24h Energy Unserved Average (MWh)	2054	5526

5 Non Network Options

Potential non-network solutions for removal of Feeder 8859 would at least need to provide essential supply to the 66kV and 132kV loads at Yarwun and Raglan networks. To meet the demand of the combined Yarwun and Raglan network, the non-network solution must be capable to delivering up to 160MW of power at peak and 3200MWh of energy per day (Refer Table 1). The non-network solution would be required to be capable of operating during a contingency or outage on a continuous basis until normal supply is restored.

Powerlink is not aware of any Demand Side Solutions (DSM) in the area supplied by Larcom Creek and Raglan substations. However, Powerlink will consider any proposed solution that can contribute significantly to the requirements of ensuring that Powerlink continues to meet its required reliability of supply obligations as part of the formal RIT-T consultation process. In this assessment Powerlink will also need to take into account the role this network plays in delivering efficient market outcomes.

6 Network Options

6.1 Preferred Option to address identified need

The recommended solution is the refit of feeder 8859 between Calliope River and Larcom Creek substations by June 2024. Further details of the condition assessment for this feeder can be found in reference 1.

6.2 Option Considered but not proposed

This section discusses alternative options, which Powerlink has investigated but does not consider technically and/or economically feasible to address the above identified issues, and thus are not considered credible options.

6.2.1 Do Nothing

“Do Nothing” would not be an acceptable option as the primary driver (transmission line condition) and associated safety, reliability and compliance risks would not be resolved. Furthermore, the “Do Nothing” option would not be consistent with good industry practice and would result in Powerlink breaching their obligations with the requirements of the Technical Rules and the Electricity Networks Access Code.

6.2.2 Rebuild Calliope River to Larcom Creek 275kV Feeder

An investigation on the alternative option to rebuild the existing 275kV Feeder 8859 between Calliope River and Larcom Creek to a double circuit steel tower (DCST) line by 2025 was also carried out. A DCST construction is aligned with the long term plan to consolidate both SCST lines between Calliope River and Bouldercombe substations (Feeders 8859/8875/811 and 812) to a higher capacity 275kV DCST. This option will be considered as part of the RIT-T, and the most economical solution will be progressed.

7 Recommendations

There is an investment need to maintain the functionality of the 275kV connection between Calliope River and Larcom Creek substations by June 2024 for Powerlink to continue to meet its reliability of supply obligations and provide network capacity to maintain the efficient operation of the National Electricity Market.

Refitting the existing single circuit Feeder 8859 will maintain the reliability and security of the supply to Larcom Creek and Raglan substations and also maintain the current power transfer capability. This also allows Powerlink to continue to meet its Transmission Authority reliability of supply obligations and jurisdictional safety obligations.

8 References

1. Transmission Line Condition Assessment Report – BS1515 Mt Miller (STR-0012) to Larcom Creek 275kV
2. Transmission Annual Planning Report 2020
3. Asset Planning Criteria Framework
4. Asset Management Plan 2020

Base Case Risk and Maintenance Costs Summary Report

CP.01656 Mt Miller- Larcom Creek 275kV TL Refit

Version Number	Objective ID	Date	Description
1.0	A4371901	29/10/2020	Original document

1 Purpose

The purpose of this model is to quantify base case risk cost profiles and maintenance costs for the single circuit 275kV transmission line between Mt Miller and Larcom Creek (built section 1515, Feeder 8859) which is a candidate for reinvestment under CP.01656.

Base case risk costs and maintenance costs have been analysed over a ten year study horizon.

2 Topography

The Mt Miller to Larcom Creek 275kV transmission circuit assists in maintaining electricity supply into the Gladstone industrial area. The transmission circuit is adjacent to smelter facilities and the coastline and is consequently exposed to high levels of corrosive elements. The built section is approximately 11km in length.

Figure 1 – Network Topography

3 Key Assumptions

In calculating the potential unserved energy (USE) arising from a failure of the ageing structures within BS1515, the following modelling assumptions have been made:

- Historical load profiles have been used when assessing the likelihood of unserved energy under concurrent failure events;
- Unserved energy generally accrues under concurrent failure events, and consideration has been given to potential failure events within the wider Gladstone network;
- The Value of Statistical Life (VSL) published within the OBPR guidance note has been used when calculating safety risk cost;
- The 275kV transmission line from Mt Miller to Larcom Creek supplies a mixture of residential, commercial and industrial load types from the greater Gladstone through to SEQ. The Queensland region VCR of $40,030/MWh has been used for calculation of network risk cost; and
- VCR values published within the AER's 2019 Value of Customer Reliability Review Final Report have been used within the risk cost assessments.

4 Base Case Risk Analysis

4.1 Risk Categories

Four main categories of risk are assessed within Powerlink's risk approach; safety, network, financial and environmental. Safety, Network and financial risks are considered material and have been modelled in this analysis.

4.2 Transmission Line Analysis

This section analyses the risks presented by BS1515.

Table 1 – Risks associated with at risk structures

	Mode of failure	
Equipment	**Peaceful**	**Explosive**
Transmission Line Structure	Safety risks due to failed structures with residential and public areas. Network risks (unserved energy) due to a failed structure. Financial risks to replace a failed structure in an emergency manner.	Not applicable.

The probability that a structure will fail includes the probability that a wind event, sufficient to bring the tower down, has occurred.

4.2.1 Structures – Risk Cost by Year

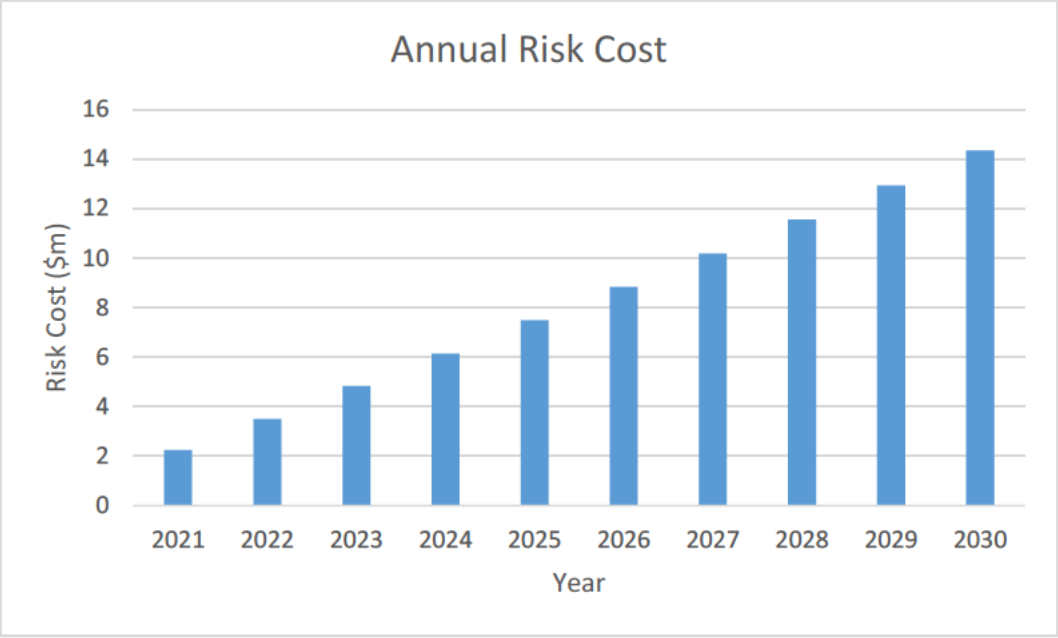


Figure 2 – Risk cost over time (10 years)

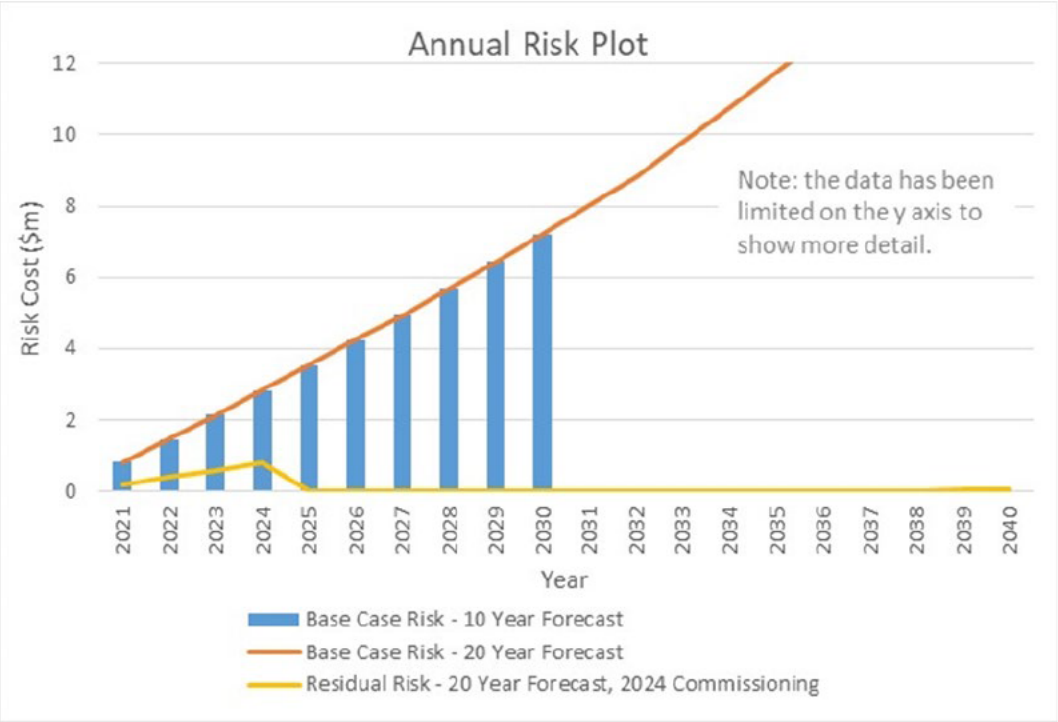


Figure 3 – Risk cost over time

4.2.2 Structures – Risk Breakdown by Risk Category

Figure 4 – Structure risk cost by category

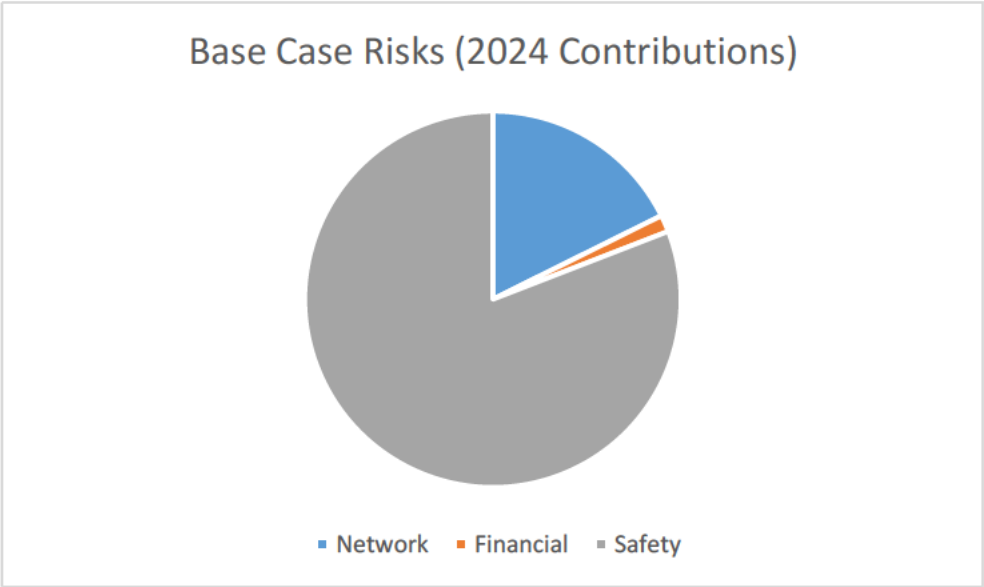


Figure 5 – Structure risk cost by category (2024)

4.3 Base case risk statement

The primary source of risk for the BS1515 Mt Miller to Larcom Creek transmission line are safety risks related to failure of the overhead line structures, followed by network risks (unserved energy).

5 Maintenance costs

Maintenance costs are still being developed. For the purposes of this report, maintenance has been modelled as 1.5% of the project capital. This is consistent with historical averages when compared to costs to establish an asset.

The total base case risk and maintenance cost is show below:

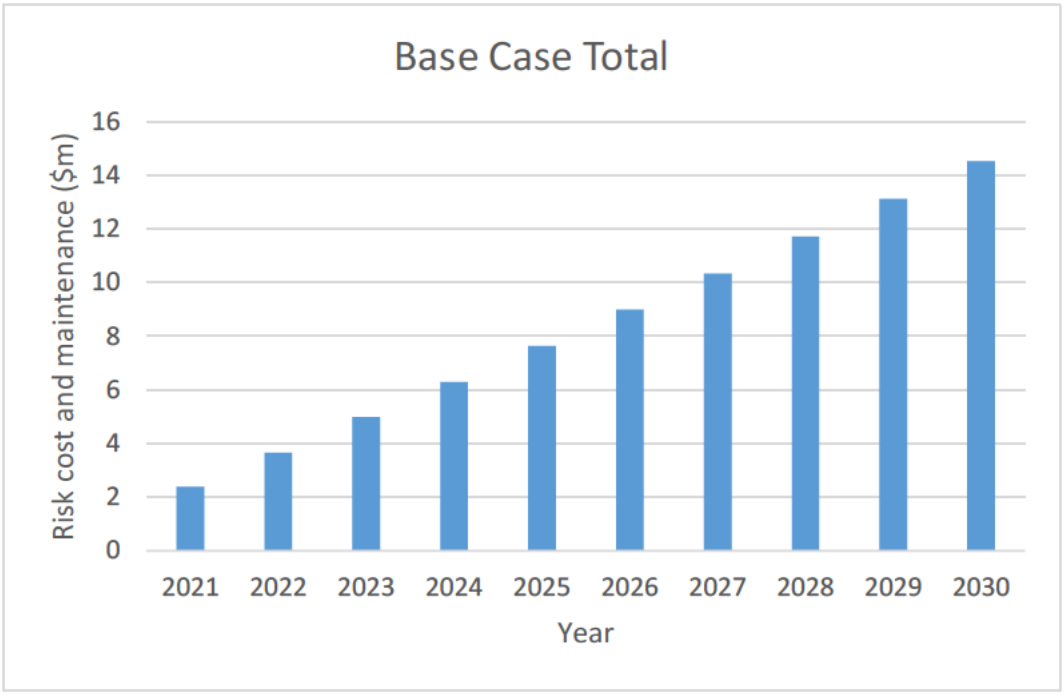


Figure 6 – Base case Total (Risk Cost + Maintenance)

6 Input participation

Risk Category	Input	Value	Unit
Network	VCR	40030	$/MWh
	Restoration time	120	hours
Financial	Tower restoration cost	0.8	$m
Safety	VSL	5	$m

Figure 2 – Transmission line risk cost model inputs

Sensitivity analysis has been carried out to determine which inputs the model is most sensitive to (how does a change in input value effect the modelled risk).

One of the main dependencies of this risk cost model is the Value of Statistical Life (VSL) since this forms the key input to the safety risk cost. Accordingly assumptions relating to VSL are one of the key salient inputs to the calculation of risk cost.

An increase in the input values for VCR or tower restoration time by 100% will result in the overall risk increasing by approximately 8%.

The effect of increasing the input value for tower restoration cost is negligible.

Project Scope Report

CP.01656

Calliope River to Larcom Creek 275kV Transmission Line Refit

Concept – Version 1

Document Control

Change Record

Issue Date	Responsible Person	Objective Document Name	Background
	[redacted]	Project Scope Report CP.01656 Calliope River to Larcom Creek 275kV Transmission Line Refit	Preliminary scope

Related Documents

Issue Date	Responsible Person	Objective Document Name
28/12/2019	[redacted]	BS1515 Mt Miller to Larcom Ck Transmission Line Condition Assessment – Report 2019 (A3188366)

Project Contacts

Project Sponsor	[redacted]	[redacted]
Connection & Development Manager	<name>	Ext.
Strategist – HV/Digital Asset Strategies	<name>	Ext.
Planner – Main/Regional Grid	<name>	Ext.
Manager Projects	<name>	Ext.
Project Manager	<name>	Ext.
Design Coordinator	<name>	Ext.
<delete or insert more if needed>		

Project Details

1. Project Need & Objective

The Calliope River to Larcom Creek 275kV transmission line includes built section BS1515 from Mt Miller to Larcom Creek, which was commissioned in 1977 and consists of 21 structures being 10 tension towers and 11 suspension towers.

The transmission line is located in Central Queensland immediately adjacent to the Gladstone industrial area. This built section covers the distance between Mt Miller and Larcom Creek via Yarwun. A proportion of the transmission line traverses tidal marine environment and large scale industrial areas and there are a few major and minor road crossings. Due to its proximity to the Gladstone industrial area and the coast it is constantly exposed to high levels of salt laden air and industrial pollutants.

The objective of this project is to undertake refit works to extend the reliable life of built section BS1515 between Mt Miller and Larcom Creek by 30 June 2024.

2. Project Drawing

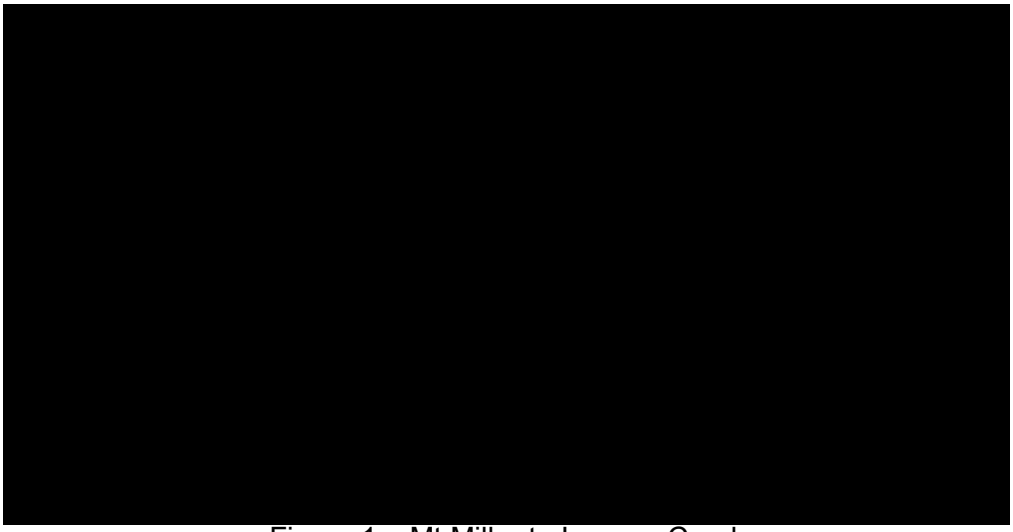


Figure 1 – Mt Miller to Larcom Creek

3. Project Scope

3.1. Original Scope

The following scope presents a functional overview of the desired outcomes of the project. The proposed solution presented in the estimate must be developed with reference to the remaining sections of this Project Scope Report, in particular *Section 5 Special Considerations*.

Briefly, the project consists of selected refit activities along the 11km length of single circuit 275kV transmission line comprising 21 structures.

3.1.1. Transmission Line Works – Built Section 1515

Undertake transmission line refit works on built section 1515 as follows:

- Review and upgrade access track as necessary to enable contractor access and works on the built section – assume 10% of tracks
- Review all tower leg/stub members and encapsulate the concrete to steel interface where corrosion is evident – assume 10% of towers
- Replace all tower nuts and bolts exhibiting grade 3 and grade 4 corrosion – approx. 35% of total
- Replace tower members exhibiting grade 3 or grade 4 corrosion – approx. 1% of total
- Undertake surface preparation and paint all towers per current Powerlink standards – 21 towers from STR-0012 to STR-0032 inclusive
- Replace all step bolts on all towers – 21 towers in total
- Replace all signage and anti-climbing barriers – 21 towers in total
- Replace all tension, beam and bridging insulators on all towers – 21 towers in total (10 tension & 11 suspension)
- Replace all insulator hardware and vibration dampers on all towers – 21 towers in total (10 tension & 11 suspension)
- Undertake earthing tests at all towers, where outside of current test date, and upgrade to current standard including the installation of grading rings where required – assume 5 towers (approx. 25% of towers)
- Update drawing records and SAP records accordingly.

3.1.2. Substation Works

Not applicable

3.1.3. Telecoms Works

Not applicable

3.1.4. Easement/Land Acquisition & Permits Works

Easement rights and approvals must be considered with the Property team.

3.2. Key Scope Assumptions

The following assumptions should be included in the estimating of this scope:

- Assumed quantities are calculated based upon the condition information available at the time of scoping.

4. Project Timing

4.1. Project Approval Date

The anticipated date by which the project will be approved is 2 March 2021.

4.2. Site Access Date

The transmission line is an existing operational asset and as such access is immediately available for the transmission line refit.

4.3. Commissioning Date

The latest date for the commissioning of the new assets included in this scope is 30 June 2024.

5. Special Considerations

Not applicable

6. Asset Management Requirements

Equipment shall be in accordance with Powerlink equipment strategies.

Unless otherwise advised [redacted] will be the Project Sponsor for this project. The Project Sponsor must be included in any discussions with any other areas of Strategy & Business Development.

7. Asset Ownership

The works detailed in this project are Powerlink Queensland assets.

8. System Operation Issues

Operational issues that should be considered as part of the scope and estimate include:

- interaction of project outage plan with other outage requirements;
- likely impact of project outages upon grid support arrangements; and
- likely impact of project outages upon the optical fibre network.

9. Options

Not applicable

10. Division of Responsibilities

A division of responsibilities document will not be required for this project.

11. Related Projects

No related projects.

Concept Estimate for CP.01656 - Calliope River to Larcom Creek 275kV Transmission Line Refit

Record ID	A3345850	
Policy stream	Asset Management	
Authored by	Project Manager	[redacted]
Reviewed by	Team Leader	[redacted]
Approved by	Manager Projects	[redacted]

Table of Contents

1. Executive Summary

The Calliope River to Larcom Creek 275kV transmission line includes Built Section 1515 from Mt Miller to Larcom Creek. The line was commissioned in 1977 and consists of 21 structures, made up of 10 tension towers and 11 suspension towers.

The transmission line is located in Central Queensland immediately adjacent to the Gladstone industrial area. A proportion of the transmission line traverses tidal marine environment and large scale industrial areas and there are a few major and minor road crossings. Due to its proximity to the Gladstone industrial area and the coast it is constantly exposed to high levels of salt laden air and industrial pollutants.

The objective of this project is to undertake refit works to extend the reliable life of built section BS1515 between Mt Miller and Larcom Creek by June 2024.

Figure 1-1: Geographic location of BS1515

1.1 Project Estimate

Estimate Components		Base $	Escalated $
Estimate Class	5		
Estimate Accuracy	+100% / -50%		
Base Estimate		**10,197,795**	**11,291,446**
Mitigated Risk	[redacted]	[redacted]	[redacted]
Contingency Allowance	[redacted]	[redacted]	[redacted]
TOTAL		[redacted]	[redacted]

1.2 Project Financial Year Cash Flows

	June 2020 Base $	Escalated $
To June 2021	1,293,167	1,345,739
To June 2022	3,735,850	4,048,469
To June 2023	3,735,850	4,214,457
To June 2024	1,432,928	1,682,781
TOTAL	**10,197,795**	**11,291,446**

2. Project and Site Specific Information

2.1 Project Dependencies & Interactions

This Concept Estimate provides for the requirements of the Project Scope Report.

The Project Scope Report has identified there are no related projects.

2.2 Site Specific Issues

Issues specific to the project are as follows:

- The general project site is within outer limits of the township of Gladstone. Accommodation, infrastructure and facilities are considered readily available in local townships for construction crews and project staff,
- The line is generally within areas with several existing transmission assets, as well as generation sites,
- The line is free of any mapped UXO, DERM Protected Areas, or World Heritage areas,
- The line does contain areas of mapped Unnamed Essential Habitat,
- There are areas of mapped Class 2 weeds “Bryophyllum delagoense” present on this and adjacent Built Sections,
- The western section of the line traverses somewhat undulating terrain, whilst the eastern section is on flat marine type terrain, with an industrial presence surrounding.

3. Transmission Line Refit Works on Built Section 1515

3.1 Definition

3.1.1 Scope

Briefly, the project consists of selected refit activities along the 11km length of single circuit 275kV transmission line (BS1515) comprising of 21 structures, by means of nut and bolt, hardware, member, and blasting and painting of structures.

3.1.1.1 Substations Works

Not applicable.

3.1.1.2 Transmission Line Works

Scope of works includes the following:

- Review and upgrade access track as necessary to enable contractor access and works on the built section – assume 10% of tracks.
- Review all tower leg/stub members and encapsulate the concrete to steel interface where corrosion is evident – assume 10% of towers, approximately 9 legs.
- Replace all tower nuts and bolts exhibiting grade 3 and grade 4 corrosion – approx. 35% of 38,220 = 13,370 nuts/bolts.
- Replace tower members exhibiting grade 3 or grade 4 corrosion – approx. 1% of 8,790 = 99 members.
- Undertake surface preparation and paint all towers per current Powerlink standards – 21 towers from STR-0012 to STR-0032 inclusive.
- Replace all step bolts on all towers – 21 towers in total 1945 step bolts.
- Replace all signage and anti-climbing barriers – 21 towers in total.
- Replace all tension, beam and bridging insulators on all towers – 21 towers in total (10 tension & 11 suspension).
- Replace all insulator hardware and vibration dampers on all towers – 21 towers in total (10 tension & 11 suspension).
- Undertake earthing tests at all towers, where outside of current test date, and upgrade to current standard including the installation of grading rings where required – approx. 25% of towers, 5 towers.
- Update drawing records and SAP records accordingly.

3.1.1.3 Telecommunication Works

Not applicable.

3.1.1.4 Easement/Land Acquisition & Permit Works

Not applicable.

3.1.2 Major Scope Assumptions

It is assumed that:

- New step bolts to be installed include climbing loops,
- No substantial new clearing or significant new access works required,
- MSP resources, (likely EQ), will be sufficient to undertake that component of the works,
- Suitable outage/s will be available as required, during non-peak load periods, i.e. April – October,
- Access to site will be available at project approval,
- Any existing paints on structures are free of any hazardous materials, i.e. lead, asbestos, etc,
- There will likely be a number of outage cancellations or recalls during delivery,
- The scope of element (nut/bolt and member) replacement will slightly increase during the works,
- Biosecurity issues could occur during delivery, i.e. weeds,
- The estimate allows for items such as delays to the delivery as a result of property owner issues, access constraints, presence of bird nests.

3.1.3 Scope Exclusions

The below is excluded from the scope of works:

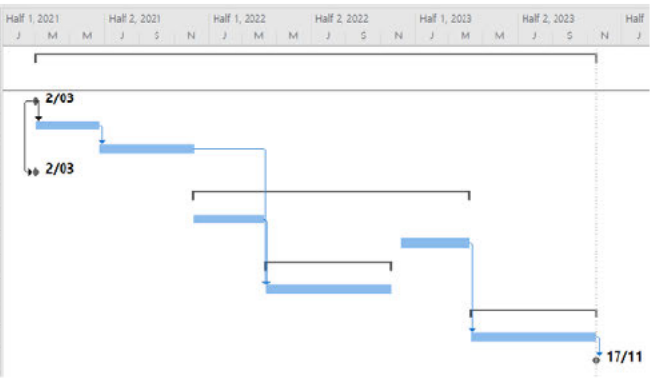
- Any works on structures in Built Section 1514 at Larcom Creek, or Built Section 1560 at Calliope River.

3.2 Project Execution

3.2.1 Project Schedule

High level schedule for the works is as per the below:

Task Name	Duration	Start	Finish
CP.01656 Calliope River to Larcom Creek 275kV Transmission Line Refit	**709 days**	**Tue 2/03/21**	**Fri 17/11/23**
Project Approval	0 days	Tue 2/03/21	Tue 2/03/21
Project Mobilisation, i.e. Scoping, Designs, Landholder Liaison etc	4 mons	Tue 2/03/21	Mon 21/06/21
Project Procurement, MSP and Contractor, inicuding mobilisation	6 mons	Tue 22/06/21	Mon 6/12/21
Site Access Date	0 days	Tue 2/03/21	Tue 2/03/21
Non-Working Periods	**350 days**	**Mon 6/12/21**	**Fri 7/04/23**
2021-2022 Peak Load and Wet Season	4.5 mons	Mon 6/12/21	Fri 8/04/22
2022-2023 Peak Load and Wet Season	4.5 mons	Mon 5/12/22	Fri 7/04/23
Refit Contractor Works	**160 days**	**Mon 11/04/22**	**Fri 18/11/22**
BS1515 (Fdr8859) Structural Refit Works	8 mons	Mon 11/04/22	Fri 18/11/22
MSP (EQ) Works	**160 days**	**Mon 10/04/23**	**Fri 17/11/23**
BS1515 (Fdr8859) Line Hardware Refit Works	8 mons	Mon 10/04/23	Fri 17/11/23
Project Commissioned	0 days	Fri 17/11/23	Fri 17/11/23



The project schedule has considered working during non-peak load periods and outside traditional wet seasons.

3.2.2 Network Impacts

These works will require suitable block outages to Fdr8859 during execution.

3.2.3 Project Staging

There is no specific staging applicable to this project, however, it is preferred to undertake the refit of the structures prior to the MSP component of the works. This approach has been adopted for the development of the high level project schedule.

3.2.4 Resourcing

This project will require the utilisation of both Refit Contractor and MSP resources during execution.

3.3 Project Estimate

Estimate Components		Base $	Escalated $
Estimate Class	5		
Estimate Accuracy	+100% / -50%		
Base Estimate		**10,197,795**	**11,291,446**
Mitigated Risk	[redacted]	[redacted]	[redacted]
Contingency Allowance	[redacted]	[redacted]	[redacted]
TOTAL		[redacted]	[redacted]

3.4 Project Financial Year Cash Flows

	June 2020 Base $	Escalated $
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TOTAL	**10,197,795**	**11,291,446**

3.5 Project Asset Classification

Asset Class	Asset Life	Base $	Percentage
Secondary systems	15 years		
Communications	15 years		
Transmission lines refit	35 years	10,197,795	100%
Primary plant	40 years		
Transmission lines	50 years		
TOTAL		**10,197,795**	

4. References

Document name	Version	Date
Project Scope Report	1.0	30/03/2020